

**Measurement Conditions**

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

<b>DASY Version</b>	DASY5	V52.8.8
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom V5.0	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
<b>Frequency</b>	5200 MHz ± 1 MHz 5250 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz 5800 MHz ± 1 MHz	

**Head TSL parameters at 5200 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	36.0	4.66 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	36.3 ± 6 %	4.56 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

**SAR result with Head TSL at 5200 MHz**

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	7.82 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>78.3 W/kg ± 19.9 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.3 W/kg ± 19.5 % (k=2)</b>

**Head TSL parameters at 5250 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.2 ± 6 %	4.61 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Head TSL at 5250 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.04 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>80.5 W / kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.9 W/kg ± 19.5 % (k=2)</b>

**Head TSL parameters at 5300 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.1 ± 6 %	4.66 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Head TSL at 5300 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>82.8 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.7 W/kg ± 19.5 % (k=2)</b>

**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 ± 0.2) °C	35.9 ± 6 %	4.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Head TSL at 5500 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>82.2 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.3 W/kg ± 19.5 % (k=2)</b>

**Head TSL parameters at 5600 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.6 ± 6 %	4.97 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Head TSL at 5600 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.14 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>81.4 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.1 W/kg ± 19.5 % (k=2)</b>

#### Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.5 ± 6 %	5.14 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

#### SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.88 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>78.8 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.4 W/kg ± 19.5 % (k=2)</b>

#### 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	35.4 ± 6 %	5.18 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.88 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>78.8 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.3 W/kg ± 19.5 % (k=2)</b>

**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	49.4 ± 6 %	5.42 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 <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.41 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>74.3 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>20.8 W/kg ± 19.5 % (k=2)</b>

**Body TSL parameters at 5250 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.3 ± 6 %	5.48 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Body TSL at 5250 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.38 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>74.0 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>20.8 W/kg ± 19.5 % (k=2)</b>

**Body TSL parameters at 5300 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.2 ± 6 %	5.55 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Body TSL at 5300 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.42 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>74.3 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.08 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>20.9 W/kg ± 19.5 % (k=2)</b>

**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	48.9 ± 6 %	5.82 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 <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.87 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>78.9 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.9 W/kg ± 19.5 % (k=2)</b>

**Body TSL parameters at 5600 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.7 ± 6 %	5.96 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Body TSL at 5600 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.72 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>77.4 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.5 W/kg ± 19.5 % (k=2)</b>

**Body TSL parameters at 5750 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.5 ± 6 %	6.18 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Body TSL at 5750 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.37 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>73.9 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.04 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>20.4 W/kg ± 19.5 % (k=2)</b>

**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	48.4 ± 6 %	6.25 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 <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.49 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>75.1 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>20.7 W/kg ± 19.5 % (k=2)</b>



**Appendix (Additional assessments outside the scope of SCS 0108)****Antenna Parameters with Head TSL at 5200 MHz**

Impedance, transformed to feed point	46.3 $\Omega$ - 7.5 j $\Omega$
Return Loss	- 21.2 dB

**Antenna Parameters with Head TSL at 5250 MHz**

Impedance, transformed to feed point	48.5 $\Omega$ - 5.3 j $\Omega$
Return Loss	- 25.1 dB

**Antenna Parameters with Head TSL at 5300 MHz**

Impedance, transformed to feed point	50.6 $\Omega$ - 3.3 j $\Omega$
Return Loss	- 29.6 dB

**Antenna Parameters with Head TSL at 5500 MHz**

Impedance, transformed to feed point	50.0 $\Omega$ - 0.3 j $\Omega$
Return Loss	- 49.9 dB

**Antenna Parameters with Head TSL at 5600 MHz**

Impedance, transformed to feed point	52.4 $\Omega$ - 4.4 j $\Omega$
Return Loss	- 26.2 dB

**Antenna Parameters with Head TSL at 5750 MHz**

Impedance, transformed to feed point	57.2 $\Omega$ + 1.6 j $\Omega$
Return Loss	- 22.6 dB

**Antenna Parameters with Head TSL at 5800 MHz**

Impedance, transformed to feed point	55.7 $\Omega$ - 1.2 j $\Omega$
Return Loss	- 25.2 dB

**Antenna Parameters with Body TSL at 5200 MHz**

Impedance, transformed to feed point	57.5 $\Omega$ + 2.0 j $\Omega$
Return Loss	- 22.8 dB

**Antenna Parameters with Body TSL at 5250 MHz**

Impedance, transformed to feed point	53.8 $\Omega$ + 2.7 j $\Omega$
Return Loss	- 26.9 dB

**Antenna Parameters with Body TSL at 5300 MHz**

Impedance, transformed to feed point	52.2 $\Omega$ + 1.8 j $\Omega$
Return Loss	- 31.2 dB

**Antenna Parameters with Body TSL at 5500 MHz**

Impedance, transformed to feed point	49.6 $\Omega$ + 0.2 j $\Omega$
Return Loss	- 47.1 dB

**Antenna Parameters with Body TSL at 5600 MHz**

Impedance, transformed to feed point	51.4 $\Omega$ + 4.1 j $\Omega$
Return Loss	- 27.4 dB

**Antenna Parameters with Body TSL at 5750 MHz**

Impedance, transformed to feed point	49.1 $\Omega$ + 7.3 j $\Omega$
Return Loss	- 22.6 dB

**Antenna Parameters with Body TSL at 5800 MHz**

Impedance, transformed to feed point	48.5 $\Omega$ + 7.0 j $\Omega$
Return Loss	- 22.7 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.192 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	February 05, 2004

**DASY5 Validation Report for Head TSL**

Date: 12.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1020**

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5250 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5800 MHz  
 Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.56$  S/m;  $\epsilon_r = 36.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.61$  S/m;  $\epsilon_r = 36.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5300$  MHz;  $\sigma = 4.66$  S/m;  $\epsilon_r = 36.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.86$  S/m;  $\epsilon_r = 35.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.97$  S/m;  $\epsilon_r = 35.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.14$  S/m;  $\epsilon_r = 35.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.18$  S/m;  $\epsilon_r = 35.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

## DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.51, 5.51, 5.51); Calibrated: 30.12.2014, ConvF(5.45, 5.45, 5.45); Calibrated: 30.12.2014, ConvF(5.21, 5.21, 5.21); Calibrated: 30.12.2014, ConvF(5.12, 5.12, 5.12); Calibrated: 30.12.2014, ConvF(4.92, 4.92, 4.92); Calibrated: 30.12.2014, ConvF(4.91, 4.91, 4.91); Calibrated: 30.12.2014, ConvF(4.9, 4.9, 4.9); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**Dipole Calibration for Head Tissue/Pin=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 = 65.15 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 28.5 W/kg

SAR(1 g) = 7.82 W/kg; SAR(10 g) = 2.23 W/kg

Maximum value of SAR (measured) = 17.5 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan,**

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 65.64 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 29.7 W/kg

SAR(1 g) = 8.04 W/kg; SAR(10 g) = 2.29 W/kg

Maximum value of SAR (measured) = 18.0 W/kg

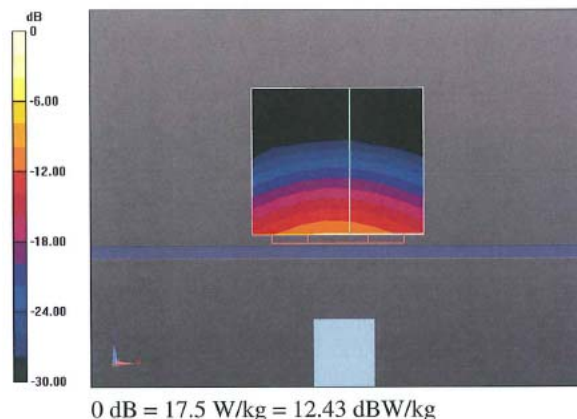
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
 Reference Value = 65.95 V/m; Power Drift = 0.03 dB  
 Peak SAR (extrapolated) = 31.3 W/kg  
**SAR(1 g) = 8.28 W/kg; SAR(10 g) = 2.37 W/kg**  
 Maximum value of SAR (measured) = 18.9 W/kg

**Dipole Calibration for Head Tissue/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 = 64.55 V/m; Power Drift = 0.04 dB  
 Peak SAR (extrapolated) = 32.6 W/kg  
**SAR(1 g) = 8.22 W/kg; SAR(10 g) = 2.33 W/kg**  
 Maximum value of SAR (measured) = 19.1 W/kg

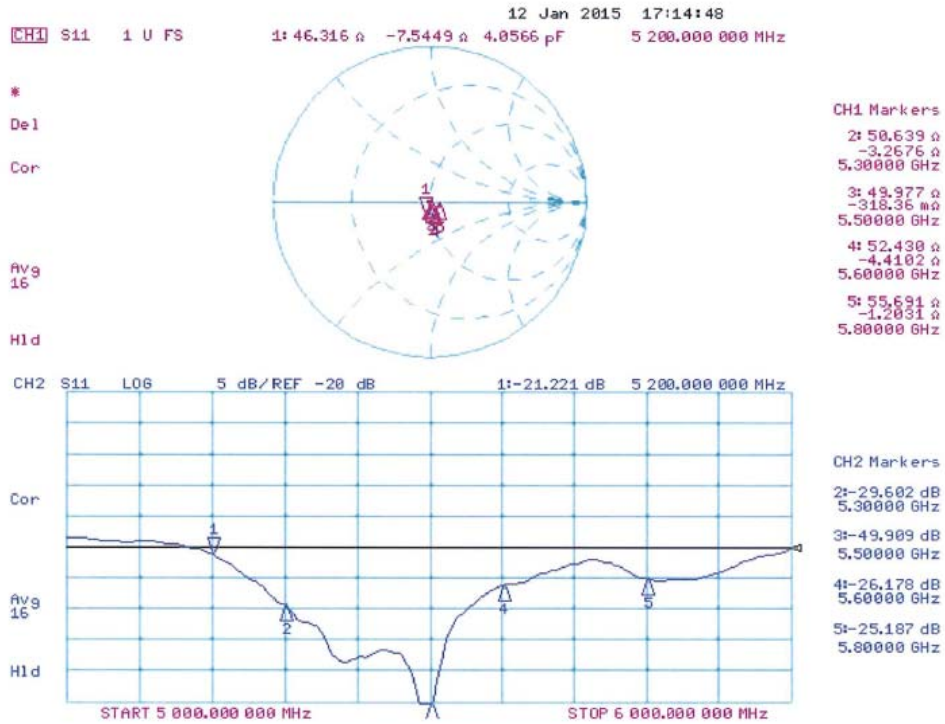
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
 Reference Value = 64.09 V/m; Power Drift = 0.02 dB  
 Peak SAR (extrapolated) = 32.4 W/kg  
**SAR(1 g) = 8.14 W/kg; SAR(10 g) = 2.31 W/kg**  
 Maximum value of SAR (measured) = 19.0 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
 Reference Value = 62.15 V/m; Power Drift = 0.02 dB  
 Peak SAR (extrapolated) = 32.3 W/kg  
**SAR(1 g) = 7.88 W/kg; SAR(10 g) = 2.24 W/kg**  
 Maximum value of SAR (measured) = 18.7 W/kg

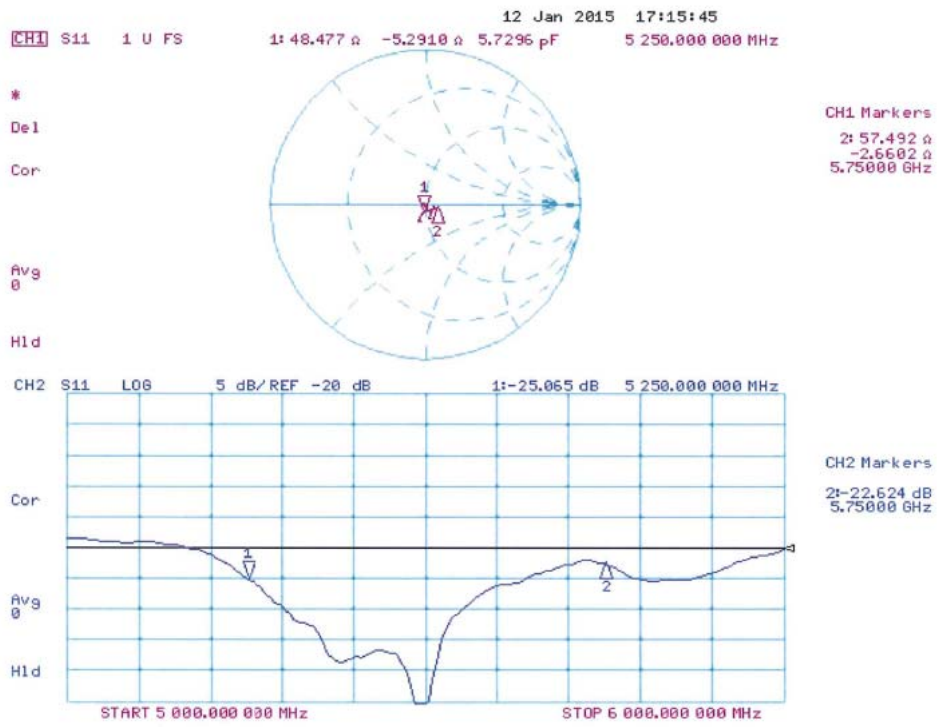
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
 Reference Value = 61.99 V/m; Power Drift = 0.02 dB  
 Peak SAR (extrapolated) = 32.8 W/kg  
**SAR(1 g) = 7.88 W/kg; SAR(10 g) = 2.23 W/kg**  
 Maximum value of SAR (measured) = 18.8 W/kg



Impedance Measurement Plot for Head TSL



Impedance Measurement Plot for Head TSL (5250, 5750)



**DASY5 Validation Report for Body TSL**

Date: 13.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1020**

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5250 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5800 MHz  
 Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.42$  S/m;  $\epsilon_r = 49.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.48$  S/m;  $\epsilon_r = 49.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5300$  MHz;  $\sigma = 5.55$  S/m;  $\epsilon_r = 49.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.82$  S/m;  $\epsilon_r = 48.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.96$  S/m;  $\epsilon_r = 48.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5750$  MHz;  $\sigma = 6.18$  S/m;  $\epsilon_r = 48.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.25$  S/m;  $\epsilon_r = 48.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

## DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.95, 4.95, 4.95); Calibrated: 30.12.2014, ConvF(4.9, 4.9, 4.9); Calibrated: 30.12.2014, ConvF(4.78, 4.78, 4.78); Calibrated: 30.12.2014, ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2014, ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2014, ConvF(4.32, 4.32, 4.32); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**Dipole Calibration for Body Tissue/Pin=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 = 57.93 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 29.2 W/kg

**SAR(1 g) = 7.41 W/kg; SAR(10 g) = 2.07 W/kg**

Maximum value of SAR (measured) = 17.1 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:**

Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 57.81 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 29.3 W/kg

**SAR(1 g) = 7.38 W/kg; SAR(10 g) = 2.07 W/kg**

Maximum value of SAR (measured) = 17.2 W/kg

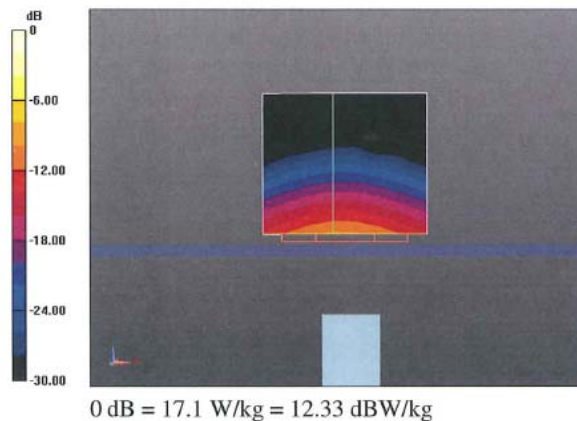
**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 57.53 V/m; Power Drift = 0.06 dB  
Peak SAR (extrapolated) = 29.9 W/kg  
**SAR(1 g) = 7.42 W/kg; SAR(10 g) = 2.08 W/kg**  
Maximum value of SAR (measured) = 17.3 W/kg

**Dipole Calibration for Body Tissue/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 = 58.06 V/m; Power Drift = 0.05 dB  
Peak SAR (extrapolated) = 33.8 W/kg  
**SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.18 W/kg**  
Maximum value of SAR (measured) = 18.8 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 56.90 V/m; Power Drift = 0.03 dB  
Peak SAR (extrapolated) = 34.3 W/kg  
**SAR(1 g) = 7.72 W/kg; SAR(10 g) = 2.14 W/kg**

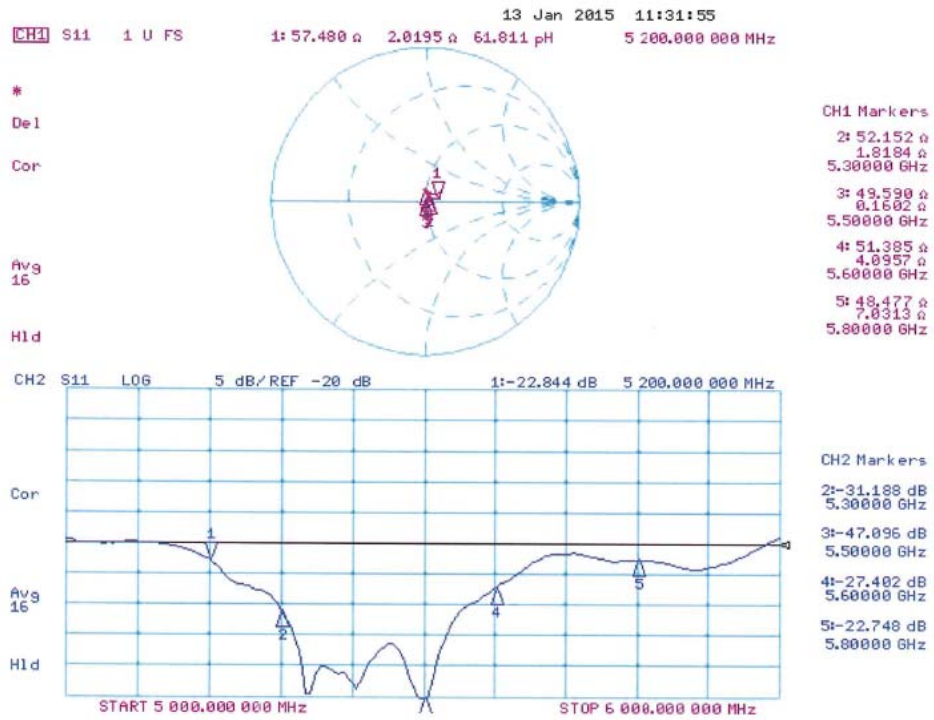
**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 54.78 V/m; Power Drift = 0.03 dB  
Peak SAR (extrapolated) = 34.1 W/kg  
**SAR(1 g) = 7.37 W/kg; SAR(10 g) = 2.04 W/kg**  
Maximum value of SAR (measured) = 18.0 W/kg

**Dipole Calibration for Body Tissue/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 = 55.43 V/m; Power Drift = 0.03 dB  
Peak SAR (extrapolated) = 35.0 W/kg  
**SAR(1 g) = 7.49 W/kg; SAR(10 g) = 2.07 W/kg**  
Maximum value of SAR (measured) = 18.5 W/kg

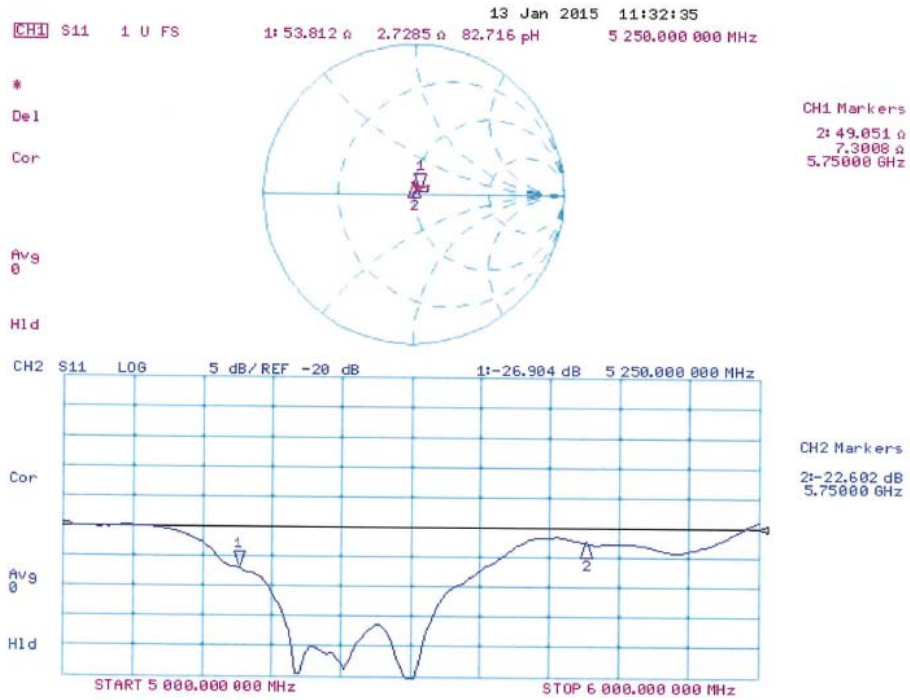




Impedance Measurement Plot for Body TSL (5200, 5300, 5500, 5600, 5800)



Impedance Measurement Plot for Body TSL (5250, 5750)



## 6. System check uncertainty

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

### Repeatability Budget for System Check

<0.3 – 3GHz range Body>

Error Description	Uncertainty value $\pm$ %	Probability distribution	divisor	(ci) 1g	Standard (1g)	vi or veff
<b>Measurement System</b>						
Probe calibration	$\pm 1.8$	Normal	1	1	$\pm 1.8$	$\infty$
Axial isotropy of the probe	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Spherical isotropy of the probe	$\pm 0.0$	Rectangular	$\sqrt{3}$	0	$\pm 0.0$	$\infty$
Boundary effects	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Probe linearity	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Detection limit	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Modulation response	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Readout electronics	$\pm 0.0$	Normal	1	1	$\pm 0.0$	$\infty$
Response time	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Integration time	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
RF ambient Noise	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
RF ambient	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Probe Positioner	$\pm 0.4$	Rectangular	$\sqrt{3}$	1	$\pm 0.2$	$\infty$
Probe positioning	$\pm 2.9$	Rectangular	$\sqrt{3}$	1	$\pm 1.7$	$\infty$
Max.SAR Eval.	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
<b>Test Sample Related</b>						
Deviation of	$\pm 0.0$	Normal	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Dipole Axis to Liquid Distance	$\pm 2.0$	Normal	$\sqrt{3}$	1	$\pm 1.2$	$\infty$
Input power and SAR drift meas.	$\pm 3.4$	Rectangular	$\sqrt{3}$	1	$\pm 2.0$	$\infty$
<b>Phantom and Setup</b>						
Phantom uncertainty	$\pm 4.0$	Rectangular	$\sqrt{3}$	1	$\pm 2.3$	$\infty$
Algorithm for correcting SAR for deviations in permittivity and conductivity	$\pm 1.9$	Normal	1	1	$\pm 1.9$	$\infty$
Liquid conductivity (meas.)	$\pm 5.0$	Rectangular	1	0.78	+ 3.9	$\infty$
Liquid permittivity (meas.)	$\pm 5.0$	Rectangular	1	0.26	- 1.3	$\infty$
Liquid conductivity - temp.unc (below 2deg.C.)	$\pm 1.7$	Rectangular	$\sqrt{3}$	0.78	$\pm 0.8$	$\infty$
Liquid permittivity - temp.unc (below 2deg.C.)	$\pm 0.3$	Rectangular	$\sqrt{3}$	0.23	$\pm 0.0$	$\infty$
<b>Combined Standard Uncertainty</b>					<b><math>\pm 6.144</math></b>	
<b>Expanded Uncertainty (k=2)</b>					<b><math>\pm 12.3</math></b>	

UL Japan, Inc.

Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8999

Facsimile: +81 596 24 8124

**Repeatability Budget for System Check**

&lt;3 – 6GHz range Body&gt;

Error Description	Uncertainty value $\pm$ %	Probability distribution	divisor	(ci) 1g	Standard (1g)	vi or veff
<b>Measurement System</b>						
Probe calibration	$\pm 1.8$	Normal	1	1	$\pm 1.8$	$\infty$
Axial isotropy of the probe	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Spherical isotropy of the probe	$\pm 0.0$	Rectangular	$\sqrt{3}$	0	$\pm 0.0$	$\infty$
Boundary effects	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Probe linearity	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Detection limit	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Modulation response	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Readout electronics	$\pm 0.0$	Normal	1	1	$\pm 0.0$	$\infty$
Response time	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Integration time	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
RF ambient Noise	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
RF ambient	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Probe Positioner	$\pm 0.8$	Rectangular	$\sqrt{3}$	1	$\pm 0.5$	$\infty$
Probe positioning	$\pm 6.7$	Rectangular	$\sqrt{3}$	1	$\pm 3.9$	$\infty$
Max.SAR Eval.	$\pm 0.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
<b>Test Sample Related</b>						
Deviation of	$\pm 0.0$	Normal	$\sqrt{3}$	1	$\pm 0.0$	$\infty$
Dipole Axis to Liquid Distance	$\pm 2.0$	Normal	$\sqrt{3}$	1	$\pm 1.2$	$\infty$
Input power and SAR drift meas.	$\pm 3.4$	Rectangular	$\sqrt{3}$	1	$\pm 2.0$	$\infty$
<b>Phantom and Setup</b>						
Phantom uncertainty	$\pm 4.0$	Rectangular	$\sqrt{3}$	1	$\pm 2.3$	$\infty$
Algorithm for correcting SAR for deviations in permittivity and conductivity	$\pm 1.9$	Normal	1	1	$\pm 1.9$	$\infty$
Liquid conductivity (meas.)	$\pm 5.0$	Rectangular	1	0.78	+ 3.9	$\infty$
Liquid permittivity (meas.)	$\pm 5.0$	Rectangular	1	0.26	- 1.3	$\infty$
Liquid conductivity - temp.unc (below 2deg.C.)	$\pm 1.7$	Rectangular	$\sqrt{3}$	0.78	$\pm 0.8$	$\infty$
Liquid permittivity - temp.unc (below 2deg.C.)	$\pm 0.3$	Rectangular	$\sqrt{3}$	0.23	$\pm 0.0$	$\infty$
<b>Combined Standard Uncertainty</b>					<b><math>\pm 7.078</math></b>	
<b>Expanded Uncertainty (k=2)</b>					<b><math>\pm 14.2</math></b>	

**UL Japan, Inc.****Ise EMC Lab.**

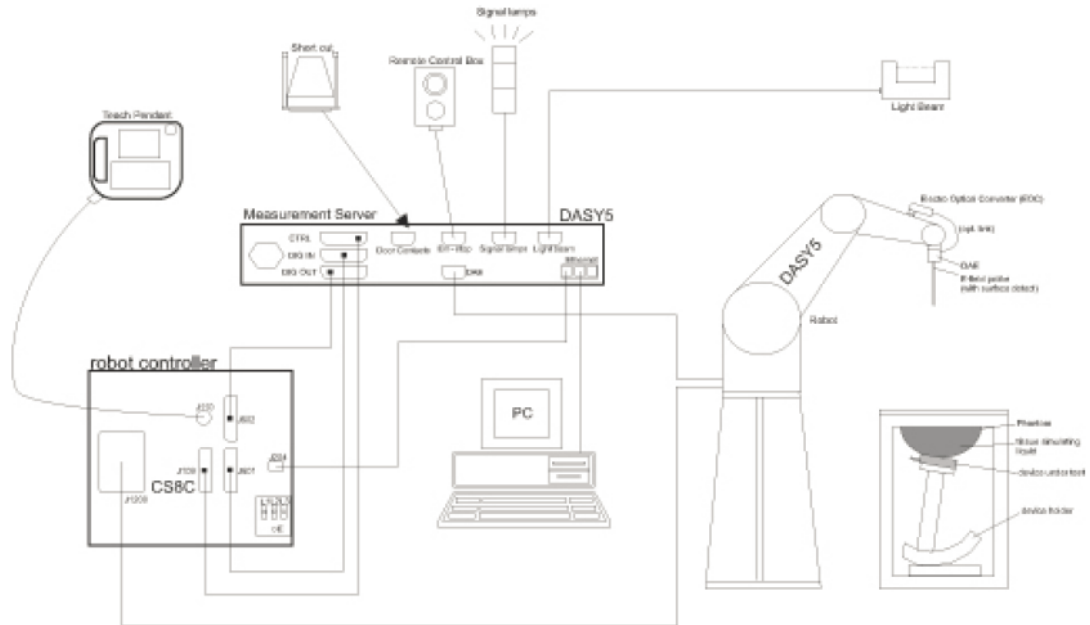
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8999

Facsimile: +81 596 24 8124

## APPENDIX 3 : System specifications

### 1. Configuration and peripherals



The DASY5 system for performing compliance tests consist of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller and software.  
An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronic (DAE), which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection.  
The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## 2. Specifications

### a) Robot TX60L

Number of Axes	:	6
Nominal Load	:	2 kg
Maximum Load	:	5kg
Reach	:	920mm
Repeatability	:	+/-0.03mm
Control Unit	:	CS8c
Programming Language	:	VAL3
Weight	:	52.2kg
Manufacture	:	Stäubli Robotics

### b) E-Field Probe

Model	:	EX3DV4
Serial No.	:	3825, 3745
Construction	:	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycol ether)
Frequency	:	10 MHz to > 6 GHz Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)
Directivity	:	+/-0.3 dB in HSL (rotation around probe axis) +/-0.5 dB in tissue material (rotation normal probe axis)
Dynamic Range	:	10uW/g to > 100 mW/g; Linearity +/-0.2 dB(noise: typically < 1uW/g)
Dimensions	:	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm
Application	:	Highprecision dosimetric measurement in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6GHz with precision of better 30%.
Manufacture	:	Schmid & Partner Engineering AG



**EX3DV4 E-field Probe**

**c)Data Acquisition Electronic (DAE4)**

<b>Features</b>	:	Signal amplifier, multiplexer, A/D converter and control logic Serial optical link for communication with DASY5 embedded system (fully remote controlled) Two step probe touch detector for mechanical surface detection and emergency robot stop
<b>Measurement Range</b>	:	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
<b>Input Offset voltage</b>	:	< 5 $\mu$ V (with auto zero)
<b>Input Resistance</b>	:	200 M $\Omega$
<b>Input Bias Current</b>	:	< 50 fA
<b>Battery Power</b>	:	> 10 h of operation (with two 9.6 V NiMH accus)
<b>Dimension</b>	:	60 x 60 x 68 mm
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

**d)Electro-Optic Converter (EOC)**

<b>Version</b>	:	EOC 61
<b>Description</b>	:	for TX60 robot arm, including proximity sensor
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

**e)DASY5 Measurement server**

<b>Features</b>	:	Intel ULV Celeron 400MHz 128MB chip disk and 128MB RAM 16 Bit A/D converter for surface detection system Vacuum Fluorescent Display Robot Interface Serial link to DAE (with watchdog supervision) Door contact port (Possibility to connect a light curtain) Emergency stop port (to connect the remote control) Signal lamps port Light beam port Three Ethernet connection ports Two USB 2.0 Ports Two serial links Expansion port for future applications
<b>Dimensions (L x W x H)</b>	:	440 x 241 x 89 mm
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

**f) Light Beam Switches**

<b>Version</b>	:	LB5
<b>Dimensions (L x H)</b>	:	110 x 80 mm
<b>Thickness</b>	:	12 mm
<b>Beam-length</b>	:	80 mm
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

**g)Software**

<b>Item</b>	:	Dosimetric Assessment System DASY5
<b>Type No.</b>	:	SD 000 401A, SD 000 402A
<b>Software version No.</b>	:	DASY52, Version 52.6 (1)
<b>Manufacture / Origin</b>	:	Schmid & Partner Engineering AG

**h)Robot Control Unit**

<b>Weight</b>	:	70 Kg
<b>AC Input Voltage</b>	:	selectable
<b>Manufacturer</b>	:	Stäubli Robotics

UL Japan, Inc.

Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone: +81 596 24 8999

Facsimile: +81 596 24 8124

**i)Phantom and Device Holder****Phantom**

<b>Type</b>	:	SAM Twin Phantom V4.0
<b>Description</b>	:	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.
<b>Material</b>	:	Vinylester, glass fiber reinforced (VE-GF)
<b>Shell Material</b>	:	Fiberglass
<b>Thickness</b>	:	2.0 +/-0.2 mm
<b>Dimensions</b>	:	Length: 1000 mm Width: 500 mm Height: adjustable feet
<b>Volume</b>	:	Approx. 25 liters
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

<b>Type</b>	:	2mm Flat phantom ERI4.0
<b>Description</b>	:	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is supported by software version DASY4.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles.
<b>Material</b>	:	Vinylester, glass fiber reinforced (VE-GF)
<b>Shell Thickness</b>	:	2.0 ± 0.2 mm (sagging: <1%)
<b>Filling Volume</b>	:	approx. 30 liters
<b>Dimensions</b>	:	Major ellipse axis: 600 mm Minor axis: 400 mm
<b>Manufacture</b>	:	Schmid & Partner Engineering AG

**Device Holder**

In combination with the Twin SAM Phantom V4.0/V4.0c or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).

<b>Material</b>	:	POM
-----------------	---	-----

**Laptio Extensions kit**

Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM, ELI4 Phantoms.

<b>Material</b>	:	POM, Acrylic glass, Foam
-----------------	---	--------------------------

**Urethane**

For this measurement, the urethane foam was used as device holder.



**j) Simulated Tissues (Liquid)**

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Mixture (%)	Frequency (MHz)									
	450		900		1800		1950		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.91	46.21	40.29	50.75	55.24	70.17	55.41	69.79	55.0	68.64
Sugar	56.93	51.17	57.90	48.21	-	-	-	-	-	-
Cellulose	0.25	0.18	0.24	0.00	-	-	-	-	-	-
Salt (NaCl)	3.79	2.34	1.38	0.94	0.31	0.39	0.08	0.2	-	-
Preventol	0.12	0.08	0.18	0.10	-	-	-	-	-	-
DGMBE	-	-	-	-	44.45	29.44	44.51	30.0	45.0	31.37
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Note: DGMBE (Diethylenglycol-monobutyl ether)

The simulated tissue (liquid) of 1800MHz was used for the test frequency of 1700MHz to 1800MHz.

Mixture (%)	Frequency (MHz)	
	650&750	1450
Tissue Type	Head and Body	Head and Body
Water	35-58%	52-75%
Sugar	40-60%	-
Cellulose	<0.3%	-
Salt (NaCl)	0-6%	<1%
Preventol	0.1-0.7%	-
DGMBE	-	25-48%

Mixture (%)	Frequency (MHz)	
	5800	
Tissue Type	Head	Body
Water	64.0	78.0
Mineral Oil	18.0	11.0
Emulsifiers	15.0	9.0
Additives and salt	3.0	2.0

3. Dosimetric E-Field Probe Calibration (EX3DV4, S/N: 3825)

Calibration Laboratory of  
Schmid & Partner  
Engineering AG  
Zeughausstrasse 43, 8094 Zurich, Switzerland



S Schweizerischer Kalibrierdienst  
S 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 (Vitec)**

Certificate No: EX3-3825\_Dec14

**CALIBRATION CERTIFICATE**

Object **EX3DV4 - SN:3825**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6  
Calibration procedure for dosimetric E-field probes**

Calibration date: **December 16, 2014**

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&E critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293674	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 789	30-Apr-14 (No. DAE4-789_Apr14)	Apr-15
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8948C	US3642U01700	4-Aug-09 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Israa El-Nacouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: December 16, 2014

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
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\theta$	$\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

#### 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

#### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>: Assessed for E-field polarization  $\theta = 0$  ( $f \leq 800$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

EX3DV4 - SN:3825

December 16, 2014

# Probe EX3DV4

## SN:3825

Manufactured: September 6, 2011  
Calibrated: December 16, 2014

Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

EX3DV4- SN:3625

December 16, 2014

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3825****Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm. [ $\mu\text{V}/(\text{V}/\text{m})^2$ ] <sup>a</sup>	0.44	0.39	0.43	$\pm 10.1\%$
DCP (mV) <sup>b</sup>	98.6	102.9	98.8	

**Modulation Calibration Parameters**

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>c</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	146.0	$\pm 2.7\%$
		Y	0.0	0.0	1.0		141.5	
		Z	0.0	0.0	1.0		129.3	

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%.

<sup>a</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).

<sup>b</sup> Numerical linearization parameter: uncertainty not required.

<sup>c</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4- SN:3825

December 16, 2014

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3825****Calibration Parameter Determined in Head Tissue Simulating Media**

f (MHz) <sup>c</sup>	Relative Permittivity <sup>f</sup>	Conductivity (S/m) <sup>f</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>g</sup>	Depth (mm) <sup>h</sup>	Unct. (k=2)
750	41.9	0.89	10.10	10.10	10.10	0.35	0.87	± 12.0 %
835	41.5	0.90	9.77	9.77	9.77	0.25	1.04	± 12.0 %
900	41.5	0.97	9.59	9.59	9.59	0.37	0.79	± 12.0 %
1750	40.1	1.37	8.46	8.46	8.46	0.73	0.62	± 12.0 %
1810	40.0	1.40	8.08	8.08	8.08	0.28	1.05	± 12.0 %
1900	40.0	1.40	7.95	7.95	7.95	0.65	0.65	± 12.0 %
1950	40.0	1.40	7.59	7.59	7.59	0.49	0.70	± 12.0 %
2000	40.0	1.40	7.75	7.75	7.75	0.38	0.87	± 12.0 %
2450	39.2	1.80	7.06	7.06	7.06	0.27	1.11	± 12.0 %
2600	39.0	1.98	6.87	6.87	6.87	0.38	0.88	± 12.0 %
5200	36.0	4.68	5.14	5.14	5.14	0.30	1.80	± 13.1 %
5300	35.9	4.76	4.95	4.95	4.95	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.73	4.73	4.73	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.66	4.66	4.66	0.35	1.80	± 13.1 %
5750	35.4	5.22	4.73	4.73	4.73	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.50	4.50	4.50	0.40	1.80	± 13.1 %

<sup>c</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 21) 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, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>f</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>g</sup> Alpha/Depth are determined during calibration. SPEAG 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.

EX3DV4- SN:3825

December 16, 2014

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3825****Calibration Parameter Determined in Body Tissue Simulating Media**

f (MHz) <sup>c</sup>	Relative Permittivity <sup>f</sup>	Conductivity (S/m) <sup>f</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>g</sup>	Depth <sup>g</sup> (mm)	Unct. (k=2)
750	55.5	0.96	9.60	9.60	9.60	0.49	0.79	± 12.0 %
835	55.2	0.97	9.49	9.49	9.49	0.26	1.11	± 12.0 %
900	55.0	1.05	9.27	9.27	9.27	0.60	0.70	± 12.0 %
1750	53.4	1.49	7.94	7.94	7.94	0.39	0.81	± 12.0 %
1810	53.3	1.52	7.77	7.77	7.77	0.41	0.80	± 12.0 %
1900	53.3	1.52	7.62	7.62	7.62	0.67	0.63	± 12.0 %
1950	53.3	1.52	7.82	7.82	7.82	0.66	0.62	± 12.0 %
2000	53.3	1.52	7.72	7.72	7.72	0.54	0.71	± 12.0 %
2450	52.7	1.95	7.21	7.21	7.21	0.76	0.54	± 12.0 %
2600	52.5	2.16	6.97	6.97	6.97	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.46	4.46	4.46	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.24	4.24	4.24	0.45	1.90	± 13.1 %
5500	48.6	5.65	3.98	3.98	3.98	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.96	3.96	3.96	0.45	1.90	± 13.1 %
5750	48.3	5.94	4.15	4.15	4.15	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.02	4.02	4.02	0.50	1.90	± 13.1 %

<sup>c</sup> 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<sup>f</sup> uncertainty of 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<sup>f</sup> assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

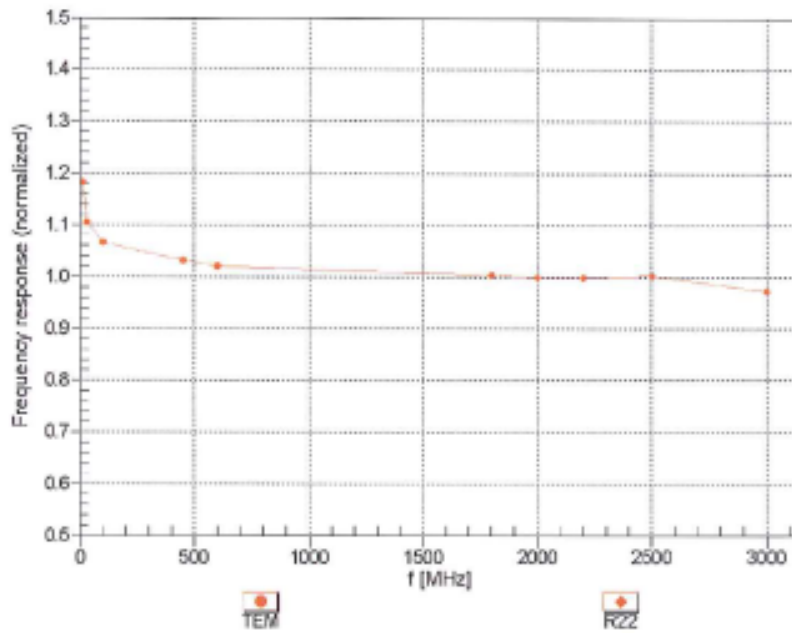
<sup>f</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF<sup>f</sup> uncertainty for indicated target tissue parameters.

<sup>g</sup> Alpha/Depth are determined during calibration. SPEAG 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.

EX30V4- SN:3825

December 16, 2014

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



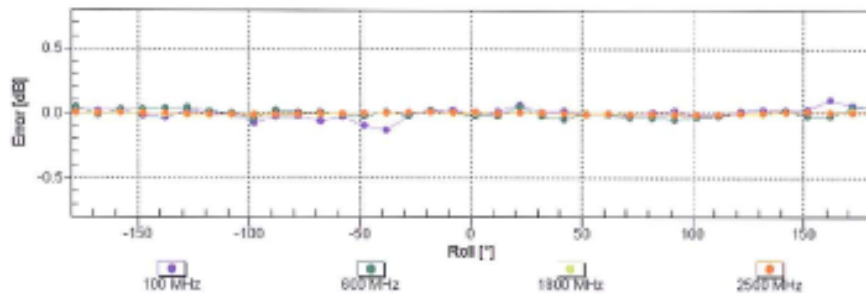
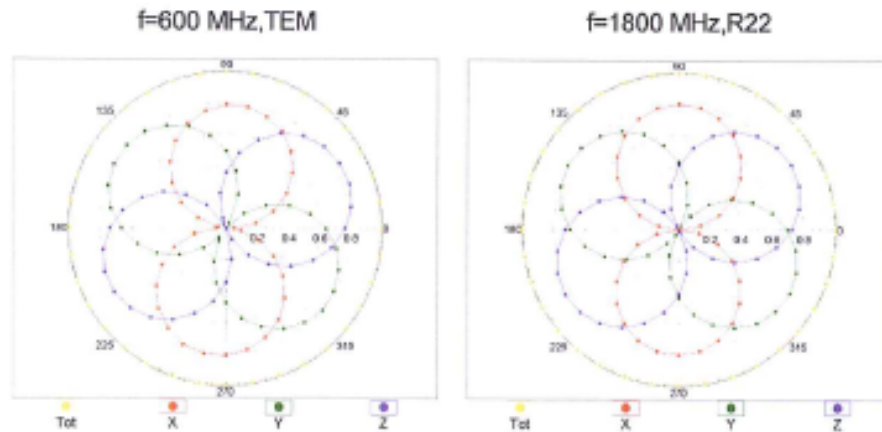
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)



EX3DV4- SN:3825

December 16, 2014

### Receiving Pattern ( $\phi$ ), $\theta = 0^\circ$

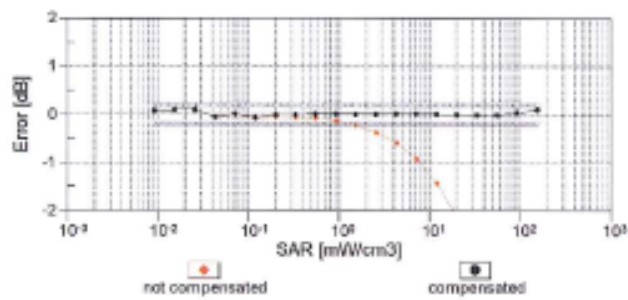
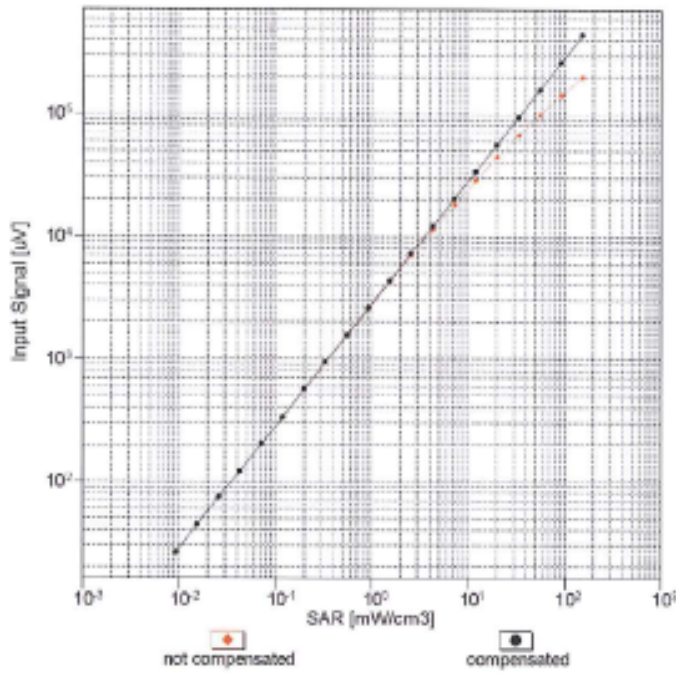


Uncertainty of Axial Isotropy Assessment:  $\pm 0.6\%$  (k=2)

EX3DV4- SN:3825

December 16, 2014

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



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