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Accreditation No.: **SCS 108**

Client **CCS**

Certificate No: **D5GHz-1003\_Aug11**

**CALIBRATION CERTIFICATE**

Object **D5GHzV2 - SN: 1003**

Calibration procedure(s) **QA CAL-22.v1  
Calibration procedure for dipole validation kits between 3-6 GHz**


Calibration date: **August 23, 2011**


This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	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)	29-Mar-11 (No. 217-01368)	Apr-12
Type-N mismatch combination	SN: 5047.2 / 06327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe EX3DV4	SN: 3503	04-Mar-11 (No. EX3-3503_Mar11)	Mar-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-09)	In house check: Oct-11
RF generator R&S SMT-06	100005	04-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

Calibrated by: **Claudio Leubler** (Name) **Laboratory Technician** (Function)  (Signature)

Approved by: **Katja Pokovic** (Name) **Technical Manager** (Function)  (Signature)

Issued: August 23, 2011

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



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### Glossary:

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

### Calibration is Performed According to the Following Standards:

- 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
- 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
- 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:

- 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.

## Measurement Conditions

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

<b>DASY Version</b>	DASY5	V52.6.2
<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 5500 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	35.7 ± 6 %	4.49 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	7.65 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>76.3 mW / g ± 17.0 % (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	2.18 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>21.7 mW / g ± 16.5 % (k=2)</b>

## Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	35.6	4.96 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	35.3 ± 6 %	4.79 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL at 5500 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	8.09 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>80.7 mW / g ± 17.0 % (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	2.31 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.0 mW / g ± 16.5 % (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	34.8 ± 6 %	5.09 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	7.63 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>76.0 mW / g ± 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.17 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>21.6 mW / g ± 16.5 % (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	48.8 ± 6 %	5.45 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	7.45 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>74.4 mW / g ± 18.1 % (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 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>20.8 mW / g ± 17.6 % (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	48.3 ± 6 %	5.86 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	8.00 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>79.9 mW / g ± 18.1 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.23 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>22.3 mW / g ± 17.6 % (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	47.7 ± 6 %	6.27 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	7.63 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>76.2 mW / g ± 18.1 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.12 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.2 mW / g ± 17.6 % (k=2)</b>

## Appendix

### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	49.4 $\Omega$ - 9.0 j $\Omega$
Return Loss	- 20.8 dB

### Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	53.8 $\Omega$ - 2.2 j $\Omega$
Return Loss	- 27.4 dB

### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	57.2 $\Omega$ - 0.9 j $\Omega$
Return Loss	- 23.4 dB

### Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	50.0 $\Omega$ - 6.6 j $\Omega$
Return Loss	- 23.6 dB

### Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	53.8 $\Omega$ + 0.7 j $\Omega$
Return Loss	- 28.7 dB

### Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	59.6 $\Omega$ + 1.0 j $\Omega$
Return Loss	- 21.1 dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	1.155 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	July 08, 2003

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN: 1003

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.49$  mho/m;  $\epsilon_r = 35.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.79$  mho/m;  $\epsilon_r = 35.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.09$  mho/m;  $\epsilon_r = 34.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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: 04.03.2011
- 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 52.6.2(482); SEMCAD X 14.4.5(3634)

### 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 = 64.470 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 28.295 W/kg

**SAR(1 g) = 7.65 mW/g; SAR(10 g) = 2.18 mW/g**

Maximum value of SAR (measured) = 17.134 mW/g

### 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 = 64.593 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 31.928 W/kg

**SAR(1 g) = 8.09 mW/g; SAR(10 g) = 2.31 mW/g**

Maximum value of SAR (measured) = 18.661 mW/g

### 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

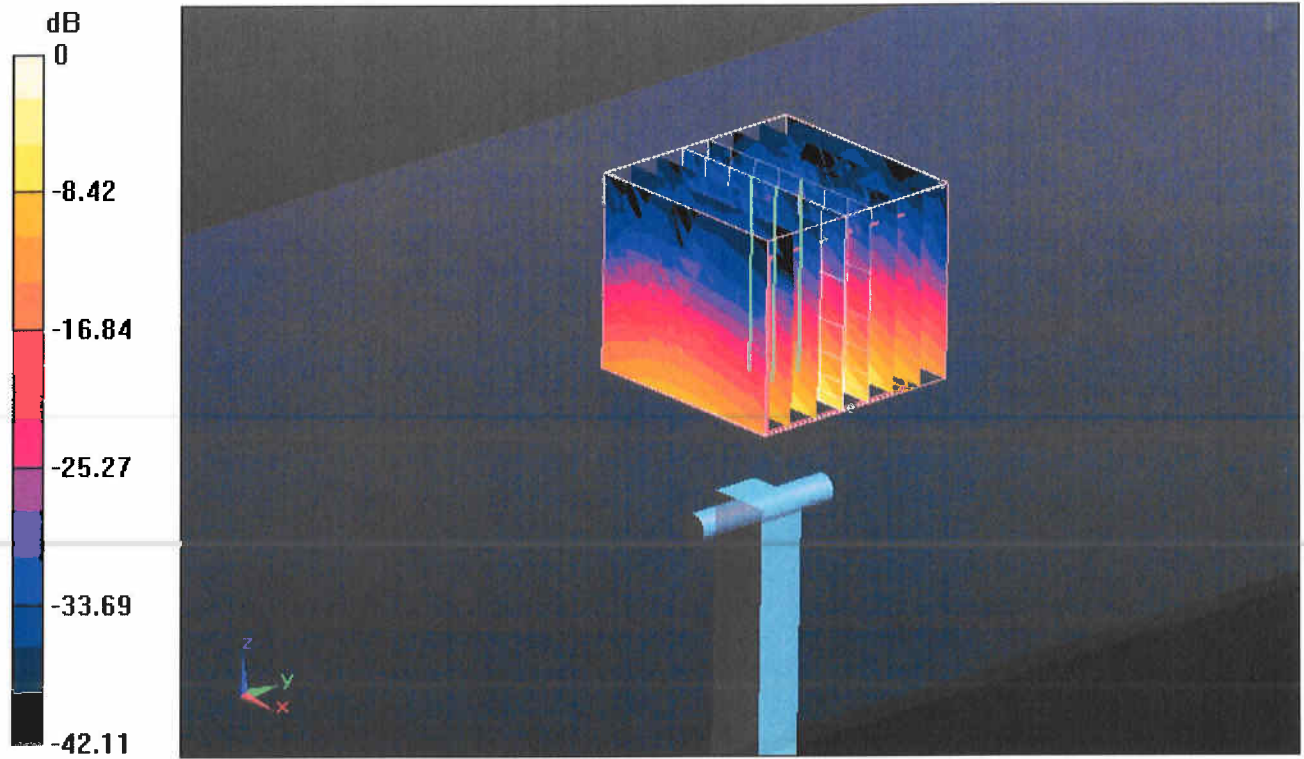
Reference Value = 60.992 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 31.719 W/kg

**SAR(1 g) = 7.63 mW/g; SAR(10 g) = 2.17 mW/g**

Maximum value of SAR (measured) = 18.017 mW/g





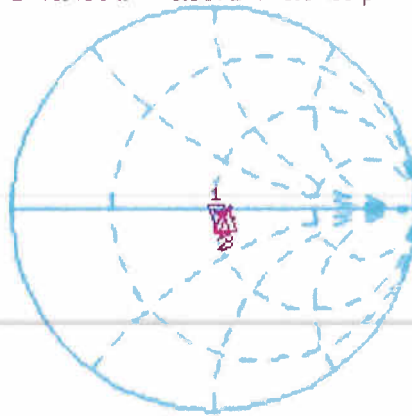
0 dB = 18.020mW/g

# Impedance Measurement Plot for Head TSL

22 Aug 2011 11:35:53

CH1 S11 1 U FS 1: 49.400  $\Omega$  -9.0371  $\Omega$  3.3868 pF 5 200.000 000 MHz

\*  
De1  
CA



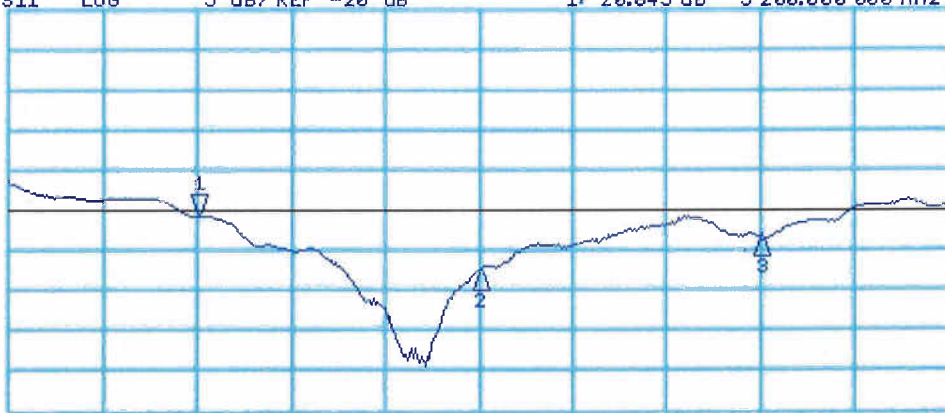
CH1 Markers  
2: 53.826  $\Omega$   
-2.2129  $\Omega$   
5.50000 GHz  
3: 57.209  $\Omega$   
-927.73 m $\Omega$   
5.80000 GHz

Avg  
16

H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-20.845 dB 5 200.000 000 MHz

CA



CH2 Markers  
2:-27.407 dB  
5.50000 GHz  
3:-23.375 dB  
5.80000 GHz

Avg  
16

H1d

START 5 000.000 000 MHz

STOP 6 000.000 000 MHz

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN: 1003**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.45$  mho/m;  $\epsilon_r = 48.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.86$  mho/m;  $\epsilon_r = 48.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.27$  mho/m;  $\epsilon_r = 47.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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: 04.03.2011
- 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 52.6.2(482); SEMCAD X 14.4.5(3634)

**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 = 58.277 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 28.968 W/kg

**SAR(1 g) = 7.45 mW/g; SAR(10 g) = 2.08 mW/g**

Maximum value of SAR (measured) = 17.205 mW/g

**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 = 58.682 V/m; Power Drift = 0.0046 dB

Peak SAR (extrapolated) = 34.084 W/kg

**SAR(1 g) = 8 mW/g; SAR(10 g) = 2.23 mW/g**

Maximum value of SAR (measured) = 19.116 mW/g

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan,**

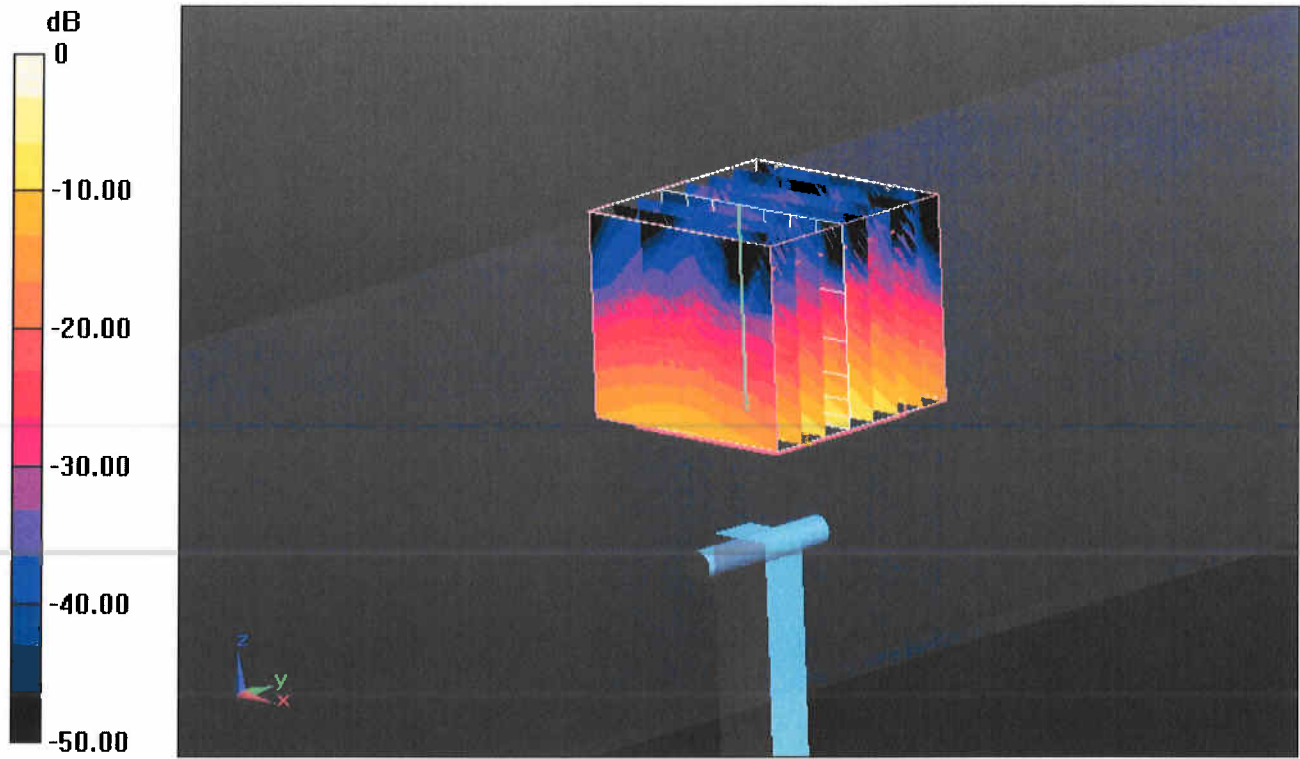
**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 55.417 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 35.084 W/kg

**SAR(1 g) = 7.63 mW/g; SAR(10 g) = 2.12 mW/g**

Maximum value of SAR (measured) = 18.703 mW/g



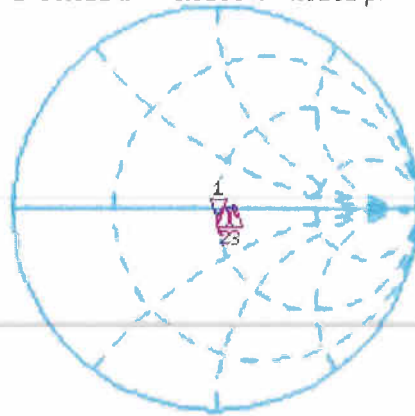
0 dB = 18.700mW/g

# Impedance Measurement Plot for Body TSL

23 Aug 2011 10:12:56

CH1 S11 1 U FS 1: 50.021  $\Omega$  -6.6133  $\Omega$  4.6281 pF 5 200.000 000 MHz

\*  
Del  
Cor



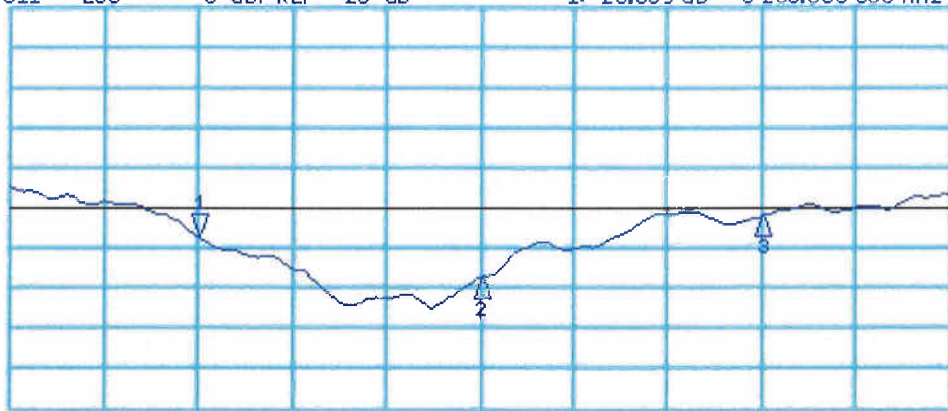
CH1 Markers  
2: 53.760  $\Omega$   
0.6602  $\Omega$   
5.50000 GHz  
3: 59.570  $\Omega$   
1.0352  $\Omega$   
5.80000 GHz

Avg  
16

H1 d

CH2 S11 LOG 5 dB/REF -20 dB 1: -23.609 dB 5 200.000 000 MHz

Cor



CH2 Markers  
2: -28.684 dB  
5.50000 GHz  
3: -21.123 dB  
5.80000 GHz

Avg  
16

H1 d

START 5 000.000 000 MHz

STOP 6 000.000 000 MHz