2450MHz Head Validation

Date/Time: 10/12/2015 9:58:04 AM

DUT: D2450V2; Type: 1S2672

Communication System: CW ; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: HSL2450 Medium parameters used: f = 2450 MHz; σ = 1.89 mho/m; ε_r = 38.2; ρ = 1000 kg/m^3
Phantom section: Flat Section

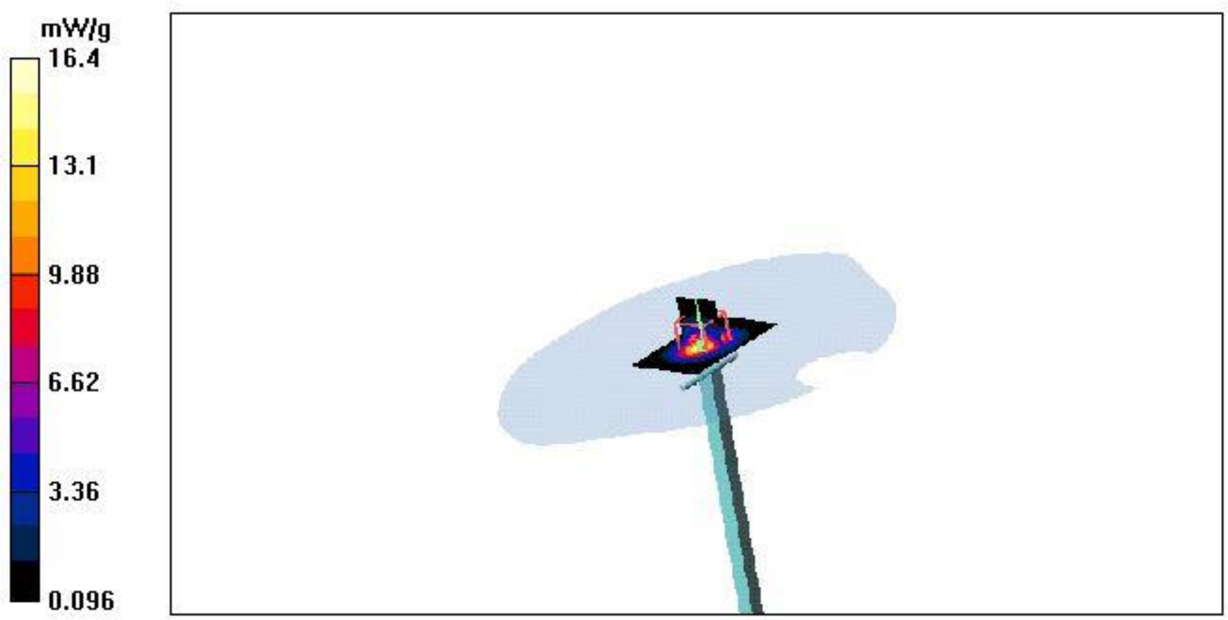
- Probe: EX3DV4 - SN3722; ConvF(6.71, 6.71, 6.71); Calibrated: 10/17/2014
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 10/14/2014
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

d=10mm, Pin=250mW/Area Scan (51x81x1):

Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 17.0 mW/g

d=10mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.6 V/m; Power Drift = -0.023 dB
Peak SAR (extrapolated) = 30.7 W/kg
SAR(1 g) = 14.1 mW/g;
Maximum value of SAR (measured) = 16.4 mW/g



2450MHz Body Validation

Date/Time: 10/13/2015 01:33:31 AM

DUT: D2450V2; Type: 1S2672

Communication System: CW; ; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: M2450 Medium parameters used: f = 2450 MHz; $\sigma = 2.05$ mho/m; $\varepsilon_r = 50.7$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section

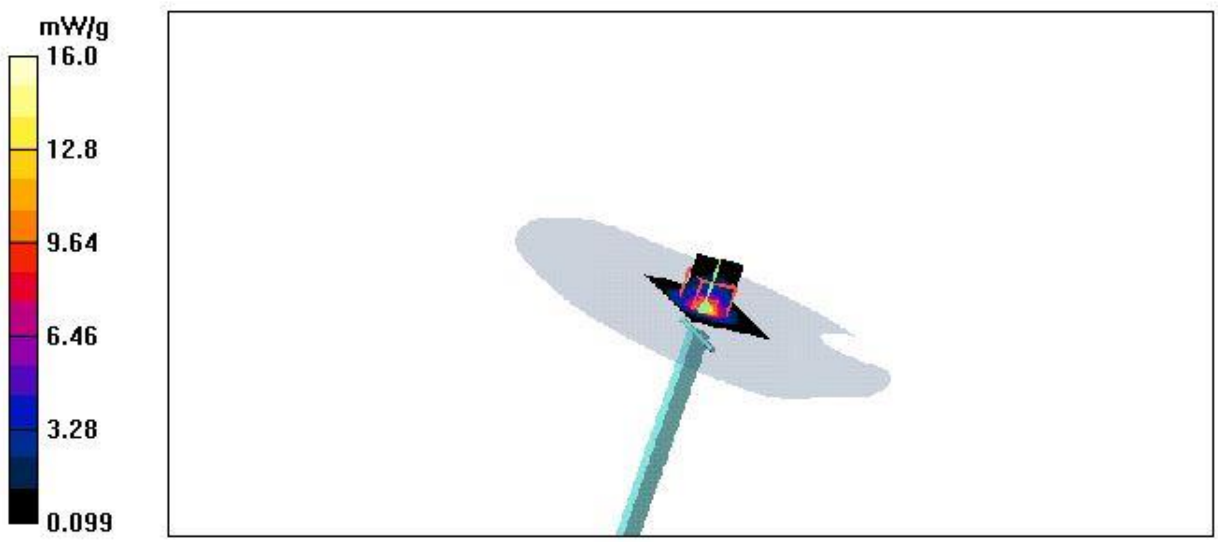
- Probe: EX3DV4 - SN3722; ConvF(6.71, 6.71, 6.71); Calibrated: 10/17/2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 10/14/2014
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

d=10mm, Pin=250mW/Area Scan (51x81x1):

Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 16.5 mW/g

d=10mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 84.7 V/m; Power Drift = 0.163 dB
Peak SAR (extrapolated) = 29.0 W/kg
SAR(1 g) = 13.8 mW/g;
Maximum value of SAR (measured) = 16.0 mW/g



APPENDIX D

5.0 GHz SYSTEM PERFORMANCE CHECK - FCC

5200MHz Head Validation

Date/Time: 10/4/2015 3:56:41 PM

DUT: Dipole 5000MHz

Communication System: CW; ; Frequency: 5200 MHz;Duty Cycle: 1:1
Medium: HSL5200-5500-5800 Medium parameters used: f = 5200 MHz; σ = 4.6 mho/m; ε_r = 35.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

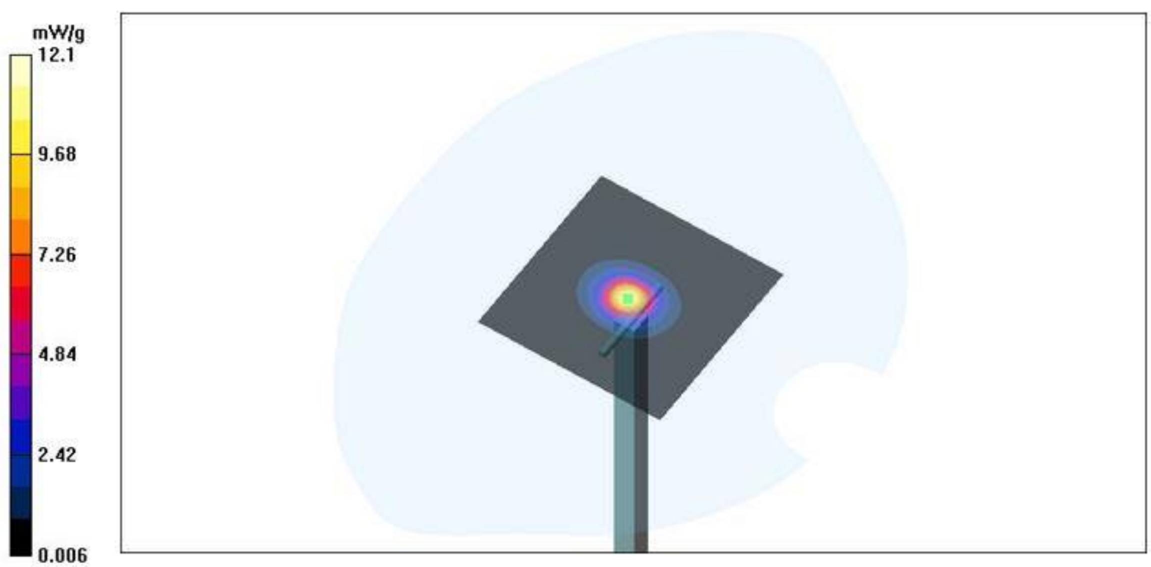
- Probe: EX3DV4 - SN3722; ConvF(4.84, 4.84, 4.84); Calibrated: 10/17/2014
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 10/14/2014
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

d=10mm, Pin=100mW, f=5200 MHz/Area Scan (91x91x1):

Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 12.1 mW/g

d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan, dist=2mm (11x11x6)/Cube 0:

Measurement grid: dx=3mm, dy=3mm, dz=2mm
Reference Value = 58.50 V/m; Power Drift = -0.006 dB
Peak SAR (extrapolated) = 24.94 W/kg
SAR(1 g) = 6.83 mW/g;
Maximum value of SAR (measured) = 15.3 mW/g



5500MHz Head Validation

Date/Time: 10/4/2015 6:32:29 PM

DUT: Dipole 5000MHz

Communication System: CW; ; Frequency: 5500 MHz;Duty Cycle: 1:1
Medium: HSL5200-5500-5800 Medium parameters used: f = 5500 MHz; σ = 4.95 mho/m; ε_r = 35.5; ρ = 1000 kg/m^3
Phantom section: Flat Section

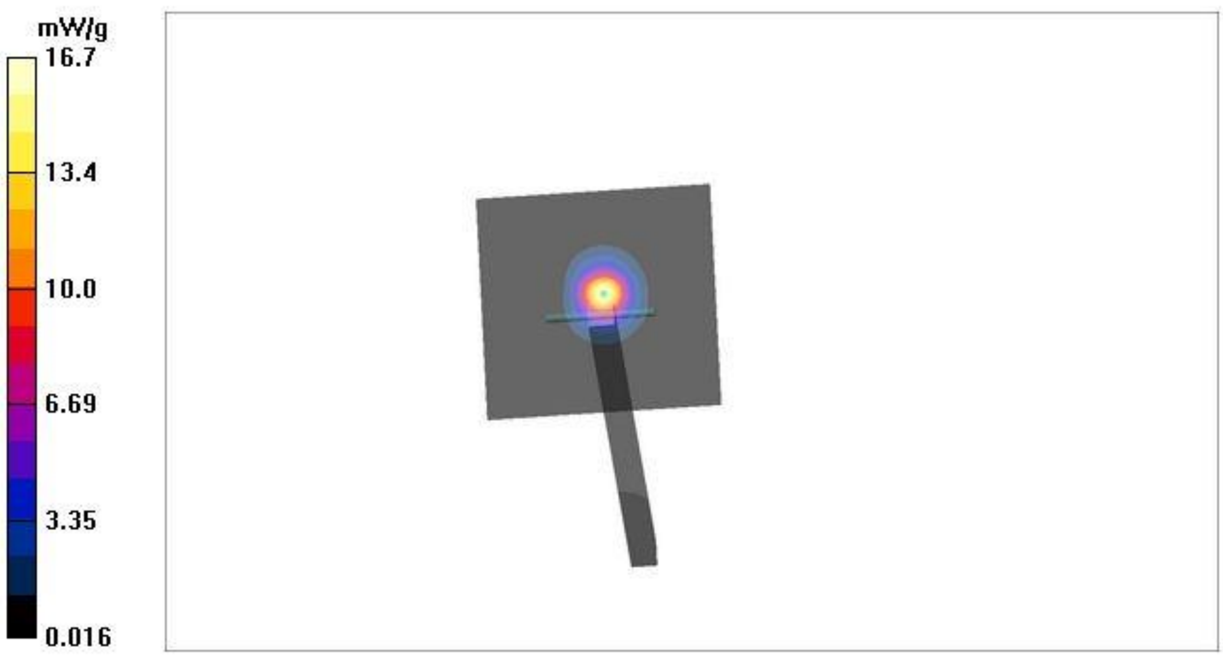
- Probe: EX3DV4 - SN3722; ConvF(4.46, 4.46, 4.46); Calibrated: 10/17/2014
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 10/14/2014
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

d=10mm, Pin=100mW, f=5500 MHz/Area Scan (91x91x1):

Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 16.7 mW/g

d=10mm, Pin=100mW, f=5500 MHz/Zoom Scan, dist=2mm (11x11x6)/Cube 0:

Measurement grid: dx=3mm, dy=3mm, dz=2mm
Reference Value = 48.4 V/m; Power Drift = 0.021 dB
Peak SAR (extrapolated) = 36.2 W/kg
SAR(1 g) = 7.6 mW/g;
Maximum value of SAR (measured) = 17.4 mW/g



5800MHz Head Validation

Date/Time: 10/4/2015 5:46:21 PM

DUT: Dipole 5000MHz

Communication System: CW; ; Frequency: 5800 MHz;Duty Cycle: 1:1
Medium: HSL5200-5500-5800 Medium parameters used: f = 5800 MHz; σ = 5.25 mho/m; ε_r = 35.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

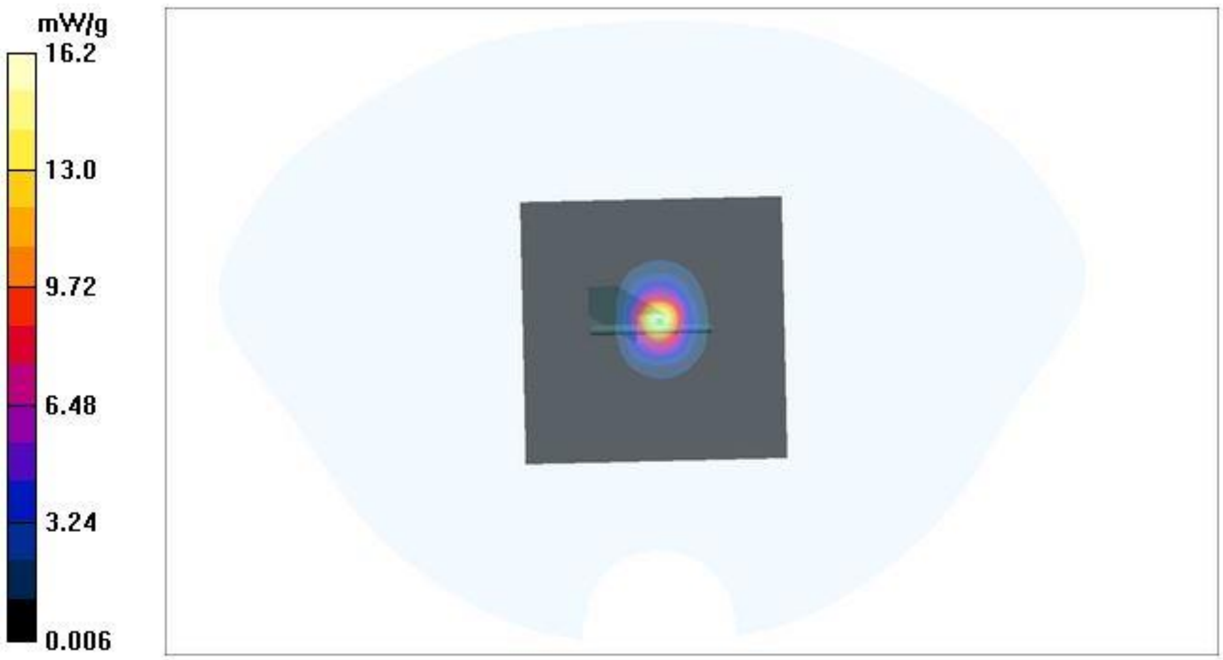
- Probe: EX3DV4 - SN3722; ConvF(4.39, 4.39, 4.39); Calibrated: 10/17/2014
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 10/14/2014
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

d=10mm, Pin=100mW, f=5800 MHz/Area Scan (91x91x1):

Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 16.2 mW/g

d=10mm, Pin=100mW, f=5800 MHz/Zoom Scan, dist=2mm (11x11x6)/Cube 0:

Measurement grid: dx=3mm, dy=3mm, dz=2mm
Reference Value = 44.9 V/m; Power Drift = -0.042 dB
Peak SAR (extrapolated) = 34.2 W/kg
SAR(1 g) = 7.12 mW/g;
Maximum value of SAR (measured) = 16.1 mW/g



5200MHz Body Validation

Date/Time: 10/9/2015 2:16:22 PM

DUT: Dipole 5000MHz

Communication System: CW; ; Frequency: 5200 MHz;Duty Cycle: 1:1
Medium: HSL5200-5500-5800 Medium parameters used: f = 5200 MHz; σ = 5.73 mho/m; ε_r = 50.7; ρ = 1000 kg/m^3
Phantom section: Flat Section

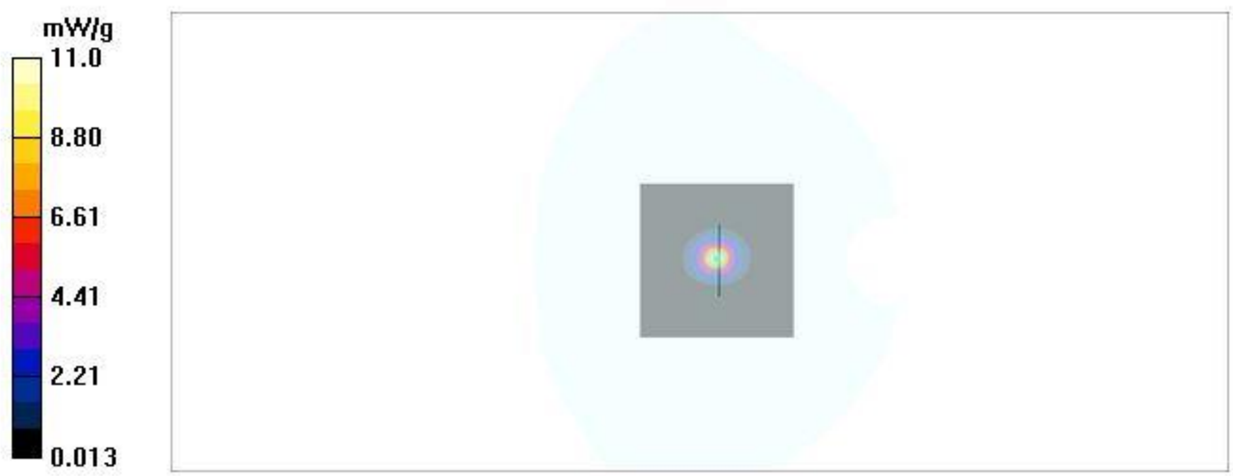
- Probe: EX3DV4 - SN3722; ConvF(4.2, 4.2, 4.2); Calibrated: 10/17/2014
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 10/14/2014
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

d=10mm, Pin=100mW, f=5200 MHz/Area Scan (91x91x1):

Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 11.0 mW/g

d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan, dist=2mm (11x11x6)/Cube 0:

Measurement grid: dx=3mm, dy=3mm, dz=2mm
Reference Value = 42.5 V/m; Power Drift = 0.007 dB
Peak SAR (extrapolated) = 18.9 W/kg
SAR(1 g) = 6.25 mW/g;
Maximum value of SAR (measured) = 10.8 mW/g



5500MHz Body Validation

Date/Time: 10/9/2015 4:19:28 PM

DUT: Dipole 5500MHz

Communication System: CW; ; Frequency: 5500 MHz;Duty Cycle: 1:1
Medium: HSL5200-5500-5800 Medium parameters used: f = 5500 MHz; σ = 6.23 mho/m; ε_r = 51.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

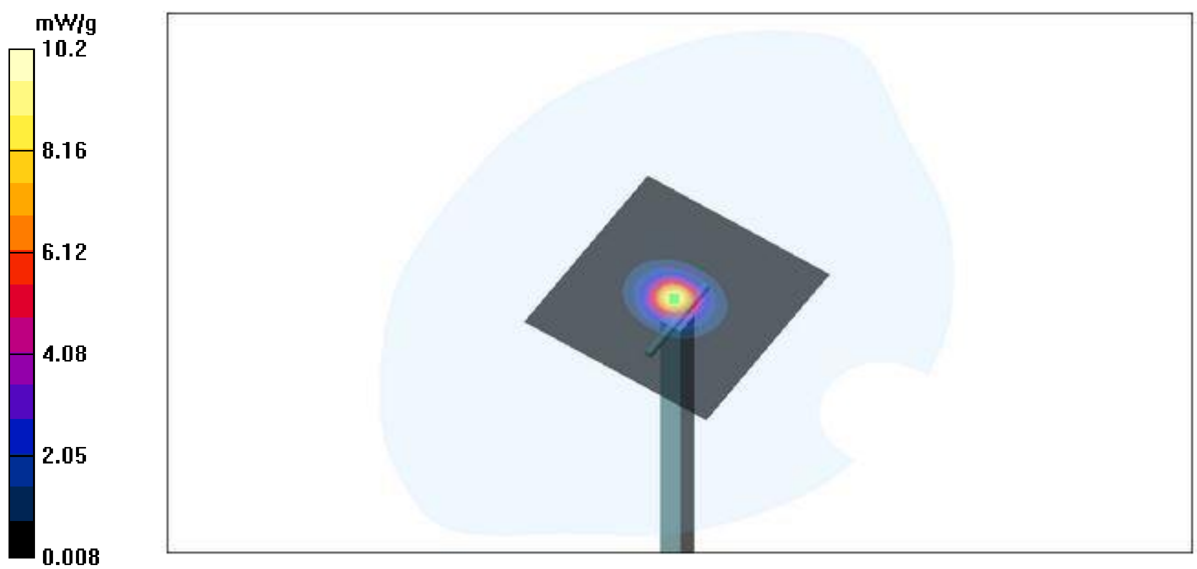
- Probe: EX3DV4 - SN3722; ConvF(3.7, 3.7, 3.7); Calibrated: 10/17/2014
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 10/14/2014
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

d=10mm, Pin=100mW, f=5200 MHz/Area Scan (91x91x1):

Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 10.2 mW/g

d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan, dist=2mm (11x11x6)/Cube 0:

Measurement grid: dx=3mm, dy=3mm, dz=2mm
Reference Value = 47.5 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 24.9 W/kg
SAR(1 g) = 6.38 mW/g;
Maximum value of SAR (measured) = 14.8 mW/g



0 dB = 10.2mW/g

5800MHz Body Validation

Date/Time: 10/9/2015 1:26:25 PM

DUT: Dipole 5800MHz

Communication System: CW; ; Frequency: 5800 MHz;Duty Cycle: 1:1
Medium: HSL5200-5500-5800 Medium parameters used: f = 5800 MHz; σ = 6.68 mho/m; ε_r = 50.3; ρ = 1000 kg/m^3
Phantom section: Flat Section

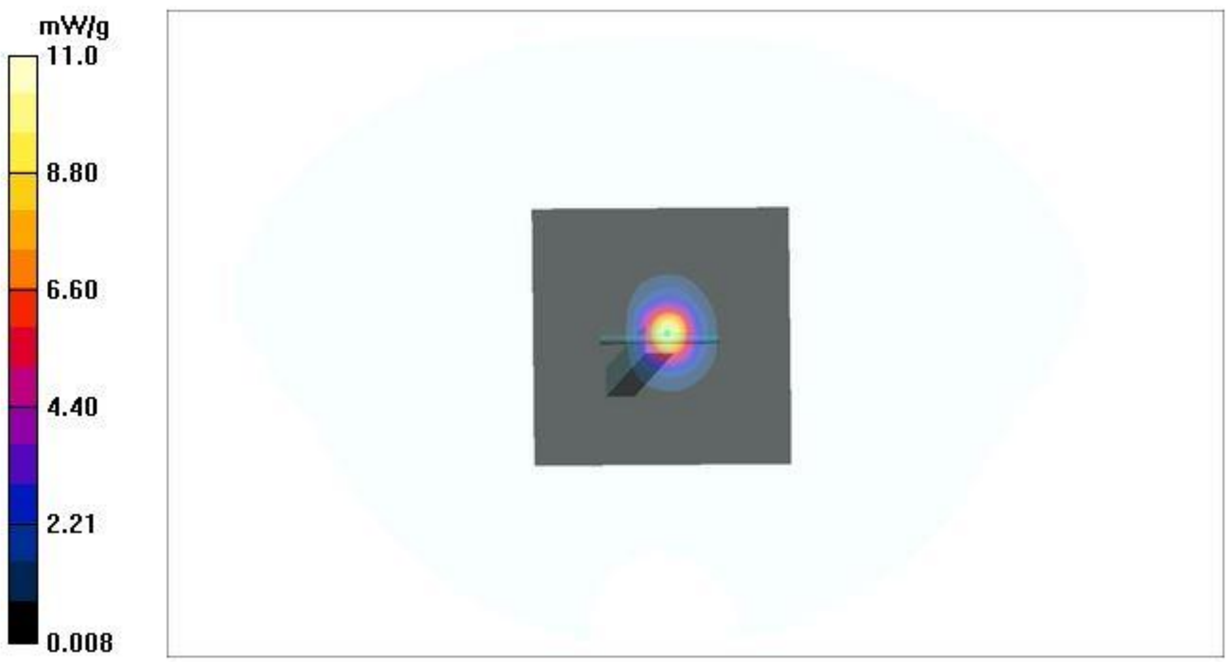
- Probe: EX3DV4 - SN3722; ConvF(3.82, 3.82, 3.82); Calibrated: 10/17/2014
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 10/14/2014
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

d=10mm, Pin=100mW, f=5800 MHz/Area Scan (91x91x1):

Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 11.0 mW/g

d=10mm, Pin=100mW, f=5800 MHz/Zoom Scan, dist=2mm (11x11x6)/Cube 0:

Measurement grid: dx=3mm, dy=3mm, dz=2mm
Reference Value = 38.7 V/m; Power Drift = 0.282 dB
Peak SAR (extrapolated) = 25.6 W/kg
SAR(1 g) = 5.98 mW/g;
Maximum value of SAR (measured) = 12.8 mW/g



APPENDIX E

2.4 DIPOLE CALIBRATION CERTIFICATE

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

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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 **MET Laboratories**

Certificate No: **D2450V2-857_Jul13**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 857
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	July 22, 2013

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	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
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-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 22, 2013

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

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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	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.8 ± 6 %	1.81 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**53.0 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.21 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.7 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.5 ± 6 %	2.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**50.8 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.03 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.8 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.5 Ω + 4.2 jΩ
Return Loss	- 24.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.0 Ω + 5.7 jΩ
Return Loss	- 24.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.158 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	April 23, 2010

DASY5 Validation Report for Head TSL

Date: 07.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

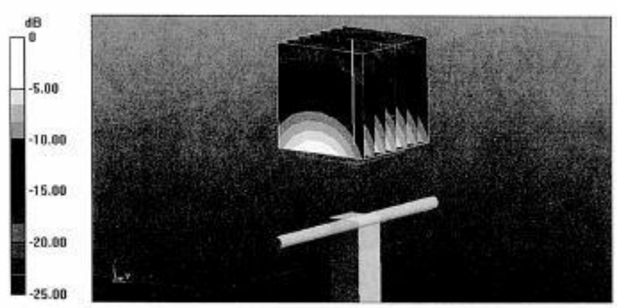
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 857

Communication System: UID 0 - CW ; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.81 S/m; ε_r = 37.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

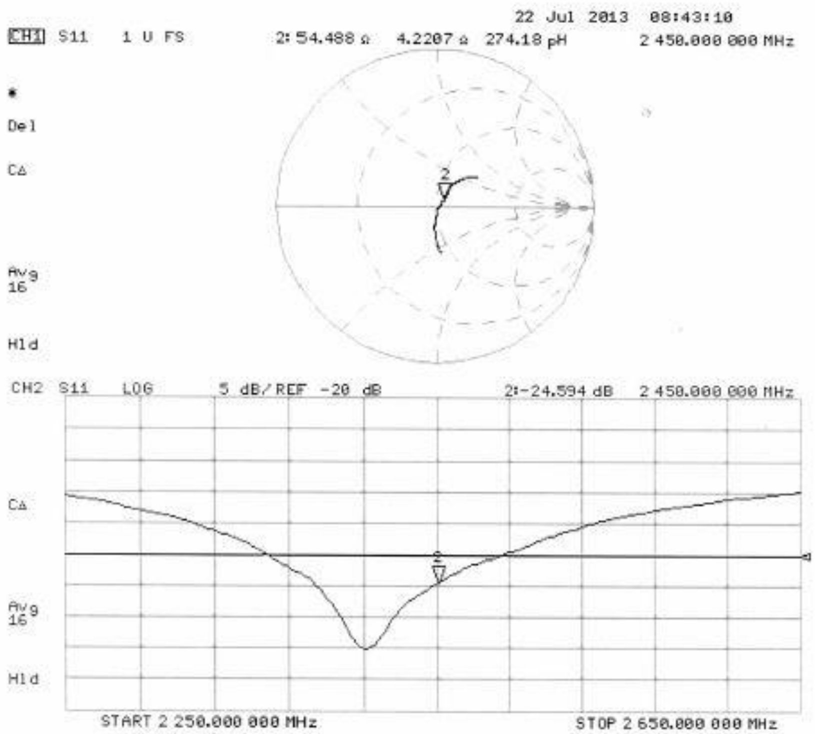
- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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 = 95.120 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 27.8 W/kg
SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.21 W/kg
Maximum value of SAR (measured) = 17.0 W/kg



0 dB = 17.0 W/kg = 12.30 dBW/kg

Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 19.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

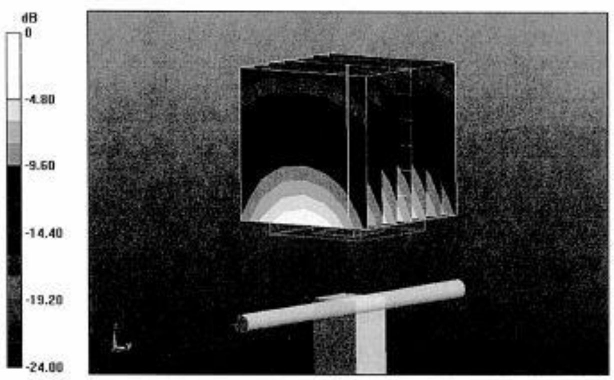
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 857

Communication System: UID 0 - CW ; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.01 S/m; ε_r = 50.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

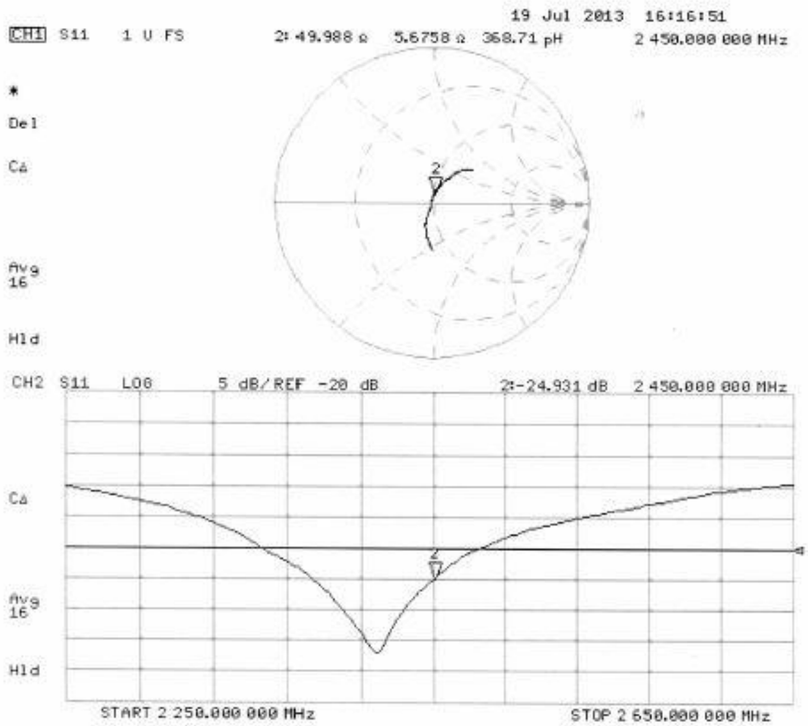
- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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 = 95.120 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 27.2 W/kg
SAR(1 g) = 13 W/kg; SAR(10 g) = 6.03 W/kg
Maximum value of SAR (measured) = 17.1 W/kg



0 dB = 17.1 W/kg = 12.33 dBW/kg

Impedance Measurement Plot for Body TSL



APPENDIX F

5.0 DIPOLE CALIBRATION CERTIFICATE

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Accreditation No.: SCS 108

Client **MET Laboratories**

Certificate No: IndexSAR-1S2571_Jul13

CALIBRATION CERTIFICATE

Object	IndexSAR - SN: 1S2571
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	July 24, 2013

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	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe EX3DV4	SN: 3503	28-Dec-12 (No. EX3-3503_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

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-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 25, 2013

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

Calibration Laboratory of
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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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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) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010

b) 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:

c) 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	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	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
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	4.46 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**71.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.11 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**20.9 W/kg ± 19.5 % (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 ± 0.2) °C	34.8 ± 6 %	4.74 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.00 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**69.5 W / kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.05 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**20.3 W/kg ± 19.5 % (k=2)**

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

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.76 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**67.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	1.93 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**19.1 W/kg ± 19.5 % (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	48.9 ± 6 %	5.40 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	6.74 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**67.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	1.92 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**19.2 W/kg ± 19.5 % (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	48.4 ± 6 %	5.79 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	6.59 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**65.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	1.89 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**18.9 W/kg ± 19.5 % (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	47.9 ± 6 %	6.21 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	6.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**64.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	1.79 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**17.9 W/kg ± 19.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	43.8 Ω - 17.6 jΩ
Return Loss	- 14.2 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	38.2 Ω - 32.5 jΩ
Return Loss	- 8.7 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	55.8 Ω - 18.0 jΩ
Return Loss	- 15.1 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	41.7 Ω - 26.4 jΩ
Return Loss	- 10.7 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	39.0 Ω - 25.2 jΩ
Return Loss	- 10.5 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	46.8 Ω - 22.3 jΩ
Return Loss	- 12.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	0.671 ns

Dipole designed and manufactured by IndexSAR. Please see details on http://www.indexsar.com/balanced.htm

Additional EUT Data

Manufactured by	IndexSAR
Manufactured on	unknown

DASY5 Validation Report for Head TSL

Date: 23.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: IndexSAR; Serial: IndexSAR - SN:1S2571

Communication System: UID 0 - CW ; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.46 S/m; ε_r = 35.2; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 4.74 S/m; ε_r = 34.8; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 5.05 S/m; ε_r = 34.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

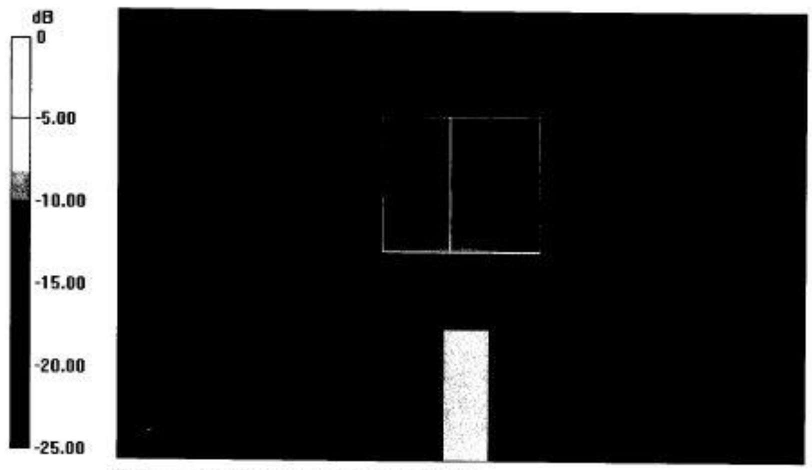
DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41); Calibrated: 28.12.2012, ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.81, 4.81, 4.81); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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 = 61.709 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 25.7 W/kg
SAR(1 g) = 7.16 W/kg; SAR(10 g) = 2.11 W/kg
Maximum value of SAR (measured) = 16.2 W/kg

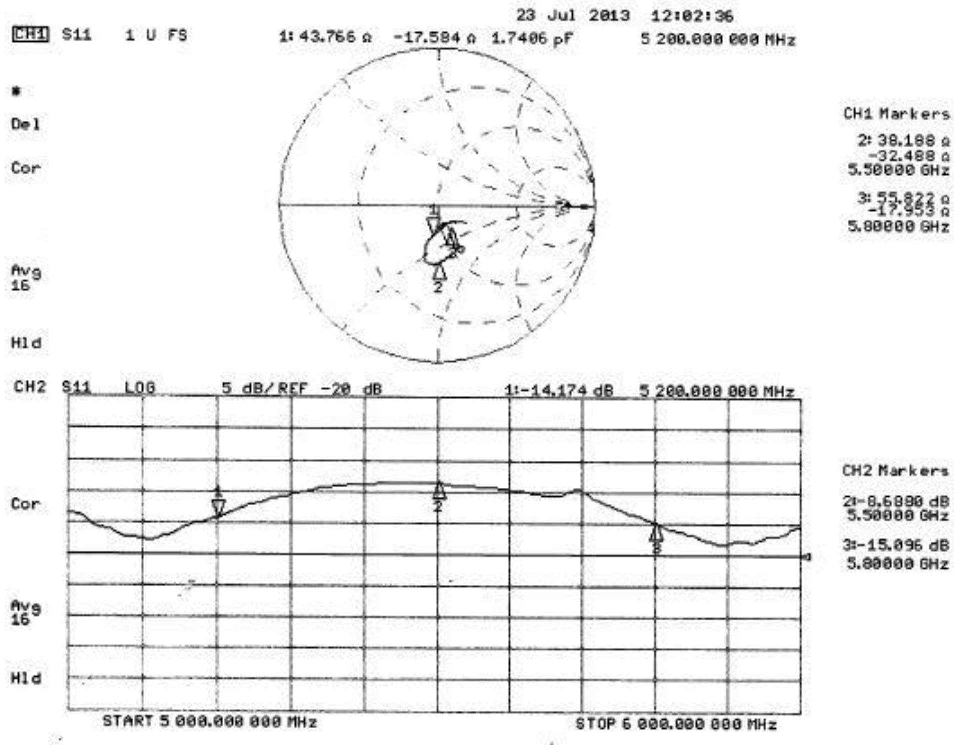
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.616 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 27.2 W/kg
SAR(1 g) = 7 W/kg; SAR(10 g) = 2.05 W/kg
Maximum value of SAR (measured) = 16.5 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 = 57.980 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 27.9 W/kg
SAR(1 g) = 6.76 W/kg; SAR(10 g) = 1.93 W/kg
Maximum value of SAR (measured) = 16.4 W/kg



0 dB = 16.4 W/kg = 12.15 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 24.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: IndexSAR; Serial: IndexSAR - SN:1S2571

Communication System: UID 0 - CW ; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.4 S/m; ε_r = 48.9; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 5.79 S/m; ε_r = 48.4; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 6.21 S/m; ε_r = 47.9; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

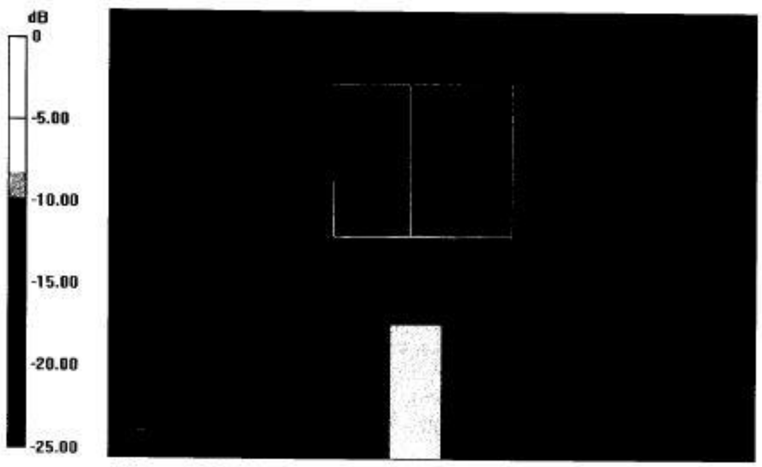
DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.43, 4.43, 4.43); Calibrated: 28.12.2012, ConvF(4.38, 4.38, 4.38); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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 = 55.464 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 26.1 W/kg
SAR(1 g) = 6.74 W/kg; SAR(10 g) = 1.92 W/kg
Maximum value of SAR (measured) = 15.5 W/kg

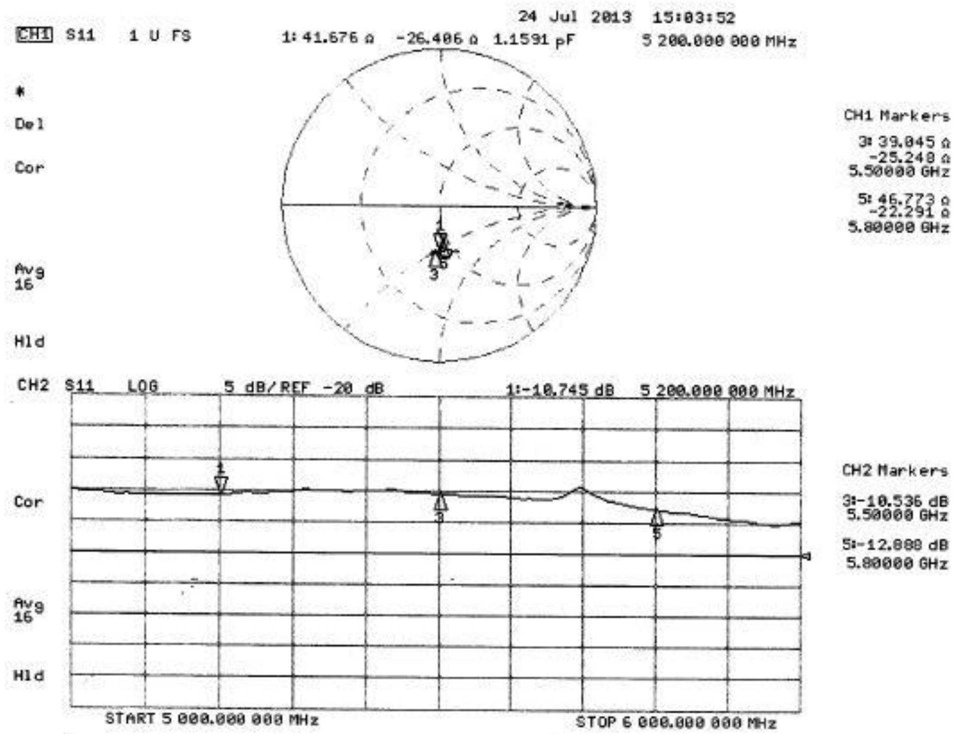
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 53.036 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 27.8 W/kg
SAR(1 g) = 6.59 W/kg; SAR(10 g) = 1.89 W/kg
Maximum value of SAR (measured) = 15.8 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 = 50.674 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 30.0 W/kg
SAR(1 g) = 6.44 W/kg; SAR(10 g) = 1.79 W/kg
Maximum value of SAR (measured) = 15.9 W/kg



0 dB = 15.9 W/kg = 12.01 dBW/kg

Impedance Measurement Plot for Body TSL



APPENDIX G

PROBE CALIBRATION CERTIFICATE

Calibration Laboratory of
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Accreditation No.: SCS 108

Client **MET Laboratories**

Certificate No: **EX3-3722_Oct14**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3722

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: October 17, 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&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	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: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (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:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: October 20, 2014

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Certificate No: EX3-3722_Oct14 Page 1 of 11

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Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 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:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * 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*.
- *DCPx,y,z:* 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
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: 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 ≤ 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 *NORMx,y,z * 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 ± 50 MHz to ± 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 *NORMx* (no uncertainty required).

Certificate No: EX3-3722_Oct14 Page 2 of 11

Probe EX3DV4

SN:3722

Manufactured: August 14, 2009
Calibrated: October 17, 2014

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3722

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.54	0.51	0.58	± 10.1 %
DCP (mV)[B]	99.4	97.1	99.4	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	147.6	±2.2 %
		Y	0.0	0.0	1.0		138.9	
		Z	0.0	0.0	1.0		147.8	

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%.

[A] The uncertainties of NormX,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3722

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	41.9	0.89	8.94	8.94	8.94	0.28	1.15	± 12.0 %
900	41.5	0.97	8.50	8.50	8.50	0.80	0.61	± 12.0 %
1810	40.0	1.40	7.44	7.44	7.44	0.73	0.61	± 12.0 %
2000	40.0	1.40	7.38	7.38	7.38	0.10	0.50	± 12.0 %
2450	39.2	1.80	6.71	6.71	6.71	0.80	0.50	± 12.0 %
5200	36.0	4.66	4.84	4.84	4.84	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.69	4.69	4.69	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.46	4.46	4.46	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.39	4.39	4.39	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] 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.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3722

Calibration Parameter Determined in Body Tissue Simulating Media

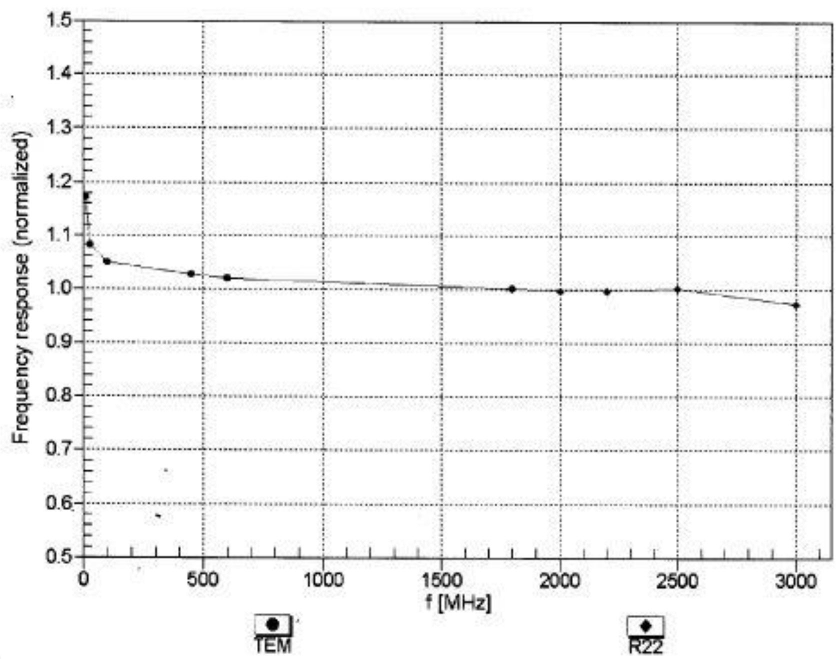
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	55.5	0.96	8.76	8.76	8.76	0.36	0.92	± 12.0 %
900	55.0	1.05	8.51	8.51	8.51	0.80	0.64	± 12.0 %
1810	53.3	1.52	7.16	7.16	7.16	0.36	0.90	± 12.0 %
2000	53.3	1.52	7.27	7.27	7.27	0.40	0.89	± 12.0 %
2450	52.7	1.95	6.71	6.71	6.71	0.80	0.55	± 12.0 %
5200	49.0	5.30	4.20	4.20	4.20	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.06	4.06	4.06	0.45	1.90	± 13.1 %
5500	48.6	5.65	3.70	3.70	3.70	0.50	1.90	± 13.1 %
5800	48.2	6.00	3.82	3.82	3.82	0.50	1.90	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] 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:3722 October 17, 2014

Frequency Response of E-Field

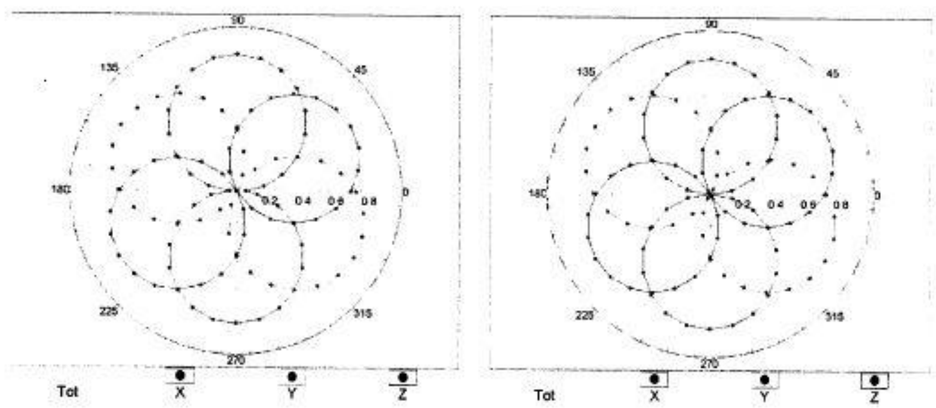
(TEM-Cell:ifi110 EXX, Waveguide: R22)

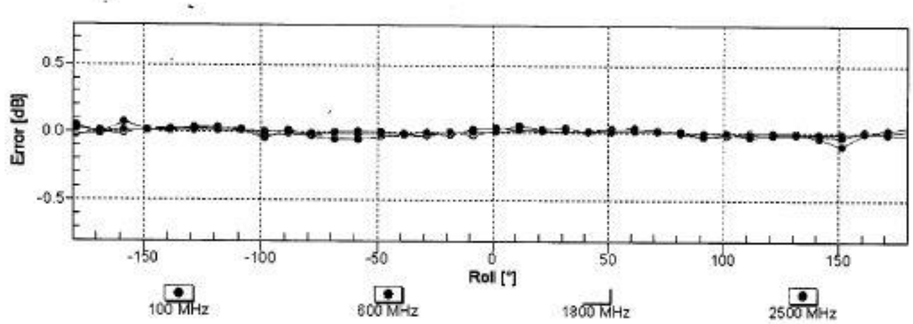


Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Certificate No: EX3-3722_Oct14 Page 7 of 11

Receiving Pattern (ϕ), ϑ = 0°



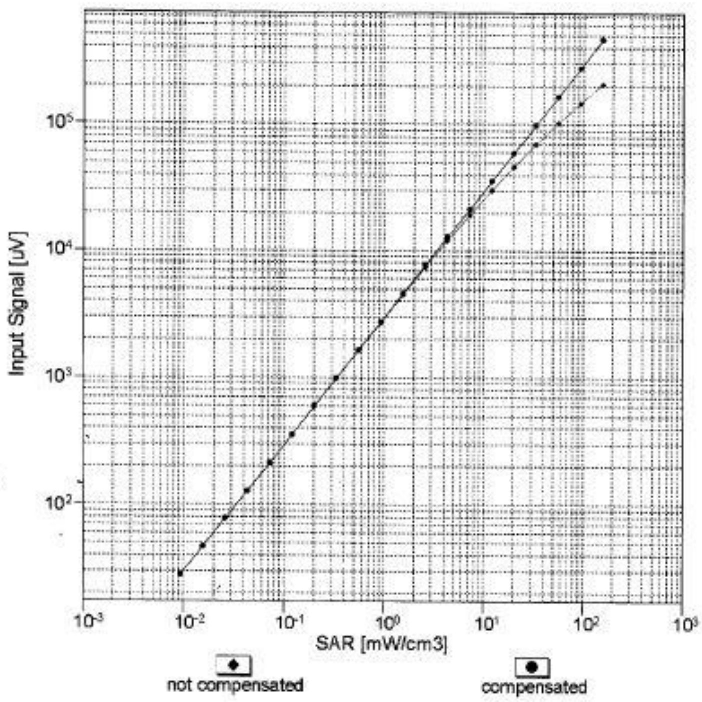


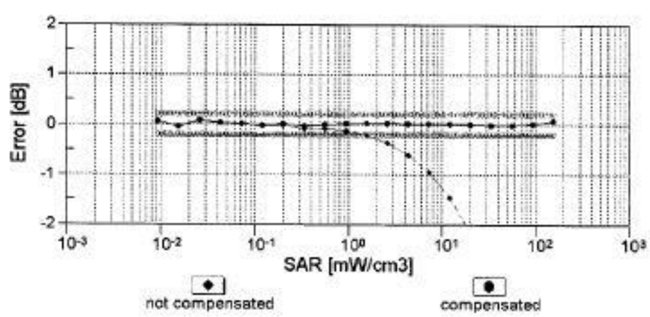
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

EX3DV4– SN:3722 October 17, 2014

Dynamic Range f(SAR_{head})

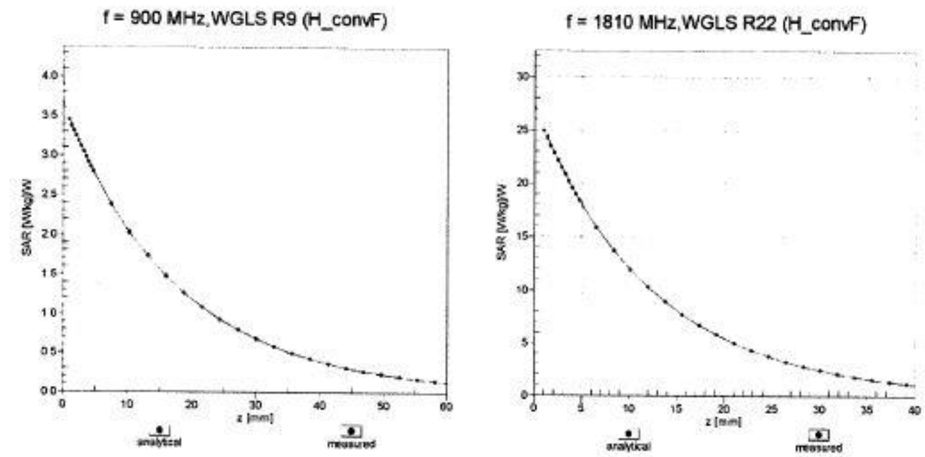
(TEM cell , f_{eval}= 1900 MHz)





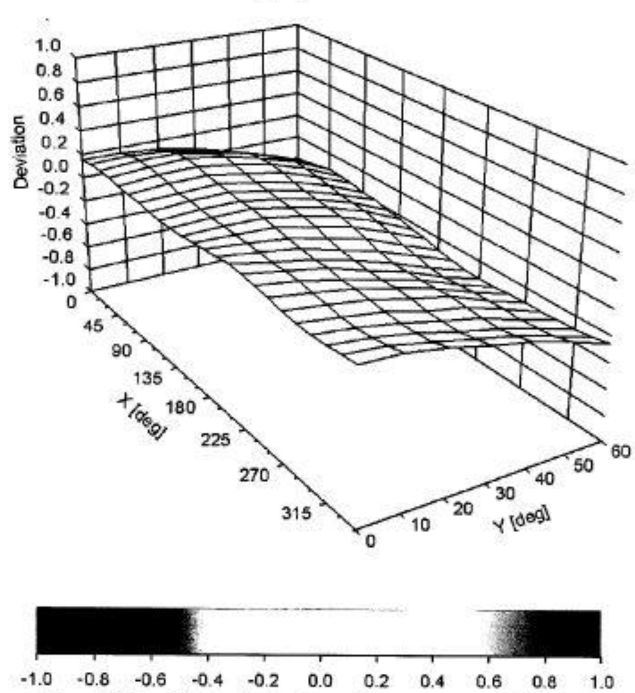
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3722

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	11.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

APPENDIX H

DAE CALIBRATION CERTIFICATE

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
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 **MET Laboratories**

Certificate No: **DAE3-584_Oct14**

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AA - SN: 584
Calibration procedure(s)	QA CAL-06.v28 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	October 14, 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&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	03-Oct-14 (No:15573)	Oct-15
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-14 (in house check)	In house check: Jan-15
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-14 (in house check)	In house check: Jan-15

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	i.V.

Issued: October 14, 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
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

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1µV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.637 ± 0.02% (k=2)	404.822 ± 0.02% (k=2)	404.252 ± 0.02% (k=2)
Low Range	3.92983 ± 1.50% (k=2)	3.91835 ± 1.50% (k=2)	3.94518 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	141.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS108)

1. DC Voltage Linearity

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	199995.08	-1.66	-0.00
Channel X	+ Input	20002.21	1.08	0.01
Channel X	- Input	-20000.68	0.02	-0.00
Channel Y	+ Input	199994.29	-2.51	-0.00
Channel Y	+ Input	20003.95	2.80	0.01
Channel Y	- Input	-19993.87	6.83	-0.03
Channel Z	+ Input	199998.36	1.04	0.00
Channel Z	+ Input	19998.84	-2.32	-0.01
Channel Z	- Input	-19998.87	1.78	-0.01

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2001.52	0.61	0.03
Channel X	+ Input	202.04	0.52	0.26
Channel X	- Input	-199.11	-0.68	0.34
Channel Y	+ Input	2000.36	-0.59	-0.03
Channel Y	+ Input	200.66	-0.74	-0.37
Channel Y	- Input	-198.89	-0.40	0.20
Channel Z	+ Input	2000.93	0.07	0.00
Channel Z	+ Input	200.48	-0.82	-0.41
Channel Z	- Input	-199.35	-0.69	0.35

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	2.93	1.03
	- 200	-0.10	-2.11
Channel Y	200	2.28	2.64
	- 200	-4.13	-3.84
Channel Z	200	-6.31	-7.07
	- 200	4.44	4.48

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	-	-0.15	-4.15
Channel Y	200	6.74	-	-0.20
Channel Z	200	7.03	5.14	-

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4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16109	15608
Channel Y	16210	15968
Channel Z	16290	16554

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	1.05	-0.16	2.07	0.47
Channel Y	-0.22	-1.35	0.95	0.48
Channel Z	-0.26	-1.18	0.83	0.44

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	–0.01	-8	-9

APPENDIX I

2.4 GHz MEASURED FLUID DIELECTRIC PARAMETERS

Cisco IP Phone

Head Simulating Liquid Parameters for 2450MHz

October 10, 2015 03:32 PM

Frequency	e'	e"
2.40000 GHz	38.386	13.813
2.40200 GHz	38.376	13.824
2.40400 GHz	38.383	13.838
2.40600 GHz	38.372	13.852
2.40800 GHz	38.373	13.862
2.41000 GHz	38.368	13.891
2.41200 GHz	38.356	13.894
2.41400 GHz	38.347	13.905
2.41600 GHz	38.349	13.925
2.41800 GHz	38.344	13.932
2.42000 GHz	38.335	13.940
2.42200 GHz	38.324	13.936
2.42400 GHz	38.320	13.938
2.42600 GHz	38.305	13.956
2.42800 GHz	38.306	13.956
2.43000 GHz	38.291	13.962
2.43200 GHz	38.292	13.969
2.43400 GHz	38.277	13.959
2.43600 GHz	38.260	13.949
2.43800 GHz	38.254	13.953
2.44000 GHz	38.248	13.949
2.44200 GHz	38.231	13.944
2.44400 GHz	38.231	13.950
2.44600 GHz	38.216	13.949
2.44800 GHz	38.210	13.951
2.45000 GHz	38.200	13.943
2.45200 GHz	38.191	13.946
2.45400 GHz	38.184	13.940
2.45600 GHz	38.179	13.946
2.45800 GHz	38.174	13.939
2.46000 GHz	38.148	13.943
2.46200 GHz	38.145	13.941
2.46400 GHz	38.132	13.941

2.46600 GHz	38.135	13.946
2.46800 GHz	38.123	13.950
2.47000 GHz	38.102	13.951
2.47200 GHz	38.101	13.955
2.47400 GHz	38.081	13.972
2.47600 GHz	38.070	13.969
2.47800 GHz	38.068	13.975
2.48000 GHz	38.049	13.984
2.48200 GHz	38.038	13.980
2.48400 GHz	38.026	13.988
2.48600 GHz	38.022	14.006
2.48800 GHz	38.007	14.020
2.49000 GHz	38.003	14.028
2.49200 GHz	37.988	14.036
2.49400 GHz	37.982	14.045
2.49600 GHz	37.963	14.047
2.49800 GHz	37.961	14.062
2.50000 GHz	37.956	14.074

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Cisco IP Phone

Body Simulating Liquid Parameters for 2450MHz

October 10, 2015 02:36 PM

Frequency	e'	e"
2.40000 GHz	50.946	14.868
2.40200 GHz	50.939	14.892
2.40400 GHz	50.928	14.899
2.40600 GHz	50.928	14.915
2.40800 GHz	50.924	14.929
2.41000 GHz	50.909	14.940
2.41200 GHz	50.889	14.958
2.41400 GHz	50.878	14.958
2.41600 GHz	50.876	14.961
2.41800 GHz	50.865	14.980
2.42000 GHz	50.836	14.991
2.42200 GHz	50.822	15.008
2.42400 GHz	50.816	15.007
2.42600 GHz	50.799	15.006
2.42800 GHz	50.805	15.015
2.43000 GHz	50.790	15.024
2.43200 GHz	50.778	15.036
2.43400 GHz	50.775	15.053
2.43600 GHz	50.750	15.051
2.43800 GHz	50.735	15.060
2.44000 GHz	50.728	15.052
2.44200 GHz	50.726	15.078
2.44400 GHz	50.711	15.076
2.44600 GHz	50.708	15.070
2.44800 GHz	50.707	15.088
2.45000 GHz	50.702	15.084
2.45200 GHz	50.696	15.098
2.45400 GHz	50.698	15.115
2.45600 GHz	50.693	15.138
2.45800 GHz	50.682	15.153
2.46000 GHz	50.674	15.165
2.46200 GHz	50.667	15.190
2.46400 GHz	50.664	15.202

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2.46600 GHz	50.651	15.213
2.46800 GHz	50.647	15.224
2.47000 GHz	50.637	15.231
2.47200 GHz	50.619	15.240
2.47400 GHz	50.621	15.262
2.47600 GHz	50.599	15.268
2.47800 GHz	50.583	15.279
2.48000 GHz	50.568	15.308
2.48200 GHz	50.557	15.323
2.48400 GHz	50.543	15.335
2.48600 GHz	50.532	15.340
2.48800 GHz	50.526	15.365
2.49000 GHz	50.515	15.365
2.49200 GHz	50.491	15.383
2.49400 GHz	50.472	15.394
2.49600 GHz	50.460	15.381
2.49800 GHz	50.449	15.404
2.50000 GHz	50.442	15.394

APPENDIX J

5.0 GHz MEASURED FLUID DIELECTRIC PARAMETERS

Cisco IP Phone

Head Simulating Liquid Parameters for 5280MHz

October 5, 2015 01:28 PM

Frequency	e’	e”
5.20000 GHz	35.449	15.938
5.20320 GHz	35.454	15.934
5.20640 GHz	35.448	15.944
5.20960 GHz	35.450	15.940
5.21280 GHz	35.451	15.935
5.21600 GHz	35.447	15.947
5.21920 GHz	35.446	15.945
5.22240 GHz	35.452	15.944
5.22560 GHz	35.445	15.954
5.22880 GHz	35.421	15.949
5.23200 GHz	35.421	15.955
5.23520 GHz	35.417	15.951
5.23840 GHz	35.416	15.951
5.24160 GHz	35.414	15.951
5.24480 GHz	35.400	15.954
5.24800 GHz	35.393	15.963
5.25120 GHz	35.875	15.959
5.25440 GHz	35.356	15.954
5.25760 GHz	35.351	15.956
5.26080 GHz	35.334	15.947
5.26400 GHz	35.334	15.960
5.26720 GHz	35.326	15.982
5.27040 GHz	35.322	15.984
5.27360 GHz	35.329	15.961
5.27680 GHz	35.313	15.983
5.28000 GHz	35.299	15.979
5.28320 GHz	35.302	15.990
5.28640 GHz	35.287	15.996
5.28960 GHz	35.284	16.000
5.29280 GHz	35.295	16.003
5.29600 GHz	35.289	16.006
5.29920 GHz	35.282	16.020
5.30240 GHz	35.285	16.019

5.30560 GHz	**35.285**	**16.017**
5.30880 GHz	**35.261**	**16.027**
5.31200 GHz	**35.273**	**16.037**
5.31520 GHz	**35.264**	**16.039**
5.31840 GHz	**35.263**	**16.047**
5.32160 GHz	**35.265**	**16.032**
5.32480 GHz	**35.258**	**16.030**
5.32800 GHz	**35.262**	**16.059**
5.33120 GHz	**35.245**	**16.046**
5.33440 GHz	**35.241**	**16.053**
5.33760 GHz	**35.245**	**16.057**
5.34080 GHz	**35.240**	**16.058**
5.34400 GHz	**35.233**	**16.059**
5.34720 GHz	**35.219**	**16.060**
5.35040 GHz	**35.227**	**16.048**
5.35360 GHz	**35.224**	**16.058**
5.35680 GHz	**35.211**	**16.052**
5.36000 GHz	**35.206**	**16.058**

Cisco IP Phone

Head Simulating Liquid Parameters for 5540MHz

October 5, 2015 02:20 PM

Frequency	e'	e"
5.50000 GHz	35.552	16.208
5.50140 GHz	35.535	16.224
5.50281 GHz	35.533	16.216
5.50421 GHz	35.541	16.219
5.50562 GHz	35.522	16.220
5.50702 GHz	35.517	16.222
5.50843 GHz	35.517	16.211
5.50983 GHz	35.513	16.221
5.51124 GHz	35.507	16.231
5.51265 GHz	35.498	16.235
5.51405 GHz	35.495	16.227
5.51546 GHz	35.488	16.235
5.51686 GHz	35.488	16.236
5.51827 GHz	35.478	16.241
5.51967 GHz	35.480	16.235
5.52108 GHz	35.480	16.258
5.52248 GHz	35.486	16.252
5.52389 GHz	35.469	16.247
5.52530 GHz	35.468	16.249
5.52670 GHz	35.478	16.244
5.52811 GHz	35.480	16.255
5.52951 GHz	35.467	16.252
5.53092 GHz	35.475	16.250
5.53232 GHz	35.470	16.262
5.53373 GHz	35.461	16.257
5.53514 GHz	35.469	16.255
5.53654 GHz	35.459	16.253
5.53795 GHz	35.459	16.252
5.53935 GHz	35.450	16.254
5.54076 GHz	35.434	16.239
5.54216 GHz	35.451	16.252
5.54357 GHz	35.456	16.249
5.54497 GHz	35.448	16.251

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5.54638 GHz	35.445	16.242
5.54779 GHz	35.447	16.244
5.54919 GHz	35.450	16.255
5.55060 GHz	35.446	16.245
5.55200 GHz	35.440	16.252
5.55341 GHz	35.447	16.261
5.55481 GHz	35.445	16.248
5.55622 GHz	35.435	16.246
5.55763 GHz	35.449	16.239
5.55903 GHz	35.443	16.243
5.56044 GHz	35.438	16.247
5.56184 GHz	35.431	16.246
5.56325 GHz	35.436	16.251
5.56465 GHz	35.418	16.242
5.56606 GHz	35.423	16.257
5.56746 GHz	35.422	16.240
5.56887 GHz	35.420	16.246
5.57028 GHz	35.429	16.251
5.57168 GHz	35.411	16.249
5.57309 GHz	35.418	16.255
5.57449 GHz	35.415	16.257
5.57590 GHz	35.412	16.252
5.57730 GHz	35.399	16.245
5.57871 GHz	35.403	16.255
5.58012 GHz	35.396	16.258
5.58152 GHz	35.388	16.251
5.58293 GHz	35.387	16.248
5.58433 GHz	35.386	16.251
5.58574 GHz	35.407	16.259
5.58714 GHz	35.389	16.268
5.58855 GHz	35.382	16.271
5.58995 GHz	35.384	16.269
5.59000 GHz	35.380	16.257

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Head Simulating Liquid Parameters for 5805MHz

October 5, 2015 02:50 PM

Frequency	e'	e"
5.76000 GHz	35.243	16.321
5.76024 GHz	35.237	16.328
5.76164 GHz	35.233	16.321
5.76305 GHz	35.235	16.317
5.76445 GHz	35.236	16.323
5.76586 GHz	35.229	16.323
5.76726 GHz	35.232	16.315
5.76867 GHz	35.227	16.319
5.77008 GHz	35.214	16.316
5.77148 GHz	35.228	16.319
5.77289 GHz	35.227	16.314
5.77429 GHz	35.228	16.302
5.77570 GHz	35.223	16.306
5.77108 GHz	35.215	16.297
5.77851 GHz	35.220	16.305
5.77991 GHz	35.230	16.300
5.78132 GHz	35.212	16.299
5.78273 GHz	35.210	16.296
5.78413 GHz	35.214	16.296
5.78554 GHz	35.207	16.299
5.78694 GHz	35.199	16.300
5.78835 GHz	35.194	16.300
5.78975 GHz	35.191	16.294
5.79116 GHz	35.202	16.304
5.79257 GHz	35.187	16.289
5.79397 GHz	35.179	16.294
5.79538 GHz	35.186	16.293
5.79678 GHz	35.179	16.291
5.79819 GHz	35.170	16.291
5.79959 GHz	35.171	16.295
5.80100 GHz	35.182	16.292
5.80240 GHz	35.175	16.292
5.80381 GHz	35.167	16.289

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5.80522 GHz	35.174	16.294
5.80662 GHz	35.165	16.296
5.80803 GHz	35.155	16.298
5.80943 GHz	35.151	16.304
5.81084 GHz	35.139	16.292
5.81224 GHz	35.129	16.277
5.81365 GHz	35.141	16.284
5.81506 GHz	35.123	16.299
5.81646 GHz	35.119	16.291
5.81787 GHz	35.106	16.295
5.81927 GHz	35.108	16.292
5.82068 GHz	35.104	16.295
5.82208 GHz	35.102	16.287
5.82349 GHz	35.110	16.296
5.82489 GHz	35.116	16.291
5.82630 GHz	35.104	16.298
5.82771 GHz	35.096	16.299
5.82911 GHz	35.104	16.298
5.83052 GHz	35.070	16.298
5.83192 GHz	35.083	16.303
5.83333 GHz	35.071	16.292
5.83473 GHz	35.079	16.302
5.83614 GHz	35.083	16.310
5.83755 GHz	35.082	16.313
5.83895 GHz	35.096	16.323
5.84000 GHz	35.091	16.334

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Body Simulating Liquid Parameters for 5280MHz

October 8, 2015 02:36 PM

Frequency	e'	e"
5.20000 GHz	50.759	18.838
5.20320 GHz	50.764	18.834
5.20640 GHz	50.778	18.844
5.20960 GHz	50.760	18.840
5.21280 GHz	50.751	18.835
5.21600 GHz	50.757	18.847
5.21920 GHz	50.756	18.845
5.22240 GHz	50.762	18.844
5.22560 GHz	50.755	18.854
5.22880 GHz	50.731	18.849
5.23200 GHz	50.731	18.855
5.23520 GHz	50.727	18.851
5.23840 GHz	50.726	18.851
5.24160 GHz	50.724	18.851
5.24480 GHz	50.710	18.854
5.24800 GHz	50.693	18.863
5.25120 GHz	50.685	18.859
5.25440 GHz	50.666	18.854
5.25760 GHz	50.661	18.856
5.26080 GHz	50.644	18.847
5.26400 GHz	50.644	18.860
5.26720 GHz	50.636	18.882
5.27040 GHz	50.632	18.884
5.27360 GHz	50.631	18.861
5.27680 GHz	50.623	18.883
5.28000 GHz	50.615	18.879
5.28320 GHz	50.602	18.890
5.28640 GHz	50.587	18.896
5.28960 GHz	50.584	18.900
5.29280 GHz	50.595	18.903
5.29600 GHz	50.589	18.906
5.29920 GHz	50.582	18.920
5.30240 GHz	50.585	18.919

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5.30560 GHz	50.585	18.917
5.30880 GHz	50.561	18.927
5.31200 GHz	50.573	18.937
5.31520 GHz	50.564	18.939
5.31840 GHz	50.563	18.947
5.32160 GHz	50.565	18.932
5.32480 GHz	50.558	18.930
5.32800 GHz	50.562	18.959
5.33120 GHz	50.545	18.946
5.33440 GHz	50.541	18.953
5.33760 GHz	50.545	18.957
5.34080 GHz	50.540	18.958
5.34400 GHz	50.533	18.959
5.34720 GHz	50.519	18.960
5.35040 GHz	50.527	18.948
5.35360 GHz	50.524	18.958
5.35680 GHz	50.511	18.952
5.36000 GHz	50.506	18.958

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Body Simulating Liquid Parameters for 5540MHz

October 8, 2015 04:30 PM

Frequency	e'	e"
5.50000 GHz	50.652	19.409
5.50140 GHz	50.636	19.422
5.50281 GHz	50.633	19.416
5.50421 GHz	50.642	19.419
5.50562 GHz	50.622	19.421
5.50702 GHz	50.618	19.422
5.50843 GHz	50.617	19.411
5.50983 GHz	50.613	19.422
5.51124 GHz	50.607	19.431
5.51265 GHz	50.598	19.436
5.51405 GHz	50.596	19.427
5.51546 GHz	50.588	19.435
5.51686 GHz	50.589	19.437
5.51827 GHz	50.578	19.441
5.51967 GHz	50.581	19.435
5.52108 GHz	50.580	19.459
5.52248 GHz	50.586	19.452
5.52389 GHz	50.569	19.448
5.52530 GHz	50.568	19.449
5.52670 GHz	50.576	19.443
5.52811 GHz	50.580	19.455
5.52951 GHz	50.567	19.452
5.53092 GHz	50.575	19.451
5.53232 GHz	50.572	19.462
5.53373 GHz	50.561	19.457
5.53514 GHz	50.569	19.454
5.53654 GHz	50.550	19.453
5.53795 GHz	50.559	19.452
5.53935 GHz	50.550	19.453
5.54076 GHz	50.546	19.439
5.54216 GHz	50.551	19.452
5.54357 GHz	50.556	19.448
5.54497 GHz	50.548	19.451

5.54638 GHz	50.546	19.442
5.54779 GHz	50.547	19.443
5.54919 GHz	50.550	19.455
5.55060 GHz	50.546	19.445
5.55200 GHz	50.541	19.451
5.55341 GHz	50.547	19.461
5.55481 GHz	50.545	19.448
5.55622 GHz	50.535	19.446
5.55763 GHz	50.549	19.430
5.55903 GHz	50.544	19.443
5.56044 GHz	50.538	19.447
5.56184 GHz	50.532	19.445
5.56325 GHz	50.536	19.451
5.56465 GHz	50.518	19.442
5.56606 GHz	50.524	19.458
5.56746 GHz	50.522	19.440
5.56887 GHz	50.520	19.446
5.57028 GHz	50.529	19.452
5.57168 GHz	50.512	19.449
5.57309 GHz	50.518	19.454
5.57449 GHz	50.515	19.457
5.57590 GHz	50.512	19.452
5.57730 GHz	50.499	19.444
5.57871 GHz	50.402	19.455
5.58012 GHz	50.496	19.458
5.58152 GHz	50.488	19.452
5.58293 GHz	50.487	19.448
5.58433 GHz	50.486	19.451
5.58574 GHz	50.408	19.457
5.58714 GHz	50.489	19.468
5.58855 GHz	50.482	19.471
5.58995 GHz	50.484	19.468
5.59000 GHz	50.473	19.469

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Body Simulating Liquid Parameters for 5805MHz

October 8, 2015 05:40 PM

Frequency	e’	e”
5.76000 GHz	50.443	19.521
5.76024 GHz	50.437	19.528
5.76164 GHz	50.434	19.521
5.76305 GHz	50.435	19.527
5.76445 GHz	50.437	19.523
5.76586 GHz	50.429	19.523
5.76726 GHz	50.433	19.535
5.76867 GHz	50.427	19.539
5.77008 GHz	50.413	19.536
5.77148 GHz	50.428	19.539
5.77289 GHz	50.427	19.534
5.77429 GHz	50.426	19.532
5.77570 GHz	50.423	19.536
5.77108 GHz	50.415	19.537
5.77851 GHz	50.421	19.545
5.77991 GHz	50.430	19.540
5.78132 GHz	50.412	19.549
5.78273 GHz	50.411	19.546
5.78413 GHz	50.414	19.546
5.78554 GHz	50.406	19.549
5.78694 GHz	50.399	19.547
5.78835 GHz	50.396	19.540
5.78975 GHz	50.391	19.554
5.79116 GHz	50.372	19.557
5.79257 GHz	50.384	19.559
5.79397 GHz	50.379	19.554
5.79538 GHz	50.386	19.553
5.79678 GHz	50.376	19.551
5.79819 GHz	50.370	19.551
5.79959 GHz	50.371	19.555
5.80100 GHz	50.383	19.552
5.80240 GHz	50.375	19.562
5.80381 GHz	50.367	19.569

5.80522 GHz	50.376	19.564
5.80662 GHz	50.365	19.566
5.80803 GHz	50.355	19.568
5.80943 GHz	50.352	19.564
5.81084 GHz	50.339	19.562
5.81224 GHz	50.325	19.567
5.81365 GHz	50.341	19.564
5.81506 GHz	50.323	19.569
5.81646 GHz	50.317	19.571
5.81787 GHz	50.306	19.575
5.81927 GHz	50.309	19.572
5.82068 GHz	50.304	19.575
5.82208 GHz	50.302	19.577
5.82349 GHz	50.312	19.576
5.82489 GHz	50.316	19.571
5.82630 GHz	50.304	19.578
5.82771 GHz	50.295	19.579
5.82911 GHz	50.304	19.578
5.83052 GHz	50.270	19.588
5.83192 GHz	50.284	19.583
5.83333 GHz	50.271	19.582
5.83473 GHz	50.279	19.582
5.83614 GHz	50.281	19.580
5.83755 GHz	50.282	19.583
5.83895 GHz	50.296	19.583
5.84000 GHz	50.292	19.584

APPENDIX K

PHANTOM CERTIFICATE OF CONFORMITY

Schmid & Partner Engineering AG
s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 1 245 9700, Fax +41 1 245 9779
info@speag.com, http://www.speag.com

Certificate of conformity / First Article Inspection

Item	SAM Twin Phantom V4.0
Type No	QD 000 P40 C
Series No	TP-1150 and higher
Manufacturer / Origin	Untersee Composites Hauptstr. 69 CH-8559 Fruthwilen Switzerland

Tests

The series production process used allows the limitation to test of first articles.
Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

Test	Requirement	Details	Units tested
Shape	Compliance with the geometry according to the CAD model.	IT'IS CAD File (*)	First article, Samples
Material thickness	Compliant with the requirements according to the standards	2mm +/- 0.2mm in specific areas; 6mm +/- 0.2mm at ERP	First article, Samples
Material parameters	Dielectric parameters for required frequencies	200 MHz – 3 GHz Relative permittivity < 5 Loss tangent < 0.05.	Material sample TP 104-5
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions	DEGMBE based simulating liquids	Pre-series, First article, Samples

Standards

[1] CENELEC EN 50361
[2] IEEE Std 1528-200x Draft CD 1.1 (Dec 02)
[3] IEC 62209/CD (Nov 02)
(*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

Date 7.8.2003

Signature / Stamp

s p e a g
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APPENDIX L

2.4 GHz & 5.0 GHz Antenna Return Loss

2.4GHz Antenna

5.0GHz Antenna

Dipole Validation Summary

Freq (MHz)	Date	Probe S/N	Probe Type	Probe Cal Point		Cond	Perm	CW Validation			Modulation Validation		
								Sensitivity	Probe Linearity	Probe Isotropy	Mod Type	Duty Factor	PAR
2450	10/12/2015	3722	EX3DV4	2450	Head	1.89	38.2	Pass	Pass	Pass	DSSS	Pass	Pass
2450	10/13/2015	3722	EX3DV4	2450	Body	2.05	50.7	Pass	Pass	Pass	DSSS	Pass	Pass
5200	10/04/2015	3722	EX3DV4	5200	Head	4.60	35.4	Pass	Pass	Pass	OFDM	N/A	Pass
5500	10/04/2015	3722	EX3DV4	5500	Head	4.95	35.5	Pass	Pass	Pass	OFDM	N/A	Pass
5800	10/04/2015	3722	EX3DV4	5800	Head	5.25	35.1	Pass	Pass	Pass	OFDM	N/A	Pass
5200	10/09/2015	3722	EX3DV4	5200	Body	5.43	50.7	Pass	Pass	Pass	OFDM	N/A	Pass
5500	10/09/2015	3722	EX3DV4	5500	Body	5.92	50.6	Pass	Pass	Pass	OFDM	N/A	Pass
5800	10/09/2015	3722	EX3DV4	5800	Body	6.34	50.3	Pass	Pass	Pass	OFDM	N/A	Pass

Table 18: Dipole validation summary.

SAR, Impedance & Return Loss Stability Report For Dipole Antennas

Date	Laboratory	Frequency	S/N	Head SAR (W/kg)	Body SAR (W/kg)	Impedance	Return Loss
07/22/2013	SPEAG	2450	857	13.4	13.0	54.5Ω + 4.2jΩ	-24.6dB
08/06/2014	MET Labs	2450	857	13.9	13.4	49.2Ω + 3.4jΩ	-18.3dB
10/13/2015	MET Labs	2450	857	14.1	13.8	56.5Ω + 4.6jΩ	-20.8dB

Table 19: SAR, impedance and return loss stability report for 2450MHz, 2.4GHz dipole antenna.

Date	Laboratory	Frequency	S/N	Head SAR (W/kg)	Body SAR (W/kg)	Impedance	Return Loss
07/24/2013	SPEAG	5200	2571	7.16	6.74	43.8Ω - 17.6jΩ	-14.2dB
08/07/2014	MET Labs	5200	2571	7.23	6.98	50.1Ω - 15.6jΩ	-17.5dB
10/9/2015	MET Labs	5200	2571	6.83	6.25	51.2Ω - 16.7jΩ	-15.6dB

Table 20: SAR, impedance and return loss stability report for 5200MHz, 5GHz dipole antenna.

Date	Laboratory	Frequency	S/N	Head SAR (W/kg)	Body SAR (W/kg)	Impedance	Return Loss
07/24/2013	SPEAG	5500	2571	7.00	6.59	38.2Ω - 32.5jΩ	-8.7dB
08/07/2014	MET Labs	5500	2571	7.46	6.92	41.8Ω - 29.2jΩ	-9.8dB
10/9/2015	MET Labs	5500	2571	7.61	6.38	40.6Ω - 28.7jΩ	-10.1dB

Table 21: SAR, impedance and return loss stability report for 5500MHz, 5GHz dipole antenna.

Date	Laboratory	Frequency	S/N	Head SAR (W/kg)	Body SAR (W/kg)	Impedance	Return Loss
07/24/2013	SPEAG	5800	2571	6.76	6.44	55.8Ω - 18.0jΩ	-15.1dB
08/07/2014	MET Labs	5800	2571	6.34	6.12	52.7Ω - 20.9jΩ	-16.6dB
10/9/2015	MET Labs	5800	2571	7.12	5.98	50.2Ω - 21.7jΩ	-17.4dB

Table 22: SAR, impedance and return loss stability report for 5800MHz, 5GHz dipole antenna.

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