

# Appendix C. Calibration Certificate for Probe and Dipole

The SPEAG calibration certificates are shown as follows.

Report Format Version 5.0.0 Issued Date : Aug. 26, 2013

Report No.: SA130716C20

Revision: R01

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





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

Accreditation No.: SCS 108

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Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA

Certificate No: D750V3-1013\_Apr13

(nebuA) TGA .V.8

# CALIBRATION CERTIFICATE

Multilateral Agreement for the recognition of calibration certificates

Object D\2003 - SN: 1013

QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz

Calibration procedure(s)

Calibration date: April 25, 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 ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

			lssued: April 26, 2013
<b>У</b> bbгоved by:	Katja Pokovic	Technical Manager	12/2/
Calibrated by:	Name Claudio Leubler	Function Laboratory Technician	Signature
PF generator P&S SMT-06 Network Analyzer HP 8753E	100002	04-Aug-99 (in house check Oct-12) 18-Oct-01 (in house check Oct-12)	In house check: Oct-13
A 1848 9H nornes newor	71629014YM	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
Secondary Standards	# <b>a</b> l	Check Date (in house)	Scheduled Check
D∀E¢	606 :NS	11-Sep-12 (No. DAE4-909_Sep12)	Sep-13
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
Type-N mismatch combination	72680 \ E. 7403 : NS	04-4Apr-13 (No. 217-01739)	4r-14
Reference 20 dB Attenuator	2N: 2028 (S0K)	04-Apr-13 (No. 217-01736)	4t-14
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Primary Standards	# al	Cal Date (Certificate No.)	Scheduled Calibration

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

Accreditation No.: SCS 108





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Multilateral Agreement for the recognition of calibration certificates

Glossary:

A\N ConvE

JST

biupil gnitalumis eussit

not applicable or not measured sensitivity in TSL / JORM x,y,z

Calibration is Performed According to the Following Standards:

b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held Communications Devices: Measurement Techniques", December 2003 Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-

Federal Communications Commission Office of Engineering & Technology (FCC OET), February 2005 devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)",

Supplement C (Edition 01-01) to Bulletin 65 Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency

## Additional Documentation:

d) DASY4/5 System Handbook

# Methods Applied and Interpretation of Parameters:

- point exactly below the center marking of the flat phantom section, with the arms oriented Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed of the certificate. All figures stated in the certificate are valid at the frequency indicated. Measurement Conditions: Further details are available from the Validation Report at the end
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole parallel to the body axis.
- reflected power. No uncertainty required. measurement at the SMA connector to the feed point. The Return Loss ensures low positioned under the liquid filled phantom. The impedance stated is transformed from the
- No uncertainty required. Electrical Delay: One-way delay between the SMA connector and the antenna feed point.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna SAR measured: SAR measured at the stated antenna input power.
- connector.
- nominal SAR result. SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the

probability of approximately 95%. multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage The reported uncertainty of measurement is stated as the standard uncertainty of measurement

## Measurement Conditions

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

Frequency	ZHM L = ZHM 09L	
Zoom Scan Resolution	mm g = zb , yb , xb	
Distance Dipole Center - TSL	աա ցլ	with Spacer
Motom	Modular Flat Phantom	
Extrapolation	Advanced Extrapolation	
nois19V YSAO	DASY5	9.8.23V

## Head TSL parameters

Head TSL temperature change during test	J° 5.0 >		7117
Measured Head TSL parameters	J° (S.0 ± 0.SS)	% 9 ± 0.14	% 9 ± m/o/m S6.0
Nominal Head TSL parameters	22.0 °C	6.14	m/odm 68.0
	Temperature	Permittivity	Conductivity

## SAR result with Head TSL

8.66 W/kg $\pm$ 17.0 % (k=2)	Wt of besilamion	PAR for nominal Head TSL parameters
2.23 W/kg	S20 mW input power	Paureasured
	Condition	AR averaged over 1 cm³ (1 g) of Head TSL

2.66 W/kg ± 16.5 % (k=2)	W1 of besilamon	SAR for nominal Head TSL parameters
1.45 W/kg	250 mW input power	SAR measured
	condition	SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL

## Body TSL parameters

Body TSL temperature change during test	O° 5.0 >	*****	
Measured Body TSL parameters	O° (S.0 ± 0.SS)	% 9 ∓ l' <del>þ</del> 9	% 9 ± m/o/m 86.0
Nominal Body TSL parameters	22.0 °C	5.33	m/o/m 96.0
	Temperature	Permittivity	Conductivity

## SAR result with Body TSL

1.48 W/kg	250 mW input power	SAR measured
	condition	SAR averaged over 10 cm $^3$ (10 g) of Body TSL
8.81 W/kg ± 17.0 % (k=2)	Wf of besilemion	SAR for nominal Body TSL parameters
2.25 W/kg	250 mW input power	SAP measured
	Condition	SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL

Wr of besilsmon

 $2.82 \text{ W/kg} \pm 16.5 \% \text{ (k=2)}$ 

SAR for nominal Body TSL parameters

## xibnəqqA

#### Antenna Parameters with Head TSL

Return Loss	ab s.92 -
Impedance, transformed to feed point	Ωį 7.0 - Ω 2.63

## Antenna Parameters with Body TSL

Return Loss	Bb 6.06 -
Impedance, transformed to feed point	Ω[ 8.S - Ω 8.8 <del>\</del>

# General Antenna Parameters and Design

an 360. f	Electrical Delay (one direction)
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still ascording to the Standard

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**

March 22, 2010	Manufactured on
SPEAG	Manufactured by

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1013

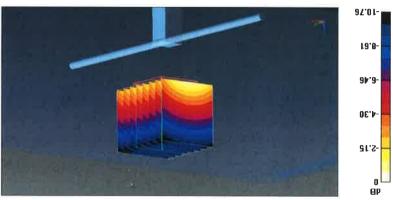
Communication System: UID 0 – CW, Frequency: 750 MHz Medium parameters used: f = 750 MHz;  $\sigma = 0.92$  S/m;  $\epsilon_r = 41$ ;  $\rho = 1000$  kg/m<sup>3</sup> Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

## DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.28, 6.28, 6.28); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 11.09.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

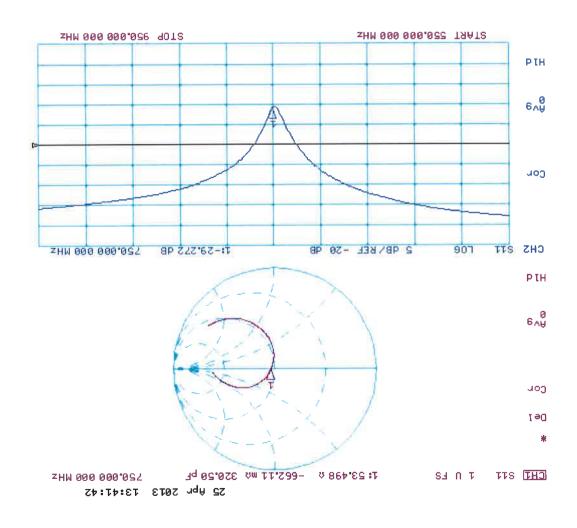
# Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x8x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 54.217 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 3.44 W/kg SAR(1 g) = 2.23 W/kg; SAR(10 g) = 1.45 W/kg Maximum value of SAR (measured) = 2.60 W/kg



0 dB = 2.60 W/kg = 4.15 dBW/kg

# Impedance Measurement Plot for Head TSL



Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1013

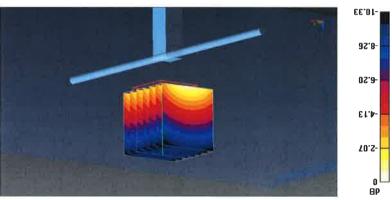
Communication System: UID 0 - CW Frequency: 750 MHz Medium parameters used: f = 750 MHz;  $\sigma = 0.98$  S/m;  $\epsilon_r = 54.1$ ;  $\rho = 1000$  kg/m Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.11, 6.11); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 11.09.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASYS2 52.8.6(1115); SEMCAD X 14.6.9(7117)

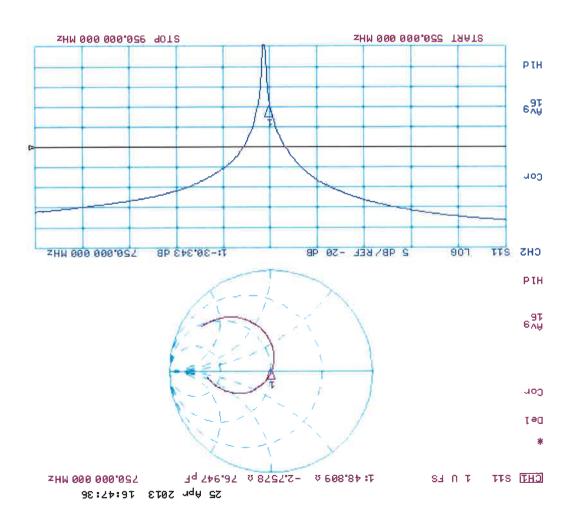
# Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 53.330 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 3.32 W/kg SAR(1 g) = 2.25 W/kg; SAR(10 g) = 1.48 W/kg Maximum value of SAR (measured) = 2.62 W/kg



0 dB = 2.62 W/kg = 4.18 dBW/kg

# Impedance Measurement Plot for Body TSL



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





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Multilateral Agreement for the recognition of calibration certificates The Swiss Accreditation Service is one of the signatories to the EA

Certificate No: D835V2-4d121\_Apr13

# CALIBRATION CERTIFICATE

D832V2 - SN: 44121 Object

QA CAL-05.v9

Calibration procedure(s)

Client

Calibration procedure for dipole validation kits above 700 MHz

April 25, 2013 Calibration date:

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

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

Calibration Equipment used (M&TE critical for calibration)

			Issued: April 26, 2013
ybbioved by:	Katja Pokovic	Technical Manager	120
Salibrated by:	Изте Claudio Leubler	Function Laboratory Technician	Signaturangi2
letwork Analyzer HP 8753E	90242 585065762U	18-Oct-01 (in house check Oct-12)	In house check: Oct-13
F generator R&S SMT-06	100005	(L1-toO koeck Oct-11)	ln house check: Oct-13
A1848 9H rosnas rawo	MY41092317	18-Oct-02 (in house check Oct-11)	ln house check: Oct-13
Secondary Standards	# <b>d</b> l	Check Date (in house)	Scheduled Check
) <b>∀</b> E4	606 :NS	11-Sep-12 (No. DAE4-909_Sep12)	St-q <del>s</del> 2
3eference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
γρe-Ν mismatch combination	5N: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	4pr-14
deference 20 dB Attenuator	2N: 2028 (50K)	04-Apr-13 (No. 217-01736)	₽1-1qA
A1848 9H rosnes rewo	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
ower meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13

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## Glossary:

A/N

**TSL** 

ConvF

not applicable or not measured sensitivity in TSL / NORM x,y,z biupil gnitalumis eussit

# Calibration is Performed According to the Following Standards:

- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held Communications Devices: Measurement Techniques", December 2003 Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), February 2005 devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)",
- Supplement C (Edition 01-01) to Bulletin 65 Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency

## Additional Documentation:

d) DASY4/5 System Handbook

# Methods Applied and Interpretation of Parameters:

- point exactly below the center marking of the flat phantom section, with the arms oriented Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed of the certificate. All figures stated in the certificate are valid at the frequency indicated. Measurement Conditions: Further details are available from the Validation Report at the end
- measurement at the SMA connector to the feed point. The Return Loss ensures low positioned under the liquid filled phantom. The impedance stated is transformed from the Feed Point Impedance and Return Loss: These parameters are measured with the dipole parallel to the body axis.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point. reflected power. No uncertainty required.
- No uncertainty required.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna SAR measured: SAR measured at the stated antenna input power.
- connector.
- nominal SAR result. SAH for nominal 1SL parameters: The measured TSL parameters are used to calculate the

probability of approximately 95%. multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage The reported uncertainty of measurement is stated as the standard uncertainty of measurement

## Measurement Conditions

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

Freduency	ZHM L ± ZHM 3E8	
Zoom Scan Resolution	mm g = zb, yb, xb	
Distance Dipole Center - TSL	աա ցլ	with Spacer
Phantom	Modular Flat Phantom	
Extrapolation	Advanced Extrapolation	
DASY Version	DASY5	9.8.23V

## Head TSL parameters

Head TSL temperature change during test	O° 6.0 >		7110
Measured Head TSL parameters	J° (S.0 ± 0.SS)	% 9 <del>+</del> 8.04	% 9 ± m/o/m 46.0
Nominal Head TSL parameters	22.0 °C	3.14	m/odm 06.0
	Temperature	Permittivity	Conductivity

## SAR result with Head TSL

9.68 W/kg ± 17.0 % (k=2)	W1 of besilamion	FAR for nominal Head TSL parameters
2.51 W/kg	250 mW input power	рэлигвэт НА
	Condition	AR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL

6.30 W/kg ± 16.5 % (k=2)	W1 of besilemion	SAR for nominal Head TSL parameters
1.62 W/kg	250 mW input power	Deausem AAS
	condition	SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL

## Body TSL parameters

The following parameters and calculations were applied.

Body TSL temperature change during test	O∘ ∂.0 >	1-240	
Measured Body TSL parameters	°(S2.0 ± 0.2S)	% 9 <del>+</del> 0.43	% 8 ± m\orlm f0.f
Nominal Body TSL parameters	22.0 °C	55.2	m\odm \76.0
	Temperature	Permittivity	Conductivity

## SAR result with Body TSL

	condition	SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL
9.69 W/kg ± 17.0 % (k=2)	W1 of bazilsmron	SAR for nominal Body TSL parameters
2.51 W/kg	250 mW input power	SAR measured
	Condition	SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL

6.38 W/kg ± 16.5 % (k=2)	W1 of besilsmoon	SAR for nominal Body TSL parameters
1.64 W/kg	250 mW input power	SAR measured
	condition	SAR averaged over 10 cm $^3$ (10 g) of Body TSL

## xibneqqA

#### Antenna Parameters with Head TSL

ıtırın Loss	Bb S.05 -
pedance, transformed to feed point	Ω[ 1.S - Ω 4.Sδ

#### Antenna Parameters with Body TSL

Bb 9.82 -	Setum Loss
Ω[ 8.ε - Ω 4.74	Impedance, transformed to feed point

# General Antenna Parameters and Design

an 395. ľ	Electrical Delay (one direction)
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

Accessive 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**

0102 ,e2 9nul	no benufactured
SPEAG	Manufactured by

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d121

Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f=835 MHz;  $\sigma=0.94$  S/m;  $\epsilon_r=40.8$ ;  $\rho=1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.05, 6.05); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 11.09.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

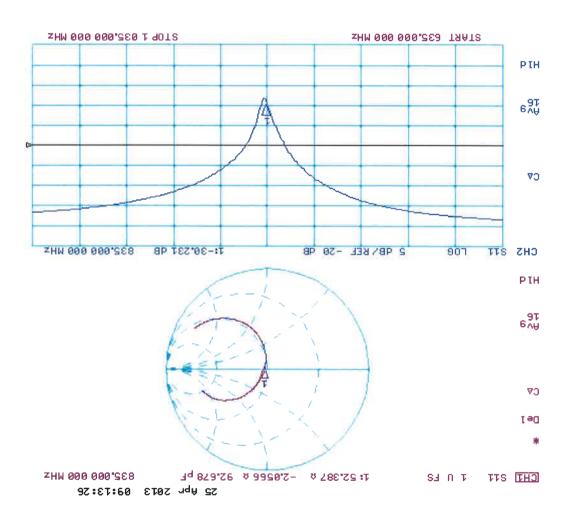
Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 57.380 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 3.86 W/kg SAR(1 g) = 2.51 W/kg; SAR(10 g) = 1.62 W/kg

Maximum value of SAR (measured) = 2.94 W/kg

10°L1-

0 dB = 2.94 W/kg = 4.68 dBW/kg

## Impedance Measurement Plot for Head TSL



Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d121

Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma = 1.01$  S/m;  $\epsilon_r = 54$ ;  $\rho = 1000$  kg/m<sup>3</sup> Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

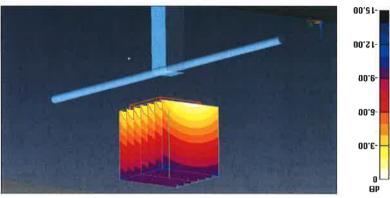
#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 11,09.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASYS2 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

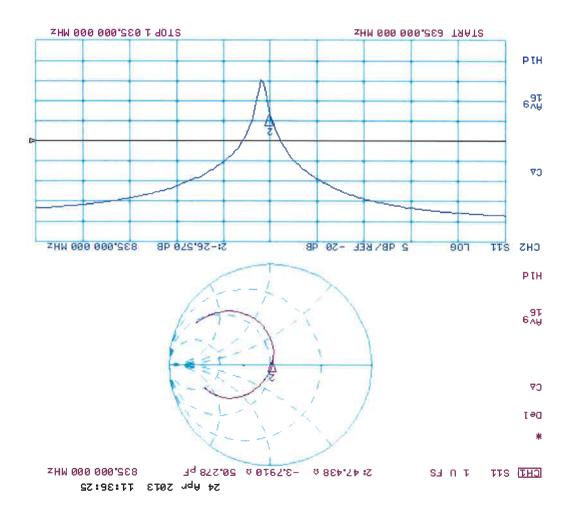
Measurement grid: dx=5mm, dy=5mm, dz=5mm Acference Value = 55.573 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 3.72 W/kg SAR(10 g) = 1.64 W/kg SAR(1 g) = 2.51 W/kg; SAR(10 g) = 1.64 W/kg

SAR(1 g) = 2.51 W/kg; SAR(10 g) = 1.64 W/kgMaximum value of SAR (measured) = 2.93 W/kg



0 dB = 2.93 W/kg = 4.67 dBW/kg

## Impedance Measurement Plot for Body TSL



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Certificate No: D1750V2-1023\_Jun13

# CALIBRATION CERTIFICATE

D1750V2 - SN: 102	Object

Calibration Equipment used (M&TE critical for calibration)

Calibration procedure for dipole validation kits above 700 MHz QA CAL-05.v9

Calibration procedure(s)

Auden

Client

June 11, 2013

Calibration date:

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

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

Jetwork Analyzer HP 8753E	0237390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13
3F generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-1)	In house check: Oct-13
A1848 9H sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
Secondary Standards	# <b>QI</b>	Check Date (in house)	Scheduled Check
₽∃∀0	NS	25-Apr-13 (No. DAE4-601_Apr13)	4r-14A
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
ype-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	41-1qA
Reference 20 dB Attenuator	2N: 2028 (S0K)	04-Apr-13 (No. 217-01736)	4r-1qA
Ower sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
ower meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Primary Standards	# QI	Cal Date (Certificate No.)	Scheduled Calibration

Issued: June 13, 2013

Signature

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

Katja Pokovic

Jeton Kastrati

Изте

Technical Manager

Laboratory Technician

Function

Approved by:

Calibrated by:

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





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Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

Multilateral Agreement for the recognition of calibration certificates The Swiss Accreditation Service is one of the signatories to the EA

TSL Glossary:

A\N

COUNT

biupil gnitalumia eussif

not applicable or not measured sensitivity in TSL / NORM x,y,z

Calibration is Performed According to the Following Standards:

b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held Communications Devices: Measurement Techniques", December 2003 Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-

"Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency c) Federal Communications Commission Office of Engineering & Technology (FCC OET), February 2005 devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)",

Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and

Supplement C (Edition 01-01) to Bulletin 65

#### d) DASY4/5 System Handbook Additional Documentation:

## Methods Applied and Interpretation of Parameters:

- of the certificate. All figures stated in the certificate are valid at the frequency indicated. Measurement Conditions: Further details are available from the Validation Report at the end
- parallel to the body axis. point exactly below the center marking of the flat phantom section, with the arms oriented Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed
- reflected power. No uncertainty required. measurement at the SMA connector to the feed point. The Return Loss ensures low positioned under the liquid filled phantom. The impedance stated is transformed from the Feed Point Impedance and Return Loss: These parameters are measured with the dipole
- No uncertainty required. Electrical Delay: One-way delay between the SMA connector and the antenna feed point.
- 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
- nominal SAR result. SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the

probability of approximately 95%. multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage The reported uncertainty of measurement is stated as the standard uncertainty of measurement

# Measurement Conditions

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

Frequency	ZHW L ∓ ZHW 09ZL	
Zoom Scan Resolution	mm 2 = zb , yb , xb	
Distance Dipole Center - TSL	тт 01	with Spacer
Phantom	Modular Flat Phantom	
Extrapolation	Advanced Extrapolation	
DASY Version	DASY5	7.8.23V

## Head TSL parameters

The following parameters and calculations were applied.

Head TSL temperature change during test	O° 5.0 >	4-4-7	
Measured Head TSL parameters	O° (S2.0 ± 0.S2)	% 9 ∓ 1.6E	% 8 ± m\odm SE.1
Nominal Head TSL parameters	22.0 °C	1.04	m\odm \c.t
	Temperature	Permittivity	Conductivity

#### SAR result with Head TSL

AA for nominal Head TSL parameters	W1 of besilamion	32:9 W/kg ± 17.0 % (k=2)
Panasam AA	250 mW input power	8.83 W/kg
AR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	

19:1 W/kg ± 16.5 % (k=2)	W1 of besilamon	SAR for nominal Head TSL parameters
4.72 W/kg	250 mW input power	SAR measured
	condition	SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL

# Body TSL parameters

The following parameters and calculations were applied.

	1-44	O° 6.0 >	Body TSL temperature change during test
% 9 ± m/odm 13.1	% 9 ∓ L'19	O° (S.0 ± 0.SS)	Measured Body TSL parameters
m\odm 64.1	4.63	22.0 °C	Nominal Body TSL parameters
Conductivity	Permittivity	Temperature	

# SAR result with Body TSL

37.1 W/kg ± 17.0 % (k=2)	Wt of besilsmon	SAB for nominal Body TSL parameters
9.41 W/kg	250 mW input power	SAR measured
	Condition	SAR averaged over 1 cm3 (1 g) of Body TSL

20.0 W/kg ± 16.5 % (k=2)	W1 of besilsmon	SAR for nominal Body TSL parameters
5.06 W√kg	250 mW input power	SAR measured
	condition	SAR averaged over 10 cm3 (10 g) of Body TSL

## xibneqqA

#### Antenna Parameters with Head TSL

Return Loss	8b S.f.p -
Impedance, transformed to feed point	Ω[ 7.0 + Ω <b>2</b> .03

## Antenna Parameters with Body TSL

Return Loss	8b 2.72 -
Impedance, transformed to feed point	Ω[ 4.0 + Ω 8.34

# General Antenna Parameters and Design

an 612.1	Electrical Delay (one direction)

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.

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

9002 ,0S fauguA	Manufactured on
SPEAG	Manufactured by

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1023

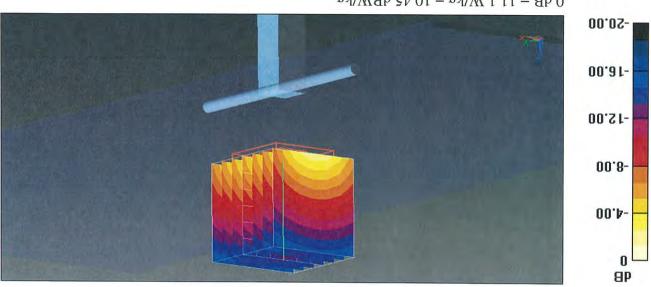
Communication System: UID 0 - CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz;  $\sigma = 1.32$  S/m;  $\epsilon_r = 39.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

## DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.18, 5.18); 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)

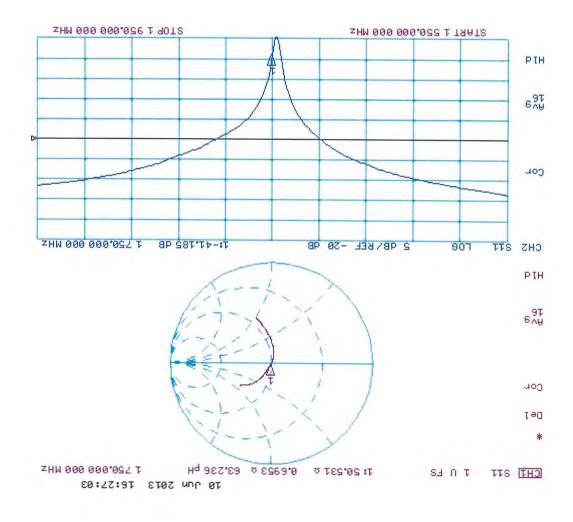
# Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 94.147 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 15.8 W/kg SAR(1 g) = 8.83 W/kg; SAR(10 g) = 4.72 W/kg Maximum value of SAR (measured) = 11.1 W/kg



0 dB = 11.1 W/kg = 10.45 dBW/kg

# Impedance Measurement Plot for Head TSL



Date: 11.06.2013

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1023

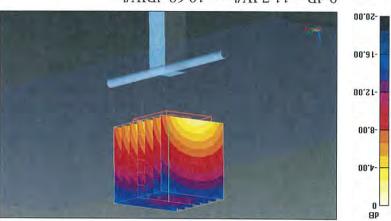
Communication System: UID 0 - CW; Frequency: 1750 MHz Medium parameters used: f=1750 MHz;  $\sigma=1.51$  S/m;  $\epsilon_r=51.7$ ;  $\rho=1000$  kg/m<sup>3</sup> Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

## DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.83, 4.83, 4.83); 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)

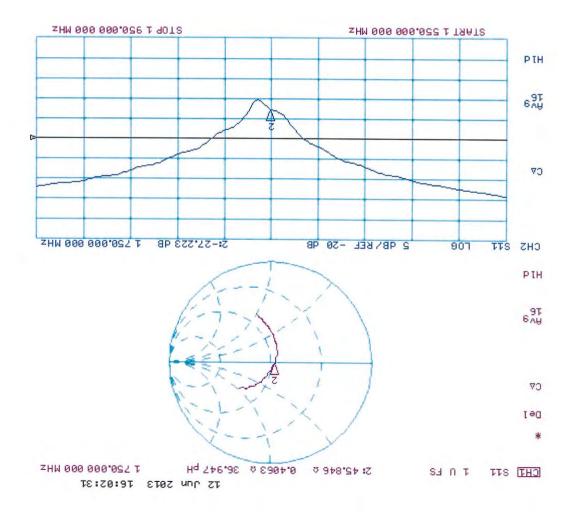
# Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 91.454 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 16.2 W/kg SAR(1 g) = 9.41 W/kg; SAR(10 g) = 5.06 W/kg Maximum value of SAR (measured) = 11.7 W/kg



0 dB = 11.7 W/kg = 10.68 dBW/kg

# Impedance Measurement Plot for Body TSL



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





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

Accreditation No.: SCS 108

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Accredited by the Swiss Accreditation Service (SAS)

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Multilateral Agreement for the recognition of calibration certificates

Certificate No: D1900V2-5d036\_Jan13

Client B.V. ADT (Auden)

# CALIBRATION CERTIFICATE

Object D1900V2 - SN: 54036

QA CAL-05.v9

Calibration procedure(s)

Calibration procedure for dipole validation kits above 700 MHz

January 21, 2013

Calibration date:

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  $(22 \pm 3)^{\circ}$ C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

			Issued: January 22, 2013
урргочед Бу:	Fin Bomholt	Deputy Technical Manager	7 Builil
Calibrated by:	Name Israe El-Naouq	Function Laboratory Technician	Signature G-Down
J6578 PH Jazylank Analyzer	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13
3F generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Ower sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
Secondary Standards	# OI	Check Date (in house)	Scheduled Check
<b>≯∃∀</b> 0	NS	27-Jun-12 (No. DAE4-601_Jun12)	£t-nuL
RVG88 Forms 3	SN: 3505	\$8-Dec-12 (No. ES3-3205_Dec12)	Dec-13
Γγρe-Ν mismatch combination	SN: 5047.3 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Peference 20 dB Attenuator	2N: 2028 (SOK)	27-Mat-12 (No. 217-01530)	£1-1qA
A1848 9H rosnes rewo	US37292783	01-Nov-12 (No. 217-01640)	£1-10O
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	£t-toO

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

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



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

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

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Glossary:

A/N

TSL

ConvF

tissue simulating liquid sensitivity in TSL / NORM x,y,z sensitivity in TSL / MORM xpylicable or not measured

Calibration is Performed According to the Following Standards:

a) IEEE 5td 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 Electrometric Fields Additional Information for Fields and Properties of Mebile and Electrometric Fields (FCC OET).

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.
- Flectrical 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.

Frequency	ZHM I ± ZHM 006 I	
Zoom Scan Resolution	mm ð = sb , yb , xb	
Distance Dipole Center - TSL	տա 0 է	with Spacer
motnsdq	Modular Flat Phantom	
Extrapolation	Advanced Extrapolation	
DASY Version	3Y2AQ	V52.8.5

## Head TSL parameters

The following parameters and calculations were applied.

Head TSL temperature change during test	< 0.5 °C	14447	1,000
Measured Head TSL parameters	O° (S.0 ± 0.2S)	% 9 <del>+</del> 4.65	% 9 ± m\odm 8£.t
Nominal Head TSL parameters	℃ 0.22	0.04	m\odm 04. t
	Temperature	Permittivity	Conductivity

#### SAR result with Head TSL

40.6 W/kg ± 17.0 % (k=2)	W1 of besilsmon	erer nominal Head JST barameters
10.1 W/kg	S20 mW input power	AAS measured
	Condition	AR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL

21.3 W/kg ± 16.5 % (k=2)	W1 of besilsmon	SAR for nominal Head TSL parameters
5.31 W/kg	250 mW input power	PAN measured
	condition	SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL

# Body TSL parameters

The following parameters and calculations were applied.

easured Body TSL parameters	O° (S.0 ± 0.2S)	55.5 52.2 ± 6 %	(% 0 ± m\odm S3.1
ominal Body TSL parameters	22.0 °C	53.3	m\odm S2.f

## SAR result with Body TSL

41.0 W/kg ± 17.0 % (k=2)	W1 of bezilsmron	SAR for nominal Body TSL parameters
10.3 W/kg	S20 mW input power	SAR measured
	Condition	SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL

21.6 W/kg ± 16.5 % (k=2)	Wf of besilamion	SAB for nominal Body TSL parameters
€.42 W/kg	250 mW input power	SAR measured
	condition	SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL

## xibnaqqA

#### Antenna Parameters with Head TSL

Bb 0.82 -	Return Loss
Ω[ 0.2 + Ω 1.13	Impedance, transformed to feed point

## Antenna Parameters with Body TSL

- 24.5 dB	Return Loss
Ω[ 2.2 + Ω 2.74	Impedance, transformed to feed point

# General Antenna Parameters and Design

an 791.1	Electrical Delay (one direction)
	the state of the s

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 cape 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.

Accessive 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**

May 08, 2003	Manufactured on
SPEAG	Manufactured by

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 54036

Communication System: CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma = 1.38$  S/m;  $\epsilon_r = 39.4$ ;  $\rho = 1000$  kg/m<sup>3</sup> Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

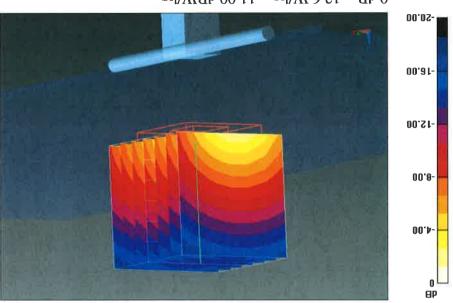
#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.98, 4.98); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DV2X27 27.8.2(1029); ZEWCAD X 14.6.8(7028)

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

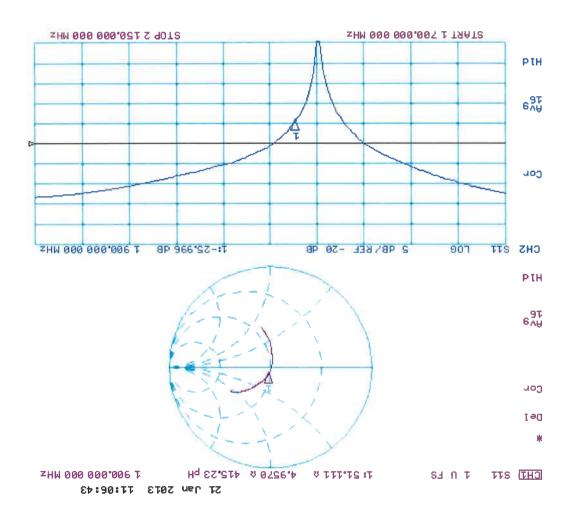
Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 98.363 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 18.4 W/kg

SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.31 W/kgMaximum value of SAR (measured) = 12.6 W/kg



0 dB = 12.6 W/kg = 11.00 dBW/kg

## Impedance Measurement Plot for Head TSL



Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 54036

Communication System: CW; Frequency: 1900 MHz Medium parameters used: f=1900 MHz;  $\sigma=1.52$  S/m;  $\epsilon_r=52.2$ ;  $\rho=1000$  kg/m<sup>3</sup> Phantom section: Flat Section

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

#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.6, 4.6, 4.6); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

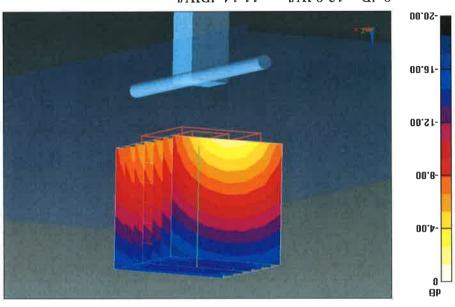
# Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 96.692 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 18.0 W/kg

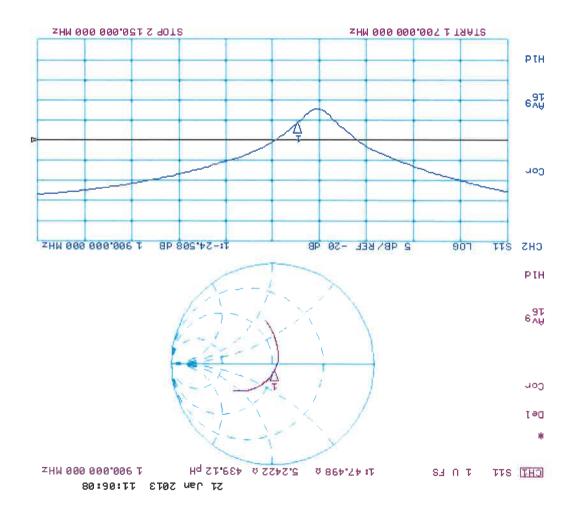
SAR(1 g) = 10.3 W/kg; SAR(10 g) = 5.42 W/kg

Maximum value of SAR (measured) = 13.0 W/kg



0 dB = 13.0 W/kg = 11.14 dBW/kg

# Impedance Measurement Plot for Body TSL



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





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Certificate No: D2450V2-737\_Jan13

B.V. ADT (Auden)

# CALIBRATION CERTIFICATE

D2450V2 - SN: 737

QA CAL-05.v9

Calibration procedure(s)

Calibration procedure for dipole validation kits above 700 MHz

January 21, 2013

Calibration date:

Object

Client

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

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

Calibration Equipment used (M&TE critical for calibration)

Approved by:	Fin Bomholt	Deputy Technical Manager	7. Sundull
			Amy.
Calibrated by:	Leif Klysner	Laboratory Technician	~ (1/4) S
	Язте	Function	Signature
JOCAO III IOZÁIRIIV VIOMONI	003+0 000000 (000	(71, 200, V2011) ecroti III) to 200,01	OT-100 (Nootle seportin
Network Analyzer HP 8753E	0S37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13
AF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Af848 9H ioanas iawo9	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
Secondary Standards	# <b>d</b> l	Check Date (in house)	Scheduled Check
DAE4	SN: 601	(StruuL_t08-4=AG .ON) St-nuL-7S	£t-nuL
Reference Probe ES3DV3	SN: 3505	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
Type-N mismatch combination	SN: 5047.3 / 06327	27-Mar-12 (No. 217-01533)	£t-1qA
Reference 20 dB Attenuator	2N: 2028 (S0K)	27-Mar-12 (No. 217-01530)	£1-1qA
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	6t-t <sub>2</sub> O
Primary Standards	# QI	Cal Date (Certificate No.)	Scheduled Calibration

Issued: January 21, 2013

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Accreditation No.: SCS 108

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Glossary:

A/N

JST

ConvF

not applicable or not measured sensitivity in TSL / NORM x,y,z biupil gnitalumia eusait

Calibration is Performed According to the Following Standards:

b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held Communications Devices: Measurement Techniques", December 2003 Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-

c) Federal Communications Commission Office of Engineering & Technology (FCC OET), February 2005 devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)",

Supplement C (Edition 01-01) to Bulletin 65 Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency

## Additional Documentation:

d) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed of the certificate. All figures stated in the certificate are valid at the frequency indicated. Measurement Conditions: Further details are available from the Validation Report at the end
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole parallel to the body axis. point exactly below the center marking of the flat phantom section, with the arms oriented
- reflected power. No uncertainty required. measurement at the SMA connector to the feed point. The Return Loss ensures low positioned under the liquid filled phantom. The impedance stated is transformed from the
- No uncertainty required. Electrical Delay: One-way delay between the SMA connector and the antenna feed point.
- 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
- nominal SAR result. SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the

probability of approximately 95%. multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage The reported uncertainty of measurement is stated as the standard uncertainty of measurement

## Measurement Conditions

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

Frequency	2450 MHz ± 1 MHz	
Zoom Scan Resolution	mm ð = sb , yb , xb	
Distance Dipole Center - TSL	mm Ot	with Spacer
Phantom	Modular Flat Phantom	
Extrapolation	Advanced Extrapolation	
DASY Version	DASY5	V52.8.5

## Head TSL parameters

The following parameters and calculations were applied.

Head TSL temperature change during test	J° 3.0 >		
Measured Head TSL parameters	J° (S.0 ± 0.SS)	% 9 <del>+</del> 6.7£	% 8 ± m\odm ₹8.1
Nominal Head TSL parameters	22.0 °C	3.65	m\odm 08.t
	Temperature	Permittivity	Conductivity

## SAR result with Head TSL

52.5 W/kg ± 17.0 % (k=2)	W1 of besilsmon	ereters TST band Insimon for PA
13.4 W/kg	250 mW input power	AR measured
	Condition	AR averaged over 1 cm³ (1 g) of Head TSL

8-17 W/kg 8-17 W/kg	S50 mW input power Wf of basilized to 1W	SAT for nominal Head TSL parameters
~7//W.ZF 9	SEO DIVIDENT DONOR	SAR averaged over 10 cm³ (10 g) of Head TSL

# Body TSL parameters

The following parameters and calculations were applied.

7777	3	> 0.5 °C	Body TSL temperature change during test
% 9 ± m\odm 10.S	% 9 <del>+</del> 5.05	°(S2.0 ± 0.2S) °C	Measured Body TSL parameters
m\odm 36.1	7.23	22.0 °C	Nominal Body TSL parameters
Conductivity	Permittivity	Temperature	

## SAR result with Body TSL

	4	
49.6 W/kg ± 17.0 % (k=2)	W1 of besilemion	eretemented JST ybod lanimon not RA
12.7 W/kg	250 mW input power	PAR measured
	noifibnoO	AR averaged over 1 cm $^3$ (1 g) of Body TSL

23:1 W/kg ± 16.5 % (k=2)	W1 of besilamion	SAR for nominal Body TSL parameters
5.86 W/kg	250 mW input power	SAR measured
	noitibnoo	SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL

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#### Antenna Parameters with Head TSL

- 26.3 dB	Return Loss
Ω[ 7.8 + Ω 4.88	Impedance, transformed to feed point

### Antenna Parameters with Body TSL

- 25.5 dB	ssoy wnje
Ωį ε.3 + Ω 1.03	Impedance, transformed to feed point

# General Antenna Parameters and Design

an 191.1	Electrical Delay (one direction)

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 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

August 26, 2003	Manufactured on
SPEAG	Manufactured by

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 737

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007) Phantom section: Flat Section Medium parameters used: f = 2450 MHz;  $\sigma = 1.85 \text{ S/m}$ ;  $\epsilon_r = 37.9$ ;  $\rho = 1000 \text{ kg/m}^3$ Communication System: CW; Frequency: 2450 MHz

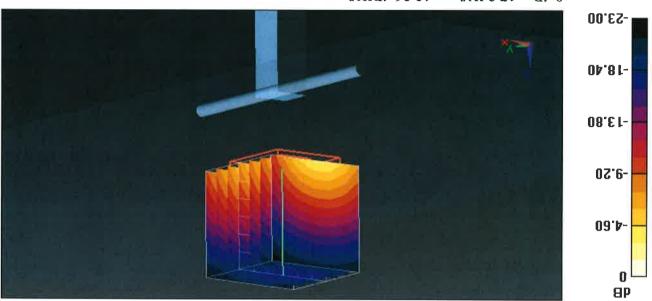
#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASYS2 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

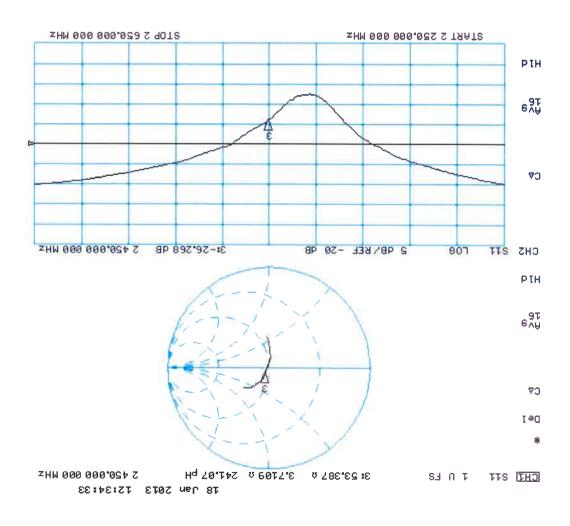
Reference Value = 99.892 V/m; Power Drift = 0.05 dBMeasurement grid: dx=5mm, dy=5mm, dz=5mm

Maximum value of SAR (measured) = 17.2 W/kg SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.17 W/kgPeak SAR (extrapolated) = 28.0 W/kg



0 dB = 17.2 W/kg = 12.36 dBW/kg

## Impedance Measurement Plot for Head TSL



Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 737

Communication System: CW; Frequency:  $2450 \, \text{MHz}$  Medium parameters used:  $f = 2450 \, \text{MHz}$ ;  $\sigma = 2.01 \, \text{S/m}$ ;  $\epsilon_r = 50.5$ ;  $\rho = 1000 \, \text{kg/m}^3$  Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

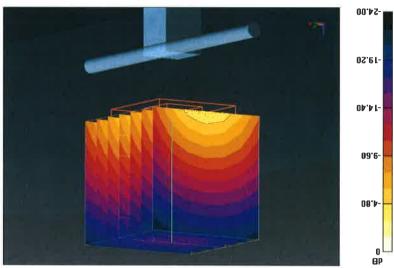
#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

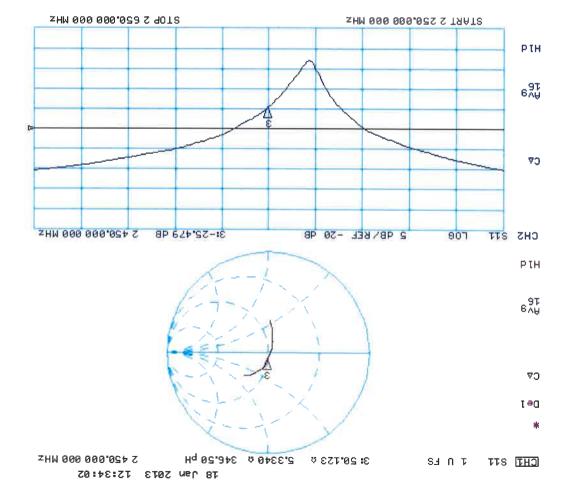
# Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

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

Maximum value of SAR (measured) = 16.8 W/kg



0 dB = 16.8 W/kg = 12.25 dBW/kg



Impedance Measurement Plot for Body TSL

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Calibration Laboratory of Schmid & Partner Engineering AG Zurich, Switzerland

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)  $\mbox{The Swiss Accreditation Service is one of the signatories to the EA$ 

Multilateral Agreement for the recognition of calibration certificates

Client B.V. ADT (Auden)

Certificate No: D2600V2-1020 Jan13

# CALIBRATION CERTIFICATE

Object DS600V2 - SN: 1020

QA CAL-05.v9

Calibration procedure(s)

Calibration procedure for dipole validation kits above 700 MHz

January 18, 2013

Calibration date:

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 ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

			Issued: January 18, 2013
ybbroved by:	Каtja Рокоviс	Technical Manager	5223
Salibrated by:	Иате Israe El-Naouq	Function Laboratory Technician	Signature Cl-Japan
7F generator R&S SMT-06 Vetwork Analyzer HP 8753E	100005	04-Aug-99 (in house check Oct-11) 18-Oct-01 (in house check Oct-12)	In house check: Oct-13
A1848 9H roanes rewoo	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
Secondary Standards	# <b>Q</b> I	Check Date (in house)	Scheduled Check
43AC	109 :NS	(Struc_t03-4=00) St-nuc-7S	£1-ոս <b>ւ</b>
Reference Probe ES3DV3	SN: 3205	\$8-Dec-1\$ (No. E\$3-3\$02_Dec1\$)	Dec-13
Type-N mismatch combination	72690 \ 8.7403 : NS	27-Mar-12 (No. 217-01533)	Apr-13
			adv.
Reference 20 dB Attenuator	2N: 2028 (50K)	27-Mar-12 (No. 217-01530)	£t-1qA
Power sensor HP 8481A Reference 20 dB Attenuator	2N: 2028 (S0K)	01-Nov-12 (No. 217-01640) 27-Mar-12 (No. 217-01530)	£t-joO £t-jqA

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

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Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

Multilateral Agreement for the recognition of calibration certificates The Swiss Accreditation Service is one of the signatories to the EA

TSL Glossary:

A\N

ConvF

not applicable or not measured sensitivity in TSL / NORM x,y,z biupil gnitalumia euseit

Calibration is Performed According to the Following Standards:

devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held Communications Devices: Measurement Techniques", December 2003 Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-

Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency c) Pederal Communications Commission Office of Engineering & Technology (FCC OET), February 2005

Supplement C (Edition 01-01) to Bulletin 65

d) DASY4/5 System Handbook Additional Documentation:

### Methods Applied and Interpretation of Parameters:

- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed of the certificate. All figures stated in the certificate are valid at the frequency indicated. Measurement Conditions: Further details are available from the Validation Report at the end
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole parallel to the body axis. point exactly below the center marking of the flat phantom section, with the arms oriented
- reflected power. No uncertainty required. measurement at the SMA connector to the feed point. The Return Loss ensures low positioned under the liquid filled phantom. The impedance stated is transformed from the
- No uncertainty required. Electrical Delay: One-way delay between the SMA connector and the antenna feed point.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna SAH measured: SAR measured at the stated antenna input power.
- nominal SAR result. SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the

The reported uncertainty of measurement is stated as the standard uncertainty of measurement

probability of approximately 95%. multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage

# Measurement Conditions

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

Freduency	2600 MHz ± 1 MHz	
Zoom Scan Resolution	mm g = zb , db , xb	
Distance Dipole Center - TSL	mm 01	with Spacer
Phantom	Modular Flat Phantom	
Extrapolation	Advanced Extrapolation	
DASY Version	BASAD	V52.8.5

## Head TSL parameters

The following parameters and calculations were applied.

## SAR result with Head TSL

27.8 W/kg ± 17.0 % (k=2)	W1 of besilamon	SAB for nominal Head TSL parameters
14.8 W/kg	250 mW input power	Parussam AAS
	Condition	SAR averaged over 1 cm³ (1 g) of Head TSL

26.0 W/kg ± 16.5 % (k=2)	W1 of besilemion	SAR for nominal Head TSL parameters
6.58 W/kg	S50 mW input power	SAR measured
	condition	SAR averaged over 10 cm $^3$ (10 g) of Head TSL

## Body TSL parameters

The following parameters and calculations were applied.

Body TSL temperature change during test	O° 5.0 >		
Measured Body TSL parameters	O° (S.0 ± 0.SS)	% 9 <del>+</del> 1.03	% 8 ± m\o\m e1.S
Nominal Body TSL parameters	22.0 °C	52.5	m\odm 81.5
	Temperature	Permittivity	Conductivity

### SAR result with Body TSL

25.8 W/kg ± 17.0 % (k=2)	W1 of besilsemon	eretement JST ybod Isnimon tof AAS
14.2 W/kg	S20 mW input power	Parusaem AAS
	Condition	SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL

24.7 W/kg ± 16.5 % (k=2)	W1 of besilemion	SAR for nominal Body TSL parameters
6.25 W/kg	250 mW input power	SAR measured
	condition	SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL

### xibnaqqA

#### Antenna Parameters with Head TSL

- Se.5 dB	Return Loss	
Ω[ ε.4 - Ω 4.84	Impedance, transformed to feed point	

### Antenna Parameters with Body TSL

8b 2.4s -	Return Loss	
Ω[ 4.6 - Ω S.24	Impedance, transformed to feed point	

# General Antenna Parameters and Design

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

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**

8003, 21 y May 13, 2008	Manufactured on
SPEAG	Manufactured by

Date: 18.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1020

Communication System: CW; Frequency:  $2600 \, \text{MHz}$  so = 2.02 S/m;  $\epsilon_r = 37.4$ ;  $\rho = 1000 \, \text{kg/m}^3$  Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.45, 4.45); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

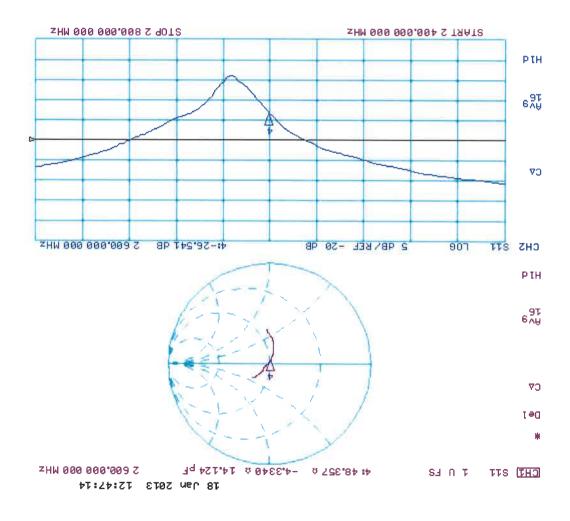
Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 101.1 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 32.3 W/kg SAR(10 g) = 14.8 W/kg; SAR(10 g) = 6.58 W/kg

Maximum value of SAR (measured) = 19.0 W/kg

08.05-

0 dB = 19.0 W/kg = 12.79 dBW/kg

## Impedance Measurement Plot for Head TSL



Date: 18.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1020

Communication System: CW; Frequency:  $2600 \, \text{MHz}$  Medium parameters used:  $f = 2600 \, \text{MHz}$ ;  $\sigma = 2.19 \, \text{S/m}$ ;  $\epsilon_r = 50.1$ ;  $\rho = 1000 \, \text{kg/m}^3$  Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

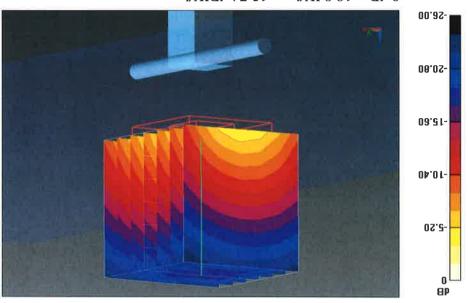
DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.32, 4.32); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DV2X27 27.8.2(1029); 2EMCAD X 14.6.8(7028)

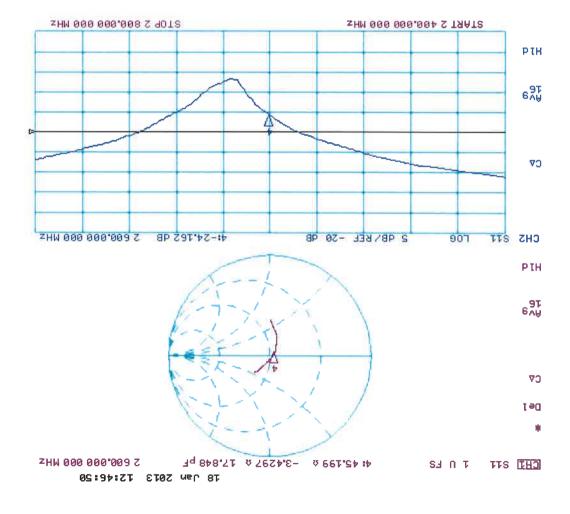
# Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 95.715 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 31.3 W/kg SAR(1 g) = 14.2 W/kg; SAR(10 g) = 6.25 W/kg

Maximum value of SAR (measured) = 18.8 W/kg



0 dB = 18.8 W/kg = 12.74 dBW/kg



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Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

B.V. ADT (Auden)

Multilateral Agreement for the recognition of calibration certificates The Swiss Accreditation Service is one of the signatories to the EA

Certificate No: D5GHzV2-1019\_Nov12

CALIBRATION CERTIFICATE

D2GH2V2 - SN: 1019 Object

QA CAL-22.v1

Calibration procedure(s)

Calibration procedure for dipole validation kits between 3-6 GHz

November 16, 2012

Calibration date:

Client

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

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

Calibration Equipment used (M&TE critical for calibration)

l				9
	Approved by:	Katja Pokovic	Technical Manager	37723
	Calibrated by:	Name Israe El-Naouq	Function Laboratory Technician	Signature El-Japua
	Network Analyzer HP 8753E	9024S 38306676SU	18-Oct-01 (in house check Oct-12)	In house check: Oct-13
	AF generator R&S SMT-06	100005	(fr-Aug-99 (in house check Oct-11)	In house check: Oct-13
	At848 9H roanes rewo9	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
1	Secondary Standards	# <b>U</b> I	Check Date (in house)	Scheduled Check
	DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	£t-nut
	Reference Probe EX3DV4	SN: 3503	30-Dec-11 (No. EX3-3503_Dec11)	Dec-12
	Type-N mismatch combination	SN: 5047.2 / 06327	27-Mar-12 (No. 217-01533)	€1-1qA
	Reference 20 dB Attenuator	2N: 2028 (SOK)	27-Mar-12 (No. 217-01530)	£1-1 <b>q</b> A
	Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	St-toO
	Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
1	Primary Standards	# <b>D</b> I	Cal Date (Certificate No.)	Scheduled Calibration

Issued: November 16, 2012

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