Sporton (Auden)

Client





S

Schweizerischer Kalibrierdlenst

Service suisse d'étalonnage C

Servizio svizzer o di taratura S

Swiss Calibration Service

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

Certificate No: D835V2-499_Mar10

Accreditation No.: SCS 108

Calibration procedure for clipole validation kits Calibration date: March 22, 2010 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID # Cal Date (Certificate No.) Scheduled Calibration Power meter EPM-442A GB37480704 06-Oct-09 (No. 217-01086) Oct-10 Power sensor HP 8481A US37292783 06-Oct-09 (No. 217-01086) Oct-10 Power sensor HP 8481A US37292783 06-Oct-09 (No. 217-01025) Mar-10 Reference 20 dB Attenuator SN: 5086 (20g) 31-Mar-09 (No. 217-01029) Mar-10 Reference Probe ES30V3 SN: 5047.2 / 06327 31-Mar-09 (No. 217-01029) Mar-11 Secondary Standards ID # Check Date (in house) Scheduled Check Power sensor HP 8481A MY41092317 18-Oct-02 (in house check Oct-09) In house check: Oct-09 D# Check Date (in house check Oct-09) In house check: Oct-09	bject	D835V2 - SN: 499		
Chis 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%.	alibration procedure(s)		dure for dipole validation kits	
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%.	alibration date:	March 22, 2010		
Calibration Equipment used (M&TE critical for calibration) Primary Standards ID # Cal Date (Certificate No.) Scheduled Calibration Power meter EPM-442A GB37480704 06-Oct-09 (No. 217-01086) Oct-10 Power sensor HP 8481A US37292783 06-Oct-09 (No. 217-01086) Oct-10 Reference 20 dB Attenuator SN: 5086 (20g) 31-Mar-09 (No. 217-01025) Mar-10 Type-N mismatch combination SN: 5047.2 / 06327 31-Mar-09 (No. 217-01029) Mar-10 Reference Probe ES3DV3 SN: 3205 26-Jun-09 (No. ES3-3205_Jun09) Jun-10 DAE4 SN: 601 02-Mar-10 (No. DAE4-601_Mar10) Mar-11 Secondary Standards ID # Check Date (in house) Scheduled Check Power sensor HP 8481A MY41092317 18-Oct-02 (in house check Oct-09) In house check: Oct- RF generator R&S SMT-06 100005 4-Aug-99 (in house check Oct-09) In house check: Oct- Network Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-09) In house check: Oct- Calibrated by: Name Function Signature				
Primary StandardsID #Cal Date (Certificate No.)Scheduled CalibrationPower meter EPM-442AGB3748070406-Oct-09 (No. 217-01086)Oct-10Power sensor HP 8481AUS3729278306-Oct-09 (No. 217-01086)Oct-10Reference 20 dB AttenuatorSN: 5086 (20g)31-Mar-09 (No. 217-01025)Mar-10Type-N mismatch combinationSN: 5047.2 / 0632731-Mar-09 (No. 217-01029)Mar-10Reference Probe ES3DV3SN: 320526-Jun-09 (No. ES3-3205_Jun09)Jun-10DAE4SN: 60102-Mar-10 (No. DAE4-601_Mar10)Mar-11Secondary StandardsID #Check Date (in house)Scheduled CheckPower sensor HP 8481AMY4109231718-Oct-02 (in house check Oct-09)In house check: Oct-Power sensor HP 8481AMY4109231718-Oct-02 (in house check Oct-09)In house check: Oct-RF generator R&S SMT-061000054-Aug-99 (in house check Oct-09)In house check: Oct-NameFunctionSignatureCalibrated by:NameFunctionSignature	I calibrations have been conduc	ted in the closed laboraton	y lacility: environment temperature (22 ± 3)°(C and humidity < 70%.
Power meter EPM-442AGB3748070406-Oct-09 (No. 217-01086)Oct-10Power sensor HP 8481AUS3729278306-Oct-09 (No. 217-01086)Oct-10Reference 20 dB AttenuatorSN: 5086 (20g)31-Mar-09 (No. 217-01025)Mar-10Type-N mismatch combinationSN: 5047.2 / 0632731-Mar-09 (No. 217-01029)Mar-10Reference Probe ES3DV3SN: 320526-Jun-09 (No. 233-205_Jun09)Jun-10DAE4SN: 60102-Mar-10 (No. DAE4-601_Mar10)Mar-11Secondary StandardsID #Check Date (in house)Scheduled CheckPower sensor HP 8481AMY4109231718-Oct-01 (in house check Oct-09)In house check: Oct-09)RF generator R&S SMT-061000054-Aug-99 (in house check Oct-09)In house check: Oct-01Network Analyzer HP 8753EUS37390585 S420618-Oct-01 (in house check Oct-09)In house check: Oct-04Calibrated by:Dimča 11lävLáboratory.TechniloianMar-U	Calibration Equipment used (M&T	'E critical (or calibration)		
Power sensor HP 8481A US37292783 06-Oct-09 (No. 217-01086) Oct-10 Reference 20 dB Attenuator SN: 5086 (20g) 31-Mar-09 (No. 217-01025) Mar-10 Type-N mismatch combination SN: 5047.2 / 06327 31-Mar-09 (No. 217-01029) Mar-10 Reference Probe ES3DV3 SN: 5047.2 / 06327 31-Mar-09 (No. 253-3205_Jun09) Jun-10 DAE4 SN: 601 02-Mar-10 (No. DAE4-601_Mar10) Mar-11 Secondary Standards ID # Check Date (in house) Scheduled Check Power sensor HP 8481A MY41092317 18-Oct-02 (in house check Oct-09) In house check: Oct-09 RF generator R&S SMT-06 100005 4-Aug-99 (in house check Oct-09) In house check: Oct-01 Network Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-09) In house check: Oct-09 Calibrated by: Name Function Signature	Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4SN: 5086 (20g) SN: 5047.2 / 06327 SN: 5047.2 / 06327 SN: 3205 26-Jun-09 (No. 217-01029)Mar-10 Mar-10 Mar-10 SN: 3205 SOULD SN: 601Secondary StandardsID #Check Date (in house)Scheduled Check Scheduled CheckPower sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753EID #Check Date (in house check Oct-09) In house check Oct-09)In house check: Oct- In house check: Oct- In house check: Oct-09)Calibrated by:NameFunction Dimce 1llevSignature Laboratory Techniloian	Power meter EPM-442A	GB37480704	06-Oct-09 (No. 217-01086)	Oct-10
ype-N mismatch combination teterence Probe ES3DV3 DAE4SN: 5047.2 / 06327 SN: 3205 SN: 3205 SN: 60131-Mar-09 (No. 217-01029) SO-ES3-3205_Jun09) De-Mar-10 O2-Mar-10 (No. DAE4-601_Mar10)Mar-10 Jun-10 Mar-11secondary StandardsID #Check Date (in house)Scheduled Check Oct-02 (in house check Oct-09)regenerator R&S SMT-06 Jetwork Analyzer HP 8753EMY41092317 US37390585 S420618-Oct-01 (in house check Oct-09) 18-Oct-01 (in house check Oct-09)In house check: Oct- Oct-02NameFunction Láboratory TechniloianSignature OCt-02	ower sensor HP 8481A	US37292783	06-Oct-09 (No. 217-01086)	Oct-10
Interference Probe ES3DV3 SN: 3205 26-Jun-09 (No. ES3-3205_Jun09) Jun-10 INAE4 SN: 601 02-Mar-10 (No. DAE4-601_Mar10) Mar-11 Intecondary Standards ID # Check Date (in house) Scheduled Check Intecondary Standards ID # Check Date (in house) Scheduled Check Intecondary Standards ID # Check Date (in house) Scheduled Check Integenerator R&S SMT-06 MY41092317 18-Oct-02 (in house check Oct-09) In house check: Oct-10 Integenerator R&S SMT-06 100005 4-Aug-99 (in house check Oct-09) In house check: Oct-10 Interverk Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-09) In house check: Oct-01 Calibrated by: Name Function Signature Dimce Illev Laboratory Technician Order	eference 20 dB Attenuator		31-Mar-09 (No. 217-01025)	Mar-10
DAE4 SN: 601 02-Mar-10 (No. DAE4-601_Mar10) Mar-11 Decondary Standards ID # Check Date (in house) Scheduled Check Power sensor HP 8481A MY41092317 18-Oct-02 (in house check Oct-09) In house check: Oct-109 AF generator R&S SMT-06 100005 4-Aug-99 (in house check Oct-09) In house check: Oct-109 Jetwork Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-09) In house check: Oct-10 Calibrated by: Name Function Signature Dimce Illev Láboratory Technician O.L.W.W			31-Mar-09 (No. 217-01029)	Mar-10
Secondary Standards ID # Check Date (in house) Scheduled Check Power sensor HP 8481A MY41092317 18-Oct-02 (in house check Oct-09) In house check: Oct-09 AF generator R&S SMT-06 100005 4-Aug-99 (in house check Oct-09) In house check: Oct-09 Network Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-09) In house check: Oct-01 Name Function Signature Calibrated by: Dimce Illev Laboratory.Technician MWU			and the second se	
Power sensor HP 8481A MY41092317 18-Oct-02 (in house check Oct-09) In house check: Oct-09) RF generator R&S SMT-06 100005 4-Aug-99 (in house check Oct-09) In house check: Oct-09) Network Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-09) In house check: Oct-09) Name Function Signature Calibrated by: Dimce 11lev Laboratory Technician	DAE4	SN: 601	02-Mar-10 (No. DAE4-601_Mar10)	Mar-11
RF generator R&S SMT-06 100005 4-Aug-99 (in house check Oct-09) In house check: Oct-09 Network Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-09) In house check: Oct-01 Name Function Signature Calibrated by: Dimce 11lev Laboratory Technician D. LUUU	Secondary Standards	ID #	Check Date (in house)	Scheduled Check
letwork Analyzer HP 8753E US37390585 S4206 18-Oct-01 (in house check Oct-09) In house check: Oct- Name Function Signature Calibrated by: Dimce Illev Laboratory Technician	Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-09)	In house check: Oct-11
Name Function Signature Calibrated by: Dimce Illev Laboratory Technician D. Turuw	RF generator R&S SMT-06	100005	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Calibrated by: Dimce Illev Láboratory Technician D. Turur	Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-09)	In house check: Oct-10
Calibrated by: Dimce Illev Laboratory Technician D. Juliu		Name	Function	Signature
K. Solo		and the second se	and the second	(Ano.
Approved by: Katja Pokovic Technical Manager	Calibrated by:	3		N. Silv
	Calibrated by:	· · · · · · · · · · · · · · · · · · ·		
Issued: March 22, 20		Katja Pokovic	Technical Manager	SE 113

Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

- S Service suisse d'étalonnage
- С Servizio svizzero di taratura
- S Swiss Callbration Service

Accreditation No.: SCS 108

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

Glossarv:

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.

Measurement Conditions

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

DASY Version	DASY5	V5.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V4.9	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittlvity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	42.9 ± 6 %	0.91 mho/m ± 6 %
Head TSL temperature during test	(22.0 ± 0.2) °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition		
SAR measured	250 mW input power	2.43 mW / g	
SAR normalized	normalized to 1W	9.72 mW / g	
SAR for nominal Head TSL parameters	normalized to 1W	9.71 mW /g ± 17.0 % (k=2)	
SAR averaged over 10 cm^3 (10 g) of Head TSL	condition		
SAR measured	250 mW input power	1.58 mW / g	
SAR normalized	normalized to 1W	6.32 mW / g	
SAR for nominal Head TSL parameters	normalized to 1W	6.31 mW /g ± 16.5 % (k=2)	

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.3 ± 6 %	1.01 mho/m ± 6 %
Body TSL temperature during test	(22.0 ± 0.2) °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition		
SAR measured	250 mW input power	2.53 mW / g	
SAR normalized	normalized to 1W	10.1 mW / g	
SAR for nominal Body TSL parameters	normalized to 1W	9.82 mW / g ± 17.0 % (k=2	
SAR averaged over 10 cm^3 (10 g) of Body TSL	condition		
SAR measured	250 mW input power	1 .66 mW / g	
SAR normalized	normalized to 1W	6.64 mW / g	

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.2 Ω - 3.2 jΩ
Return Loss	- 28.4 dB

Antenna Parameters with Body TSL

impedance, transformed to feed point	50.1 Ω - 5.9 jΩ
Return Loss	- 24.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.391 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. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 10, 2003

DASY5 Validation Report for Head TSL

Date/Time: 22.03.2010 10:17:58

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:499

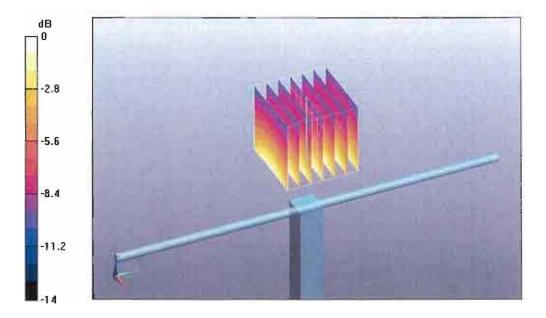
Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1 Medium: HSL900 Medium parameters used: f = 835 MHz; σ = 0.91 mho/m; ϵ_r = 42.9; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.03.2010
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- Measurement SW: DASY5, V5.2 Build 157; SEMCAD X Version 14.0 Build 57

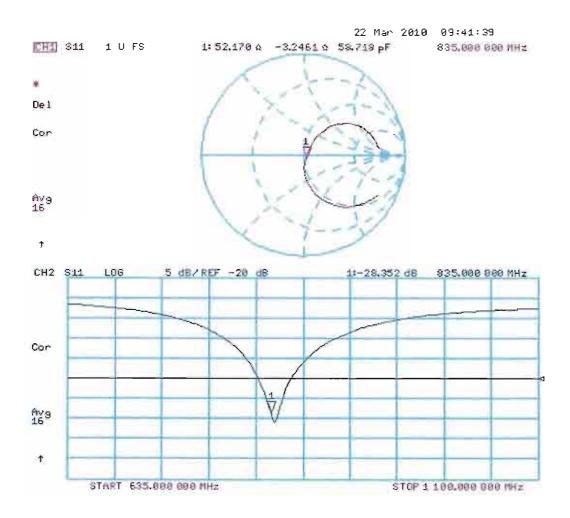
Pin=250 mW /d=15mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement

grid: dx=5mm, dy=5mm, dz=5mmReference Value = 57.5 V/m; Power Drift = 0.00691 dB Peak SAR (extrapolated) = 3.63 W/kg SAR(1 g) = 2.43 mW/g; SAR(10 g) = 1.58 mW/g Maximum value of SAR (measured) = 2.84 mW/g



 $0 \, dB = 2.84 \, mW/g$

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body

Date/Time: 22.03.2010 14:07:53

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:499

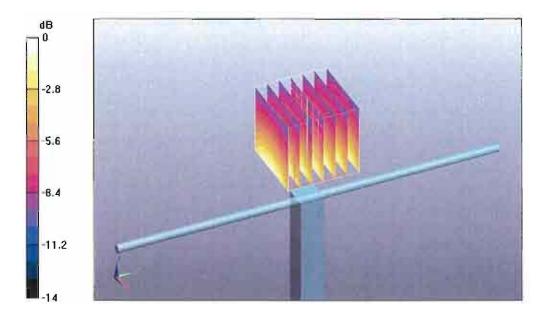
Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1 Medium: MSL900 Medium parameters used: f = 835 MHz; σ = 1.01 mho/m; ϵ_r = 55.3; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

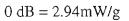
DASY5 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.97, 5.97, 5.97); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.03.2010
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- Measurement SW: DASY5, V5.2 Build 157; SEMCAD X Version 14.0 Build 57

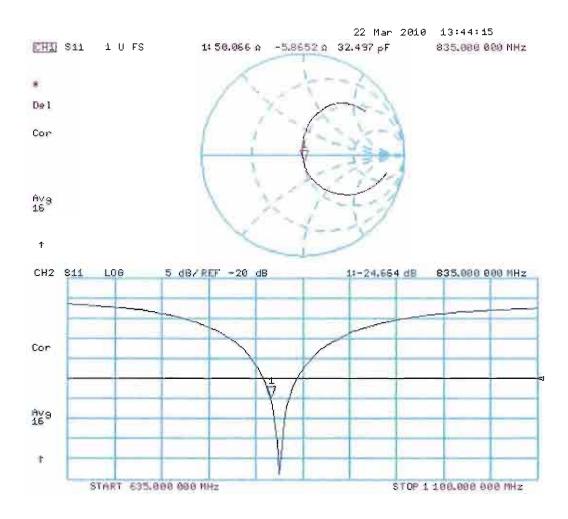
Pin250 mW /d=15mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement

grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 55.6 V/m; Power Drift = 0.011 dB Peak SAR (extrapolated) = 3.73 W/kg SAR(1 g) = 2.53 mW/g; SAR(10 g) = 1.66 mW/g Maximum value of SAR (measured) = 2.94 mW/g





Impedance Measurement Plot for Body TSL





D835V2, serial no. 499 Extended Dipole Calibrations

Referring to KDB 450824, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

<Justification Procedure of Extended Dipole Calibration>

- 1. Setup a Network Analyzer (Agilent N5230A) and set the start frequency and stop frequency to Network Analyzer according to the dipole frequency, at least +/- 200MHz around the calibration point.
- 2. Using calibration kit to perform Network Analyzer Open, Short and Load calibration.
- 3. Connect the dipole with the calibrated Network Analyzer.
- 4. Place the dipole underneath the phantom which is filled with head-simulating or body-simulating liquid.
- 5. Set the Network Analyzer frequency by the dipole calibration frequency. Monitor the return-loss and impedance results with Log Magnitude format and Smith Chart, respectively.
- 6. Record the result and compare with the prior calibration. Please check the Appendix C for detail records.

					D 835 V2 –	serial i	10. 499					
835 Head					-			835 B	ody			
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
3.22.2010	-28.352		52.17		-3.2461		-24.664		50.066		-5.8652	
3.22.2011	-28.323	0.102	51.095	1.075	-3.5773	0.331	-24.665	-0.004	50.685	-0.619	-1.477	-4.388

<Justification of the extended calibration>

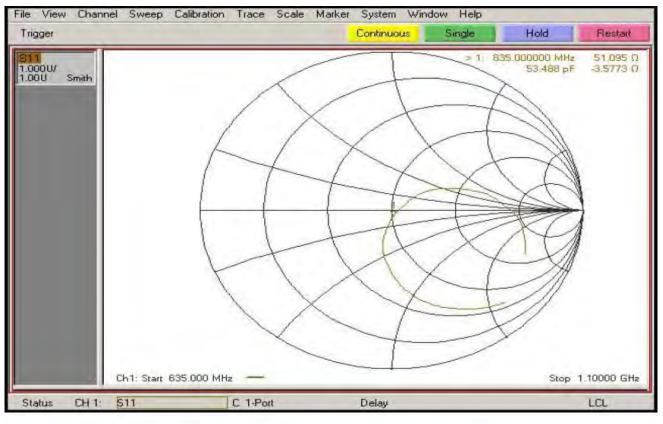
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration.

Therefore the verification result should support extended calibration.



<Dipole Verification Data> - D835 V2, serial no. 499 (Date of Measurement : 3.22.2011)

835 MHz - Head

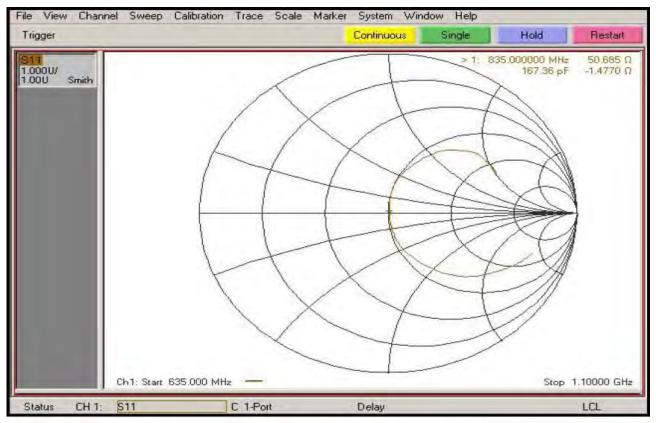


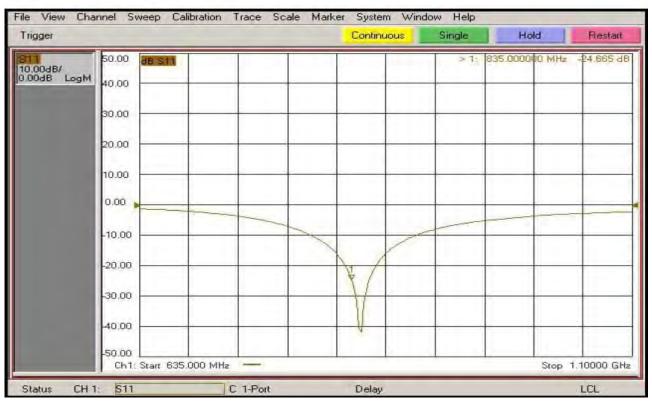
rigger					Contin	uous	Single	Ho	Id	Restart
1	50.00 BB \$11					1	≥ /1:	835.00000	00 MHz	-28:323 dE
0.00dB/ .00dB LogM	40.00		-	-			-		-	-
	30.00		-				-		-	
	20.00						-			-
	10.00						-			-
	0.00				-		-			
	-10.00			1		1	-			
	-20.00	-			-	-	-			-
	-30.00				1		-			-
	40.00			-						-
	-50.00 Ch1: Start 63	5.000 MHz	_		_		-		Stop 1	.10000 GH

SPORTON INTERNATIONAL INC. TEL : 886-3-327-3456 FAX : 886-3-328-4978



835 MHz – Body







D835V2, serial no. 499 Extended Dipole Calibrations

Referring to KDB 450824, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

<Justification Procedure of Extended Dipole Calibration>

- 1. Setup a Network Analyzer (Agilent N5230A) and set the start frequency and stop frequency to Network Analyzer according to the dipole frequency, at least +/- 200MHz around the calibration point.
- 2. Using calibration kit to perform Network Analyzer Open, Short and Load calibration.
- 3. Connect the dipole with the calibrated Network Analyzer.
- 4. Place the dipole underneath the phantom which is filled with head-simulating or body-simulating liquid.
- 5. Set the Network Analyzer frequency by the dipole calibration frequency. Monitor the return-loss and impedance results with Log Magnitude format and Smith Chart, respectively.
- 6. Record the result and compare with the prior calibration. Please check the Appendix C for detail records.

	D835V2 – serial no. 499											
835 Head				835 Body								
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
3.22.2010	-28.352		52.17		-3.2461		-24.664		50.066		-5.8652	
3.22.2011	-28.323	0.102	51.095	1.075	-3.5773	0.331	-24.665	-0.004	50.685	-0.619	-1.477	-4.388
3.22.2012	-28.265	0.307	50.685	1.485	-3.2627	0.0166	-23.821	3.42	50.977	-0.911	-3.2487	-2.6165

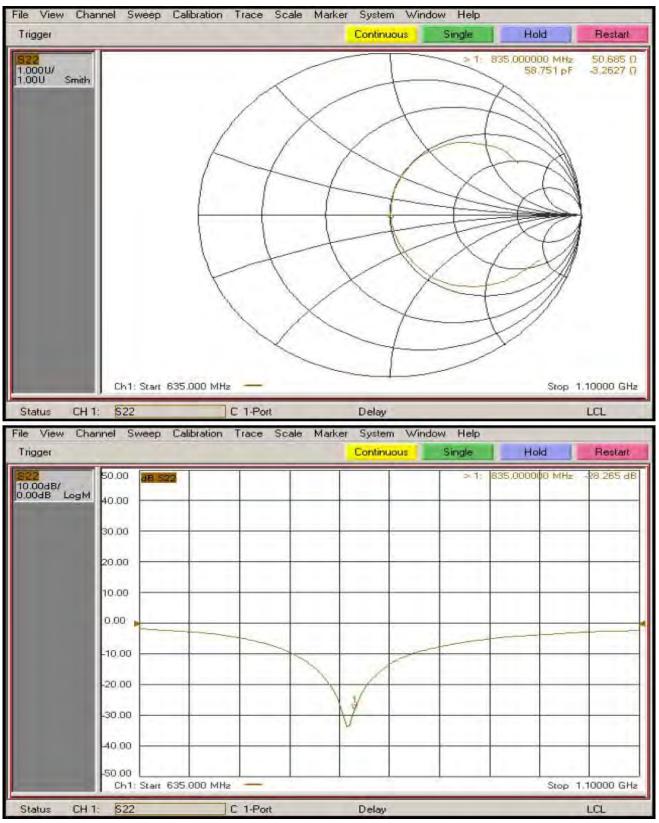
<Justification of the extended calibration>

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



<Dipole Verification Data> - D835 V2, serial no. 499 (Date of Measurement : 3.22.2012)

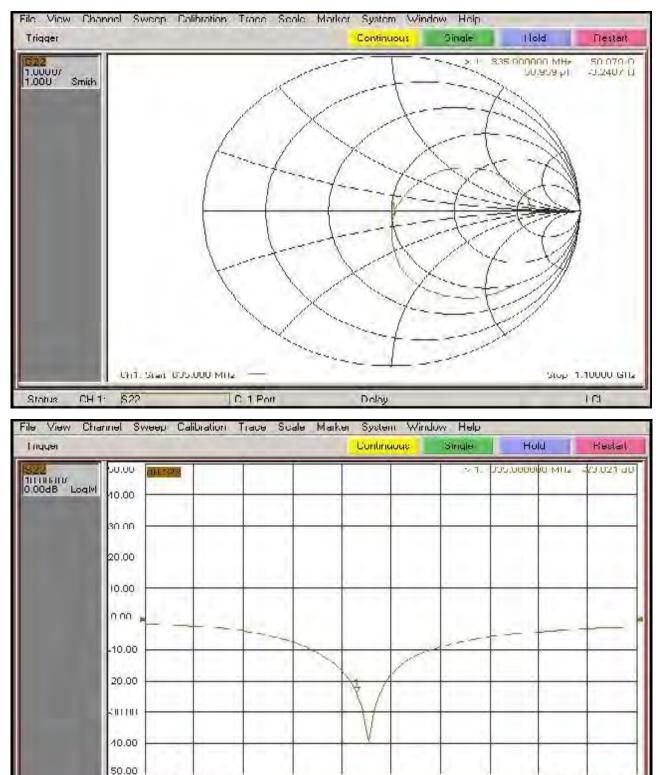
835 MHz - Head



SPORTON INTERNATIONAL INC. TEL : 886-3-327-3456 FAX : 886-3-328-4978



835 MHz – Body



Stop 1.10000 GHz

LCL

Status

CI11: 522

CHT. Start 005,000 MHz

C 1-Port

Delay

chmid & Partner Engineering AG eughausstrasse 43, 8004 Zurich		Hac MRA Bac MRA Bac MRA S	Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service
ccredited by the Swiss Accreditat he Swiss Accreditation Service	is one of the signatories	to the EA	No.: SCS 108
lultilateral Agreement for the re lient Sporton (Auder			D1900V2-5c1041_Mar10
CALIBRATION	Endeloate	್ ಕ್ರಮ್ಮ ಸ್ಥಾನ ಕ್ರಾಹಿಸ್ ಕ್ರಾಹಿಸ್ ಕ್ರಾ	
Object	D1900V2 - SN: 50	1041	
Calibration procedure(s)	QA CAL-05 v7 Calibration proced	dure for dipole validation kits	
Calibration date:	March 23, 2010		
The measurements and the unce	rtainties with confidence pr	onal standards, which realize the physical ur robability are given on the following pages a	nd are part of the certificate.
The measurements and the unce	rtainties with confidence pr		nd are part of the certificate.
The measurements and the unce All calibrations have been conduc	rtainties with confidence pr	obability are given on the following pages a	nd are part of the certificate.
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&1 Primary Standards	rtainties with confidence pr sted in the closed laborator FE critical for calibration)	robability are given on the following pages any facility: environment temperature (22 ± 3)°	nd are part of the certificate. C and humidity < 70%.
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter EPM-442A	rtainties with confidence pr sted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783	robability are given on the following pages any facility: environment temperature (22 ± 3)° Cal Date (Certificate No.)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator	rtainties with confidence pr sted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g)	Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 01-Oct-09 (No. 217-01086) 031-Mar-09 (No. 217-01025)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-10
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T <u>Primary Standards</u> Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination	rtainties with confidence pr sted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327	Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01025) 31-Mar-09 (No. 217-01029)	nd are part of the certificate. C and humidity < 70%. <u>Scheduled Calibration</u> Oct-10 Oct-10 Mar-10 Mar-10
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T <u>Primary Standards</u> Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	rtainties with confidence pr sted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205	Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01025) 31-Mar-09 (No. 217-01029) 26-Jun-09 (No. ES3-3205_Jun09)	nd are part of the certificate. C and humidity < 70%. <u>Scheduled Calibration</u> Oct-10 Oct-10 Mar-10 Mar-10 Jun-10
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T <u>Primary Standards</u> Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	rtainties with confidence pr sted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327	Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01025) 31-Mar-09 (No. 217-01029)	nd are part of the certificate. C and humidity < 70%. <u>Scheduled Calibration</u> Oct-10 Oct-10 Mar-10 Mar-10
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	rtainties with confidence pr sted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205	Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01025) 31-Mar-09 (No. 217-01029) 26-Jun-09 (No. ES3-3205_Jun09)	nd are part of the certificate. C and humidity < 70%. <u>Scheduled Calibration</u> Oct-10 Oct-10 Mar-10 Mar-10 Jun-10
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	rtainties with confidence pr sted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601	Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01025) 31-Mar-09 (No. 217-01025) 31-Mar-09 (No. 217-01029) 26-Jun-09 (No. ES3-3205_Jun09) 02-Mar-10 (No. DAE4-601_Mar10)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-10 Oct-10 Mar-10 Jun-10 Mar-11
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&1 Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A	rtainties with confidence pr cted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID #	Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01025) 31-Mar-09 (No. 217-01025) 31-Mar-09 (No. ES3-3205_Jun09) 02-Mar-10 (No. DAE4-601_Mar10) Check Date (in house)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-10 Oct-10 Mar-10 Jun-10 Jun-10 Mar-11 Scheduled Check
The measurements and the unce All calibrations have been conduct Calibration Equipment used (M&T Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards	rtainties with confidence pr ted in the closed laborator IE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # ID # MY41092317	Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01025) 31-Mar-09 (No. 217-01025) 31-Mar-09 (No. 217-01029) 26-Jun-09 (No. ES3-3205_Jun09) 02-Mar-10 (No. DAE4-601_Mar10) Check Date (in house) 18-Oct-02 (in house check Oct-09)	nd are part of the certificate. C and humidity < 70%. <u>Scheduled Calibration</u> Oct-10 Oct-10 Mar-10 Mar-10 Jun-10 Mar-11 <u>Scheduled Check</u> In house check: Oct-11
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T <u>Primary Standards</u> Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 <u>Secondary Standards</u> Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	rtainties with confidence pr cted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # MY41092317 100005 US37390585 S4206 Name	Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01025) 31-Mar-09 (No. 217-01025) 31-Mar-09 (No. 217-01029) 26-Jun-09 (No. ES3-3205_Jun09) 02-Mar-10 (No. DAE4-601_Mar10) Check Date (in house) 18-Oct-02 (in house check Oct-09) 4-Aug-99 (in house check Oct-09) 18-Oct-01 (in house check Oct-09) Function	nd are part of the certificate. C and humidity < 70%. <u>Scheduled Calibration</u> Oct-10 Oct-10 Mar-10 Mar-10 Jun-10 Mar-11 <u>Scheduled Check</u> In house check: Oct-11 in house check: Oct-11
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	rtainties with confidence pr cted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # MY41092317 100005 US37390585 S4206	cobability are given on the following pages are y facility: environment temperature (22 ± 3)* Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01086) 31-Mar-09 (No. 217-01025) 31-Mar-09 (No. 217-01029) 26-Jun-09 (No. ES3-3205_Jun09) 02-Mar-10 (No. DAE4-601_Mar10) Check Date (in house) 18-Oct-02 (in house check Oct-09) 4-Aug-99 (in house check Oct-09) 18-Oct-01 (in house check Oct-09)	And are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-10 Oct-10 Mar-10 Mar-10 Jun-10 Mar-11 Scheduled Check In house check: Oct-11 In house check: Oct-11 In house check: Oct-10
The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T <u>Primary Standards</u> Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 <u>Secondary Standards</u> Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	rtainties with confidence pr cted in the closed laborator FE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # MY41092317 100005 US37390585 S4206 Name	Cal Date (Certificate No.) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01086) 06-Oct-09 (No. 217-01025) 31-Mar-09 (No. 217-01025) 31-Mar-09 (No. 217-01029) 26-Jun-09 (No. ES3-3205_Jun09) 02-Mar-10 (No. DAE4-601_Mar10) Check Date (in house) 18-Oct-02 (in house check Oct-09) 4-Aug-99 (in house check Oct-09) 18-Oct-01 (in house check Oct-09) Function	And are part of the certificate. C and humidity < 70%. Scheduled Calibration Oct-10 Oct-10 Mar-10 Mar-10 Jun-10 Mar-11 Scheduled Check In house check: Oct-11 In house check: Oct-11 In house check: Oct-10

¥.

Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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

Accreditation No.: SCS 108

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

Glossarv:

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 ٠ positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power. •
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna • connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the • nominal SAR result.

Measurement Conditions

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

DASY Version	DASY5	V5.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.1 ±6 %	1.45 mho/m ± 6 %
Head TSL temperature during test	(21.5 ± 0.2) °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.1 mW / g
SAR normalized	normalized to 1W	40.4 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	39.8 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.25 mW / g
SAR normalized	normalized to 1W	21.0 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	20.9 mW /g ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.9 ± 6 %	1.58 mho/m ± 6 %
Body TSL temperature during test	(21.5 ± 0.2) °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.4 mW / g
SAR normalized	normalized to 1W	41.6 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	40.0 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.57 mW / g
SAR normalized	normalized to 1W	22.3 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	22.1 mW / g ± 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.9 Ω + 5.9 jΩ
Return Loss	- 24.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.3 Ω + 5.7 jΩ				
Return Loss	- 23.1 dB				

General Antenna Parameters and Design

Electrical Delay (one direction)	1.202 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 04, 2003

DASY5 Validation Report for Head TSL

Date/Time: 23.03.2010 12:03:30

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d041

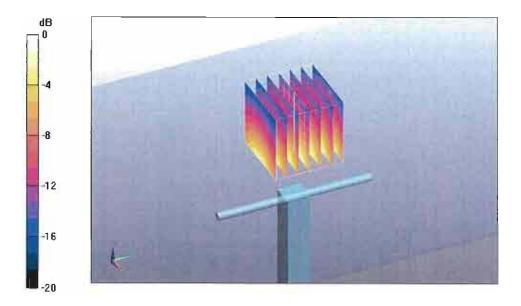
Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1 Medium: HSL U11 BB Medium parameters used: f = 1900 MHz; σ = 1.45 mho/m; ϵ_r = 41.2; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.09, 5.09, 5.09); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.03.2010
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY5, V5.2 Build 157; SEMCAD X Version 14.0 Build 57

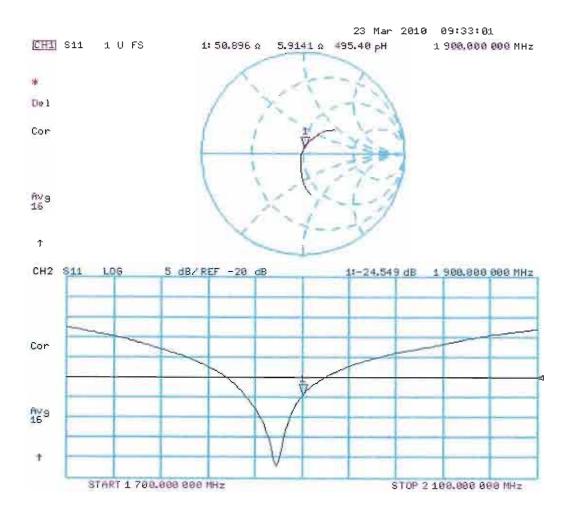
Pin=250 mW/d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement

grid: dx=5mm, dy=5mm, dz=5mmReference Value = 96.8 V/m; Power Drift = 0.040 dB Peak SAR (extrapolated) = 18.4 W/kg SAR(1 g) = 10.1 mW/g; SAR(10 g) = 5.25 mW/g Maximum value of SAR (measured) = 12.7 mW/g



0 dB = 12.7 mW/g

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body

Date/Time: 17.03.2010 12:43:32

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d041

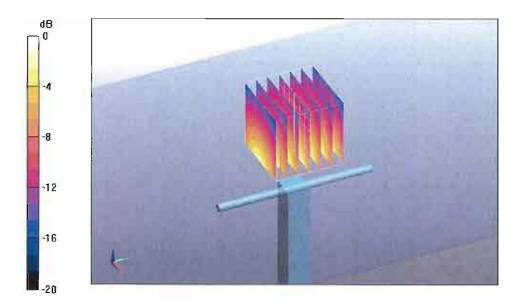
Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1 Medium: MSL U11 BB Medium parameters used: f = 1900 MHz; σ = 1.58 mho/m; ϵ_r = 55; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.59, 4.59, 4.59); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.03.2010
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY5, V5.2 Build 157; SEMCAD X Version 14.0 Build 57

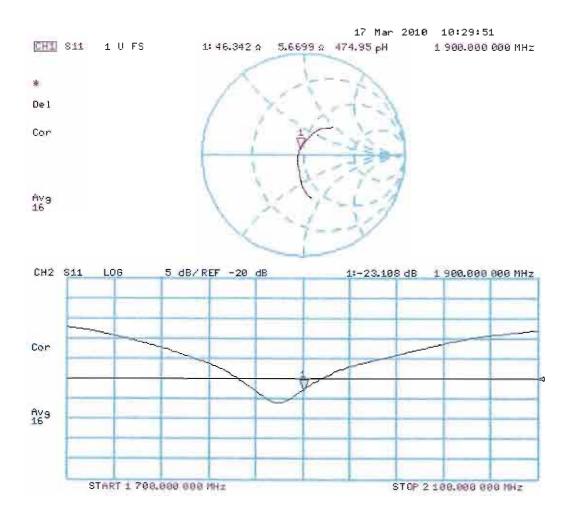
Pin250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement

grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 96.1 V/m; Power Drift = 0.017 dB Peak SAR (extrapolated) = 17.5 W/kg SAR(1 g) = 10.4 mW/g; SAR(10 g) = 5.57 mW/gMaximum value of SAR (measured) = 13.1 mW/g



 $0 \, dB = 13.1 \, mW/g$

Impedance Measurement Plot for Body TSL





D1900V2, serial no. 5D041 Extended Dipole Calibrations

Referring to KDB 450824, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

<Justification Procedure of Extended Dipole Calibration>

- 1. Setup a Network Analyzer (Agilent N5230A) and set the start frequency and stop frequency to Network Analyzer according to the dipole frequency, at least +/- 200MHz around the calibration point.
- 2. Using calibration kit to perform Network Analyzer Open, Short and Load calibration.
- 3. Connect the dipole with the calibrated Network Analyzer.
- 4. Place the dipole underneath the phantom which is filled with head-simulating or body-simulating liquid.
- 5. Set the Network Analyzer frequency by the dipole calibration frequency. Monitor the return-loss and impedance results with Log Magnitude format and Smith Chart, respectively.
- 6. Record the result and compare with the prior calibration. Please check the Appendix C for detail records.

	D1900V2 – serial no. 5D041											
	1900 Head					1900 Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta
3.23.2010	-24.549		50.896		5.9141		-23.108		46.342		5.669	
3.23.2011	-24.489	0.244	50.921	-0.025	5.9588	-0.045	-23.022	0.372	48.808	-2.466	6.991	-1.322

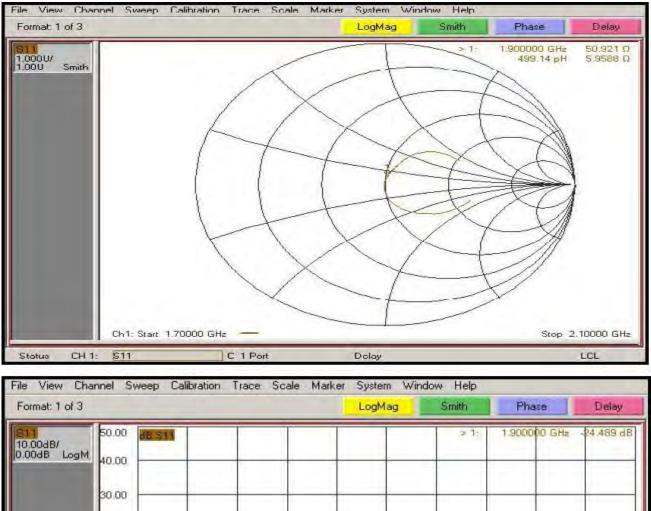
<Justification of the extended calibration>

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



<Dipole Verification Data> - D1900 V2, serial no. 5D041 (Date of Measurement : 3.23.2011)

1900 MHz - Head



 30.00
 30.00

 20.00
 10.00

 10.00
 10.00

 10.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 20.00
 10.00

 30.00
 10.00

 50.00
 10.00

 51.00
 CH1:

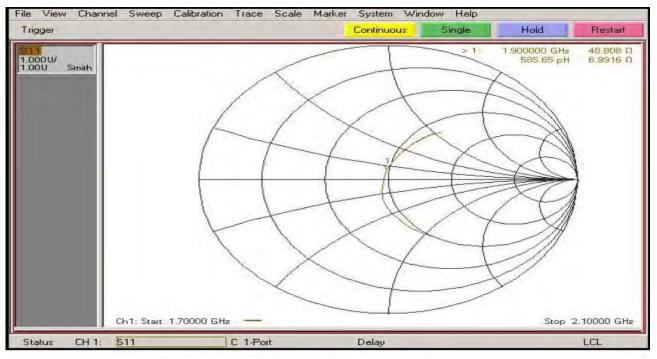
 Status
 CH1:
 S11

 C 1.Port
 Delay
 LCL

SPORTON INTERNATIONAL INC. TEL : 886-3-327-3456 FAX : 886-3-328-4978



1900 MHz – Body



dB/	50.00	B S11	-				aous	Single	Hole		Restart
B LogM				-				>1:	1.90000	0 GHz	-23.022 dE
	40.00				+			++			-
	30.00 -			-	-	-				_	
	20.00 -			-		-					-
	10.00			-	-	-				_	-
	0.00		_	-	-					_	-
	-10.00				-	-					
	-20.00 -		_		1	5	/		_	_	-
	-30.00 -			-		N					
	40.00 -		_								
	-50.00	art 1.700	100 GHz	_	-					Stop 2	2.10000 GH



D1900V2, serial no. 5D041 Extended Dipole Calibrations

Referring to KDB 450824, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

<Justification Procedure of Extended Dipole Calibration>

- 1. Setup a Network Analyzer (Agilent N5230A) and set the start frequency and stop frequency to Network Analyzer according to the dipole frequency, at least +/- 200MHz around the calibration point.
- 2. Using calibration kit to perform Network Analyzer Open, Short and Load calibration.
- 3. Connect the dipole with the calibrated Network Analyzer.
- 4. Place the dipole underneath the phantom which is filled with head-simulating or body-simulating liquid.
- 5. Set the Network Analyzer frequency by the dipole calibration frequency. Monitor the return-loss and impedance results with Log Magnitude format and Smith Chart, respectively.
- 6. Record the result and compare with the prior calibration. Please check the Appendix C for detail records.

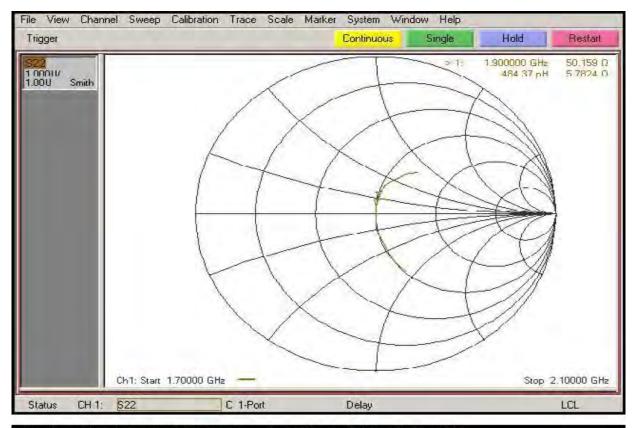
	D1900V2 – serial no. 5D041											
	1900 Head					1900 Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
3.23.2010	-24.549		50.896		5.9141		-23.108		46.342		5.669	
3.23.2011	-24.489	0.244	50.921	-0.025	5.9588	-0.045	-23.022	0.372	48.808	-2.466	6.991	-1.322
3.23.2012	-26.159	6.56	50.159	0.737	5.7824	0.1317	-24.341	5.33	47.059	-0.707	4.8668	0.8022

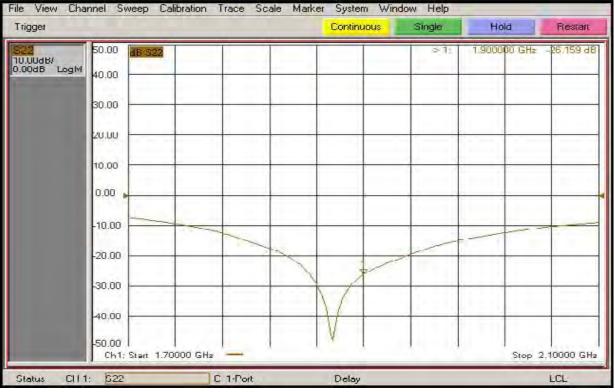
<Justification of the extended calibration>

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



<Dipole Verification Data> - D1900 V2, serial no. 5D041 (Date of Measurement : 3.23.2012) 1900 MHz - Head



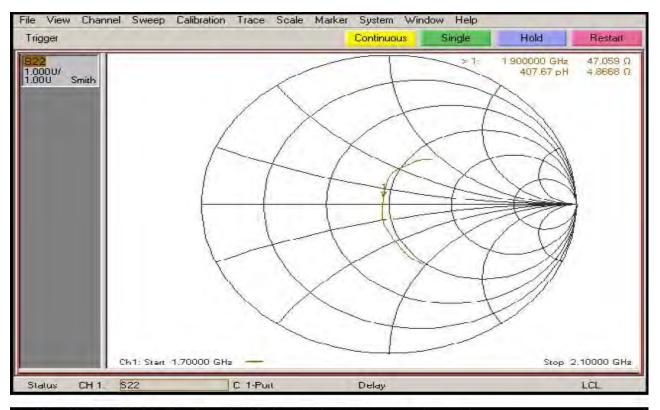


SPORTON INTERNATIONAL INC.

TEL : 886-3-327-3456 FAX : 886-3-328-4978



1900 MHz - Body





SPORTON INTERNATIONAL INC. TEL : 886-3-327-3456 FAX : 886-3-328-4978

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





S

Accreditation No.: SCS 108

Schweizerischer Kalibrierdienst

- Service suisse d'étalonnage С
- Servizio svizzero di taratura S

Swiss Calibration Service

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

Sporton (Auden) Client

Certificate No: D2450V2-736_Jul11

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 7	36	
Calibration procedure(s)	QA CAL-05.v8		
	Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date:	July 25, 2011		
		ional standards, which realize the physical un robability are given on the following pages an	
All calibrations have been conduc	ted in the closed laborator	ry facility: environment (emperature (22 ± 3)°(C and humidity < 70%.
Calibration Equipment used (M&T	E critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	06-Oct-10 (No. 217-01266)	Oct-11
Power sensor HP 8481A	US37292783	06-Oct-10 (No. 217-01266)	Oct-11
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-11 (No. 217-01367)	Apr-12
Type-N mismatch combination	SN: 5047.2 / 06327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe ES3DV3	SN: 3205	29-Apr-11 (No. ES3-3205_Apr11)	Apr-12
DAE4	SN: 601	04-Jul-11 (No. DAE4-601_Jul11)	Jul-12
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317		
	141141032017	18-Oct-02 (in house check Oct-09)	In house check: Oct-11
	100005	18-Oct-02 (in house check Oct-09) 04-Aug-99 (in house check Oct-09)	In house check: Oct-11 In house check: Oct-11
RF generator R&S SMT-06			
RF generator R&S SMT-06 Network Analyzer HP 8753E	100005	04-Aug-99 (in house check Oct-09)	In house check: Oct-11 In house check: Oct-11
RF generator R&S SMT-06	100005 US37390585 S4206	04-Aug-99 (in house check Oct-09) 18-Oct-01 (in house check Oct-10)	In house check: Oct-11 In house check: Oct-11 Signature
RF generator R&S SMT-06 Network Analyzer HP 8753E Calibrated by:	100005 US37390585 S4206 Name Claudio Leubler	04-Aug-99 (in house check Oct-09) 18-Oct-01 (in house check Oct-10) Function Laboratory Technician	In house check: Oct-11 In house check: Oct-11 Signature
RF generator R&S SMT-06 Network Analyzer HP 8753E	100005 US37390585 S4206 Name	04-Aug-99 (in house check Oct-09) 18-Oct-01 (in house check Oct-10) Function	In house check: Oct-11 In house check: Oct-11
RF generator R&S SMT-06 Network Analyzer HP 8753E Calibrated by:	100005 US37390585 S4206 Name Claudio Leubler	04-Aug-99 (in house check Oct-09) 18-Oct-01 (in house check Oct-10) Function Laboratory Technician	In house check: Oct-11 In house check: Oct-11 Signature

Calibration Laboratory of

Schmid & Partner **Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

- S Service suisse d'étalonnage
- C Servizio svizzero di taratura
- S **Swiss Calibration Service**

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

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.

Accreditation No.: SCS 108

Measurement Conditions

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

DASY Version	DASY5	V52.6.2
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	38.9 ± 6 %	1.85 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	13.9 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	54.8 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.44 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	25.6 mW /g ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.7 ± 6 %	2.00 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	13.3 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	52.3 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW inp⊔t power	6.18 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	24.5 mW / g ± 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.4 Ω + 1.5 jΩ
Return Loss	- 27.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.8 Ω + 2.8 jΩ
Return Loss	- 30.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 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. 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	August 26, 2003

DASY5 Validation Report for Head TSL

Date: 25.07.2011

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 736

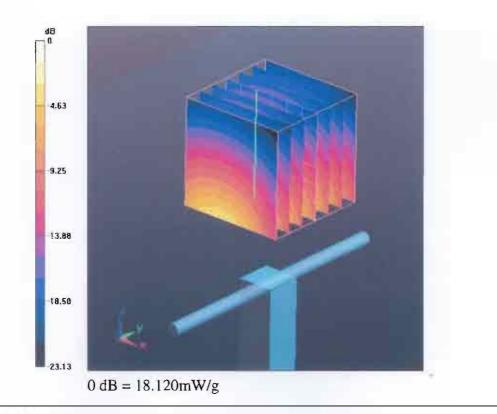
Communication System: CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 1.85 mho/m; ϵ_r = 38.9; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

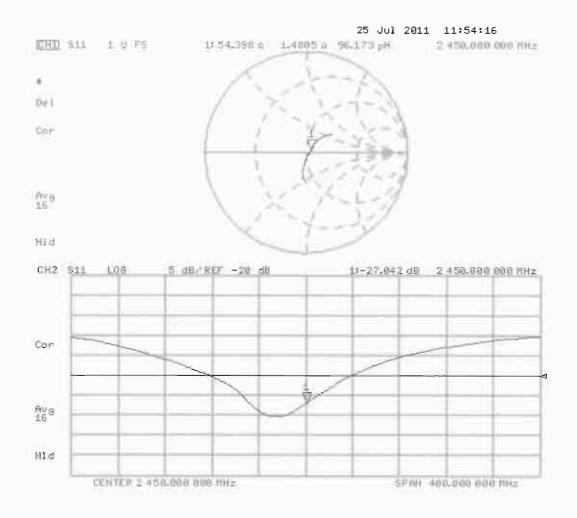
DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 98.095 V/m; Power Drift = 0.09 dB Peak SAR (extrapolated) = 28.615 W/kg SAR(1 g) = 13.9 mW/g; SAR(10 g) = 6.44 mW/g Maximum value of SAR (measured) = 18.121 mW/g





DASY5 Validation Report for Body TSL

Date: 25.07.2011

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 736

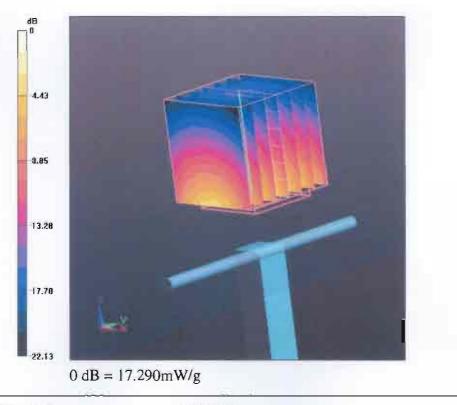
Communication System: CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 2 mho/m; ϵ_r = 51.7; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

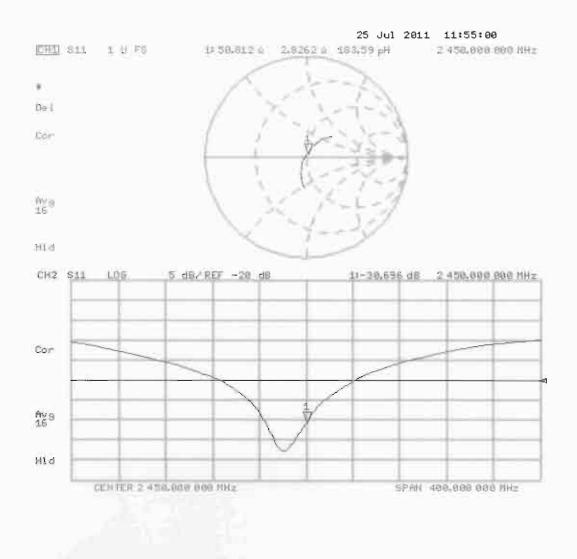
- Probe: ES3DV3 SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 96.550 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 27.432 W/kg SAR(1 g) = 13.3 mW/g; SAR(10 g) = 6.18 mW/g Maximum value of SAR (measured) = 17.294 mW/g



Certificate No: D2450V2-736_Jul11





D2450V2, serial no. 736 Extended Dipole Calibrations

Referring to KDB 450824, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

<Justification Procedure of Extended Dipole Calibration>

- 1. Setup a Network Analyzer (Agilent N5230A) and set the start frequency and stop frequency to Network Analyzer according to the dipole frequency, at least +/- 200MHz around the calibration point.
- 2. Using calibration kit to perform Network Analyzer Open, Short and Load calibration.
- 3. Connect the dipole with the calibrated Network Analyzer.
- 4. Place the dipole underneath the phantom which is filled with head-simulating or body-simulating liquid.
- 5. Set the Network Analyzer frequency by the dipole calibration frequency. Monitor the return-loss and impedance results with Log Magnitude format and Smith Chart, respectively.
- 6. Record the result and compare with the prior calibration. Please check the Appendix C for detail records.

	D2450V2 – serial no. 736											
	2450 Head				2450 Body							
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.25.2011	-27.042		54.398		1.4805		-30.696		50.812		2.8262	
7.25.2012	-27.950	-3.365	52.541	1.857	0.77343	0.707	-31.781	-3.535	50.572	0.24	1.5953	1.2309

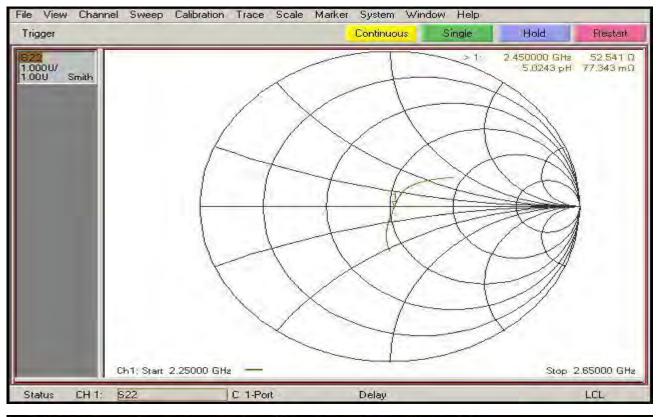
<Justification of the extended calibration>

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



<Dipole Verification Data> - D2450 V2, serial no. 736 (Date of Measurement : 7.25.2012)

2450 MHz - Head

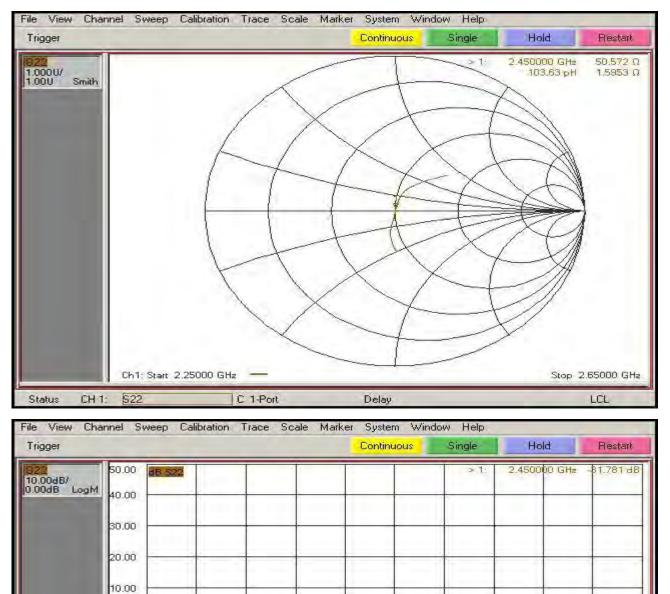


gger	_			Continuc	ous 🔄	Single	Hold	Restart
200487	50.00 dB 522				-	> 1:	2.450000 GH	1z -27.950 dB
00dB/ 0dB LogM	40.00			-		6		
	30.00	-			_			_
	20.00					-		
	10.00			-				-
	0.00			-		£		
	-10.00	-		-				
	-20.00				/	_		
	-30.00	-		-				
	40.00					÷		
	-50.00 Ch1: Start 2	25000 GHz -	_				Stop	5 2.65000 GH
tatus CH 1	: \$22	IC 1	-Port	Delay				LCL

SPORTON INTERNATIONAL INC. TEL : 886-3-327-3456 FAX : 886-3-328-4978



2450 MHz – Body



Stop 2.65000 GHz

LCL

Status

0.00

-10.00

-20.00

-30.00

40.00

50.00

CH 1: 522

Ch1: Start 2.25000 GHz

C 1-Port

Delay

Calibration Laboratory of Schmid & Partner Engineering AG

Client

Zeughausstrasse 43, 8004 Zurich, Switzerland

Sporton (Auden)





s

Accreditation No.: SCS 108

Schweizerlscher Kalibrierdienst

C Service suisse d'étalonnage

Servizio svizzero di tarature

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

Certificate No: D5GHzV2-1006_Jan12

Object	D5GHzV2 - SN:	1006	
Calibration procedure(s)	QA CAL-22.v1 Calibration proce	dure for dipole validation kits bet	ween 3-6 GHz
Calibration date:	January 18, 2012	2	
The measurements and the unce	ertainties with confidence p cted in the closed laborator	onal standards, which reelize the physical un robability are given on the following pages an ry facility: environment temperature (22 ± 3)°(nd are part of the certificate.
Calibration Equipment used (M&	TE ortifical for calibration)		
n an an Arthur an Arthur Annalis, an an an Arthur An Canadr Annalasana	TE critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
rimary Standarda	ALA No.	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451)	Scheduled Calibration Oct-12
imary Standards ower mater EPM-442A		and a second	and the second se
rimary Standarda rower meter EPM-442A rower sansor HP 8481A Reference 20 dB Attenuator	ID # GB37480704 US37292783 SN: 5065 (20g)	05-Oct-11 (No. 217-01451)	Oct-12
Primary Standarda Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination	ID # GB37480704 US37292783	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451)	Oct-12 Oct-12
himary Standarda Yower meter EPM-442A Yower sansor HP 8481A Reference 20 dB Attenuator Yope-N mismatch combination Reference Probe EX3DV4	ID # GB37480704 US37292783 SN: 5065 (20g)	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. EX3-3503_Dec11)	Oct-12 Oct-12 Apr-12
Primary Standarda Power mater EPM-442A Power sansor HP 8481A Reference 20 dB Attenuator Sype-N mismatch combination Reference Ptobe EX3DV4	ID # GB37480704 US37292783 SN: 5085 (20g) SN: 5047.2 / 06327	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371)	Oct-12 Oct-12 Apr-12 Apr-12
Primary Standarda Power meter EPM-442A Power sansor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	ID # GB37480704 US37292783 SN: 5065 (20g) SN: 5047.2 / 06327 SN: 3503	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. EX3-3503_Dec11)	Oct-12 Oct-12 Apr-12 Apr-12 Dec-12
Primary Standarda Power meter EPM-442A Power sansor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Ptobe EX3DV4 DAE4 Secondary Standards Power sensor HP 8481A	ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3503 SN: 601	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. DXE4-501_Jul11)	Oct-12 Oct-12 Apr-12 Apr-12 Dec-12 Jul-12
Primary Standarda Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3503 SN: 601 ID #	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. EX3-3503_Dec11) 04-Jul-11 (No. DAE4-601_Jul11) Check Date (in house)	Oct-12 Oct-12 Apr-12 Apr-12 Dec-12 Jul-12 Scheduled Check In house check: Oct-13
Primary Standarda Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	ID # GB37480704 US37292783 SN: 5086 (209) SN: 5047.2 / 06327 SN: 3503 SN: 601 ID # MY41092317	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. DAE4-601_adul11) 04-Jul-11 (No. DAE4-601_adul11) Check Date (in house) 18-Oct-02 (in house check Oct-11)	Oct-12 Oct-12 Apr-12 Apr-12 Dec-12 Jul-12 Scheduled Check
Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	ID # GB37480704 US37292783 SN: 5065 (209) SN: 5047.2 / 06327 SN: 3503 SN: 601 ID # MY41092317 100005	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 04-Jul-11 (No. DAE4-501_Jul-11) 04-Jul-11 (No. DAE4-501_Jul-11) Check Date (in house) 18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-11)	Oct-12 Oct-12 Apr-12 Apr-12 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12
Primary Standarda Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	ID # GB37480704 US37292783 SN: 5065 (209) SN: 5047.2 / 06327 SN: 3503 SN: 601 ID # MY41092317 100005	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 04-Jul-11 (No. DAE4-501_Jul-11) 04-Jul-11 (No. DAE4-501_Jul-11) Check Date (in house) 18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-11)	Oct-12 Oct-12 Apr-12 Apr-12 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12
Primary Standarda Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power sensor HP 8481A RF generator P&S SMT-06 Network Analyzer HP 8753E	ID # GB37480704 US37292783 SN: 5086 (209) SN: 5047.2 / 06327 SN: 3503 SN: 601 ID # MY41092317 100005 US37390585 S4206	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01368) 29-Mar-11 (No. 217-01451) 30-Dec-11 (No. 217-01451) 30-Dec-11 (No. 217-01451) 30-Dec-11 (No. 217-01451) 30-Dec-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. 217-01	Oct-12 Oct-12 Apr-12 Apr-12 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12
Primary Standarda Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power sensor HP 8481A RF generator PAS SMT-06 Network Analyzer HP 8753E	ID # GB37480704 US37292783 SN: 5066 (209) SN: 5047.2 / 06327 SN: 3503 SN: 601 ID # MY41092317 100005 US37390585 S4206 Name Jeton Kasitati	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01368) 29-Mar-11 (No. 217-01451) 30-Dec-11 (No. 217-01451) 30-Dec-11 (No. 217-01451) 04-Jul-11 (No. 217-01368) Check Date (in house) 18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-11) 18-Oct-01 (in house check Oct-11) 18-Oct-01 (in house check Oct-11) 18-Oct-01 (in house check Oct-11)	Oct-12 Oct-12 Apr-12 Apr-12 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12
Calibration Equipment used (M& Primary Standards Power mater EPM-442A Power sansor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power sansor HP 8481A RF generator P&S SMT-06 Network Analyzer HP 8753E	ID # GB37480704 US37292783 SN: 5066 (209) SN: 5047.2 / 06327 SN: 3503 SN: 601 ID # MY41092317 100005 US37390585 S4206 Name Jeton Kasitati	05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01371) 30-Dec-11 (No. 217-01368) 29-Mar-11 (No. 217-01451) 30-Dec-11 (No. 217-01451) 30-Dec-11 (No. 217-01451) 04-Jul-11 (No. 217-01368) Check Date (in house) 18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-11) 18-Oct-01 (in house check Oct-11) 18-Oct-01 (in house check Oct-11) 18-Oct-01 (in house check Oct-11)	Oct-12 Oct-12 Apr-12 Apr-12 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12

Calibration Laboratory of

Classon

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





s

Schweizerischer Kallbrierdienst

- C Service suisse d'étaionnage
- Servizio avizzero di taratura
- S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates Accreditation No.: SCS 108

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.

Measurement Conditions

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

DASY Version	DASY5	V52.8.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with 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	36.3 ± 6 %	4.60 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.91 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	79.2 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm ⁴ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.26 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	22.6 mW /g ± 16.5 % (k=2)

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) *C	35.8 ± 6 %	4.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.52 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	85.2 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.42 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.2 mW / g ± 16.5 % (k=2)

Certificate No: D5GHzV2-1006_Jan12

Head TSL parameters at 5800 MHz The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3±6%	5.22 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.90 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	79.0 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	22.4 mW / g ± 16.5 % (k=2)

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.2±6%	5.46 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 ² (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.25 mW./g
SAR for nominal Body TSL parameters	normalized to 1W	72.6 mW / g ± 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.04 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	20.5 mW / g ± 17.6 % (k=2)

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) *C	48.7 ± 6 %	5.86 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	10000	1

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	7.86 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	78.8 mW / g ± 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.19 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	21.9 mW / g ± 17.5 % (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	48.2 ± 6 %	6.28 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		2013.

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.30 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	73.1 mW / g ± 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.03 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	20.3 mW / g ± 17.6 % (k=2)

Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	52.3 Ω - 9.6 jΩ	
Return Loss	- 20.3 dB	

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	50.8 Ω - 2.8 μΩ	
Return Loss	- 30.7 dB	

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	58.1 Ω + 1.6 jΩ
Return Loss	- 22.4 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	52.7 Ω - 9.1 jΩ
Return Loss	+ 20.7 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	48.9 Ω + 0.1 jΩ	
Return Loss	+ 39.3 dB	

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	60.1 Ω - 1,1 μΩ	
Return Loss	× 20.7 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.104 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	August 28, 2003	

Certificate No: D5GHzV2-1006_Jan12

DASY5 Validation Report for Head TSL

Date: 17.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1006

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz; $\sigma = 4.6$ mho/m; $\varepsilon_r = 36.3$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5500 MHz; $\sigma = 4.9$ mho/m; $\varepsilon_r = 35.8$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5800 MHz; $\sigma = 5.22$ mho/m; $\varepsilon_r = 35.3$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

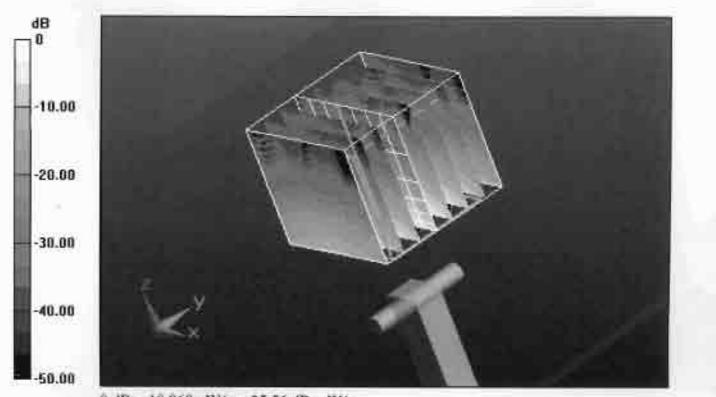
DASY52 Configuration

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

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 63.826 V/m; Power Drift = 0.09 dB Peak SAR (extrapolated) = 29.2570 SAR(1 g) = 7.91 mW/g; SAR(10 g) = 2.26 mW/g Maximum value of SAR (measured) = 17.937 mW/g

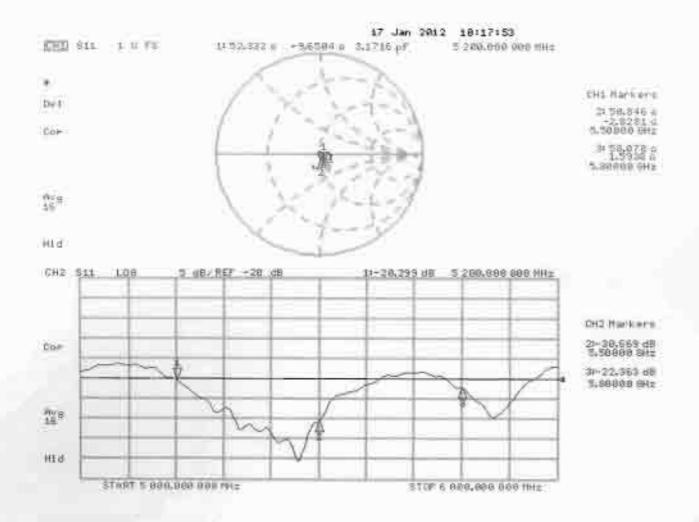
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 64.861 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 33.9880 SAR(1 g) = 8.52 mW/g; SAR(10 g) = 2.42 mW/g Maximum value of SAR (measured) = 19.922 mW/g

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 61.585 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 33.3960 SAR(1 g) = 7.9 mW/g; SAR(10 g) = 2.24 mW/g Maximum value of SAR (measured) = 18.961 mW/g



0 dB = 18.960mW/g = 25.56 dB mW/g

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 18.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1006

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz; $\sigma = 5.46$ mho/m; $\varepsilon_r = 49.2$; $\rho = 1000$ kg/m³. Medium parameters used: f = 5500 MHz; $\sigma = 5.86$ mho/m; $\varepsilon_r = 48.7$; $\rho = 1000$ kg/m³. Medium parameters used: f = 5800 MHz; $\sigma = 6.28$ mho/m; $\varepsilon_r = 48.2$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

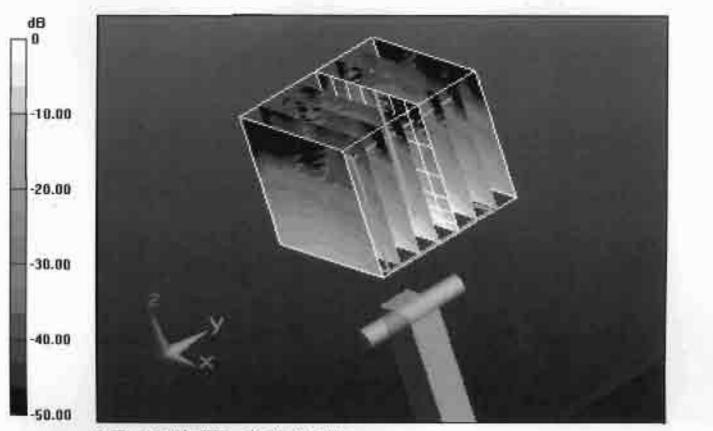
DASY52 Configuration:

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

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 57.425 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 28.4360 SAR(1 g) = 7.25 mW/g; SAR(10 g) = 2.04 mW/g Maximum value of SAR (measured) = 17.037 mW/g

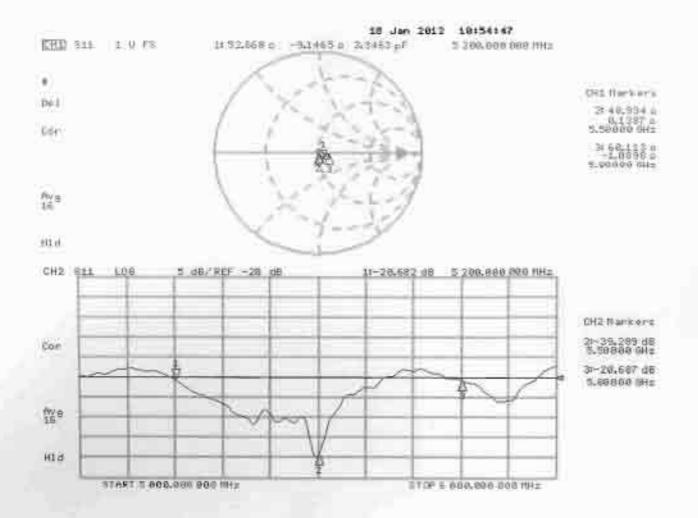
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 57.904 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 33.5870 SAR(1 g) = 7.86 mW/g; SAR(10 g) = 2.19 mW/g Maximum value of SAR (measured) = 19.044 mW/g

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 54.193 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 33.8240 SAR(1 g) = 7.3 mW/g; SAR(10 g) = 2.03 mW/g Maximum value of SAR (measured) = 18.191 mW/g



0 dB = 18.190 mW/g = 25.20 dB mW/g

Impedance Measurement Plot for Body TSL



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





S

C

Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

Servizio svizzero di taratura Sules Calibration Service

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

Certificate No: DAE3-495_Apr12

Accreditation No.: SCS 108

CALIBRATION CERTIFICATE

Amphenol (Auden)

Client

Object	DAE3 - SD 000 D	03 AD - SN: 495	
Calibration procedure(s)	QA CAL-06.v24 Calibration proceed	lure for the data acquisitio	n electronics (DAE)
Calibration date:	April 23, 2012		
The measurements and the unce	rtainties with confidence pro	nal standards, which realize the phy obability are given on the following p r facility: environment temperature (3	ages and are part of the certificate.
Primary Standards	iD #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	28-Sep-11 (No:11450)	Scheduled Calibration Sep-12
Secondary Standards	1D #	Check Date (in house)	Scheduled Check
Calibrator Box V2.1	SE UWS 053 AA 1001		In house check: Jan-13
	Name	Function	Signature
Calibrated by:	Eric Hainfeld	Technician	2441
Approved by:	Fin Bomholt	R&D Director	; V. BRUMMA
		ull without written approval of the la	issued: April 23, 2012

Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

- s Service suisse d'étalonnage
- С Servizio svizzero di taratura
- S Swiss Calibration Service

Accreditation No.: SCS 108

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

Glossary

DAE Connector angle data acquisition electronics 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 p	parameters: Aut	o Zero Time: 3	sec; Measuring	time: 3 sec

Calibration Factors	x	Y	z
High Range	404.352 ± 0.1% (k=2)	405.327 ± 0.1% (k=2)	405.654 ± 0.1% (k=2)
Low Range	3.95463 ± 0.7% (k=2)	3.99214 ± 0.7% (k=2)	3.96716 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	147.5 ° ± 1 °
eenneeter rangie to be dood in enter ofeien	· · · · · ·



Appendix

1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199997.08	-0.41	-0.00
Channel X + Input	20003.46	2.34	0.01
Channel X - Input	-19997.49	2.47	-0.01
Channel Y + Input	199999.33	2.06	0.00
Channel Y + Input	20001.56	0.65	0.00
Channel Y - Input	-19999.50	0.75	-0.00
Channel Z + Input	199996.88	-0.61	-0.00
Channel Z + Input	20002.89	1.96	0.01
Channel Z - Input	-19998.27	1.91	-0.01

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2003.09	1.65	0.08
Channel X + Input	202,47	0.71	0.35
Channel X - Input	-197,92	0.18	-0.09
Channel Y + Input	2001.21	0.06	0.00
Channel Y + input	201.12	-0.45	-0.22
Channel Y - Input	-199.11	-0.70	0.35
Channel Z + Input	2002.44	1.11	0.06
Channel Z + Input	200.50	-1.13	-0.56
Channel Z - Input	-198.21	-0.02	0.01

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	3.65	2.03
	- 200	-1.07	-2.24
Channel Y	200	-0.86	-1.37
	- 200	0.62	0.64
Channel Z	200	1.94	1,92
	- 200	-2.48	-2.59

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	×	-2.83	-1.94
Channel Y	200	4.87	-	-5.00
Channel Z	200	14.63	-0.87	(*)

Certificate No: DAE3-495_Apr12

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	15807	16448
Channel Y	15754	16462
Channel Z	15889	15649

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec Input $10M\Omega$

7.1	Average (µV)	min. Offset (μV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	-0.14	-1.77	1.06	0.51
Channel Y	0.58	-1.02	2.16	0.57
Channel Z	-0.65	-2.31	1.22	0.68

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

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





Schweizerischer Kalibrierdienst

- S Service suisse d'étalonnage
- С Servizio svizzero di taratura
- S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates Accreditation No.: SCS 108

Sporton-TW (Auden) Client

Certificate No: DAE4-778_Aug12

	health a feature of the second second		
Object	DAE4 - SD 000 D0	04 BJ - SN: 778	
alibration procedure(s)	QA CAL-06.v25 Calibration proced	ure for the data acquisition e	lectronics (DAE)
Calibration date:	August 27, 2012		
The measurements and the unce	rtainties with confidence pro	nal standards, which realize the physica bability are given on the following page facility: environment temperature (22 ±	s and are part of the certificate.
	E critical for calibration)		
Calibration Equipment used (M&T	E critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
Calibration Equipment used (M&T Primary Standards		Cal Date (Certificate No.) 28-Sep-11 (No:11450)	Scheduled Calibration Sep-12
Calibration Equipment used (M&T Primary Standards Keithley Multimeter Type 2001	ID # SN: 0810278 ID #	28-Sep-11 (No:11450) Check Date (in house)	- Contracting and the Second Second Second Second
Calibration Equipment used (M&T Primary Standards Keithley Multimeter Type 2001 Secondary Standards Calibrator Box V2.1	ID # SN: 0810278 ID #	28-Sep-11 (No:11450)	Sep-12
Calibration Equipment used (M&T Primary Standards Keithley Multimeter Type 2001 Secondary Standards	ID # SN: 0810278 ID # SE UWS 053 AA 1001	28-Sep-11 (No:11450) Check Date (in house) D5-Jan-12 (in house check)	Sep-12 Scheduled Check In house check: Jan-13
Calibration Equipment used (M&T Primary Standards Keithley Multimeter Type 2001 Secondary Standards	ID # SN: 0810278 ID #	28-Sep-11 (No:11450) Check Date (in house)	Sep-12 Scheduled Check
Calibration Equipment used (M&T Primary Standards Keithley Multimeter Type 2001 Secondary Standards Calibrator Box V2.1	ID # SN: 0810278 ID # SE UWS 053 AA 1001	28-Sep-11 (No:11450) Check Date (in house) D5-Jan-12 (in house check) Function	Sep-12 Scheduled Check In house check: Jan-13
Calibration Equipment used (M&T Primary Standards Keithley Multimeter Type 2001 Secondary Standards Calibrator Box V2.1	ID # SN: 0810278 ID # SE UWS 053 AA 1001	28-Sep-11 (No:11450) Check Date (in house) D5-Jan-12 (in house check) Function	Sep-12 Scheduled Check In house check: Jan-13

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





S Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

C Service suisse d etalomage Servizio svizzero di taratura

S Swiss Calibration Service

Accreditation No.: SCS 108

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

Glossary

DAE data acq Connector angle informati

data acquisition electronics information used in DASY system to align probe sensor X to the robot

Methods Applied and Interpretation of Parameters

coordinate system.

- 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: Aut	o Zero Time: 3	sec; Measuring	time: 3 sec

Calibration Factors	x	Y	z
High Range	404.663 ± 0.1% (k=2)	403.465 ± 0.1% (k=2)	405.010 ± 0.1% (k=2)
Low Range	3.98578 ± 0.7% (k=2)	3.96516 ± 0.7% (k=2)	3.99894 ± 0.7% (k=2)

Connector Angle

	Contraction of the Articles
Connector Angle to be used in DASY system	283 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	200000.39	2.63	0.00
Channel X + Input	20001.58	1.36	0.01
Channel X - Input	-19998.48	2.54	-0.01
Channel Y + Input	200000.90	3.34	0.00
Channel Y + Input	20000.55	0.30	0.00
Channel Y - Input	-19999.91	1.23	-0.01
Channel Z + Input	199999.59	1.90	0.00
Channel Z + Input	19998.55	-1.57	-0.01
Channel Z - Input	-20004.33	-3.11	0.02

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2000.71	0.06	0.00
Channel X + Input	201.15	0.23	0.11
Channel X - Input	-198.08	0.92	-0.46
Channel Y + Input	2000.36	-0.13	-0.01
Channel Y + Input	199.81	-0.98	-0.49
Channel Y - Input	-200.22	-1.21	0.61
Channel Z + Input	2000.89	0.54	0.03
Channel Z + Input	200.06	-0.72	-0.36
Channel Z - Input	-199.79	-0.68	0.34

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	-4.83	-5.89
	- 200	7.67	5.93
Channel Y	200	-1.95	-2.63
	- 200	-0.79	-0.35
Channel Z	200	-8.43	-9.27
	- 200	8.42	8.08

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		-1.46	-2.45
Channel Y	200	9.44	1	0.28
Channel Z	200	4.92	6.59	2

Certificate No: DAE4-778_Aug12

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	16053	16715	
Channel Y	16161	14601	
Channel Z	16434	15429	

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec Input $10M\Omega$

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	1.04	0.34	1.84	0.34
Channel Y	-1.10	-2.50	0.04	0.56
Channel Z	-0.63	-1.70	1.29	0.47

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

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





Schweizerischer Kallbrierdienst

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

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

Sporton Client

Certificate No: DAE3-577 Jun12

Accreditation No.: SCS 108

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D0)3 AA - SN: 577	
Calibration procedure(s)	QA CAL-06.v24 Calibration proced	ure for the data acquisitio	n electronics (DAE)
Calibration date:	June 06, 2012		
The measurements and the uncer All calibrations have been conduct	tainties with confidence pro	nal standards, which realize the phy bability are given on the following p facility: environment temperature (2	ages and are part of the certificate.
Calibration Equipment used (M&T			
Primary Standards	ID # SN: 0810278	Cal Date (Certificate No.)	Scheduled Calibration Sep-12
Keithley Multimeter Type 2001	SN: 0010270	28-Sep-11 (No:11450)	-00p-12
Secondary Standards	1D #	Check Date (in house)	Scheduled Check
Calibrator Box V2.1	SE UWS 053 AA 1001	05-Jan-12 (in house check)	In house check; Jan-13
	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	VII
Approved by:	Fin Bomholt	R&D Director	V.Bleand
This calibration certificate shall no	t be reproduced except in	ull without written approval of the la	Issued: June 6, 2012 boratory.

Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





S

Schweizerischer Kalibrierdienst

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

Accreditation No.: SCS 108

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

Glossary

DAE Connector angle

data acquisition electronics

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
NASY massimement	narameters: Au	o Zero Time 3	sec Measuring	time: 3 sec

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

Calibration Factors	x	Y	Z
High Range	404.058 ± 0 1% (k=2)	403.945 ± 0.1% (k=2)	404.061 ± 0.1% (k=2)
Low Range	3.93352 ± 0.7% (k=2)	3.95384 ± 0.7% (k=2)	3.95036 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	111.5°±1°
Sources of Angle to be about it brief a system	11110

Appendix

1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199995.54	-0.89	-0.00
Channel X + Input	20002.00	1.99	0.01
Channel X - Input	-19998.81	2.31	-0.01
Channel Y + Input	199996.22	-0.29	-0.00
Channel Y + Input	19999.47	-0.49	-0.00
Channel Y - Input	-20001.10	0.06	-0.00
Channel Z + Input	199994.90	-1.65	-0.00
Channel Z + Input	20001.77	1.80	0.01
Channel Z - Input	-19999.69	1.56	-0.01

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2000.56	0.24	0.01
Channel X + Input	200.49	-0.28	-0.14
Channel X - Input	-198.35	0.69	-0.35
Channel Y + Input	2000.53	0.31	0.02
Channel Y + Input	200.35	-0.44	-0.22
Channel Y - Input	-199.12	0.17	-0.08
Channel Z + Input	1999.73	-0.51	-0.03
Channel Z + Input	199.96	-0.76	-0.38
Channel Z - Input	-200.14	-0.91	0.46

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	-8.13	-11.22
	- 200	12.49	10.42
Channel Y	200	10.28	10.45
	- 200	-12.29	-11.56
Channel Z	200	7.71	8.46
	- 200	-10.39	-10.87

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	- F	-0.16	-3.68
Channel Y	200	6.63	2	0.62
Channel Z	200	5.48	4.85	14

Certificate No: DAE3-577_Jun12

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	16237	16308
Channel Y	16451	16683
Channel Z	15995	16468

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec input $10M\Omega$

	Average (µV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (µV)
Channel X	-0.65	-2.12	0.66	0.54
Channel Y	0.02	-1.35	1.15	0.59
Channel Z	-2.84	-3.96	-1.77	0.47

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

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





s

Accreditation No.: SCS 108

Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

С Servizio svizzero di taratura s

Swiss Calibration Service

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

Sporton (Auden) Client

Certificate No: DAE4-1279 May12

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D	04 BJ - SN: 1279	
Calibration procedure(s)	QA CAL-06.v24 Calibration proceed	lure for the data acquisition e	lectronics (DAE)
Calibration date:	May 03, 2012		
	Children and Children and Large and Alexandre	nal standards, which realize the physical bability are given on the following pages	
All calibrations have been conduc	ted in the closed laboratory	facility: environment temperature (22 ±	3)°C and humidity < 70%.
Calibration Equipment used (M&T	E critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	28-Sep-11 (No:11450)	Sep-12
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V2.1	SE UWS 053 AA 1001	05-Jan-12 (in house check)	In house check: Jan-13
	Name	Function	Signature
Calibrated by	Name Dominique Steffen	Function Technician	Signature
Calibrated by	and the second sec	and the design of the second sec	12
Calibrated by Approved by:	and the second sec	and the design of the second sec	XD

Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

- s Service suisse d'étalonnage С
 - Servizio svizzero di taratura
- S Swiss Calibration Service

Accreditation No.: SCS 108

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

Glossary

DAE Connector angle data acquisition electronics 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

 $\begin{array}{cccc} \mbox{High Range:} & 1LSB = & 6.1 \mu V \ , & \mbox{full range} = & -100...+300 \ mV \\ \mbox{Low Range:} & 1LSB = & 61nV \ , & \mbox{full range} = & -1.....+3mV \\ \mbox{DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec} \end{array}$

Calibration Factors	x	Y	z
High Range	405.179 ± 0.1% (k=2)	404.974 ± 0.1% (k=2)	404.316 ± 0.1% (k=2)
Low Range	3.98658 ± 0.7% (k=2)	3.98731 ± 0.7% (k=2)	3.99734 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	117.0°±1°
---	-----------

Appendix

1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199991.33	-3.98	-0.00
Channel X + Input	20000.42	1.05	0.01
Channel X - Input	-20000.99	0.62	-0.00
Channel Y + Input	199992.57	-2.48	-0.00
Channel Y + Input	20000.37	1.13	0.01
Channel Y - Input	-20001.77	-0.06	0.00
Channel Z + Input	199995.61	0.39	0.00
Channel Z + Input	19999.27	0.00	0.00
Channel Z - Input	-20002.85	+1.22	0.01

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + input	1999.48	-0.32	-0.02
Channel X + Input	200.41	0.23	0.11
Channel X - Input	-199.28	0.50	-0.25
Channel Y + Input	2000.24	0.55	0.03
Channel Y + Input	200.58	0.44	0.22
Channel Y - Input	-199.75	-0.01	0.00
Channel Z + Input	1998.83	-0.82	-0.04
Channel Z + Input	198.55	-1.51	-0.75
Channel Z - Input	-201.15	-1.30	0.65

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	17.08	15.93
	- 200	-15.69	-16.88
Channel Y	200	8.48	8 38
	- 200	-9.22	-9.58
Channel Z	200	-0.67	-0.84
	- 200	-0.62	-0.65

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		3.17	-3.15
Channel Y	200	7.76		3.57
Channel Z	200	8.98	6.44	*

Certificate No: DAE4-1279_May12

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	15658	14778
Channel Y	16426	15731
Channel Z	15918	15544

5. Input Offset Measurement

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

	Average (µV)	min. Offset (μV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	0.78	-0.61	2.27	0.58
Channel Y	0.16	-1,45	2.45	0.76
Channel Z	-0.63	-2.21	0.54	0.54

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

Calibration Laboratory of Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland

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

Auden Client

DC MRA



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

Accreditation No.: SCS 108

S

С

S

Certificate No: EX3-3801_Jun12

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3801
Calibration procedure(s)	QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4 Calibration procedure for dosimetric E-field probes
Calibration date:	June 22, 2012
	uments the traceability to national standards, which realize the physical units of measurements (SI). ncertainties with confidence probability are given on the following pages and are part of the certificate.
	ducted 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	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-D1529)	Apr-13
Reference 30 dB Attenuator	SN: S5129 (30b)	27-Mar-12 (No. 217-01532)	Apr-13
Reference Probe ES3DV2	SN: 3013	29-Dec-11 (No. ES3-3013_Dec11)	Dec-12
DAE4	SN: 660	10-Jan-12 (No. DAE4-660_Jan12)	Jan-13
Secondary Standards	D	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

	Name	Function	Signature (
Calibrated by:	Claudio Leubler	Laboratory Technician	A
Approved by:	Katja Pokovic	Technical Manager	ll 13
This calibration certificate	shall not be reproduced except in full	without written approval of the laborator	Issued: June 22, 2012 Iy.

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





S

С

s

Schweizerischer Kalibrierdienst

- Service suisse d'étalonnage
- Servizio svizzero di taratura
- Swiss Calibration Service

Accreditation No.: SCS 108

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

Glossary: TSL tissue simulating liquid NORMx,y,z sensitivity in free space ConvF sensitivity in TSL / NORMx,v,z DCP diode compression point CF crest factor (1/duty_cycle) of the RF signal A. B. C modulation dependent linearization parameters Polarization @ o rotation around probe axis Polarization & 9 rotation around an axis that is in the plane normal to probe axis (at measurement center). i.e., 9 = 0 is normal to probe axis

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

Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field polarization 9 = 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 E²-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; VRx,y,z: A, B, C 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.

Probe EX3DV4

SN:3801

Manufactured: Calibrated:

April 5, 2011 June 22, 2012

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

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m)2)A	0.55	0.60	0.54	± 10.1 %
DCP (mV) ⁸	98.6	101.4	102.0	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc ^E (k=2)
0	CW 0.00	CW 0.00 X	X	0.00	0.00	1.00	177.5	±3.8 %
			Y	0.00	0.00	1.00	184.0	
			Z	0.00	0.00	1.00	175.5	

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%.

¹ The uncertainties of NormX,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6). ⁸ Numerical linearization parameter: uncertainty not required.

⁶ Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	9.09	9.09	9.09	0.80	0.61	± 12.0 %
835	41.5	0.90	8.71	8.71	8.71	0.42	0.82	± 12.0 %
900	41.5	0.97	8.68	8.68	8.68	0.63	0.73	± 12.0 %
1750	40.1	1.37	7.70	7.70	7.70	0.35	1.02	± 12.0 %
1900	40.0	1.40	7.42	7.42	7.42	0.35	1.01	± 12.0 %
2000	40.0	1.40	7.37	7.37	7.37	0.60	0.74	± 12.0 %
2450	39.2	1.80	6.70	6.70	6.70	0.41	0.93	± 12.0 %

Calibration Parameter Determined in Head Tissue Simulating Media

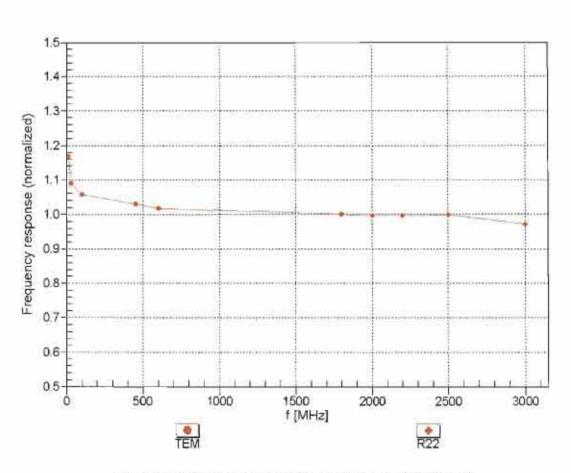
^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. ^F At frequencies below 3 GHz, the validity of tissue parameters (*ε* and *σ*) can be relaxed to ± 10% if liquid compensation formula is applied to

¹ At frequencies below 3 GHz, the validity of tissue parameters (r and o) 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 (r and o) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

f (MHz) ^c	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	9.00	9.00	9.00	0.80	0.66	± 12.0 %
835	55.2	0.97	8.82	8.82	8.82	0.53	0.78	± 12.0 %
900	55.0	1.05	8.72	8.72	8.72	0.80	0.61	± 12.0 %
1750	53.4	1.49	7.50	7.50	7.50	0.77	0.68	± 12.0 %
1900	53.3	1.52	7.13	7.13	7.13	0.51	0.79	± 12.0 %
2000	53.3	1.52	7.13	7.13	7.13	0.70	0.68	± 12.0 %
2450	52.7	1.95	6.59	6.59	6.59	0.80	0.59	± 12.0 %

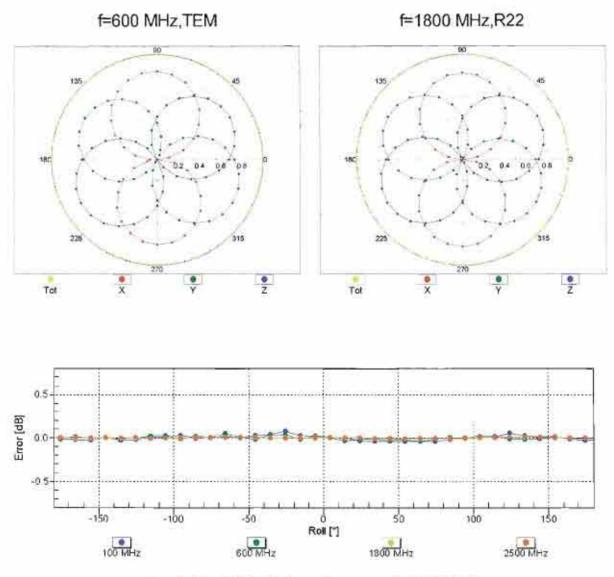
Calibration Parameter Determined in Body Tissue Simulating Media

^c Frequency validity of \pm 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to \pm 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. ^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to \pm 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 \pm 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

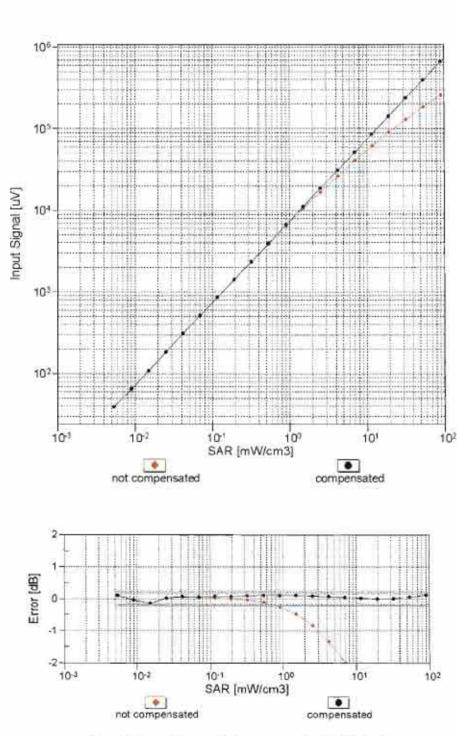


Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

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

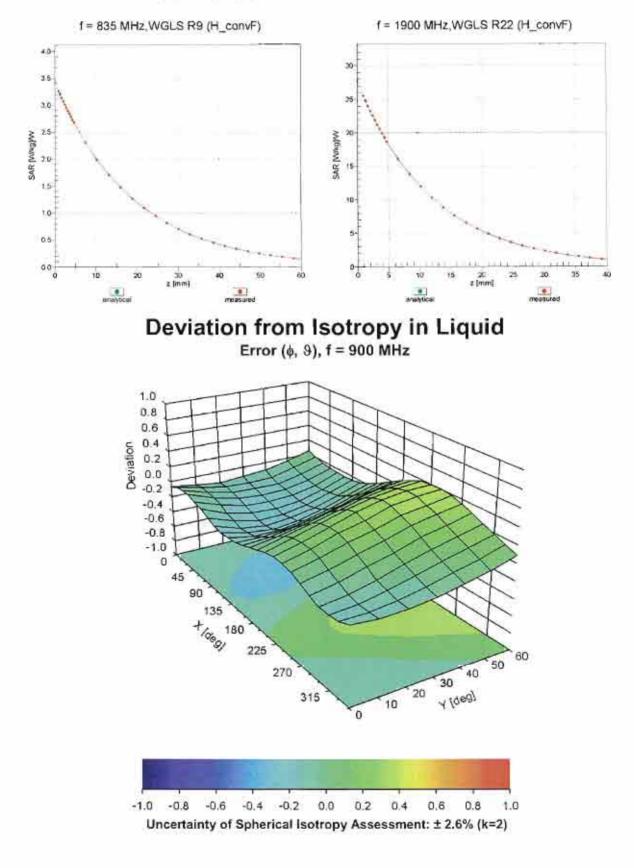


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)



Dynamic Range f(SAR_{head}) (TEM cell, f = 900 MHz)

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



Conversion Factor Assessment

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	124.4
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	2 mm

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



SWISS CRUSS REARING

S Schweizerischer Kalibrierdienst C Service suisse d'étalonnage

Servizio svizzero di taratura Swiss Calibration Service

In house check: Oct-12

Accreditation No.: SCS 108

s

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

Client Sporton-TW (Auden)

Certificate No: ET3-1787_May12

CALIBRATION	CERTIFICA	TE
-------------	-----------	----

Object	ET3DV6 - SN:17	87	
Calibration procedure(s)	2 2 2 4 2 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2	A CAL-23.v4, QA CAL-25.v4 dure for dosimetric E-field probe	es
Calibration date:	May 29, 2012		
	A REAL PROPERTY OF A REAL PROPER	onal standards, which realize the physical u obability are given on the following pages a	
		y facility: environment temperature (22 ± 3)	
Calibration Equipment used (M			
Primary Standards	iD	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01505)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
			1.0MIC.CM

Reference 30 dB Attenuator SN: S5129 (30b) 27-Mar-12 (No. 217-01532) Apr-13 Reference Probe ES3DV2 SN: 3013 29-Dec-11 (No. ES3-3013_Dec11) Dec-12 DAE4 SN: 660 10-Jan-12 (No. DAE4-660_Jan12) Jan-13 D Secondary Standards Check Date (in house) Scheduled Check RF generator HP 8648C US3642U01700 4-Aug-99 (in house check Apr-11) In house check: Apr-13

18-Oct-01 (in house check Oct-11)

	Name	Function	Signature
Calibrated by:	Jeton Kastrali	Laboratory Technician	fl
Approved by:	Katja Pokovic	Technical Manager	Lelle
			Issued: May 29, 2012

Network Analyzer HP 8753E

US37390585

Calibration Laboratory of Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst s

Service suisse d'étalonnage

Servizio svizzero di taratura

С s Swiss Calibration Service

Accreditation No.: SCS 108

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

Glossary: TSL tissue simulating liquid NORMx,y,z sensitivity in free space sensitivity in TSL / NORMx,y,z ConvF DCP diode compression point CF crest factor (1/duty_cycle) of the RF signal A, B, C modulation dependent linearization parameters Polarization ϕ o rotation around probe axis 9 rotation around an axis that is in the plane normal to probe axis (at measurement center), Polarization & i.e., 9 = 0 is normal to probe axis

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- 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 9 = 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 E²-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, v, 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, VRx,y,z: A, B, C 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.

Probe ET3DV6

SN:1787

Manufactured: Calibrated:

May 28, 2003 May 29, 2012

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

Certificate No: ET3-1787_May12

Page 3 of 11

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m) ²) ^A	1.61	1.67	2.16	± 10.1 %
DCP (mV) ^B	99.8	99.1	93.9	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc ^t (k=2)
0 CW	CW 0.00	CW 0.00 X	0.00	0.00	1.00	134.2	±1.9 %	
			Y	0.00	0.00	1.00	141.3	
			Z	0.00	0.00	1.00	158.6	

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%.

- * The uncertainties of NormX, Y.Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^a Numerical linearization parameter: uncertainty not required. ^f Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

f (MHz) ^c	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.46	6.46	6.46	0.28	2.84	± 12.0 %
835	41.5	0.90	6.12	6,12	6.12	0.31	3.00	± 12.0 %
900	41.5	0.97	5.91	5,91	5.91	0.33	3.00	± 12.0 %
1450	40.5	1.20	5.40	5.40	5.40	0.47	2.74	± 12.0 %
1750	40.1	1.37	5.27	5.27	5.27	0.70	2.21	± 12.0 %
1900	40.0	1.40	5.06	5.06	5.06	0.69	2.29	± 12.0 %
2000	40.0	1.40	4.96	4.96	4.96	0.80	2.04	± 12.0 %
2150	39.7	1.53	4.78	4.78	4.78	0.80	1.98	± 12.0 %
2450	39.2	1.80	4.31	4.31	4.31	0.80	1.66	± 12.0 %

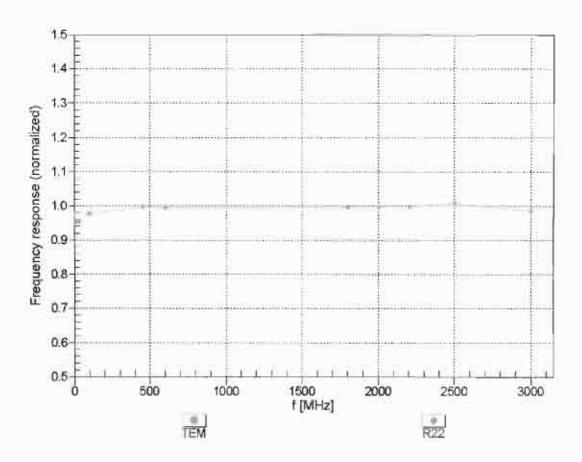
Calibration Parameter	Determined in Head	Tissue Simulating Media
-----------------------	--------------------	-------------------------

^c Frequency validity 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. ^r At frequencies below 3 GHz, the validity of tissue parameters (s 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 (s and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

f (MHz) ^c	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.20	6.20	6.20	0.30	2.70	± 12.0 %
835	55.2	0.97	6.08	6.08	6.08	0.32	3.00	± 12.0 %
900	55.0	1.05	6.01	6.01	6.01	0.43	2.28	± 12.0 %
1450	54.0	1.30	5.18	5.18	5,18	0.59	2.30	± 12.0 %
1750	53.4	1.49	4.81	4.81	4.81	0.80	2.47	± 12.0 %
1900	53.3	1.52	4.58	4.58	4.58	0.80	2.47	± 12.0 %
2000	53.3	1.52	4.65	4.65	4.65	0.80	2.44	± 12.0 %
2150	53.1	1.66	4,50	4.50	4.50	0.80	2.17	± 12.0 %
2450	52.7	1.95	4.04	4.04	4.04	0.67	1.35	± 12.0 %

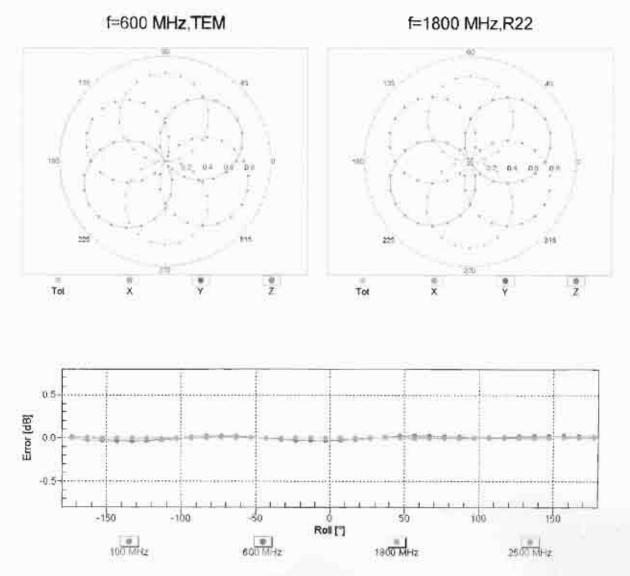
Calibration Param	eter Determine	d in Body Tissue	Simulating Media
-------------------	----------------	------------------	------------------

^c Frequency validity 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. ^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.

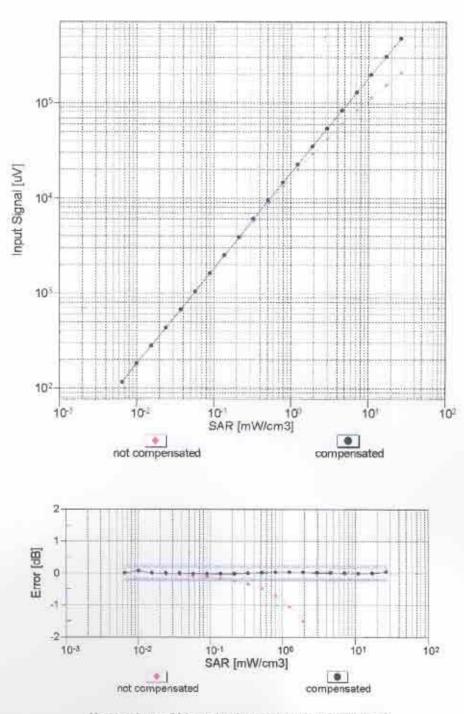


Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

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



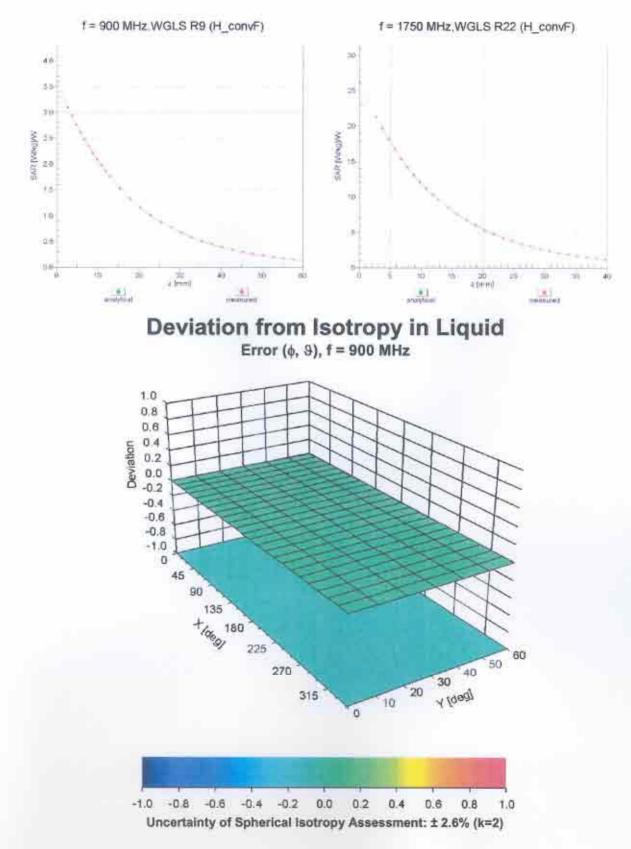
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)



Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)

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

May 29, 2012



Conversion Factor Assessment

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (*)	167
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	6.8 mm
Probe Tip to Sensor X Calibration Point	2.7 mm
Probe Tip to Sensor Y Calibration Point	2.7 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	4 mm

Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland

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

Client Sporton-TW (Auden)

SMIS CMRA R B MRA CP CP SMIS

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

Accreditation No.: SCS 108

Certificate No: ES3-3270_Sep12

s

C

S

CALIBRATION CERTIFICATE

Object	ES3DV3 - SN:3270
Calibration procedure(s)	QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4 Calibration procedure for dosimetric E-field probes
Calibration date:	September 28, 2012
a consider the second strategy and state and state and strategy and state and st	uments the traceability to national standards, which realize the physical units of measurements (SI), scertainties with confidence probability are given on the following pages and are part of the certificate.
All calibrations have been con	ducted 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 GB41293874 Apr-13 Power meter E44198 29-Mar-12 (No. 217-01508) Power sensor E4412A MY41498087 29-Mar-12 (No. 217-01508) Apr-13 Reference 3 dB Attenuator SN: \$5054 (3c) 27-Mar-12 (No. 217-01531) Apr-13 Reference 20 dB Attenuator SN: S5086 (20b) 27-Mar-12 (No. 217-01529) Apr-13 Reference 30 dB Attenuator SN: S5129 (30b) 27-Mar-12 (No. 217-01532) Apr-13 Reference Probe ES3DV2 SN: 3013 29-Dec-11 (No. ES3-3013_Dec11) Dec-12 DAE4 SN: 660 20-Jun-12 (No. DAE4-660 Jun12) Jun-13 Secondary Standards 1D Check Date (in house) Scheduled Check 4-Aug-99 (in house check Apr-11) RF generator HP 8648C US3642U01700 In house check: Apr-13 Network Analyzer HP 8753E US37390585 18-Oct-01 (in house check Oct-11) In house check: Oct-12

	Name	Function	Sidinature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Poković	Technical Manager	alat
			Issued: October 1, 2012
This calibration certificate	shall not be reproduced except in full	without written approval of the laboratory	<u> </u>

Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

Servizio svizzero di taratura

Swiss Calibration Service

Accreditation No.: SCS 108

S

C

S

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

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	modulation dependent linearization parameters
Polarization ϕ	φ rotation around probe axis
Polarization 9	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis

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

Methods Applied and Interpretation of Parameters:

- NORMx, y, z: Assessed for E-field polarization 9 = 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 E²-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, VRx,y,z: A, B, C 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.

Probe ES3DV3

SN:3270

Calibrated:

Manufactured: February 25, 2010 September 28, 2012

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

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	1.11	1.21	1.22	± 10.1 %
DCP (mV) ⁸	101.7	100.7	99.1	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc ^L (k=2)
0	CW	0.00	X	0.00	0.00	1.00	143.0	±3.0 %
			Y	0.00	0.00	1.00	114.5	
			Z	0.00	0.00	1.00	149.7	

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 E2-field uncertainty inside TSL (see Pages 5 and 6).

⁸ Numerical linearization parameter: uncertainty not required

⁶ Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

f (MHz) ^c	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
835	41.5	0.90	6.20	6.20	6.20	0.41	1.53	± 12.0 %
900	41.5	0.97	6.12	6.12	6.12	0.24	2.13	± 12.0 %
1750	40.1	1.37	5.20	5.20	5.20	0.58	1.35	± 12.0 %
1900	40.0	1.40	5.05	5.05	5.05	0.74	1.20	± 12.0 %
2000	40.0	1.40	5.02	5.02	5.02	0.76	1.20	± 12.0 %
2450	39.2	1.80	4.45	4.45	4.45	0.77	1.30	± 12.0 %

Calibration Parameter Determined in Head Tissue Simulating Media

^c Frequency validity of \pm 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to \pm 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. ^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to \pm 10% if liquid compensation formula is applied to

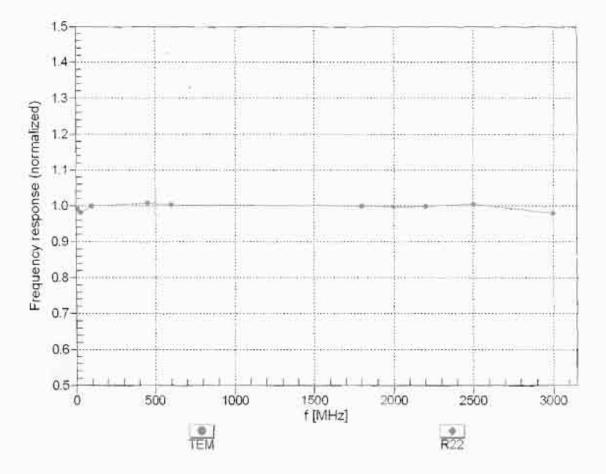
^c At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

f (MHz) ^c	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
835	55.2	0.97	6.16	6.16	6.16	0.36	1.73	± 12.0 %
900	_ 55.0	1.05	6.10	6.10	6.10	0.48	1.51	± 12.0 %
1750	53.4	1.49	4.98	4.98	4.98	0.41	1.79	± 12.0 %
1900	53.3	1.52	4.67	4.67	4.67	0.80	1.18	± 12.0 %
2000	53.3	1.52	4.69	4.69	4.69	0.76	1.29	± 12.0 %
2450	52.7	1.95	4.17	4.17	4.17	0.75	1.08	± 12.0 %

Calibration Parameter Determined in Body Tissue Simulating Media

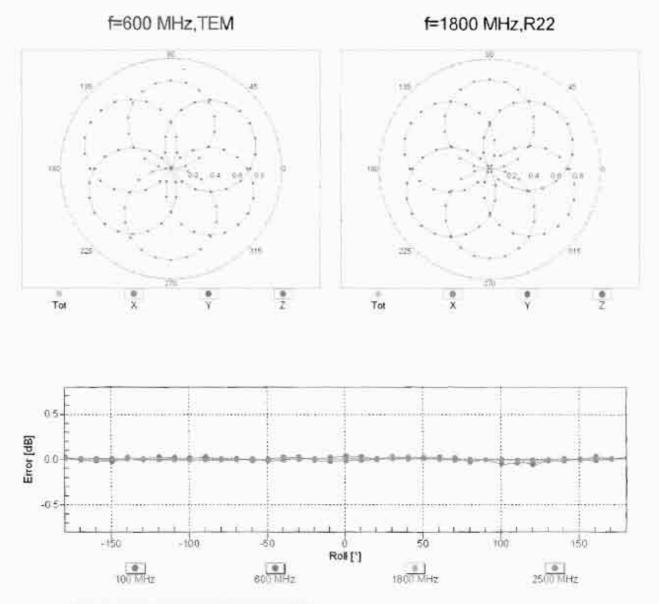
^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

⁶ At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to \pm 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 \pm 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

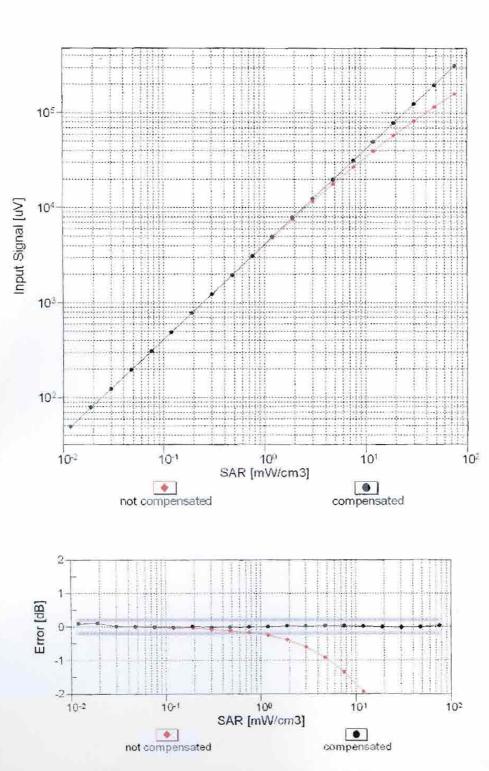


Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

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

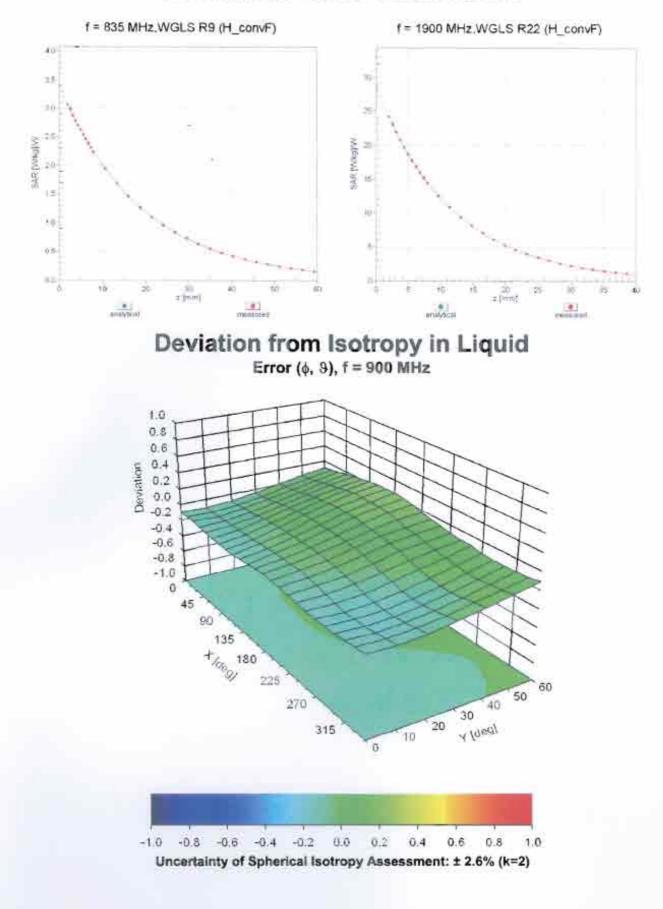


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)



Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)

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



Conversion Factor Assessment

Page 10 of 11

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-19.3
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

Calibration Laboratory of Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland





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

Accreditation No.: SCS 108

s

С

S

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

Client Sporton-TW (Auden)

Certificate No: EX3-3792_Jun12

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3792
Calibration procedure(s)	QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4 Calibration procedure for dosimetric E-field probes
Calibration date:	June 21, 2012
그는 가지, 같은 것 같은 것이 같은 것이 것이 없는 것이 없다.	uments the traceability to national standards, which realize the physical units of measurements (SI) ncertainties with confidence probability are given on the following pages and are part of the certificate.
All calibrations have been cor	ducted in the closed laboratory facility: environment temperature (22 \pm 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	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
Reference 30 dB Attenuator	SN: S5129 (30b)	27-Mar-12 (No. 217-01532)	Apr-13
Reference Probe ES3DV2	SN: 3013	29-Dec-11 (No. ES3-3013_Dec11)	Dec-12
DAE4	SN: 660	10-Jan-12 (No. DAE4-660_Jan12)	Jan-13
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	U\$3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

	Name	Function	Signature /
Calibrated by	Jeton Kastreti	Laboratory Technician	4-U
Approved by:	Katje Pokovic	Technical Manager	della.
			Issued: June 22, 2012
This calibration certificate	shall not be reproduced except in ful	without written approval of the laborator	

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





С

s

S Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

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

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	modulation dependent linearization parameters
Polarization ϕ	φ rotation around probe axis
Polarization 9	9 rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., 9 = 0 is normal to probe axis

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

Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field polarization 9 = 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 E²-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, VRx,y,z; A, B, C 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.

Accreditation No.: SCS 108

Probe EX3DV4

SN:3792

Manufactured: April 5, 2011 Calibrated:

June 21, 2012

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

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	0.64	0.54	0.53	± 10.1 %
DCP (mV) ⁸	99.0	99.4	103.0	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc ^E (k=2)
0	CW	0.00	X	0.00	0.00	1.00	mV 136.2 131.7	±3.3 %
			Y	0.00	0.00	1.00	131.7	
			Z	0.00	0.00	1.00	165.7	

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%.

^h The uncertainties of NormX,Y,Z do not affect the E¹-field uncertainty inside TSL (see Pages 5 and 6). ^B Numerical linearization parameter: uncertainty not required.

* Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

f (MHz) ^c	Relative Permittivity ^F	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
835	41.5	0.90	9.02	9.02	9.02	0.41	0.85	± 12.0 %
900	41.5	0.97	8.89	8.89	8.89	0.57	0.73	± 12.0 %
1750	40.1	1.37	8.16	8.16	8.16	0.75	0.61	± 12.0 %
1900	40.0	1.40	7.73	7.73	7.73	0.41	0.83	± 12.0 %
2000	40.0	1.40	7.68	7.68	7.68	0.44	0.78	± 12.0 %
2300	39.5	1.67	7.27	7.27 7.27 0.65 0.64		0.64	± 12.0 %	
2450	39.2	1.80	6.82	6.82	.82 6.82 0.36 0.87		0.87	± 12.0 %
2600	39.0	1.96	6.72	6.72	6.72	0.44	0.78	± 12.0 %
3500	37,9	2.91	6.83	6.83	6.83	0.41	0.93	± 13.1 %
5200	36.0	4.66	5.07	5.07	5.07	0.30	1.80	± 13.1 %
5300	35.9	4.76	4.96	4.96	4.96	0.38	1.80	± 13.1 %
5500	35.6	4.96	4.71 4.71 4.71 0.40 1.80		0.40 1.80	± 13.1 %		
5600	35.5	5.07	4.66	4.66	4.66 4.66 0.40 1.80		1.80	± 13.1 %
5800	35.3	5.27	4.48	4.48	4.48	0.48	1.80	± 13,1 %

Calibration Parameter Determined in Head Tissue Simulating Media

^C Frequency validity of \pm 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to \pm 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. ^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and α) can be relaxed to \pm 10% if liquid compensation formula is applied to

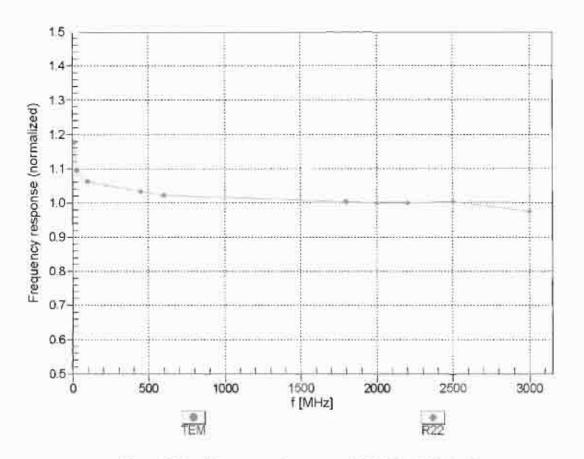
⁵ At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

f (MHz) ^c	z) ^c Relative Permittivity			ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
835	55.2	0.97	8.99	8.99	8.99	0.80	0.62	± 12.0 %	
900	55.0	1.05	8.98	8.98	8.98	0.66	0.67	± 12.0 %	
1750	53.4	1.49	7.71	7.71	7.71	0.37	0.92	± 12.0 %	
1900	53.3	1.52	7.29	7.29	7.29	0.40	0.88	± 12.0 %	
2000	53.3	1.52	7.44	7.44	7.44	0.40	0.89	± 12.0 %	
2300	52.9	1.81	7.14	7.14	7.14	0.57	0.72	± 12.0 %	
2450	52.7	1.95	7.10	0 7.10 7.10 0.80 0.5		0.55	± 12.0 %		
2600	52.5	2.16	6.84	6.84	6.84	0.80	0.50	± 12.0 %	
3500	51.3	3.31	6.13	6.13 6.13 6.13	6.13	0.37	1.15	± 13.1 %	
5200	49.0	5.30	4.20	4.20	4.20	0.50	1.90	± 13.1 %	
5300	48.9	5.42	4.01	4.01	4.01	0.50	1.90	± 13.1 %	
5500	48.6 5.65 3.81 3.81		3.81	0.50	1.90	± 13.1 %			
5600	48.5	5.77	3.72	3.72 3.72 0.50 1.90		1.90	± 13.1 %		
5800	48.2	6.00	3.89	3.89	3.89	0.60	1.90	± 13.1 %	

Calibration Parameter Determined in Body Tissue Simulating Media

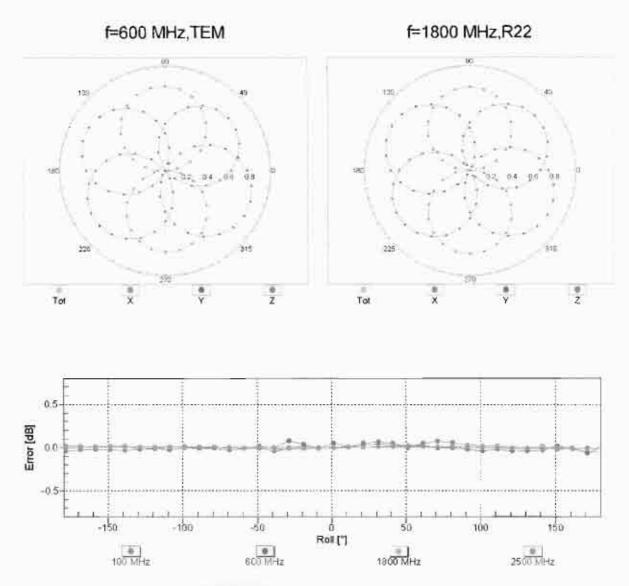
⁶ Frequency validity of \pm 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to \pm 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. ⁶ At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to \pm 10% if liquid compensation formula is applied to

⁵ At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to \pm 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 \pm 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

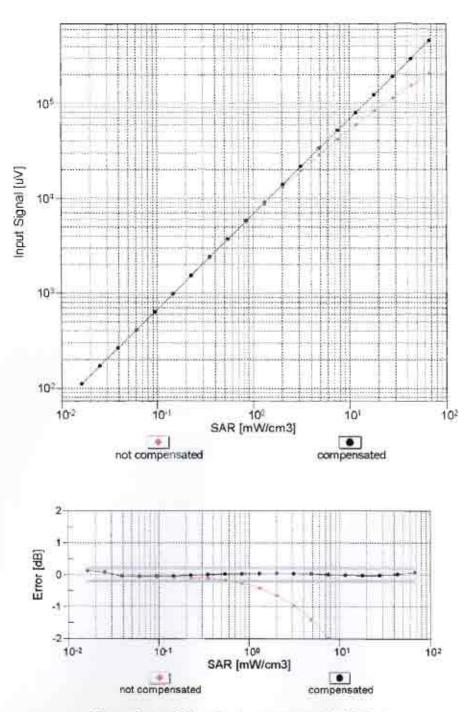


Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

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

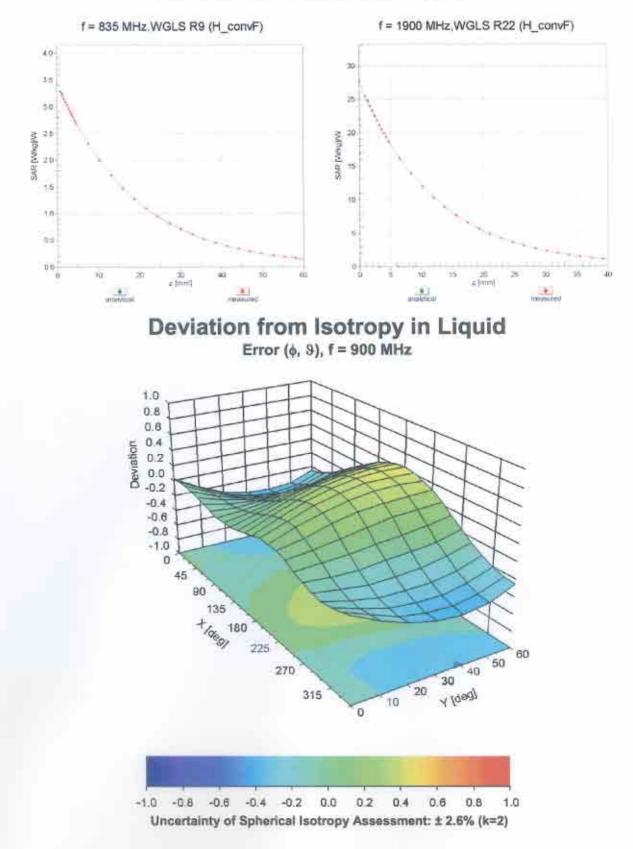


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)



Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)

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



Conversion Factor Assessment

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	31.3
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	2 mm

Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland

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

Client Sporton-CN (Auden)

SWISS CRUBRA

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

Accreditation No.: SCS 108

s

С

S

Certificate No: EX3-3697_Sep12

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3697
Calibration procedure(s)	QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4 Calibration procedure for dosimetric E-field probes
Calibration date:	September 28, 2012
	uments the traceability to national standards, which realize the physical units of measurements (SI), ncertainties with confidence probability are given on the following pages and are part of the certificate.
All calibrations have been con	ducted 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	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
Reference 30 dB Attenuator	SN: S5129 (30b)	27-Mar-12 (No. 217-01532)	Apr-13
Reference Probe ES3DV2	SN: 3013	29-Dec-11 (No. ES3-3013_Dec11)	Dec-12
DAE4	SN: 660	20-Jun-12 (No. DAE4-660_Jun12)	Jun-13
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

	Name	Function	Signature
Callbrated by:	Clinidio Leubler	Laboratory Technician	UP
Approved by:	Katja Poković	Technical Manager	Self
This calibration certificate	e shall not be reproduced except in full	without written approval of the laboratory	Issued: September 28, 2012

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





s

C

S

Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

- 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

Glossary:

tissue simulating liquid
sensitivity in free space
sensitivity in TSL / NORMx,y,z
diode compression point
crest factor (1/duty_cycle) of the RF signal
modulation dependent linearization parameters
o rotation around probe axis
9 rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., 9 = 0 is normal to probe axis

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

Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field polarization 9 = 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 E²-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, VRx,y,z; A, B, C 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.

Accreditation No.: SCS 108

Probe EX3DV4

SN:3697

Manufactured: April 22, 2009 Calibrated:

September 28, 2012

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

Certificate No: EX3-3697_Sep12

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m) ²) ^A	0.47	0.47	0.52	± 10.1 %
DCP (mV) ^e	99.1	99.9	98.4	

Modulation Calibration Parameters

DID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc ^t (k=2)
0	CW	0.00	X	0.00	0.00	1.00	154.0	±3.5 %
			Y	0.00	0.00	1.00	154.1	
			Z	0.00	0.00	1.00	157.5	

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 E²-field uncertainty inside TSL (see Pages 5 and 6).

⁶ Numerical linearization parameter: uncertainty not required.

[©] Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

f (MHz) ^c	Relative Permittivity	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	8.98	8.98	8.98	0.18	1.41	± 12.0 %
835	41.5	0.90	8.64	8.64	8.64	0.34	0.95	± 12.0 %
900	41.5	0.97	8.66	8.66	8.66	0.53	0.69	± 12.0 %
1450	40.5	1.20	8,19	8.19	8.19	0.16	1.83	± 12.0 %
1750	40.1	1.37	7.70	7.70	7.70	0.60	0.69	± 12.0 %
1900	40.0	1.40	7.43	7.43	7.43	0.51	0.74	± 12.0 %
2000	40.0	1.40	7.36	7.36	7.36	0.63	0.66	± 12.0 %
2300	39.5	1.67	6.93	6.93	6.93	0.34	0.91	± 12.0 %
2450	39.2	1.80	6.58	6.58	6.58	0.28	1.01	± 12.0 %
2600	39.0	1.96	6.42	6.42	6.42	0.40	0.81	± 12.0 %
5200	36.0	4.66	4.86	4.86	4.86	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.60	4.60	4.60	0.30	1.80	± 13.1 %
5600	35.5	5.07	4.25	4.25	4.25	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.28	4.28	4.28	0.45	1.80	± 13.1 %

Calibration Parameter Determined in Head Tissue Simulating Media

^C Frequency validity 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. ^F At frequencies below 3 GHz, the validity of tissue parameters (c and α) can be relaxed to ± 10% if liquid compensation formula is applied to

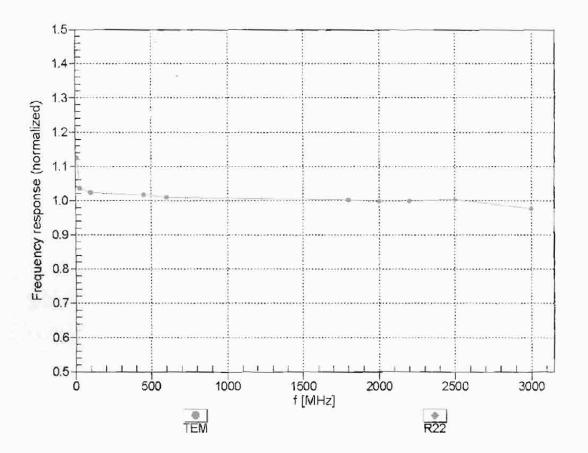
⁵ At frequencies below 3 GHz, the validity of tissue parameters (ε and α) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and α) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

f (MHz) ^c	Relative Permittivity	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	8.86	8.86	8.86	0.49	0.78	± 12.0 %
835	55.2	0.97	8 65	8.65	8.65	0.30	1.08	± 12.0 %
900	55.0	1.05	8.57	8.57	8.57	0.33	1.01	± 12.0 %
1450	54.0	1.30	7.80	7.80	7.80	0.19	1.80	± 12.0 %
1750	53.4	1.49	7.26	7.26	7.26	0.46	0.79	± 12.0 %
1900	53.3	1.52	6.96	6.96	6.96	0.40	0.83	± 12.0 %
2000	53.3	1.52	7.10	7.10	7.10	0.33	0.90	± 12.0 %
2300	52.9	1.81	6.76	6.76	6.76	0.54	0.72	± 12.0 %
2450	52.7	1.95	6.57	6.57	6.57	0.75	0.57	± 12.0 %
2600	52.5	2.16	6.40	6.40	6.40	0.80	0.56	± 12.0 %
5200	49.0	5.30	4.29	4.29	4.29	0.40	1.90	± 13.1 %
5500	48.6	5.65	3.91	3.91	3.91	0.40	1.90	± 13.1 %
5600	48.5	5.77	3.75	3.75	3.75	0.40	1.90	± 13.1 %
5800	48.2	6.00	4.06	4.06	4.06	0.50	1.90	± 13.1 %

Calibration Parameter Determined in Body Tissue Simulating Media

^E Frequency validity 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.

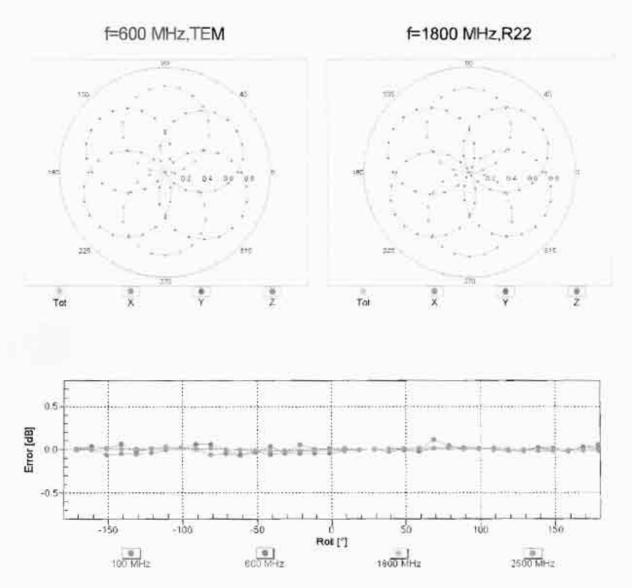
⁶ At frequencies below 3 GHz, the validity of tissue parameters (*e* and *o*) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (*e* and *o*) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.



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

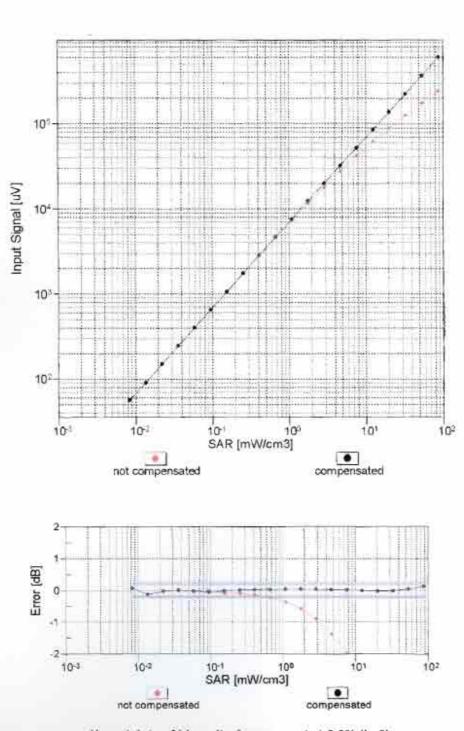
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Certificate No: EX3-3697_Sep12



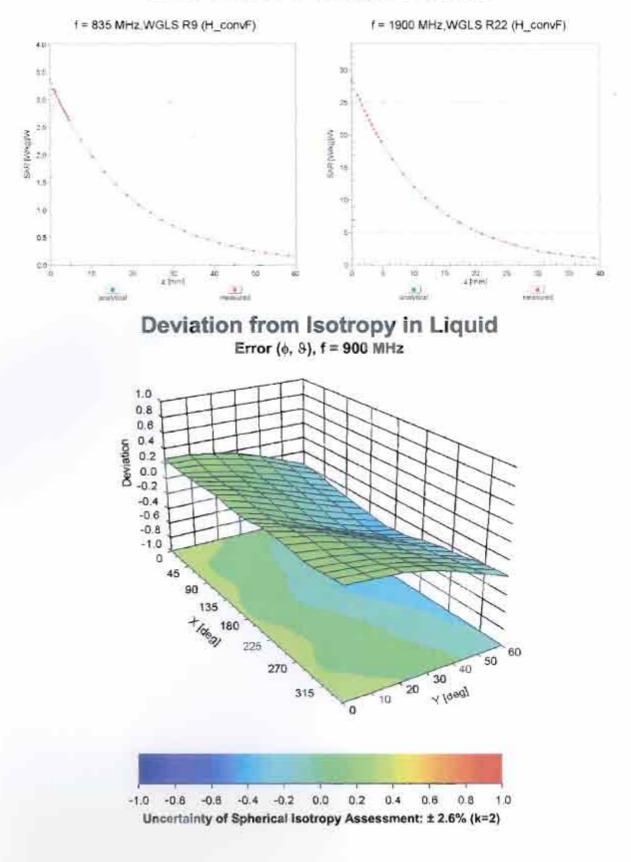
Receiving Pattern (ϕ), $\vartheta = 0^{\circ}$

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



Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)

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



Conversion Factor Assessment

Other Probe Parameters

Sensor Arrangement	Triangular		
Connector Angle (°)	-91.1		
Mechanical Surface Detection Mode	enabled		
Optical Surface Detection Mode	disablec		
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	2 mm		