

## 6. DAE & Probe Calibration Certificate

ccredited by the Swiss Accreditation Servic			tation No.: SCS 108
Iultilateral Agreement for the r			
lient SGS-TW (Aude	en)	Certifica	te No: DAE4-547_Jun12
CALIBRATION O	CERTIFICATE		
Dhired	DAE4 - SD 000 D	04 B L ON: 547	
Object	DAE4 - 5D 000 D	04 BJ - SN: 547	
Calibration procedure(s)	QA CAL-06.v24		
		dure for the data acquisition	electronics (DAE)
Collegion data	hune 01 0010		
Calibration date:	June 01, 2012		and the second se
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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

Accreditation No.: SCS 108

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#### Glossary

DAF Connector angle

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

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#### 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.

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#### **DC Voltage Measurement**

A/D - Converter Resolution nominal

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

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

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

Calibration Factors	x	Y	Z
High Range	403.991 ± 0.1% (k=2)	404.021 ± 0.1% (k=2)	404.165 ± 0.1% (k=2)
Low Range	3.95833 ± 0.7% (k=2)	3.96044 ± 0.7% (k=2)	3.97334 ± 0.7% (k=2)

#### **Connector Angle**

Connector Angle to be used in DASY system	188.5°±1°
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#### Appendix

#### 1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199998.35	2.97	0.00
Channel X + Input	20003.01	3.40	0.02
Channel X - Input	-19999.79	1.72	-0.01
Channel Y + Input	199995.78	0.56	0.00
Channel Y + Input	19997.80	-1.85	-0.01
Channel Y - Input	-20002.86	-1.29	0.01
Channel Z + Input	199994.37	-1.29	-0.00
Channel Z + Input	19999.89	0,33	0.00
Channel Z - Input	-20004.55	-3.05	0.02

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2000.42	0.22	0.01
Channel X + Input	200.58	0.05	0.03
Channel X - Input	-200.36	-0.95	0.47
Channel Y + Input	2000.13	0,09	0.00
Channel Y + Input	200.21	-0.28	-0.14
Channel Y - Input	-200.21	-0.72	0.36
Channel Z + Input	2000.48	0.50	0.02
Channel Z + Input	200.00	-0.35	-0.18
Channel Z - Input	-200.24	-0.72	0.36

#### 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)
200	2.44	0.42
- 200	-1.09	-2.58
200	-12.58	-13.15
- 200	12.53	12.88
200	20.17	19.90
-200	-20.96	-21.63
	Input Voltage (mV)           200           -200           200           200           200           200           200           200	Input Voltage (mV)         Average Reading (μV)           200         2.44           -200         -1.09           200         -12.58           -200         12.53           200         20.17

#### 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		2.91	-1.28
Channel Y	200	9.12		4.48
Channel Z	200	5.56	7.61	+

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#### 4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	16136	15101
Channel Y	16450	16073
Channel Z	15981	16890

#### 5. Input Offset Measurement

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

	Average (µV)	min. Offset (μV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	1.92	0.96	3.04	0.39
Channel Y	-0.95	-1.86	0.27	0.40
Channel Z	-2,66	-3.84	-1.65	0.45

#### 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

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Accreditation No.: SCS 108

Certificate No: DAE4-1260 Aug12

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SGS - TW (Auden) Client

Dbject	DAE4 - SD 000 D0	04 BJ - SN: 1260	
Calibration procedure(s)	QA CAL-06,v25 Calibration proced	ure for the data acquisition e	electronics (DAE)
Calibration date:	August 23, 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 ±	es and are part of the certificate.
Primary Standards	D#	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
	SE UWS 053 AA 1001	05-Jan-12 (in house check)	In house check: Jan-13
Calibrator Box V2.1			
Calibrator Box V2.1	Name	Function	Signature
	Name Dominique Steffen	Function Technician	Signature
Calibrator Box V2.1 Calibrated by: Approved by:	1 TELETIE		Signature
Calibrated by:	Dominique Steffen	Technician	Signature

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Accreditation No.: SCS 108

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#### Glossary

DAE Connector angle

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

SWISS

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#### Methods Applied and Interpretation of Parameters

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  - 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.

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#### DC Voltage Measurement

A/D - Converter Re:	solution nominal			
High Range:	1LSB =	6.1µV	full range =	-100+300 mV
Low Range:	1LSB =	61nV .	full range =	-1+3mV
DASY measuremen	t parameters: Au	to Zero Time: 3	sec; Measuring	time: 3 sec

Calibration Factors	x	Y	Z
High Range	406.027 ± 0.1% (k=2)	404.990 ± 0.1% (k=2)	405.578 ± 0.1% (k=2)
Low Range	3.95812 ± 0.7% (k=2)	4.02102 ± 0.7% (k=2)	4.00659 ± 0.7% (k=2)

#### **Connector Angle**

Connector Angle to be used in DASY system	178°±1°

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#### Appendix

#### 1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199996.29	-1.98	-0.00
Channel X + Input	20001.94	1.40	0.01
Channel X - Input	-19998.51	2.45	-0.01
Channel Y + Input	199992.21	-5.42	-0.00
Channel Y + Input	20000.13	-0.24	-0.00
Channel Y - Input	-20000.44	0.59	-0.00
Channel Z + Input	199995.90	-1.96	-0.00
Channel Z + Input	20000.09	-0.26	-0.00
Channel Z - Input	-20002.29	-1.29	0.01

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2002.24	1.09	0.05
Channel X + Input	201.50	0.25	0.12
Channel X - Input	-198.43	0.20	-0.10
Channel Y + Input	2001.61	0.80	0.04
Channel Y + Input	200.95	-0.06	-0.03
Channel Y - Input	-198.67	0.28	-0,14
Channel Z + Input	2001.79	1.00	0.05
Channel Z + Input	200.07	-1.00	-0.50
Channel Z - Input	-199.87	-1.03	0.52

#### 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	0.81	-1.47
	- 200	3.01	1.23
Channel Y	200	12.54	12.18
	- 200	-13.54	-13.77
Channel Z	200	-1.73	-1.86
	- 200	-0.40	-0.75

#### 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	-	6.38	-2.53
Channel Y	200	9.63	-	6.79
Channel Z	200	10.16	7.98	-

Certificate No: DAE4-1260\_Aug12

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#### 4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	15915	15098
Channel Y	15818	16189
Channel Z	16044	16463

#### 5. Input Offset Measurement

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

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	0.02	-1.30	1.27	0.40
Channel Y	-0.43	-1.82	0,60	0.44
Channel Z	-0.66	-1.79	0.56	0.42

#### 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

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Illent SGS-TW (Aud			ES3-3172_Aug12
CALIBRATION	CERTIFICATE		
Dbject	ES3DV3 - SN:31	72	
Calibration procedure(s)		A CAL-23.v4, QA CAL-25.v4 dure for dosimetric E-field probes	
Calibration date:	August 28, 2012		
	ertainties with confidence pr	robability are given on the following pages and a	are part of the certificate.
The measurements and the unc	ertainties with confidence pr ucted in the closed laborator		are part of the certificate.
The measurements and the unc All calibrations have been condu Calibration Equipment used (M&	ertainties with confidence pr ucted in the closed laborator &TE critical for calibration)	robability are given on the following pages and a y facility: environment temperature (22 ± 3)°C a	are part of the certificate.
The measurements and the unc All calibrations have been condu Calibration Equipment used (M& Primary Standards	ertainties with confidence pr ucted in the closed laborator &TE critical for calibration)	robability are given on the following pages and a y facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.)	are part of the certificate. and humidity < 70%. Scheduled Calibration
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power meter E4419B	ertainties with confidence pr ucted in the closed laborator &TE critical for calibration) ID GB41293874	vobability are given on the following pages and a y facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 29-Mar-12 (No. 217-01508)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power meter E4419B Power sensor E4412A	ertainties with confidence pr ucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087	Cal Date (Certificate No.) 29-Mar-12 (No. 217-01508) 29-Mar-12 (No. 217-01508)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13
The measurements and the unc All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator	ertainties with confidence pr ucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c)	cobability are given on the following pages and a sy facility: environment temperature (22 ± 3)°C a           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01531)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13
The measurements and the unc All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator	ertainties with confidence pr ucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5086 (20b)	Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator	ertainties with confidence pr ucted in the closed laborator RTE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5056 (20b) SN: S5129 (30b)	Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01529)           27-Mar-12 (No. 217-01529)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13
The measurements and the unc All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator	ertainties with confidence pr ucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5086 (20b)	Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Apr-13
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4	ertainties with confidence pr ucted in the closed laborator RTE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5086 (20b) SN: S5129 (30b) SN: 3013	cobability are given on the following pages and a           y facility: environment temperature (22 ± 3)°C a           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01531)           27-Mar-12 (No. 217-01529)           27-Mar-12 (No. 217-01522)           29-Dec-11 (No. ES3-3013_Dec11)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Dec-12
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2	ertainties with confidence pr ucted in the closed laborator 3TE critical for calibration) ID GB41293874 MY41498087 SN: 55054 (3c) SN: 55054 (3c) SN: 55086 (20b) SN: 55129 (30b) SN: 55129 (30b) SN: 660	Cal Date (Certificate No.) 29-Mar-12 (No. 217-01508) 27-Mar-12 (No. 217-01508) 27-Mar-12 (No. 217-01508) 27-Mar-12 (No. 217-01508) 27-Mar-12 (No. 217-0151) 27-Mar-12 (No. 217-0152) 27-Mar-12 (No. ES3-3013_Dec11) 20-Jun-12 (No. DAE4-660_Jun12)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards	ertainties with confidence pr ucted in the closed laborator STE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5056 (20b) SN: S5129 (30b) SN: S5129 (30b) SN: 3013 SN: 660 ID	Cal Date (Certificate No.) 29-Mar-12 (No. 217-01508) 27-Mar-12 (No. 217-01508) 27-Mar-12 (No. 217-01508) 27-Mar-12 (No. 217-01531) 27-Mar-12 (No. 217-01531) 27-Mar-12 (No. 217-01532) 29-Dec-11 (No. ES3-3013_Dec11) 20-Jun-12 (No. DAE4-660_Jun12) Check Date (in house)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 70 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	ertainties with confidence pr ucted in the closed laborator TE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5056 (20b) SN: S5129 (30b) SN: S5129 (30b) SN: S013 SN: 660 ID US3642U01700	Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01529)           27-Mar-12 (No. 217-01532)           29-Dec-11 (No. ES3-3013_Dec11)           20-Jun-12 (No. DAE4-660_Jun12)           Check Date (in house)           4-Aug-99 (in house check Apr-11)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Apr-13
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power meter E44198 Power sensor E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 90 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	ertainties with confidence pr ucted in the closed laborator RTE critical for calibration) GB41293874 MY41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585	Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01531)           27-Mar-12 (No. 217-01531)           27-Mar-12 (No. 217-01529)           27-Mar-12 (No. 217-01522)           29-Dec-11 (No. ES3-3013_Dec11)           20-Jun-12 (No. DAE4-660_Jun12)           Check Date (in house)           4-Aug-99 (in house check Apr-11)           18-Oct-01 (in house check Oct-11)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Apr-13 In house check: Oct-12
The measurements and the unc All calibrations have been condu- Calibration Equipment used (M& Primary Standards Power meter E44198 Power sensor E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 3 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	ertainties with confidence pr ucted in the closed laborator 3TE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585 Name	cobability are given on the following pages and a           y facility: environment temperature (22 ± 3)°C a           Cal Date (Certificate No.)           29-Mar-12 (No. 217-01508)           29-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01508)           27-Mar-12 (No. 217-01529)           27-Mar-12 (No. 217-01529)           27-Mar-12 (No. 217-01522)           29-Dec-11 (No. ES3-3013_Dec11)           20-Jun-12 (No. DAE4-660_Jun12)           Check Date (in house)           4-Aug-99 (in house check Apr-11)           18-Oct-01 (in house check Oct-11)	are part of the certificate. and humidity < 70%. Scheduled Calibration Apr-13 Apr-13 Apr-13 Apr-13 Apr-13 Dec-12 Jun-13 Scheduled Check In house check: Apr-13 In house check: Oct-12

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



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Accreditation No.: SCS 108

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#### Glossary:

tissue simulating liquid TSL NORMx,y,z sensitivity in free space sensitivity in TSL / NORMx,y,z ConvF diode compression point DCP CF crest factor (1/duty\_cycle) of the RF signal A, B, C modulation dependent linearization parameters Polarization (p 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., 8 = 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
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close b) 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.

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ES3DV3 - SN:3172

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August 28, 2012

# Probe ES3DV3

## SN:3172

Manufactured: Calibrated:

January 23, 2008 August 28, 2012

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

Certificate No: ES3-3172\_Aug12

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台灣檢驗科技股份有限公司 t (886-2) 2299-3279

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ES3DV3-SN:3172

August 28, 2012

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3172

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	1.37	1.14	0.98	± 10.1 %
DCP (mV) <sup>B</sup>	102.0	102.8	94.6	

#### Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc <sup>E</sup> (k=2)	
0	CW	CW	CW 0.00	CW 0.00 X	0.00	0.00	1.00	166.6	±2.5 %
			Y	0.00	0.00	1.00	151.1		
			Z	0.00	0.00	1.00	138.5		

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%.

<sup>1</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).
<sup>1</sup> Numerical linearization parameter: uncertainty not required.
<sup>2</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the inducement. field value

Certificate No: ES3-3172\_Aug12

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ES3DV3- SN:3172

August 28, 2012

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3172

<b>Calibration Parameter</b>	Determined in Hea	ad Tissue Simulating Media
------------------------------	-------------------	----------------------------

f (MHz) <sup>c</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.07	6.07	6.07	0.32	1.78	± 12.0 %
835	41.5	0.90	5.85	5.85	5.85	0.80	1.09	± 12.0 %
900	41.5	0.97	5.76	5.76	5.76	0.43	1.49	± 12.0 %
1750	40.1	1.37	5.03	5.03	5.03	0.80	1.15	± 12.0 %
1900	40.0	1.40	4.85	4.85	4.85	0.63	1.32	± 12.0 %
2000	40.0	1.40	4,79	4.79	4.79	0.61	1.35	± 12.0 %
2300	39.5	1.67	4.50	4.50	4.50	0.73	1.26	± 12.0 %
2450	39.2	1.80	4.21	4.21	4.21	0.80	1.19	± 12.0 %

<sup>C</sup> 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.
<sup>F</sup> Al frequencies below 3 GHz, the validity of tissue parameters (*i*: and *i*) 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 (*i*: and *i*) 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 (*i*: and *i*) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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ES3DV3- SN:3172

August 28, 2012

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3172

<b>Calibration Paramete</b>	r Determined in Bod	y Tissue Simulating Media
-----------------------------	---------------------	---------------------------

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	5.90	5.90	5.90	0.30	1.96	± 12.0 %
835	55.2	0.97	5.81	5.81	5.81	0.36	1.80	± 12.0 %
900	55.0	1.05	5.82	5.82	5.82	0.80	1.17	± 12.0 %
1750	53.4	1.49	4.71	4.71	4.71	0.36	2.09	± 12.0 %
1900	53.3	1.52	4.44	4.44	4.44	0.44	1.76	± 12.0 %
2000	53.3	1.52	4.40	4.40	4.40	0.57	1.59	± 12.0 %
2300	52.9	1.81	4.07	4.07	4.07	0.65	1.38	± 12.0 %
2450	52.7	1.95	3.88	3.88	3.88	0.80	1.01	± 12.0 %

<sup>C</sup> 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. <sup>C</sup> 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.

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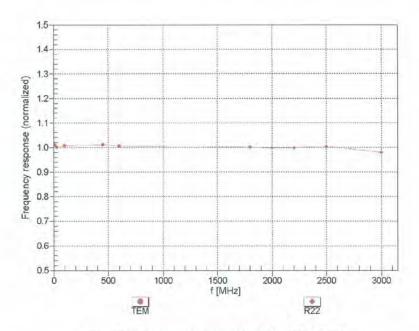
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ES3DV3-SN:3172

August 28, 2012

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



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

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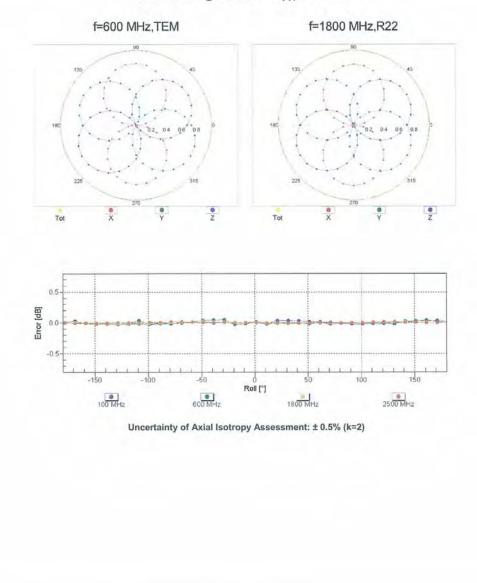
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August 28, 2012



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

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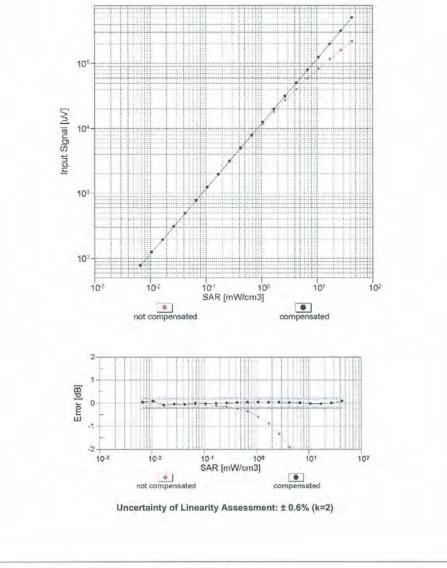
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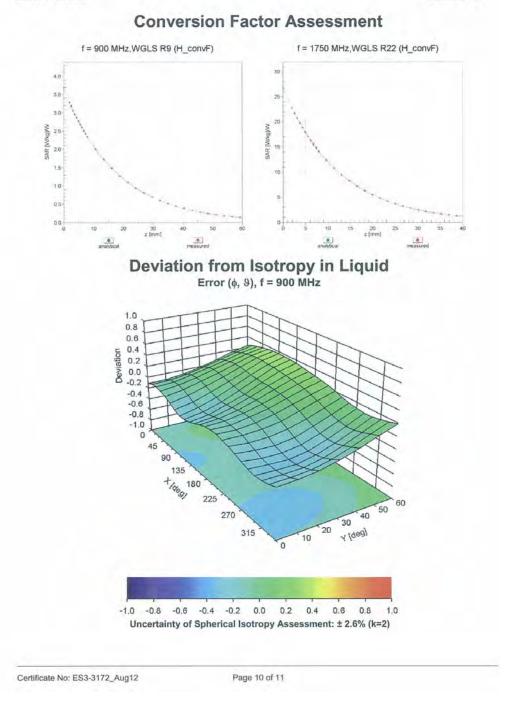
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ES3DV3- SN:3172

August 28, 2012



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ES3DV3-SN:3172

August 28, 2012

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3172

#### **Other Probe Parameters** Sensor Arrangement Triangular -178.7 Connector Angle (°) 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

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Accreditation No.: SCS 108

Certificate No: EX3-3831\_Jan12

Object	EX3DV4 - SN:38	31						
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:	January 4, 2012							
The measurements and the unc	certainties with confidence pructed in the closed laborator	onal standards, which realize the physical units robability are given on the following pages and y facility: environment temperature $(22 \pm 3)^\circ$ C a	are part of the certificate.					
Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration					
Power meter E4419B	GB41293874	31-Mar-11 (No. 217-01372)	Apr-12					
	MY41498087	31-Mar-11 (No. 217-01372)	- Contraction of the contraction					
Power sensor F4412A								
			Apr-12 Apr-12					
Reference 3 dB Attenuator	SN: S5054 (3c)	29-Mar-11 (No. 217-01369)	Apr-12					
Reference 3 dB Attenuator Reference 20 dB Attenuator	SN: S5054 (3c) SN: S5086 (20b)	29-Mar-11 (No. 217-01369) 29-Mar-11 (No. 217-01367)	Apr-12 Apr-12					
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator	SN: S5054 (3c) SN: S5086 (20b) SN: S5129 (30b)	29-Mar-11 (No. 217-01369) 29-Mar-11 (No. 217-01367) 29-Mar-11 (No. 217-01370)	Apr-12 Apr-12 Apr-12					
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2	SN: S5054 (3c) SN: S5086 (20b)	29-Mar-11 (No. 217-01369) 29-Mar-11 (No. 217-01367)	Apr-12 Apr-12					
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4	SN: S5054 (3c) SN: S5086 (20b) SN: S5129 (30b) SN: 3013	29-Mar-11 (No. 217-01369) 29-Mar-11 (No. 217-01367) 29-Mar-11 (No. 217-01370) 29-Dec-11 (No. ES3-3013_Dec11)	Apr-12 Apr-12 Apr-12 Dec-12					
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards	SN: S5054 (3c) SN: S5086 (20b) SN: S5129 (30b) SN: 3013 SN: 654	29-Mar-11 (No. 217-01369) 29-Mar-11 (No. 217-01367) 29-Mar-11 (No. 217-01370) 29-Dec-11 (No. ES3-3013_Dec11) 3-May-11 (No. DAE4-654_May11)	Apr-12 Apr-12 Apr-12 Dec-12 May-12					
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	SN: S5054 (3c)           SN: S5086 (20b)           SN: S5129 (30b)           SN: 3013           SN: 654           ID	29-Mar-11 (No. 217-01369) 29-Mar-11 (No. 217-01367) 29-Mar-11 (No. 217-01370) 29-Dec-11 (No. ES3-3013_Dec11) 3-May-11 (No. DAE4-654_May11) Check Date (in house)	Apr-12 Apr-12 Apr-12 Dec-12 May-12 Scheduled Check					
Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	SN: S5054 (3c)           SN: S5086 (20b)           SN: S5129 (30b)           SN: 3013           SN: 654           ID           US3642U01700	29-Mar-11 (No. 217-01369) 29-Mar-11 (No. 217-01367) 29-Mar-11 (No. 217-01370) 29-Dec-11 (No. ES3-3013_Dec11) 3-May-11 (No. DAE4-654_May11) Check Date (in house) 4-Aug-99 (in house check Apr-11)	Apr-12 Apr-12 Apr-12 Dec-12 May-12 Scheduled Check In house check: Apr-13 In house check: Oct-12					
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	SN: S5054 (3c)           SN: S5086 (20b)           SN: S5129 (30b)           SN: 3013           SN: 654           ID           US3642U01700           US37390585	29-Mar-11 (No. 217-01369) 29-Mar-11 (No. 217-01367) 29-Mar-11 (No. 217-01370) 29-Dec-11 (No. ES3-3013_Dec11) 3-May-11 (No. DAE4-654_May11) Check Date (in house) 4-Aug-99 (in house check Apr-11) 18-Oct-01 (in house check Oct-11)	Apr-12 Apr-12 Apr-12 Dec-12 May-12 Scheduled Check In house check: Apr-13					
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	SN: S5054 (3c)           SN: S5086 (20b)           SN: S5129 (30b)           SN: 3013           SN: 654           ID           US3642U01700           US37390585           Name	29-Mar-11 (No. 217-01369) 29-Mar-11 (No. 217-01367) 29-Mar-11 (No. 217-01370) 29-Dec-11 (No. ES3-3013_Dec11) 3-May-11 (No. DAE4-654_May11) Check Date (in house) 4-Aug-99 (in house check Apr-11) 18-Oct-01 (in house check Oct-11) Function	Apr-12 Apr-12 Apr-12 Dec-12 May-12 Scheduled Check In house check: Apr-13 In house check: Oct-12					

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Accreditation No.: SCS 108

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#### Glossary:

TSL tissue simulating liquid NORMx,y,z sensitivity in free space sensitivity in TSL / NORMx,y,z ConvF DCP diode compression point crest factor (1/duty\_cycle) of the RF signal CF A, B, C modulation dependent linearization parameters Polarization or to rotation around probe axis Polarization 8 8 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:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement
- Techniques", December 2003 IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close b) 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 \* Irequency\_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 ٠ 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 I > 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.

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EX3DV4 - SN:3831

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January 4, 2012

# Probe EX3DV4

## SN:3831

Manufactured: Calibrated: September 6, 2011 January 4, 2012

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

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EX3DV4-SN:3831

January 4, 2012

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	0.44	0.41	0.43	± 10.1 %
DCP (mV) <sup>B</sup>	101.7	101.4	99.5	

#### Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc <sup>E</sup> (k=2)
10000	CW	0.00	X	0.00	0,00	1.00	111.7	±3.0 %
			Y	0.00	0,00	1.00	96.2	
			Z	0.00	0.00	1.00	106.7	

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%

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

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EX3DV4-SN:3831

January 4, 2012

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

f (MHz) <sup>c</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	9.32	9.32	9.32	0.44	0.84	± 12.0 %
835	41.5	0.90	8.82	8.82	8.82	0.19	1.48	± 12.0 %
900	41.5	0.97	8.71	8.71	8.71	0.22	1.38	± 12.0 %
1750	40.1	1.37	8.03	8.03	8.03	0.39	0.81	± 12.0 %
1900	40.0	1.40	7.76	7.76	7.76	0.44	0.77	± 12.0 %
2000	40.0	1.40	7.65	7.65	7.65	0.61	0.63	± 12.0 %
2300	39.5	1.67	7.44	7.44	7.44	0.41	0.83	± 12.0 %
2450	39.2	1.80	6.84	6.84	6.84	0.49	0.73	± 12.0 %
2600	39.0	1.96	6,67	6.67	6.67	0.33	0.96	± 12.0 %
5200	36.0	4.66	4.64	4.64	4.64	0.42	1.80	± 13.1 %
5300	35.9	4.76	4.37	4.37	4.37	0.44	1.80	± 13.1 %
5600	35.5	5.07	4.10	4.10	4.10	0.48	1.80	± 13.1 %
5800	35.3	5.27	4.12	4.12	4.12	0.45	1.80	± 13.1 %

### Calibration Parameter Determined in Head Tissue Simulating Media

<sup>C</sup> 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.
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters (c 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 (c 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 (c and o) can be relaxed to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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EX3DV4- SN:3831

January 4, 2012

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

f (MHz) <sup>c</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	9.24	9.24	9.24	0.23	1.25	± 12.0 %
835	55.2	0.97	9.02	9.02	9.02	0.28	1.13	± 12.0 %
900	55.0	1.05	8.93	8.93	8.93	0.25	1.28	± 12.0 %
1750	53.4	1.49	7.67	7.67	7.67	0.38	0.87	± 12.0 %
1900	53.3	1.52	7.25	7.25	7.25	0.57	0.70	± 12.0 %
2000	53.3	1.52	7.31	7.31	7.31	0.27	1.09	± 12.0 %
2300	52.9	1.81	7.26	7.26	7.26	0.71	0.66	± 12.0 %
2450	52.7	1.95	6.82	6.82	6.82	0.74	0.62	± 12.0 %
2600	52.5	2.16	6.63	6.63	6.63	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.12	4,12	4.12	0.50	1.90	± 13.1 %
5300	48.9	5.42	3.92	3.92	3.92	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.30	3.30	3.30	0.65	1.90	± 13.1 %
5800	48.2	6.00	3.77	3.77	3.77	0.60	1.90	± 13.1 %

#### Calibration Parameter Determined in Body Tissue Simulating Media

<sup>C</sup> 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. <sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters (c 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 (c 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 (c and o) can be relaxed to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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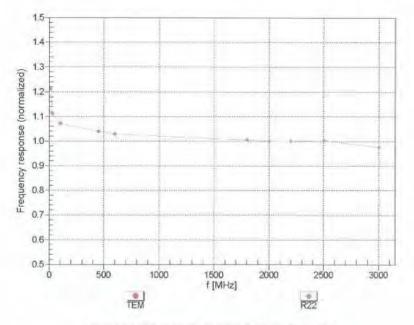
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### Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



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

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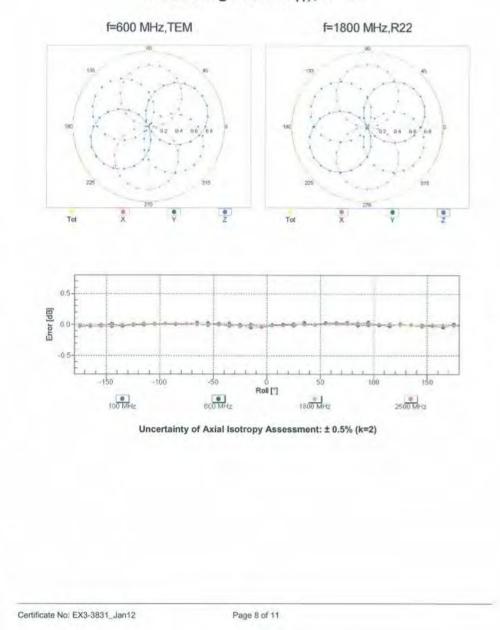
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Receiving Pattern ( $\phi$ ),  $\vartheta = 0^{\circ}$ 

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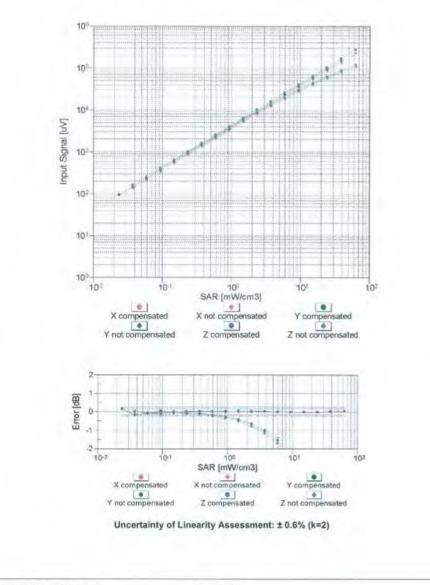
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EX3DV4-SN:3831

January 4, 2012

Dynamic Range f(SAR<sub>head</sub>) (TEM cell, f = 900 MHz)



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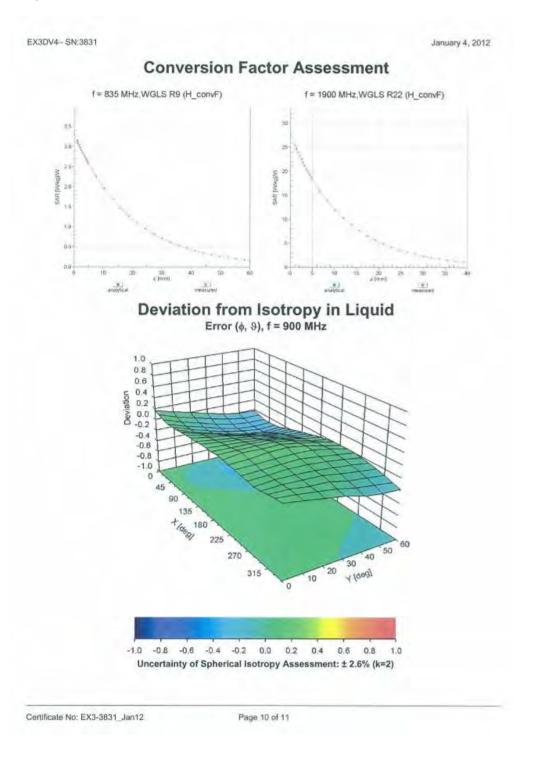
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EX3DV4- SN:3831

January 4, 2012

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

#### **Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
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

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## 7. Uncertainty Budget

Measurement Uncertainty evaluation template for DUT SAR test

IEEE 1528

IEEE 1528							-		
A	с	D	е		f	g	h=c * f / e	i=c * g / e	k
Source of Uncertainty	Tolerance/ Uncertaint	Probabilit v	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
Measurement svstem									
Probe calibration	6.55%	N	1	1	1	1	6.55%	6.55%	$\infty$
Isotropy , Axial	3.50%	R	√3	1.732	1	1	2.02%	2.02%	$\infty$
Isotropy, Hemispherical	9.60%	R	√3	1.732	1	1	5.54%	5.54%	$\infty$
Boundary Effect	1.00%	R	√3	1.732	1	1	0.58%	0.58%	$\infty$
Linearity	4.70%	R	√3	1.732	1	1	2.71%	2.71%	$\infty$
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	$\infty$
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	$\infty$
Response time	0.80%	R	√3	1.732	1	1	0.46%	0.46%	$\infty$
Integration Time	2.60%	R	$\sqrt{3}$	1.732	1	1	1.50%	1.50%	$\infty$
Measurement drift (class A	1.75%	R	√3	1.732	1	1	1.01%	1.01%	$\infty$
RF ambient condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	$\infty$
RF ambient conditions -	3.00%	R	√3	1.732	1	1	1.73%	1.73%	$\infty$
Probe positioner Mechanical	0.40%	R	$\sqrt{3}$	1.732	1	1	0.23%	0.23%	$\infty$
Probe Positioning with respect to	2.90%	R	√3	1.732	1	1	1.67%	1.67%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Post-processing	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	$\infty$
Max SAR Eval	1.00%	R	√3	1.732	1	1	0.58%	0.58%	$\infty$
Test Sample									
related									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	$\sqrt{3}$	1.732	1	1	2.89%	2.89%	$^{\circ}$
Phantom and Setup									
Phantom Uncertainty	4.00%	R	√3	1.732	1	1	2.31%	2.31%	$\infty$
Liquid conductivity(meas.) Max at 5200 band	4.31%	N	1	1	0.64	0.43	2.76%	1.85%	М
Liquid permitivity(meas.) Max at 5500 band	3.72%	N	1	1	0.6	0.49	2.23%	1.82%	Μ
Combined standard uncertainty		RSS					12.10%	11.86%	
Expant uncertainty (95% confidence							24.20%	23.72%	

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## 8. Phantom Description

Schmud & Panner Engineering AG

Zeughausstraser 43, 8004 Zunch, Switzerland Phone +41 1 245 9700, Fax +41 1 245 9779 Info@spreg.com. http://www.spreg.com

Certificate of Conformity / First Article Inspection

ttern	SAM Twin Phentom V4.0	
Type No .	QD 000 P40 C	
Series No	TP-1150 and higher	
Manufacturer	SPEAG Zeughausstrasse 43 CH-8004 Z0rich Switzerland	

Tests

The series production process used allows the imitation to test of first articles. Complete tests were made on the pre-series Type No. QD 000 P40 AA. Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1008. Certain parameters have been releated using further series items (called samples) or are tested at each item.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the geometry according to the CAD model.	(T'IS CAD File (*)	First article, Samples
Material thickness of shell	Compliant with the requirements according to the standards	2mm +/- 0.2mm in flat and specific areas of head section	First article, Samples, TP-1314 ff,
Material thickness at ERP	Compliant with the requirements according to the standards	6mm +/- 0.2mm at ERP	First article, All items
Material parameters	Dielectric parsimeters for required frequencies	300 MHz - 0 GHz: Relative permittivity < 5. Loss tangent < 0.05	Material samples
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions. Observe technical Note for material compatibility.	DEGMBE based simulating liquids	Pre-series, First article, Material samples
Sagging	Compliant with the requirements according to the standards. Sagging of the flat section when filled with tissue simulating liquid	< 1% typical < 0.8% if filed with 155mm of HSL900 and without OUT below	Prototypes, Sample testing

5tandarda [1] CENELEC EN 50361 [2] IEEE Std 1528-2003 [3] IEO 62208 Part 1

2340 The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of the other documents.

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standards [1] to [4]

Date 07,07,2005 Signature / Stamp		Scienter & Parsan Englineering AG Terrighausgivess 43, 8024 2 upp Salaserland
		Plane yet a per Urson rank in 245 0778 Into Peperg, cam, http://www.sperg.com
Doc He MI1 - QO 000 P40 C - *		Page T(1)

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## 9. System Validation from Original Equipment Supplier

ccredited by the Swiss Accred he Swiss Accreditation Serv			on No.: SCS 108		
Aultilateral Agreement for the			-		
lient SGS-TW (Au			No: D2450V2-727_Apr12		
CALIBRATION	CERTIFICATE				
Object	D2450V2 - SN: 7	27			
Calibration procedure(s)	QA CAL-05.v8 Calibration procedure for dipole validation kits above 700 MHz				
and a second second	April 25, 2012				
This calibration certificate docu The measurements and the un All calibrations have been cone	iments the traceability to nat certainties with confidence p ducted in the closed laborato	ional standards, which realize the physical u robability are given on the following pages a ry facility: environment temperature (22 $\pm$ 3)	and are part of the certificate.		
This calibration certificate docu The measurements and the un All calibrations have been cont Calibration Equipment used (N Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator	Internets the traceability to nat certainties with confidence p ducted in the closed laborato t&TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k)	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530)	and are part of the certificate. %C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Apr-13		
The measurements and the un	Internets the traceability to nat certainties with confidence p ducted in the closed laborato t&TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k)	robability are given on the following pages a ry facility: environment temperature (22 ± 3) Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451)	and are part of the certificate. %C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12		
This calibration certificate doct The measurements and the un All calibrations have been cont Calibration Equipment used (N Primary Standards 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	Internets the traceability to nat certainties with confidence p ducted in the closed laborato l&TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205	Cal Date (Certificate No.)           05-Oct-11 (No. 217-01451)           05-Oct-11 (No. 217-01451)           27-Mar-12 (No. 217-01530)           27-Mar-12 (No. 217-01533)           30-Dec-11 (No. ES3-3205_Dec11)	and are part of the certificate. )°C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12		
This calibration certificate doct The measurements and the un All calibrations have been cond Calibration Equipment used (N 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 Network Analyzer HP 8753E	Internets the traceability to nat certainties with confidence p ducted in the closed laborato laTE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 3205 SN: 601 ID # MY41092317 100005 US37390585 S4206 Name	robability are given on the following pages a ry facility: environment temperature (22 ± 3) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01530) 27-Mar-12 (No. 217-01533) 30-Dec-11 (No. ES3-3205_Dec11) 04-Jul-11 (No. DAE4-601_Jul11) Check Date (in house) 18-Oct-02 (in house check Oct-11) 18-Oct-01 (in house check Oct-11) 18-Oct-01 (in house check Oct-11) Function	and are part of the certificate. *C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13		
This calibration certificate doct The measurements and the un All calibrations have been cont Calibration Equipment used (N Primary Standards 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	Internets the traceability to nat certainties with confidence p ducted in the closed laborato l&TE critical for calibration) ID # GB37480704 US37292783 SN: 5047 2 / 06327 SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 505 (20k) SN: 505 (20k) SN: 601 ID # MY41092317 100005 US37390585 S4206	Cal Date (Certificate No.)           05-Oct-11 (No. 217-01451)           05-Oct-11 (No. 217-01451)           05-Oct-11 (No. 217-01451)           27-Mar-12 (No. 217-01530)           27-Mar-12 (No. 217-01533)           30-Dec-11 (No. ES3-3205_Dec11)           04-Jul-11 (No. DAE4-601_Jul11)           Check Date (in house)           18-Oct-02 (in house check Oct-11)           04-Aug-99 (in house check Oct-11)	and are part of the certificate. y°C and humidity < 70%. Scheduled Calibration Oct-12 Oct-12 Apr-13 Apr-13 Dec-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-13		

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## Report No. : ES/2012/B0010 Page : 211 of 230

#### Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 6004 Zurich, Switzerland



- SWISS S Schu C Serv Serv S Swis
  - Schweizerischer Kallbrierdienst Service sulsse d'étalonnage Servizio svizzero di taratura
  - Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SA5) 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.

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%.

Certificate No: D2450V2-727\_Apr12

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# **Measurement Conditions**

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

DASY5	V52.8.1
Advanced Extrapolation	
Modular Flat Phantom	
10 mm	with Spacer
dx, dy, dz = 5 mm	
2450 MHz ± 1 MHz	
	Advanced Extrapolation Modular Flat Phantom 10 mm dx, dy, dz = 5 mm

#### 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	39.6 ± 6 %	1.81 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	Gene	

# SAR result with Head TSL

Condition	
250 mW input power	12.8 mW / g
normalized to 1W	51.2 mW /g ± 17.0 % (k=2)
and the second	
condition	
condition 250 mW input power	5.95 mW / g
	250 mW input power

#### **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	52,4 ± 6 %	1.98 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	-	-

# SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.7 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	50.4 mW / g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	5.92 mW / g

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# Appendix

# Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6 Ω + 2.8 μΩ	
Return Loss	- 27.2 dB	

# Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.3 Ω + 3.9 jΩ
Return Loss	- 27.8 dB

## **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.149 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	January 09, 2003	

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## DASY5 Validation Report for Head TSL

Date: 25.04.2012

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 727

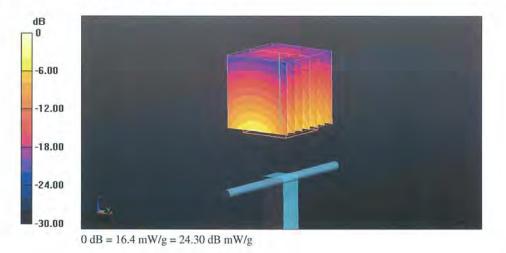
Communication System: CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.81$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- · Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 98.712 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 26.388 mW/g SAR(1 g) = 12.8 mW/g; SAR(10 g) = 5.95 mW/g Maximum value of SAR (measured) = 16.4 mW/g



Certificate No: D2450V2-727\_Apr12

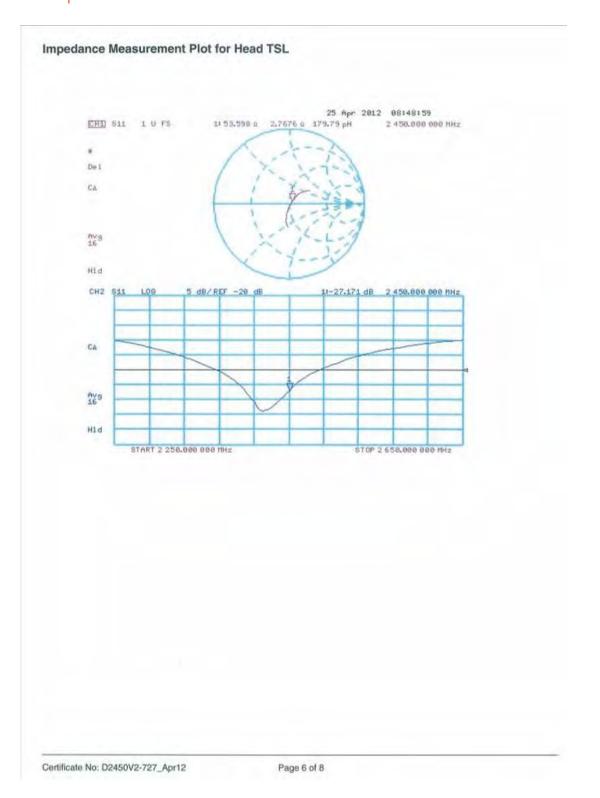
Page 5 of 8

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# **DASY5 Validation Report for Body TSL**

Date: 25.04.2012

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 727

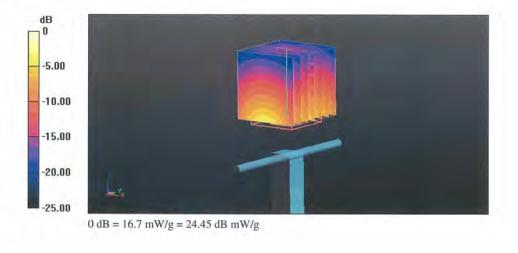
Communication System: CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.98$  mho/m;  $\epsilon_r = 52.4$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 95.136 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 25.811 mW/g SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.92 mW/g Maximum value of SAR (measured) = 16.7 mW/g



Certificate No: D2450V2-727\_Apr12

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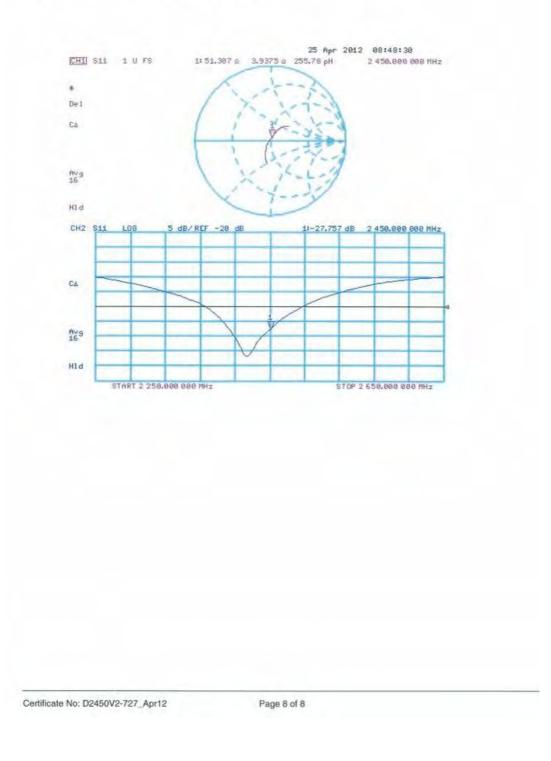
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# Impedance Measurement Plot for Body TSL



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# Report No. : ES/2012/B0010 Page : 218 of 230

Engineering AG eughausstrasse 43, 8004 Zuric	y Of h, Switzerland	ACTINE CONTRA	Service suisse d'étalonnage Servizio svizzero di taratura
Accredited by the Swiss Accredita The Swiss Accreditation Service Multilateral Agreement for the re-	e is one of the signatorie	s to the EA	n No.: SCS 108
Client SGS-TW (Aude	en)	Certificate N	D5GHzV2-1023_Jan12
CALIBRATION O	CERTIFICATE		
Object	D5GHzV2 - SN:	1023	
Calibration procedure(s)	QA CAL-22.v1 Calibration proce	dure for dipole validation kits bet	ween 3-6 GHz
Calibration date:	January 19, 2012	2	
The measurements and the unce All calibrations have been conduc	ertainties with confidence p cted in the closed laborato	ional standards, which realize the physical ur robability are given on the following pages ar ry facility: environment temperature $(22 \pm 3)^{\circ}$	nd are part of the certificate.
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# Report No. : ES/2012/B0010 Page : 219 of 230

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



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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
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.

Certificate No: D5GHzV2-1023\_Jan12

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#### **Measurement Conditions**

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

AST system configuration, as far as the	a great of 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

	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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.98 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	79.9 mW /g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.28 mW / g

#### Head TSL parameters at 5500 MHz

	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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.45 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	84.5 mW / g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
	and a set have a set of the	a . a
SAR measured	100 mW input power	2.40 mW / g

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### Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.95 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	79.5 mW / g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2:26 mW / g

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#### 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 %	5.45 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.22 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	72.3 mW / g ± 18.1 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2.03 mW / g

# Body TSL parameters at 5500 MHz

	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		-

#### SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.81 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	78.2 mW / g ± 18.1 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.17 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	21.7 mW/g ± 17.6 % (k=2)

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#### Body TSL parameters at 5800 MHz

and the second	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		

#### SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm <sup>2</sup> (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 <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2.02 mW / g.

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#### Appendix

#### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	49.2 Ω - 7.4 jΩ	
Return Loss	- 22.5 dB	

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	52.4 Ω - 0.9 μΩ	
Return Loss	- 32.2 dB	

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	56.1 Ω + 0.0 JΩ
Return Loss	- 24.9 dB

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

Impedance, transformed to feed point	50.9 Ω - 5.2 μΩ
Return Loss	- 25.7 dB

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

Impedance, transformed to feed point	52.3 Ω + 0.2 μΩ
Return Loss	- 32.9 dB

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

Impedance, transformed to feed point	52.4 Ω - 6.5 jΩ
Return Loss	- 23.4 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.198 ns	
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

#### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	February 05, 2004

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#### **DASY5 Validation Report for Head TSL**

Date: 19.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1023

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz;  $\sigma$  = 4.6 mho/m;  $\epsilon_r$  = 36.3;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5500 MHz;  $\sigma$  = 4.9 mho/m;  $\epsilon_r$  = 35.8;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5800 MHz;  $\sigma$  = 5.22 mho/m;  $\epsilon_r$  = 35.3;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.41, 5.41, 5.41), ConvF(4.91, 4.91, 4.91), ConvF(4.81, 4.81, 4.81); Calibrated: 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 = 64.814 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 29.7440 SAR(1 g) = 7.98 mW/g; SAR(10 g) = 2.28 mW/g Maximum value of SAR (measured) = 18.473 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 = 63.894 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 33.6120 SAR(1 g) = 8.45 mW/g; SAR(10 g) = 2.4 mW/g Maximum value of SAR (measured) = 20.122 mW/g

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 60.857 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 33.4260 SAR(1 g) = 7.95 mW/g; SAR(10 g) = 2.26 mW/g Maximum value of SAR (measured) = 19.432 mW/g

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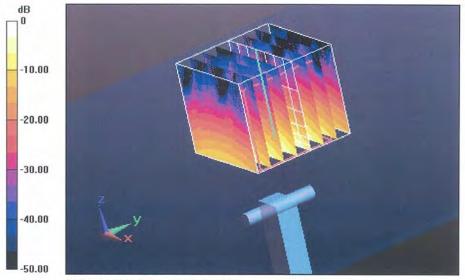
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0 dB = 19.430 mW/g = 25.77 dB mW/g

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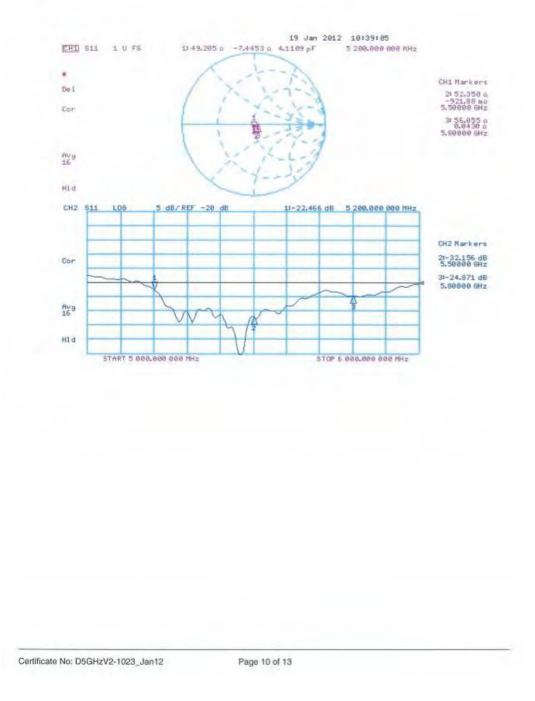
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# Impedance Measurement Plot for Head TSL



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#### DASY5 Validation Report for Body TSL

Date: 18.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1023

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz;  $\sigma$  = 5.46 mho/m;  $\epsilon_r$  = 49.2;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5500 MHz;  $\sigma$  = 5.86 mho/m;  $\epsilon_r$  = 48.7;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 5800 MHz;  $\sigma$  = 6.28 mho/m;  $\epsilon_r$  = 48.2;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(4.91, 4.91, 4.91), ConvF(4.43, 4.43, 4.43), ConvF(4.38, 4.38, 4.38); Calibrated: 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 = 56.490 V/m; Power Drift = -0.0024 dB Peak SAR (extrapolated) = 28.2170 SAR(1 g) = 7.22 mW/g; SAR(10 g) = 2.03 mW/g Maximum value of SAR (measured) = 16.833 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 = 57.075 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 33.4060 SAR(1 g) = 7.81 mW/g; SAR(10 g) = 2.17 mW/g Maximum value of SAR (measured) = 18.867 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 = 53.714 V/m; Power Drift = 0.0063 dB Peak SAR (extrapolated) = 34.0450 SAR(1 g) = 7.3 mW/g; SAR(10 g) = 2.02 mW/g Maximum value of SAR (measured) = 18.209 mW/g

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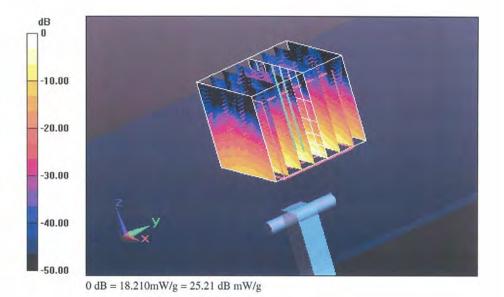
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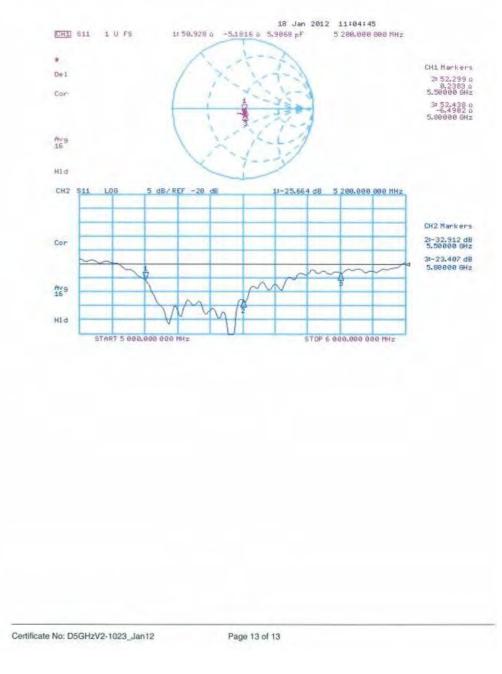
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# Impedance Measurement Plot for Body TSL



# - End of 2<sup>nd</sup> part of report -

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