



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



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Accreditation No.: SCS 108

Client Sporton (Auden)

Certificate No: D2450V2-736_Jul09

CALIBRATION CERTIFICATE

Object: D2450V2 - SN: 736
Calibration procedure(s): QA CAL-05.v7 Calibration procedure for dipole validation kits
Calibration date: July 20, 2009
Condition of the calibrated item: In Tolerance

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)

Table with 4 columns: Primary Standards, ID #, Cal Date (Calibrated by, Certificate No.), Scheduled Calibration. Includes items like Power meter EPM-442A, Power sensor HP 8481A, Reference 20 dB Attenuator, etc.

Calibrated by: Claudio Leubler, Laboratory Technician
Approved by: Katja Pokovic, Technical Manager

Issued: July 22, 2009

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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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



Measurement Conditions

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

DASY Version	DASY5	V5.0
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	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	40.2 ± 6 %	1.78 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	13.4 mW / g
SAR normalized	normalized to 1W	53.6 mW / g
SAR for nominal Head TSL parameters ¹	normalized to 1W	54.2 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.33 mW / g
SAR normalized	normalized to 1W	25.3 mW / g
SAR for nominal Head TSL parameters ¹	normalized to 1W	25.5 mW /g ± 16.5 % (k=2)

¹ Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"



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	52.8 ± 6 %	1.99 mho/m ± 6 %
Body TSL temperature during test	(21.0 ± 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	13.4 mW / g
SAR normalized	normalized to 1W	53.6 mW / g
SAR for nominal Body TSL parameters ²	normalized to 1W	53.0 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.26 mW / g
SAR normalized	normalized to 1W	25.0 mW / g
SAR for nominal Body TSL parameters ²	normalized to 1W	24.9 mW /g ± 16.5 % (k=2)

² Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"



Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.9 Ω + 2.2 j Ω
Return Loss	- 27.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.7 Ω + 4.2 j Ω
Return Loss	- 27.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.158 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	August 26, 2003

DASY5 Validation Report for Head TSL

Date/Time: 20.07.2009 17:44:29

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN736

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: HSL U11 BB

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.78$ mho/m; $\epsilon_r = 40.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC)

DASY5 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.35, 4.35, 4.35); Calibrated: 30.04.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 07.03.2009
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.4 Build 45

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

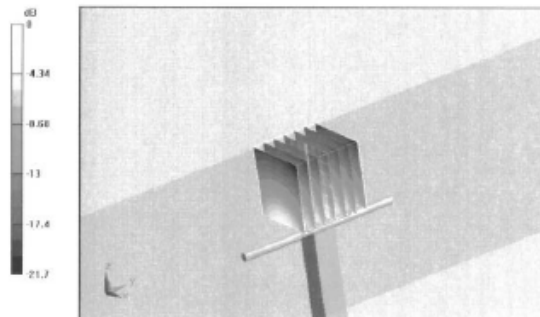
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.6 V/m; Power Drift = 0.037 dB

Peak SAR (extrapolated) = 27.4 W/kg

SAR(1 g) = 13.4 mW/g; SAR(10 g) = 6.33 mW/g

Maximum value of SAR (measured) = 16.9 mW/g



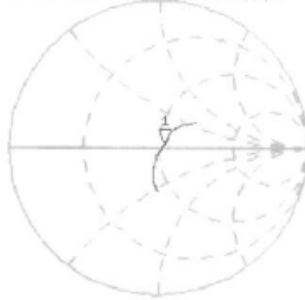
0 dB = 16.9mW/g



Impedance Measurement Plot for Head TSL

20 Jul 2009 16:51:21
[CH1] S11 1 U FS 1: 53.949 Ω 2.2812 μ 142.99 μ H 2 450.000 000 MHz

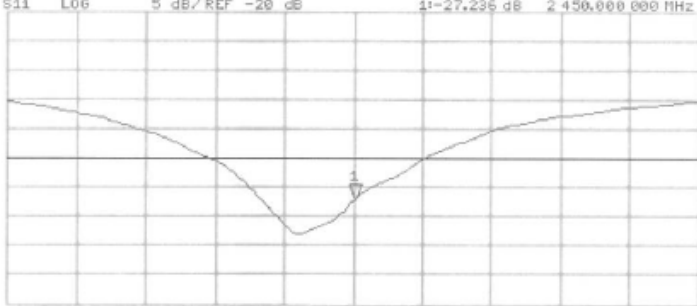
*
De1
Cor



f

CH2 S11 LOG 5 dB/ REF -20 dB 1: -27.236 dB 2 450.000 000 MHz

Cor



f

DASY5 Validation Report for Body TSL

Date/Time: 14.07.2009 17:46:41

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: MSL U10 BB

Medium parameters used: $f = 2450$ MHz; $\sigma = 2$ mho/m; $\epsilon_r = 52.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC)

DASY5 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.06, 4.06, 4.06); Calibrated: 30.04.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 07.03.2009
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.4 Build 45

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

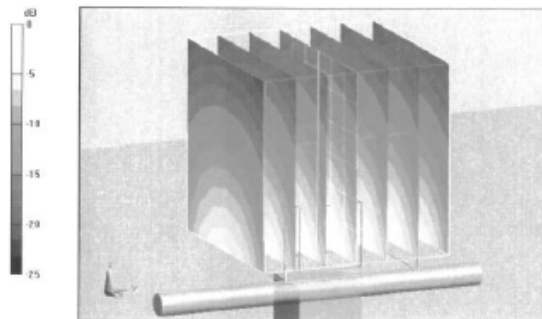
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98 V/m; Power Drift = -0.018 dB

Peak SAR (extrapolated) = 27.1 W/kg

SAR(1 g) = 13.4 mW/g; SAR(10 g) = 6.26 mW/g

Maximum value of SAR (measured) = 17.8 mW/g



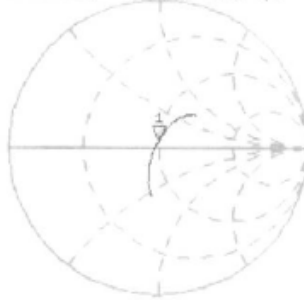
0 dB = 17.8mW/g



Impedance Measurement Plot for Body TSL

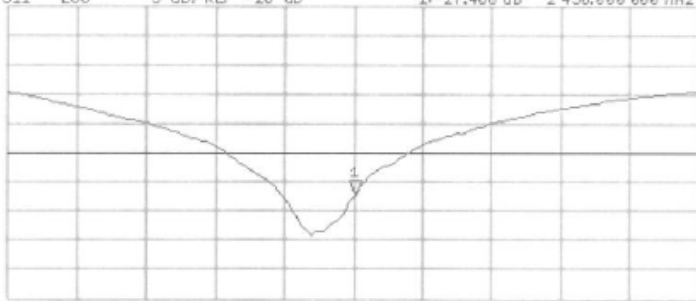
14 Jul 2009 11:56:22
CH1 S11 1 U FS 1: 49.652 Ω 4.2324 Ω 274.94 pF 2 450.000 000 MHz

*
De1
Ca
Avg
16



CH2 S11 L06 5 dB/REF -20 dB 1: -27.406 dB 2 450.000 000 MHz

De1
Ca
Avg
16





Calibration Certificate of DAS Y

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Accreditation No.: **SCS 108**

Client **Sporton (Auden)**

Certificate No: **DAE4-778_Sep09**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BJ - SN: 778**

Calibration procedure(s) **QA CAL-06.v20
 Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **September 18, 2009**

Condition of the calibrated item **In Tolerance**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	30-Sep-08 (No: 7670)	Sep-09
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V1.1	SE UMS 008 AB 1004	05-Jun-09 (in house check)	In house check: Jun-10

Calibrated by:	Name Dominique Steffen	Function Technician	Signature
Approved by:	Fin Bomholt	R&D Director	

Issued: September 18, 2009

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Glossary

DAE data acquisition electronics
Connector angle information used in DAS Y 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 DAS Y 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:* DAE input resistance at the connector, during internal auto-zeroing and during measurement.
 - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
 - *Power consumption:* Typical value for information. Supply currents in various operating modes.



DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

Calibration Factors	X	Y	Z
High Range	404.759 ± 0.1% (k=2)	403.533 ± 0.1% (k=2)	405.087 ± 0.1% (k=2)
Low Range	3.98990 ± 0.7% (k=2)	3.96736 ± 0.7% (k=2)	3.99650 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DAS Y system	308.5 ° ± 1 °
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Appendix

1. DC Voltage Linearity

High Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	199989.9	-19.33	-0.01
Channel X + Input	19998.71	-1.49	-0.01
Channel X - Input	-19997.52	2.48	-0.01
Channel Y + Input	200005.5	-2.55	-0.00
Channel Y + Input	19998.69	-1.31	-0.01
Channel Y - Input	-20000.77	-1.07	0.01
Channel Z + Input	199996.6	-1.53	-0.00
Channel Z + Input	19995.31	-4.89	-0.02
Channel Z - Input	-20004.85	0.02	0.02

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	1999.2	-0.67	-0.03
Channel X + Input	198.75	-1.25	-0.62
Channel X - Input	-202.40	-2.40	1.20
Channel Y + Input	1999.9	-0.34	-0.02
Channel Y + Input	198.02	-2.08	-1.04
Channel Y - Input	-202.77	-2.77	1.38
Channel Z + Input	1998.9	-1.13	-0.06
Channel Z + Input	197.15	-2.65	-1.33
Channel Z - Input	-202.66	-2.76	1.38

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	-11.65	-12.94
	-200	5.27	4.21
Channel Y	200	-1.68	-2.17
	-200	0.94	0.50
Channel Z	200	-10.40	-10.34
	-200	7.99	8.37

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	-	3.78	0.43
Channel Y	200	2.72	-	3.55
Channel Z	200	1.91	-1.15	-



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	16047	16291
Channel Y	16164	15200
Channel Z	16419	16616

5. Input Offset Measurement

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

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	-0.27	-1.21	0.66	0.34
Channel Y	-1.11	-2.22	0.27	0.51
Channel Z	-1.33	-2.34	-0.31	0.45

6. Input Offset Current

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

7. Input Resistance

	Zeroing (MOhm)	Measuring (MOhm)
Channel X	0.2000	203.5
Channel Y	0.2000	203.3
Channel Z	0.2000	203.9

8. Low Battery Alarm Voltage (verified during pre test)

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

9. Power Consumption (verified during pre test)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.0	+6	+14
Supply (- Vcc)	-0.01	-8	-9



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Accreditation No.: SCS 108

Client Sporton (Auden)

Certificate No: DAE4-1210_Nov09

CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BJ - SN: 1210
Calibration procedure(s): QA CAL-06.v12 Calibration procedure for the data acquisition electronics (DAE)
Calibration date: November 16, 2009

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.

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Calibration Equipment used (M&TE critical for calibration)

Table with 4 columns: Primary Standards, ID #, Cal Date (Certificate No.), Scheduled Calibration. Includes entries for Keithley Multimeter Type 2001 and Calibrator Box V1.1.

Calibrated by: Name Andrea Guntli, Function Technician, Signature [Handwritten]

Approved by: Name Fin Bomholt, R&D Director, Signature [Handwritten]

Issued: November 16, 2009

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

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- 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:* 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 = 6.1 μ V , full range = -100...+300 mV

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

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

Calibration Factors	X	Y	Z
High Range	404.067 \pm 0.1% (k=2)	404.894 \pm 0.1% (k=2)	405.003 \pm 0.1% (k=2)
Low Range	3.99984 \pm 0.7% (k=2)	3.98399 \pm 0.7% (k=2)	3.99985 \pm 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	68.0 $^{\circ}$ \pm 1 $^{\circ}$
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Appendix

1. DC Voltage Linearity

High Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	200008.5	-1.69	-0.00
Channel X + Input	20000.09	-0.01	-0.00
Channel X - Input	-19997.52	2.38	-0.01
Channel Y + Input	200007.5	-1.28	-0.00
Channel Y + Input	19998.46	-1.44	-0.01
Channel Y - Input	-20000.73	-0.93	0.00
Channel Z + Input	200006.2	-1.72	-0.00
Channel Z + Input	19998.73	-1.17	-0.01
Channel Z - Input	-20001.90	0.01	0.01

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	2000.5	0.62	0.03
Channel X + Input	199.70	-0.30	-0.15
Channel X - Input	-201.06	-1.06	0.53
Channel Y + Input	1999.8	-0.21	-0.01
Channel Y + Input	198.19	-1.81	-0.91
Channel Y - Input	-200.95	-1.05	0.52
Channel Z + Input	1999.8	-0.10	-0.01
Channel Z + Input	198.44	-1.66	-0.83
Channel Z - Input	-201.19	-1.19	0.60

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	-6.03	-7.54
	- 200	8.69	7.00
Channel Y	200	-10.15	-10.13
	- 200	8.67	8.77
Channel Z	200	11.96	11.80
	- 200	-14.04	-13.97

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	-	3.24	0.57
Channel Y	200	2.21	-	4.99
Channel Z	200	2.72	0.51	-



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	15936	16217
Channel Y	15950	15266
Channel Z	15863	15911

5. Input Offset Measurement

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

Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	-0.48	-2.57	1.51	0.53
Channel Y	-0.60	-1.88	0.36	0.36
Channel Z	-1.78	-2.90	0.13	0.42

6. Input Offset Current

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

7. Input Resistance

	Zeroing (MOhm)	Measuring (MOhm)
Channel X	0.2000	200.9
Channel Y	0.2000	198.6
Channel Z	0.2000	197.7

8. Low Battery Alarm Voltage (verified during pre test)

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

9. Power Consumption (verified during pre test)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.0	+6	+14
Supply (- Vcc)	-0.01	-8	-9



Calibration Certificate of DAS Y

Calibration Laboratory of
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Accreditation No.: SCS 108

Client **Sporton (Auden)**

Certificate No: **ET3-1788_Sep09**

CALIBRATION CERTIFICATE

Object **ET3DV6 - SN:1788**

Calibration procedure(s) **QA CAL-01.v6, QA CAL-23.v3 and QA CAL-25.v2
Calibration procedure for dosimetric E-field probes**

Calibration date: **September 23, 2009**

Condition of the calibrated item **In Tolerance**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	1-Apr-09 (No. 217-01030)	Apr-10
Power sensor E4412A	MY41495277	1-Apr-09 (No. 217-01030)	Apr-10
Power sensor E4412A	MY41498087	1-Apr-09 (No. 217-01030)	Apr-10
Reference 3 dB Attenuator	SN: S5054 (3c)	31-Mar-09 (No. 217-01026)	Mar-10
Reference 20 dB Attenuator	SN: S5086 (20b)	31-Mar-09 (No. 217-01028)	Mar-10
Reference 30 dB Attenuator	SN: S5129 (30b)	31-Mar-09 (No. 217-01027)	Mar-10
Reference Probe ES3DV2	SN: 3013	2-Jan-09 (No. ES3-3013_Jan09)	Jan-10
DAE4	SN: 660	9-Sep-08 (No. DAE4-660_Sep08)	Sep-09

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-08)	In house check: Oct-09

Calibrated by:	Name Claudio Leubler	Function Laboratory Technician	Signature
Approved by:	Name Katja Pokovic	Technical Manager	

Issued: September 23, 2009

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

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Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
Polarization ϕ	ϕ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ 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:

- **NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not effect the E²-field uncertainty inside TSL (see below *ConvF*).
- **NORM(f)_{x,y,z}** = NORM_{x,y,z} * *frequency_response* (see Frequency Response Chart). This linearization is implemented in DAS Y4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- **DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- **ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ 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 DAS Y4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * *ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DAS Y 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.



ET3DV6 SN:1788

September 23, 2009

Probe ET3DV6

SN:1788

Manufactured:	May 28, 2003
Last calibrated:	September 23, 2008
Recalibrated:	September 23, 2009

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)



ET3DV6 SN:1788

September 23, 2009

DASY - Parameters of Probe: ET3DV6 SN:1788

Sensitivity in Free Space^A

Diode Compression^B

NormX	1.79 ± 10.1%	μV/(V/m) ²	DCP X	95 mV
NormY	1.68 ± 10.1%	μV/(V/m) ²	DCP Y	98 mV
NormZ	1.74 ± 10.1%	μV/(V/m) ²	DCP Z	91 mV

Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 8.

Boundary Effect

TSL 835 MHz Typical SAR gradient: 5 % per mm

Sensor Center to Phantom Surface Distance		3.7 mm	4.7 mm
SAR _{be} [%]	Without Correction Algorithm	10.4	6.8
SAR _{be} [%]	With Correction Algorithm	0.8	0.5

TSL 1750 MHz Typical SAR gradient: 10 % per mm

Sensor Center to Phantom Surface Distance		3.7 mm	4.7 mm
SAR _{be} [%]	Without Correction Algorithm	12.5	8.3
SAR _{be} [%]	With Correction Algorithm	0.8	0.4

Sensor Offset

Probe Tip to Sensor Center 2.7 mm

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 Page 8).

^B Numerical linearization parameter: uncertainty not required.

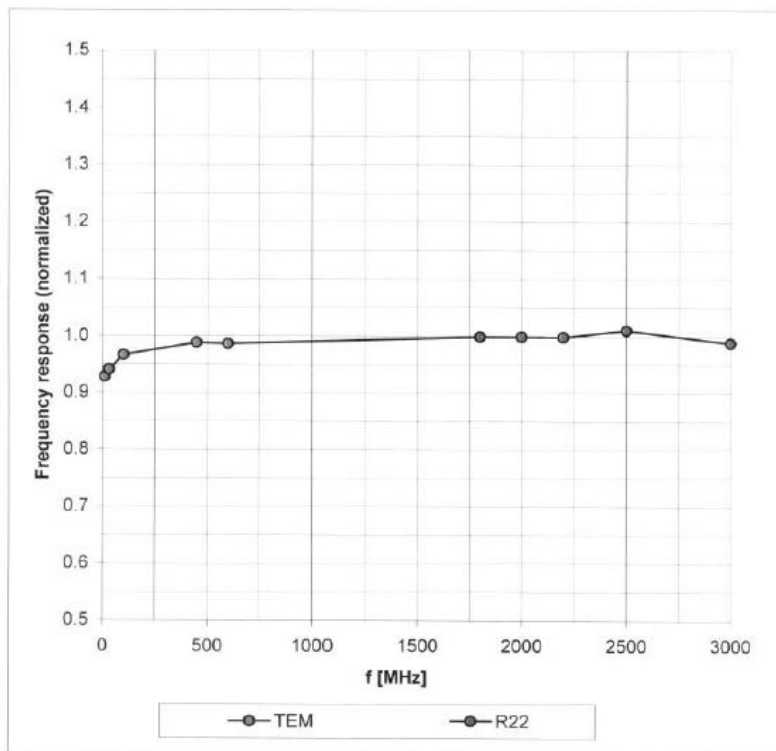


ET3DV6 SN:1788

September 23, 2009

Frequency Response of E-Field

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



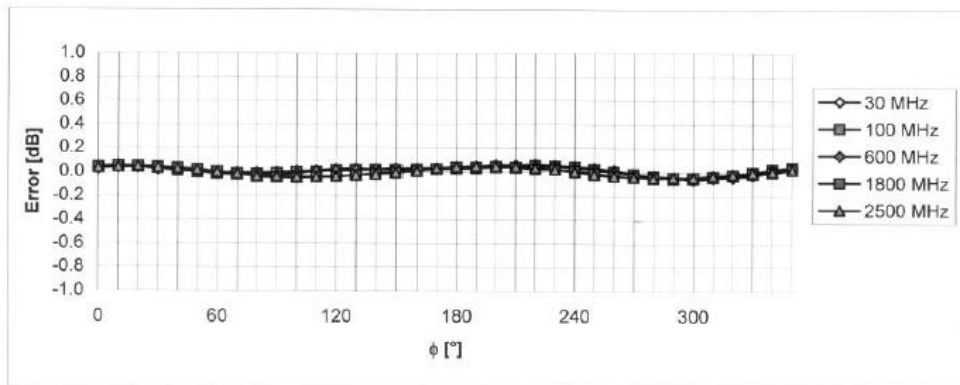
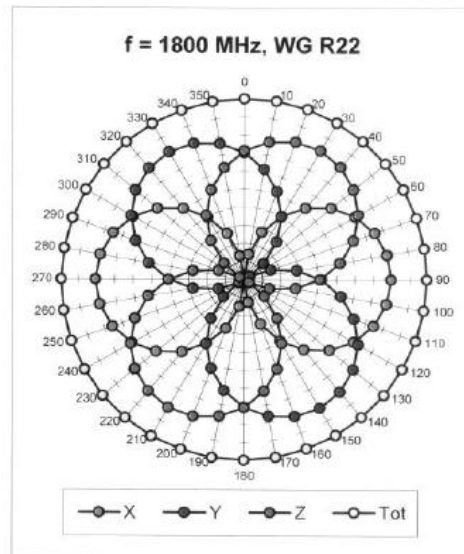
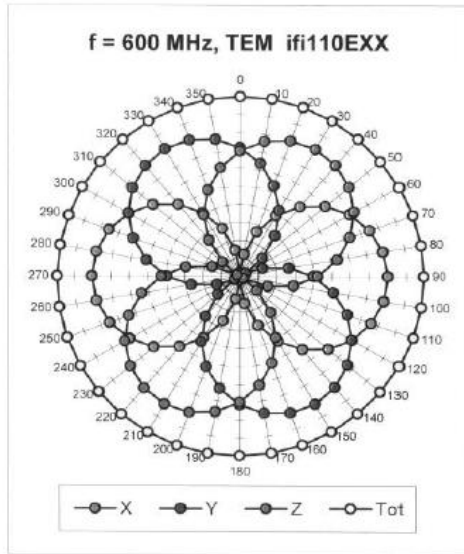
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)



ET3DV6 SN:1788

September 23, 2009

Receiving Pattern (ϕ), $\theta = 0^\circ$



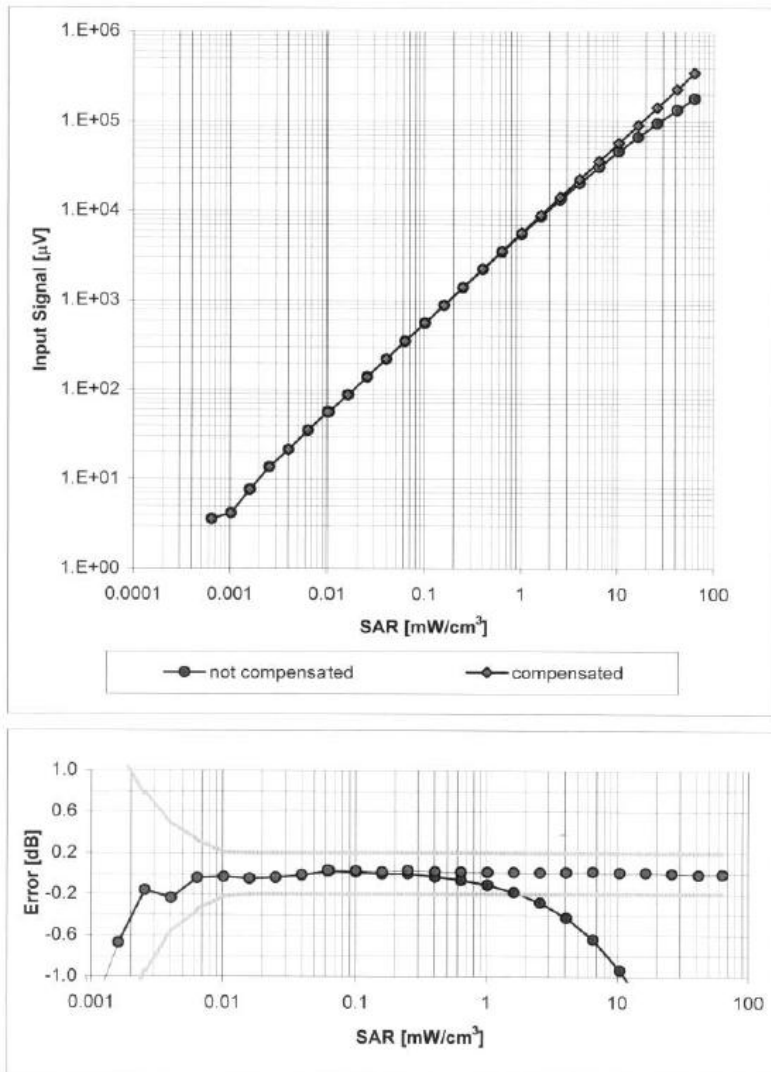
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)



ET3DV6 SN:1788

September 23, 2009

Dynamic Range $f(\text{SAR}_{\text{head}})$ (Waveguide R22, $f = 1800 \text{ MHz}$)

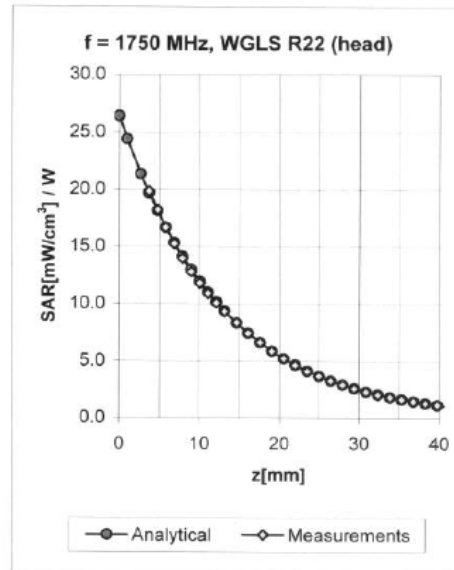
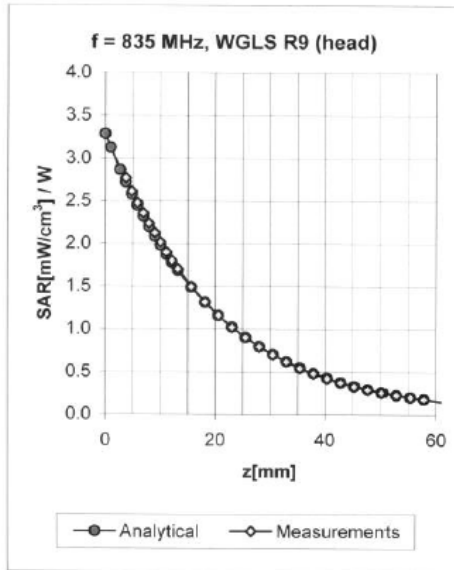


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

ET3DV6 SN:1788

September 23, 2009

Conversion Factor Assessment



f [MHz]	Validity [MHz] ^c	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
835	± 50 / ± 100	Head	41.5 ± 5%	0.90 ± 5%	0.35	2.50	6.30 ± 11.0% (k=2)
1750	± 50 / ± 100	Head	40.1 ± 5%	1.37 ± 5%	0.50	2.63	5.40 ± 11.0% (k=2)
1900	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.68	2.24	5.11 ± 11.0% (k=2)
2450	± 50 / ± 100	Head	39.2 ± 5%	1.80 ± 5%	0.99	1.77	4.48 ± 11.0% (k=2)
835	± 50 / ± 100	Body	55.2 ± 5%	0.97 ± 5%	0.33	2.65	6.08 ± 11.0% (k=2)
1750	± 50 / ± 100	Body	53.4 ± 5%	1.49 ± 5%	0.58	3.48	4.77 ± 11.0% (k=2)
1900	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.75	2.85	4.52 ± 11.0% (k=2)
2450	± 50 / ± 100	Body	52.7 ± 5%	1.95 ± 5%	0.99	1.54	4.19 ± 11.0% (k=2)

^c The validity of ± 100 MHz only applies for DASYS v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

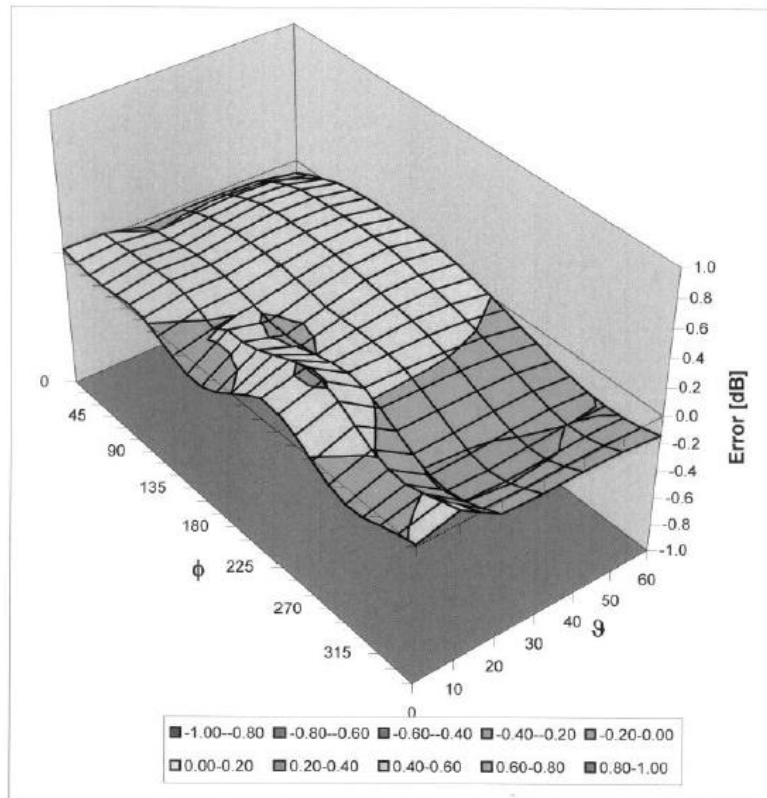


ET3DV6 SN:1788

September 23, 2009

Deviation from Isotropy in HSL

Error (ϕ , θ), $f = 900$ MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ ($k=2$)



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Accreditation No.: SCS 108

Client Sporton (Auden)

Certificate No: EX3-3697_Nov09

CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3697
Calibration procedure(s) QA CAL-01.v6, QA CAL-23.v3 and QA CAL-25.v2 Calibration procedure for dosimetric E-field probes
Calibration date: November 23, 2009

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)

Table with 4 columns: Primary Standards, ID #, Cal Date (Certificate No.), Scheduled Calibration. Lists equipment like Power meter E4419B, Reference 3 dB Attenuator, etc.

Table with 4 columns: Secondary Standards, ID #, Check Date (in house), Scheduled Check. Lists equipment like RF generator HP 8648C, Network Analyzer HP 8753E.

Calibrated by: Jeton Kastrati, Laboratory Technician
Approved by: Katja Pokovic, Technical Manager

Handwritten signatures of Jeton Kastrati and Katja Pokovic.

Issued: November 23, 2009

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Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,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 ϑ	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:

- *NORM_{x,y,z}*: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). *NORM_{x,y,z}* are only intermediate values, i.e., the uncertainties of *NORM_{x,y,z}* does not effect the E^2 -field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)_{x,y,z}* = *NORM_{x,y,z}* * *frequency_response* (see Frequency Response Chart). This linearization is implemented in DAS Y4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCP_{x,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.
- *A_{x,y,z}*; *B_{x,y,z}*; *C_{x,y,z}*; *VR_{x,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 $f \leq 800$ 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 DAS Y4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORM_{x,y,z}* * *ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DAS Y 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.



EX3DV4 SN:3697

November 23, 2009

Probe EX3DV4

SN:3697

Manufactured:	April 22, 2009
Calibrated:	November 23, 2009

Calibrated for DASYS Systems

(Note: non-compatible with DASYS2 system!)



EX3DV4 SN:3697

November 23, 2009

DASY - Parameters of Probe: EX3DV4 SN:3697

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.42	0.45	0.47	± 10.1%
DCP (mV) ^B	88.8	91.6	90.2	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dBuV	C	VR mV	Unc ^E (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	300	± 1.5%
			Y	0.00	0.00	1.00	300	
			Z	0.00	0.00	1.00	300	

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).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the maximum deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



EX3DV4 SN:3697

November 23, 2009

DASY - Parameters of Probe: EX3DV4 SN:3697

Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz]	Validity [MHz] ^c	Permittivity	Conductivity	ConvF X	ConvF Y	ConvF Z	Alpha	Depth Unc (k=2)
835	± 50 / ± 100	41.5 ± 5%	0.90 ± 5%	8.32	8.32	8.32	0.99	0.56 ± 11.0%
1750	± 50 / ± 100	40.1 ± 5%	1.37 ± 5%	7.54	7.54	7.54	0.77	0.60 ± 11.0%
1900	± 50 / ± 100	40.0 ± 5%	1.40 ± 5%	7.32	7.32	7.32	0.66	0.65 ± 11.0%
2450	± 50 / ± 100	39.2 ± 5%	1.80 ± 5%	6.69	6.69	6.69	0.42	0.79 ± 11.0%

^c The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.



EX3DV4 SN:3697

November 23, 2009

DASY - Parameters of Probe: EX3DV4 SN:3697

Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz]	Validity [MHz] ^c	Permittivity	Conductivity	ConvF X	ConvF Y	ConvF Z	Alpha	Depth Unc (k=2)
835	± 50 / ± 100	55.2 ± 5%	0.97 ± 5%	8.22	8.22	8.22	0.85	0.58 ± 11.0%
1750	± 50 / ± 100	53.4 ± 5%	1.49 ± 5%	7.37	7.37	7.37	0.66	0.65 ± 11.0%
1900	± 50 / ± 100	53.3 ± 5%	1.52 ± 5%	7.04	7.04	7.04	0.69	0.64 ± 11.0%
2450	± 50 / ± 100	52.7 ± 5%	1.95 ± 5%	6.84	6.84	6.84	0.43	0.81 ± 11.0%

^c The validity of ± 100 MHz only applies for DAS Y v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

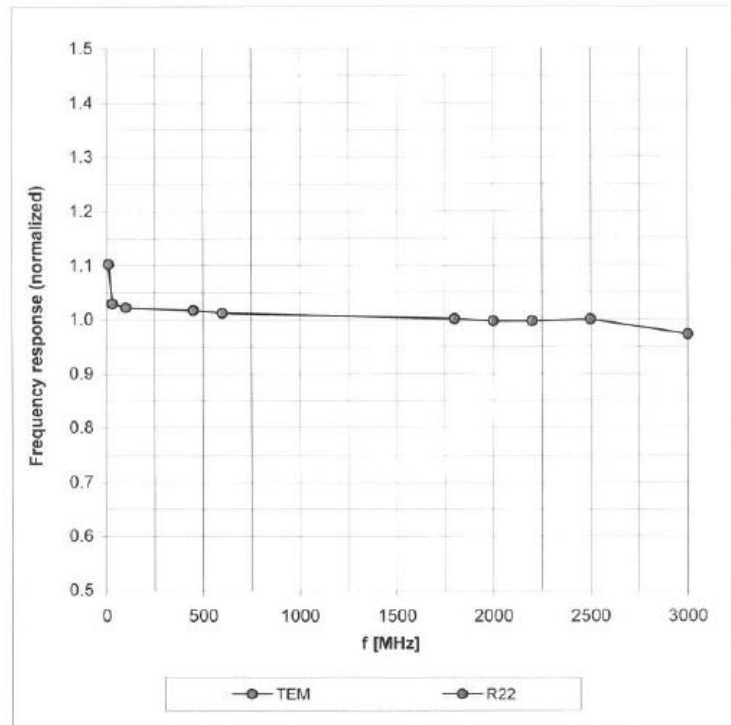


EX3DV4 SN:3697

November 23, 2009

Frequency Response of E-Field

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



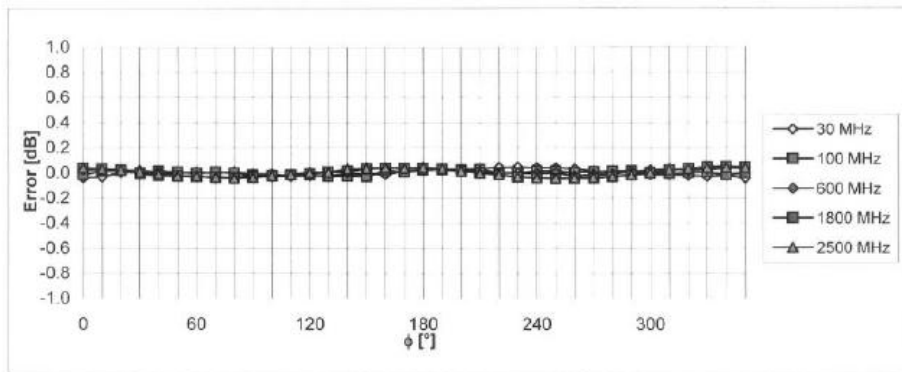
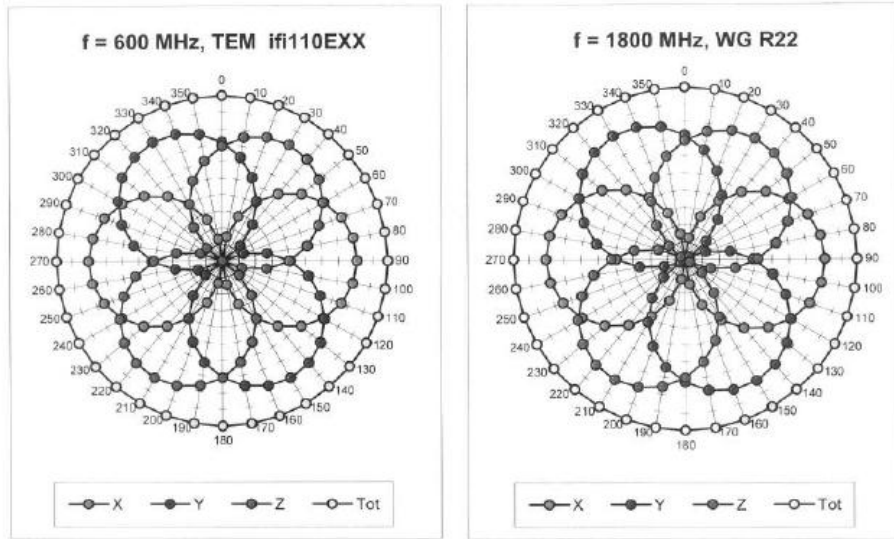
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)



EX3DV4 SN:3697

November 23, 2009

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



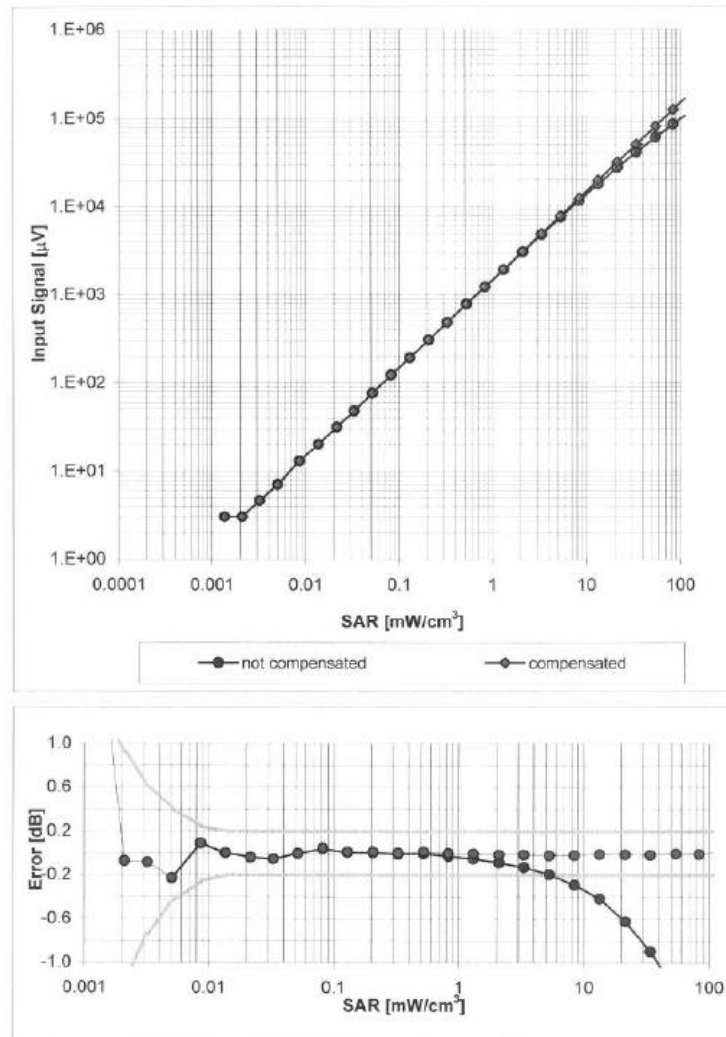
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)



EX3DV4 SN:3697

November 23, 2009

Dynamic Range $f(\text{SAR}_{\text{head}})$ (Waveguide R22, $f = 1800 \text{ MHz}$)

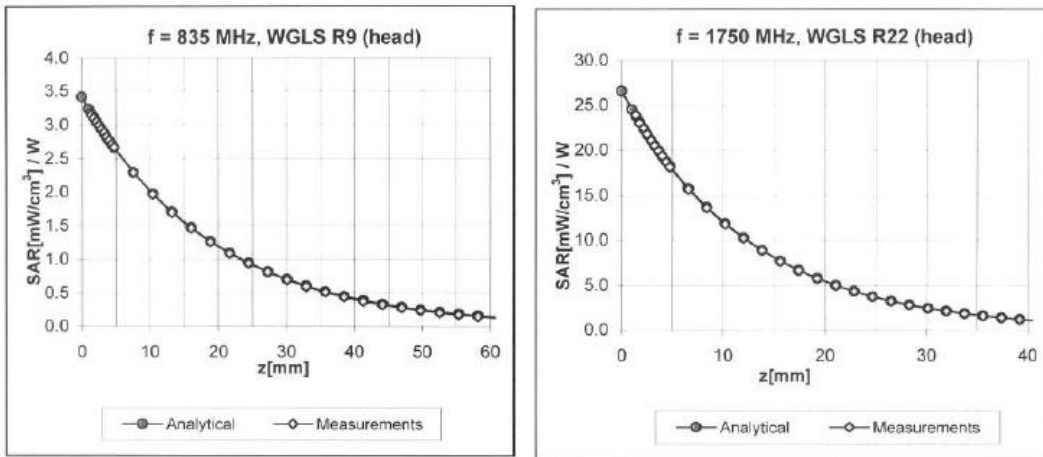


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

EX3DV4 SN:3697

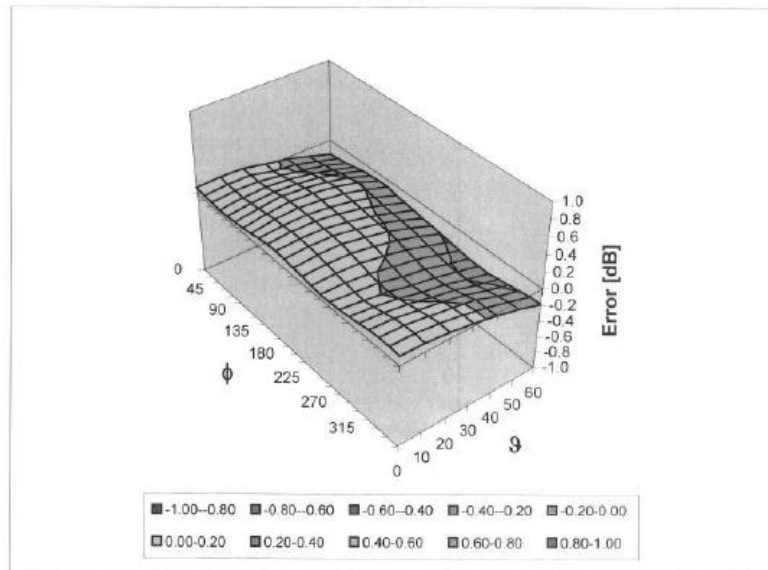
November 23, 2009

Conversion Factor Assessment



Deviation from Isotropy in HSL

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ (k=2)



EX3DV4 SN:3697

November 23, 2009

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