APPENDIX 11 : Dosimetric E-field Probe Calibration (ET3DV6, S/N:1685)

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

IMPORTANT NOTICE

USAGE OF PROBES IN ORGANIC SOLVENTS

Diethylene Gycol Monobuthy Ether (the basis for liquids above 1 GHz), as many other organic solvents, is a very effective softener for synthetic materials. These solvents can cause irreparable damage to certain SPEAG products, except those which are explicitly declared as compliant with organic solvents.

Compatible Probes:
- ET3DV6
- ET3DV6R
- ES3DV2
- ER3DV6
- H3DV6

Important Note for ET3DV6 Probes:
The ET3DV6 probes shall not be exposed to solvents longer than necessary for the measurements and shall be cleaned daily after use with warm water and stored dry.

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

Schmid & Partner Engineering AG

Technical Note 01.06.15-1 June 2002

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

Client UL Apex (MTT)

CALIBRATION CERTIFICATE

Object(s)	ET3DV6 - SN:1685
Calibration procedure(s)	QA CAL-01 v2 Calibration procedure for dosimetric E-field probes
Calibration date:	October 10, 2003
Condition of the calibrated item	In Tolerance (according to the specific calibration document)

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM E4419B	GB41293874	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor E4412A	MY41495277	2-Apr-03 (METAS, No 252-0250)	Apr-04
Reference 20 dB Attenuator	SN: 5086 (20b)	3-Apr-03 (METAS No. 251-0340	Apr-04
Fluke Process Calibrator Type 702	SN: 6295803	8-Sep-03 (Sintrel SCS No. E-030020)	Sep-04
Power sensor HP 8481A	MY41092180	18-Sep-02 (Agilent, No. 20020918)	In house check: Oct 03
RF generator HP 8684C	US3642U01700	4-Aug-99 (SPEAG, in house check Aug-02)	In house check: Aug-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (Agilent, No. 24BR1033101)	In house check: Oct 03

	Name	Function	Signature
Calibrated by:	Nico Vetterli	Technician	N. Vetterli
Approved by:	Katja Pokovic	Laboratory Director	

Date issued: October 23, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

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Schmid & Partner Engineering AG

s p e a g

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

Probe ET3DV6

SN:1685

Manufactured:	April 3, 2002
Last calibration:	May 10, 2002
Recalibrated:	October 10, 2003

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

ET3DV6 SN:1685 October 10, 2003

DASY - Parameters of Probe: ET3DV6 SN:1685

Sensitivity in Free Space

NormX	**1.60**	$\mu V/(V/m)^2$
NormY	**1.65**	$\mu V/(V/m)^2$
NormZ	**1.56**	$\mu V/(V/m)^2$

Diode Compression

DCP X	**95**	mV
DCP Y	**95**	mV
DCP Z	**95**	mV

Sensitivity in Tissue Simulating Liquid

Head 900 MHz ε_r = 41.5 ± 5% σ = 0.97 ± 5% mho/m

Valid for f=800-1000 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**6.6**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.6**	± 9.5% (k=2)	Alpha	**0.26**
ConvF Z	**6.6**	± 9.5% (k=2)	Depth	**3.07**

Head 1800 MHz ε_r = 40.0 ± 5% σ = 1.40 ± 5% mho/m

Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**5.2**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.2**	± 9.5% (k=2)	Alpha	**0.41**
ConvF Z	**5.2**	± 9.5% (k=2)	Depth	**2.77**

Boundary Effect

Head 900 MHz Typical SAR gradient: 5 % per mm

Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	8.9	5.4
SAR_{be} [%]	With Correction Algorithm	0.4	0.5

Head 1800 MHz Typical SAR gradient: 10 % per mm

Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	11.8	8.4
SAR_{be} [%]	With Correction Algorithm	0.4	0.2

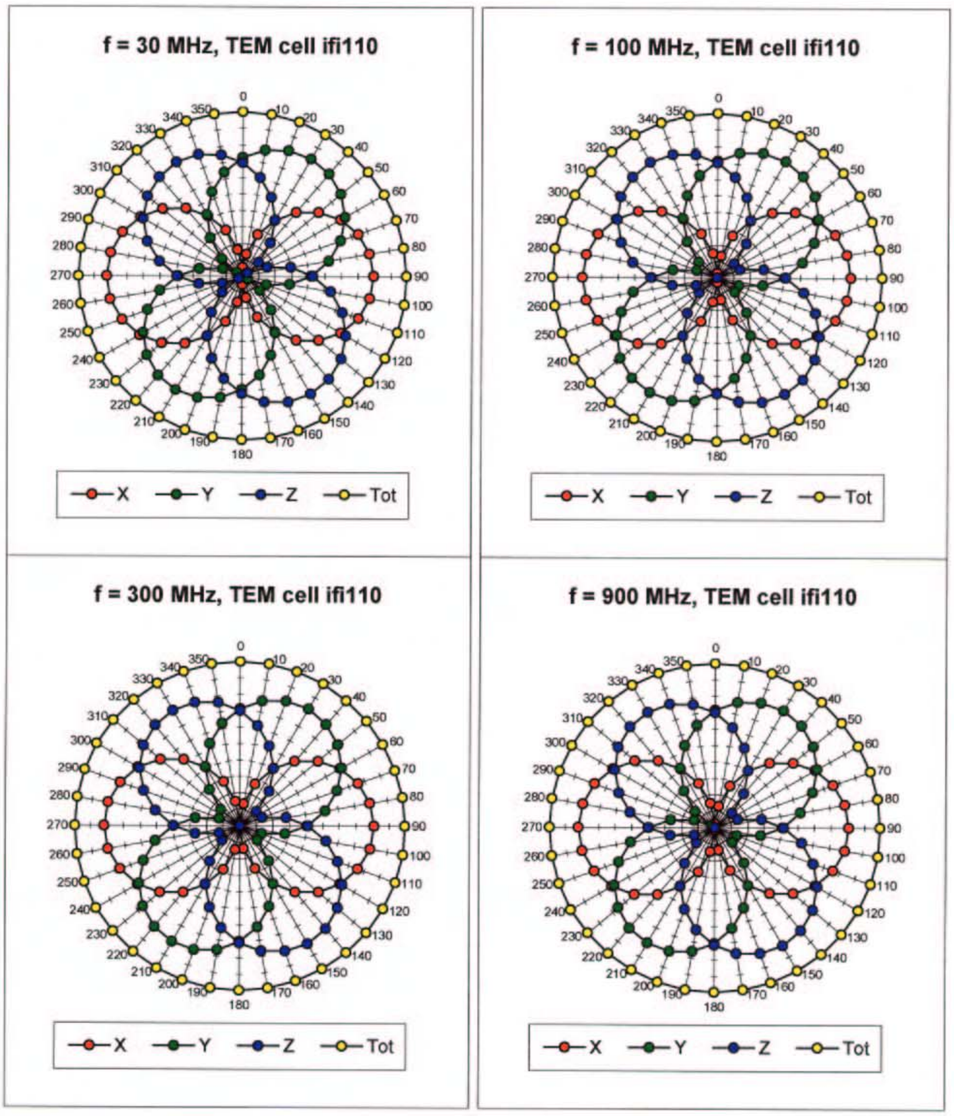
Sensor Offset

Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.6 ± 0.2**	mm

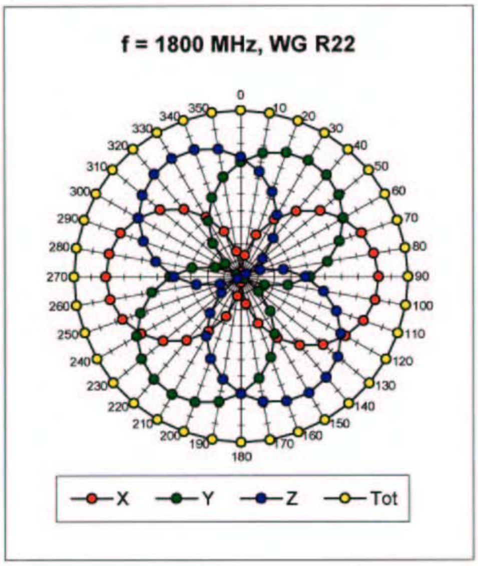
UL Apex Co., Ltd.
Head Office EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8116
Facsimile: +81 596 24 8124

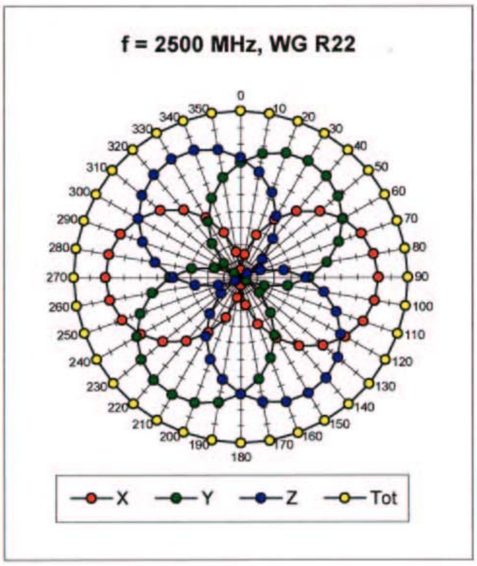
ET3DV6 SN:1685 October 10, 2003

Receiving Pattern (ϕ), θ = 0°

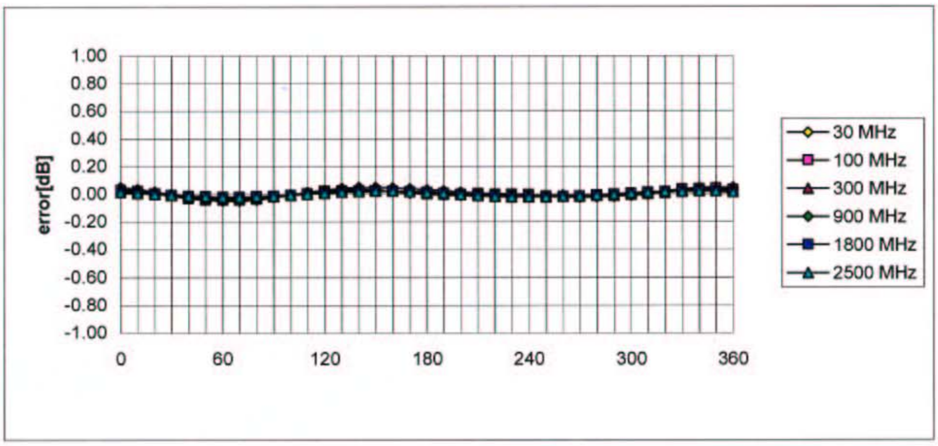


ET3DV6 SN:1685 October 10, 2003





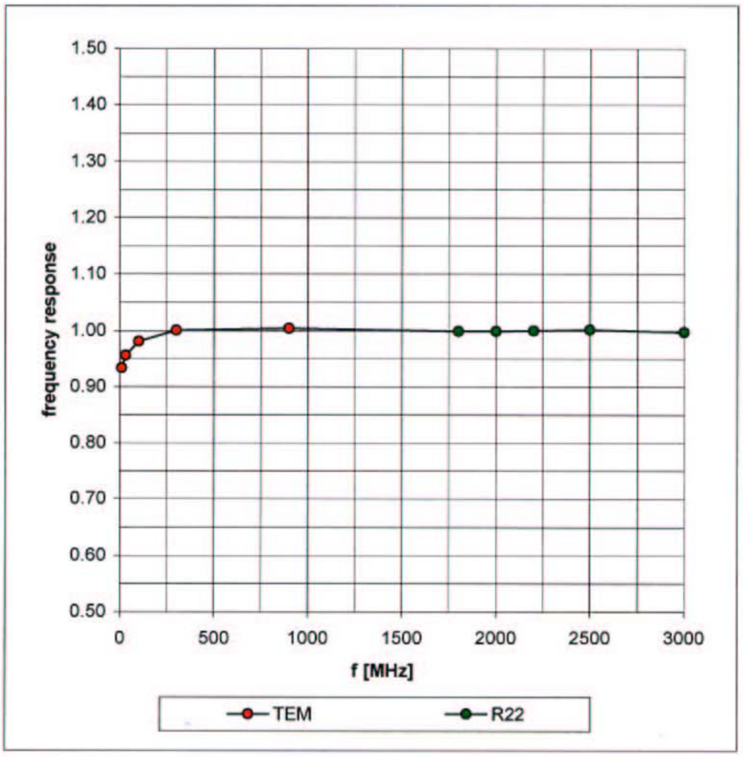
Isotropy Error (ϕ), θ = 0°



ET3DV6 SN:1685 October 10, 2003

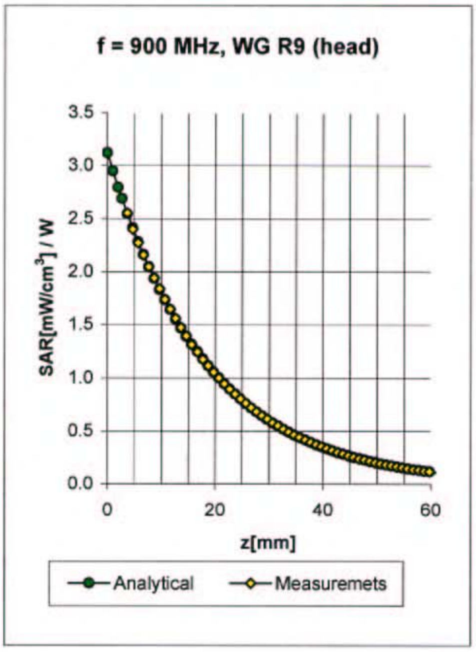
Frequency Response of E-Field

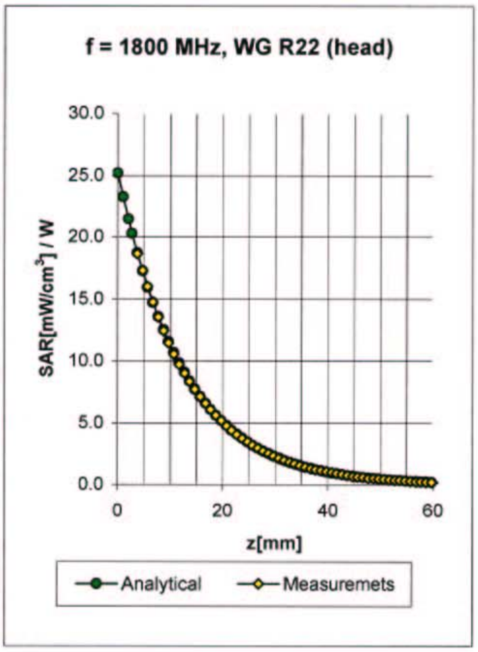
(TEM-Cell:ifi110, Waveguide R22)



ET3DV6 SN:1685 October 10, 2003 ET3DV6 S

Conversion Factor Assessment





Head **900 MHz** ε_r **= 41.5 ± 5%** **σ = 0.97 ± 5% mho/m**

Valid for f=800-1000 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**6.6**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.6**	± 9.5% (k=2)	Alpha	**0.26**
ConvF Z	**6.6**	± 9.5% (k=2)	Depth	**3.07**

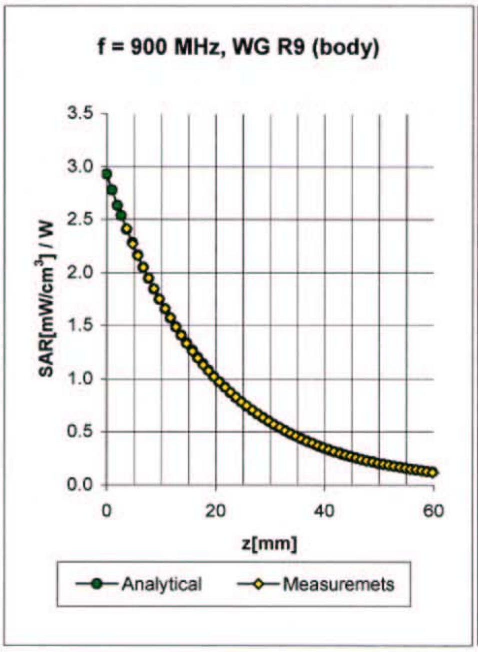
Head **1800 MHz** ε_r **= 40.0 ± 5%** **σ = 1.40 ± 5% mho/m**

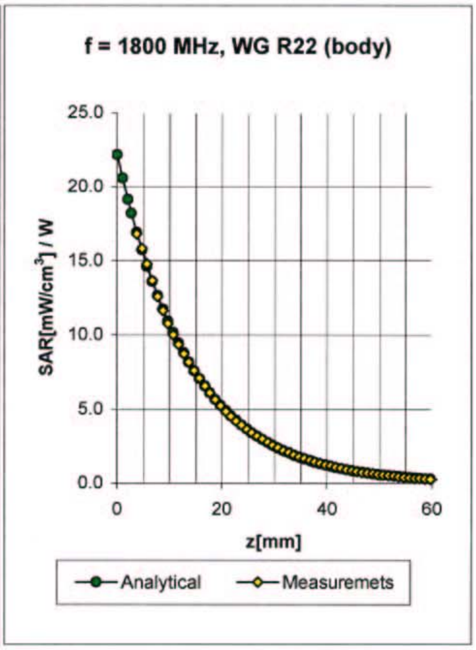
Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**5.2**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.2**	± 9.5% (k=2)	Alpha	**0.41**
ConvF Z	**5.2**	± 9.5% (k=2)	Depth	**2.77**

ET3DV6 SN:1685 October 10, 2003

Conversion Factor Assessment





Body **900 MHz** ε_r **= 55.0 ± 5%** **σ = 1.05 ± 5% mho/m**

Valid for f=800-1000 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	**6.4**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.4**	± 9.5% (k=2)	Alpha	**0.27**
ConvF Z	**6.4**	± 9.5% (k=2)	Depth	**3.22**

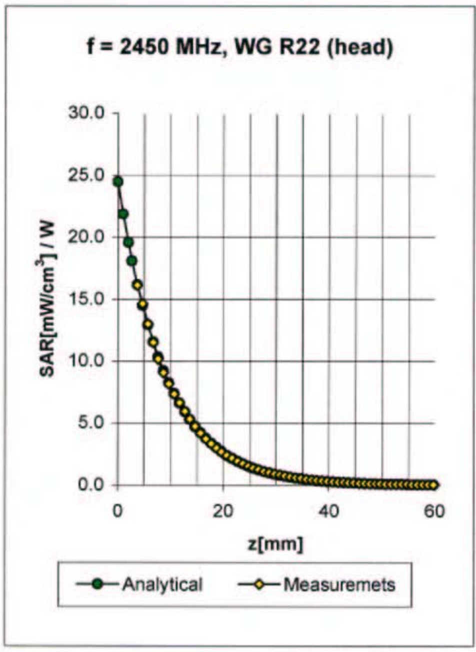
Body **1800 MHz** ε_r **= 53.3 ± 5%** **σ = 1.52 ± 5% mho/m**

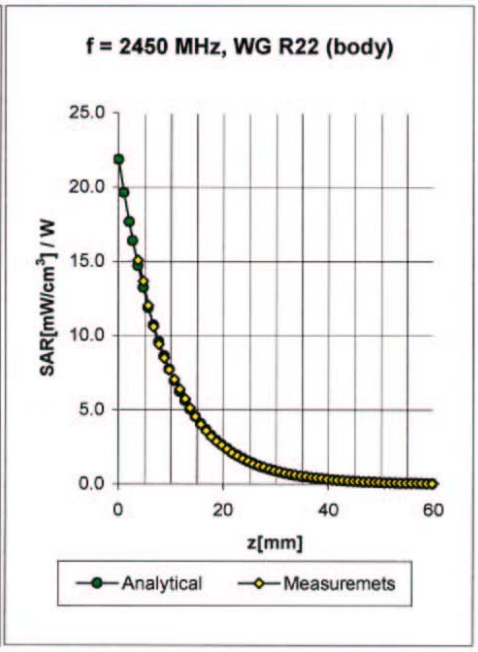
Valid for f=1710-1910 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	**4.7**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**4.7**	± 9.5% (k=2)	Alpha	**0.48**
ConvF Z	**4.7**	± 9.5% (k=2)	Depth	**2.94**

ET3DV6 SN:1685 October 10, 2003

Conversion Factor Assessment





Head **2450 MHz** ε_r = 39.2 ± 5% σ = 1.80 ± 5% mho/m

Valid for f=2400-2500 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**4.7** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**4.7** ± 9.5% (k=2)	Alpha	**0.78**
ConvF Z	**4.7** ± 9.5% (k=2)	Depth	**2.04**

Body **2450 MHz** ε_r = 52.7 ± 5% σ = 1.95 ± 5% mho/m

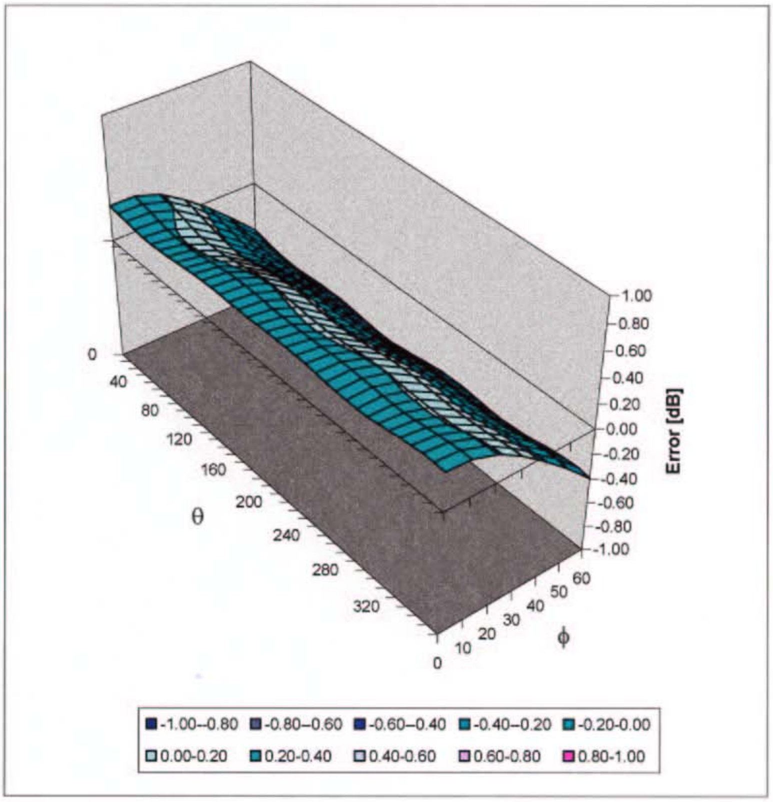
Valid for f=2400-2500 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	**4.3** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**4.3** ± 9.5% (k=2)	Alpha	**0.80**
ConvF Z	**4.3** ± 9.5% (k=2)	Depth	**1.89**

ET3DV6 SN:1685 October 10, 2003

Deviation from Isotropy in HSL

Error (θφ), f = 900 MHz



APPENDIX 12 : Dosimetric E-field Probe Calibration (EX3DV3, S/N:3507)

Schmid & Partner Engineering AG
s p e a g
Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 1 245 9700, Fax +41 1 245 9779
info@speag.com, http://www.speag.com

IMPORTANT NOTICE

UNCERTAINTY OF THE PROBE CONVERSION FACTOR

Important Note:

The Swiss accreditation body (METAS) has requested an additional uncertainty for narrow bandwidth probe calibration compared to the uncertainty table of IEEE/IEC defined for a single frequency. SPEAG and the IT'IS foundation are currently investigating the most appropriate method for narrow and broadband uncertainty assessment.

A preliminary uncertainty value for the indicated frequency bandwidth is included in the attached probe calibration document.

s p e a g
Schmid & Partner Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 1 245 9700, Fax +41 1 245 9779
info@speag.com, http://www.speag.com

Schmid & Partner Engineering AG

January 2004

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

Client **UL A-Pex (MTT)**

CALIBRATION CERTIFICATE

Object(s) **EX3DV3 - SN:3507**

Calibration procedure(s) **QA CAL-01.v2**
Calibration procedure for dosimetric E-field probes

Calibration date: **February 20, 2004**

Condition of the calibrated item **In Tolerance (according to the specific calibration document)**

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 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM E4419B	GB41293874	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor E4412A	MY41495277	2-Apr-03 (METAS, No 252-0250)	Apr-04
Reference 20 dB Attenuator	SN: 5086 (20b)	3-Apr-03 (METAS, No. 251-0340)	Apr-04
Fluke Process Calibrator Type 702	SN: 6295803	8-Sep-03 (Sintrel SCS No. E-030020)	Sep-04
Power sensor HP 8481A	MY41092180	18-Sep-02 (SPEAG, in house check Oct-03)	In house check: Oct 05
RF generator HP 8684C	US3642U01700	4-Aug-99 (SPEAG, in house check Aug-02)	In house check: Aug-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Oct-03)	In house check: Oct 05

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Laboratory Director	
Approved by:	Fin Bomholt	R&D Director	

Date issued: February 26, 2004

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

Probe EX3DV3

SN:3507

Manufactured: December 15, 2003
Last calibrated: February 20, 2004

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: EX3DV3 SN:3507

EX3D\

Sensitivity in Free Space

NormX	**0.71** $\mu V/(V/m)^2$	
NormY	**0.73** $\mu V/(V/m)^2$	
NormZ	**0.72** $\mu V/(V/m)^2$	

Diode Compression[A]

DCP X	**96**	mV
DCP Y	**96**	mV
DCP Z	**96**	mV

Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Plese see Page 7.

Boundary Effect

Head 900 MHz Typical SAR gradient: 5 % per mm

Sensor Cener to Phantom Surface Distance		**2.0 mm**	**3.0 mm**
SAR_{be} [%]	Without Correction Algorithm	3.5	2.9
SAR_{be} [%]	With Correction Algorithm	1.4	1.3

Head 1800 MHz Typical SAR gradient: 10 % per mm

Sensor to Surface Distance		**2.0 mm**	**3.0 mm**
SAR_{be} [%]	Without Correction Algorithm	2.9	1.4
SAR_{be} [%]	With Correction Algorithm	0.2	0.4

Sensor Offset

Probe Tip to Sensor Center **1.0** mm

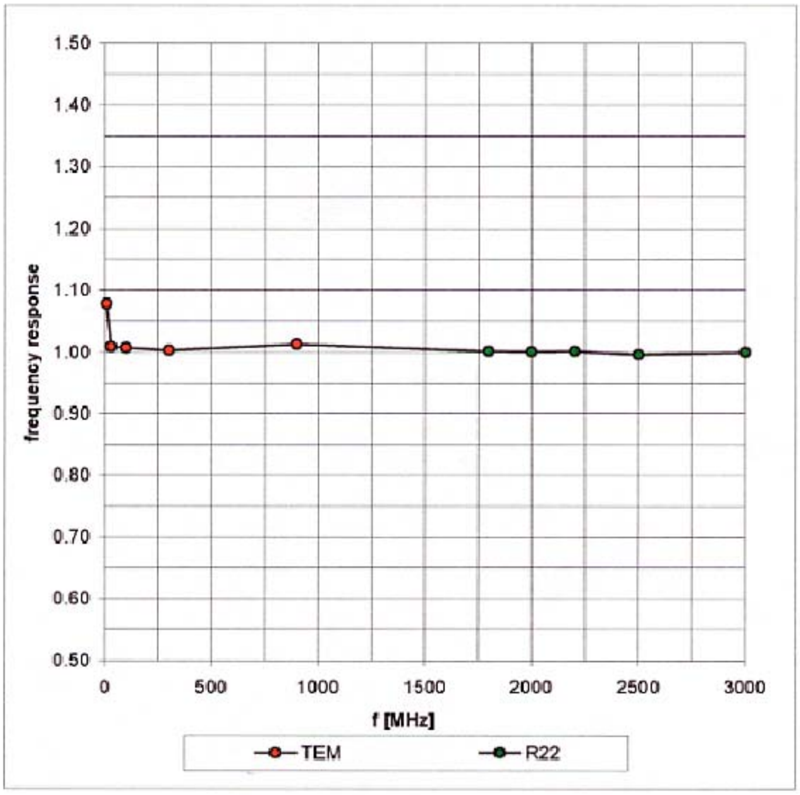
The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] numerical linearization parameter: uncertainty not required

EX3DV3 SN:3507 February 20, 2004

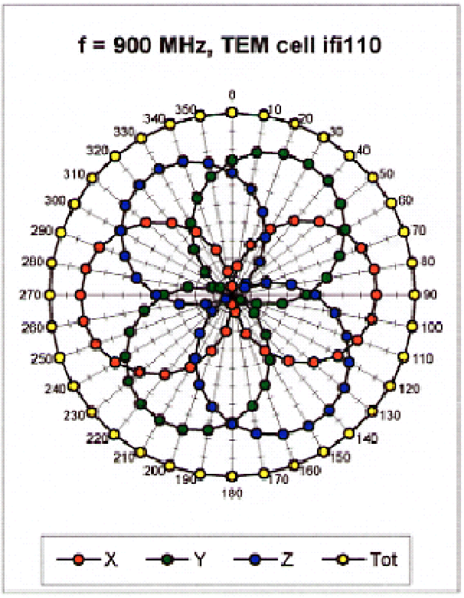
Frequency Response of E-Field

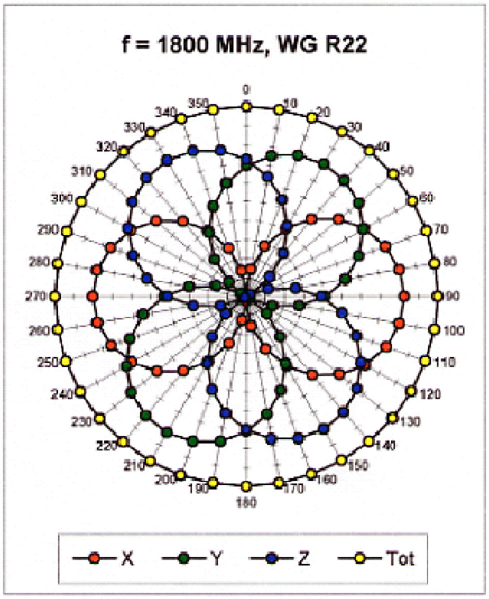
(TEM-Cell:ifi110, Waveguide R22)

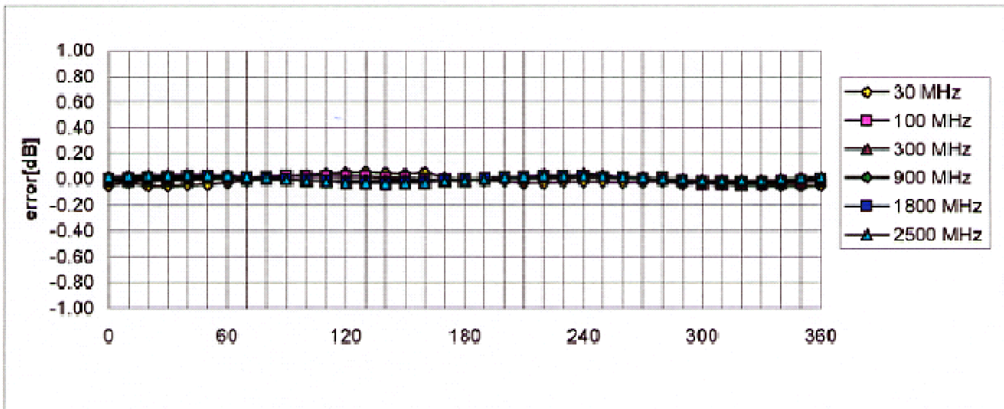


EX3DV3 SN:3507 February 20, 2004

Receiving Pattern (ϕ) , θ = 0°





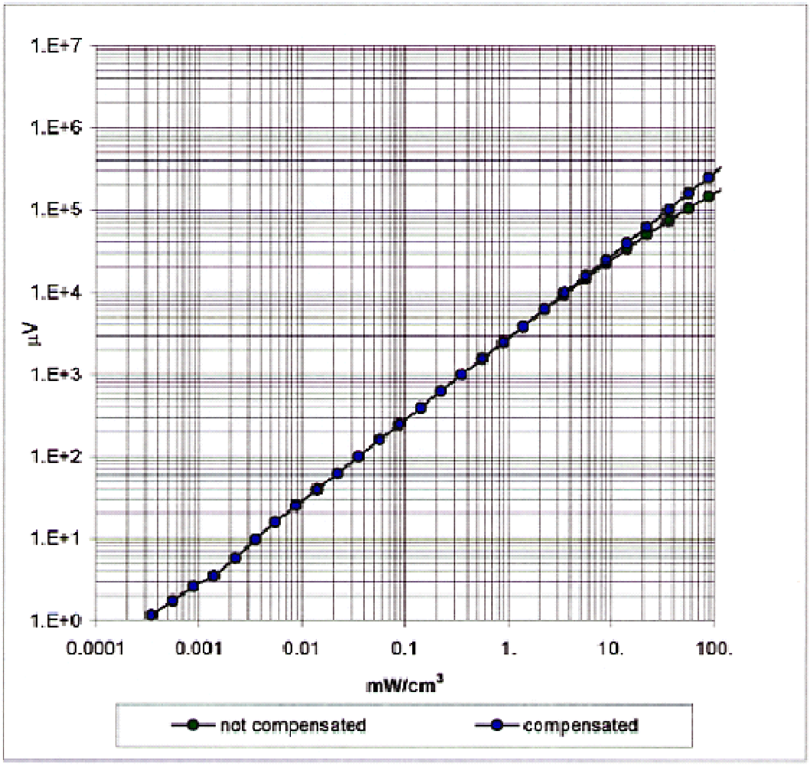


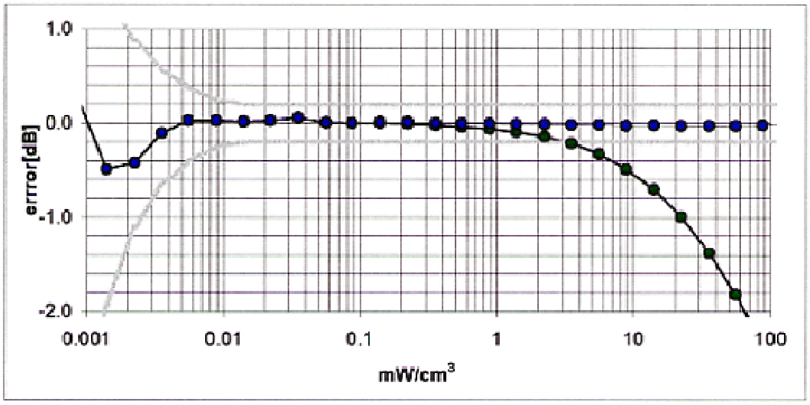
Axial Isotropy Error < ± 0.2 dB

EX3DV3 SN:3507 February 20, 2004

Dynamic Range f(SAR_{head})

(Waveguide R22)

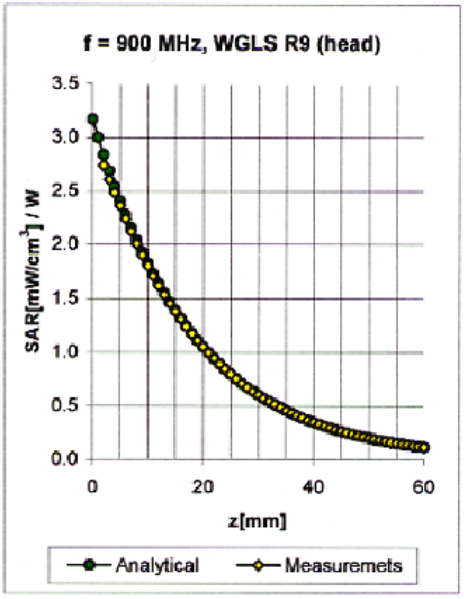


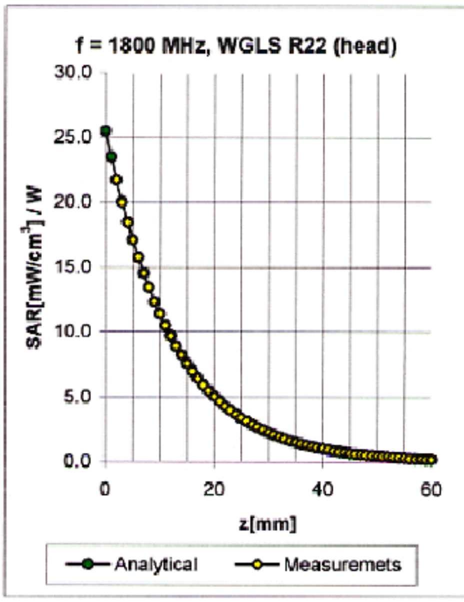


Probe Linearity < ± 0.2 dB

EX3DV3 SN:3507 February 20, 2004

Conversion Factor Assessment





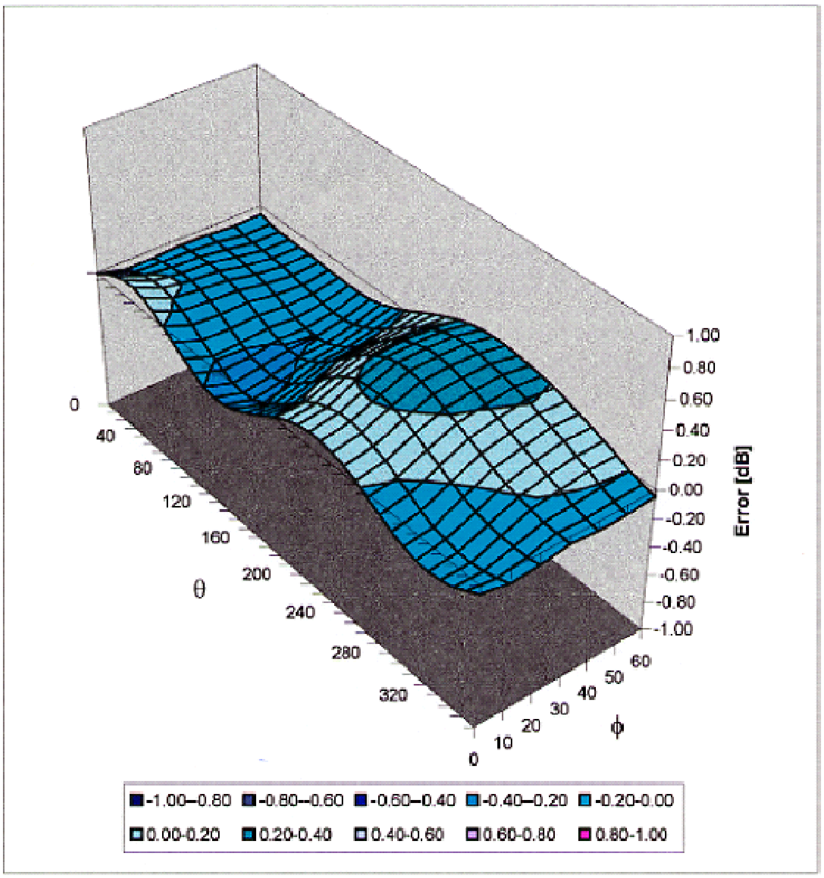
f [MHz]	Validity [MHz][8]	Tissue	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
900	800-1000	Head	41.5 ± 5%	0.97 ± 5%	0.20	1.50	10.7 ± 11.3% (k=2)
1800	1710-1910	Head	40.0 ± 5%	1.40 ± 5%	0.06	2.63	9.10 ± 11.7% (k=2)
5200	4940-5460	Head	36.0 ± 5%	4.66 ± 5%	0.45	1.80	5.27 ± 22.6% (k=2)
5800	5510-6090	Head	35.3 ± 5%	5.27 ± 5%	0.45	1.80	4.76 ± 23.4% (k=2)
5200	4940-5460	Body	49.0 ± 5%	5.30 ± 5%	0.45	1.90	4.62 ± 22.6% (k=2)
5800	5510-6090	Body	48.2 ± 5%	6.00 ± 5%	0.42	1.90	4.21 ± 23.4% (k=2)

[8] The total standard uncertainty is calculated as root-sum-square of standard uncertainty of the Conversion Factor at calibration frequency and the standard uncertainty for the indicated frequency band.

EX3DV3 SN:3507 February 20, 2004

Deviation from Isotropy in HSL

Error (θ,ϕ), f = 900 MHz



Spherical Isotropy Error < ± 0.4 dB

APPENDIX 13 : The 5-6GHz Extension (SPEAG information)

Chapter 26

The 5-6 GHz Extension

26.1 Introduction

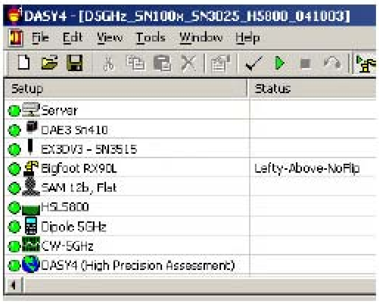
In July 2003, the SPEAG calibration laboratory and its service center released extension for conducting SAR assessments with DASY4 in the frequency range 5-6 GHz. In addition, in January 2004, SPEAG released the smallest dosimetric probe EX3DV3 which allowed a significant improvement of the extension with respect to the measurement accuracy.

These new items and services enable the user to perform routine evaluations of compliance with exposure guidelines operating in the 5 GHz frequency band, as defined in the supplement IEEE 802.11a (1999) and HiperLAN/2 standards with an uncertainty of less than ±30 %.

The new extension for the higher frequency range meets the same requirements for SAR evaluations as described in IEEE 1528 [1], CENELEC EN50361 [2], IEC 62209 [3] for lower frequencies (300 MHz - 3 GHz). The performance of the new setup has been validated by the Foundation for Research on Information Technologies in Society IT'IS.

DASY Software Settings

The recommended usage of a DASY system and its components in the frequency range 300 MHz - 3 GHz is described in detail in the previous Chapters. This Chapter provides all additions and deviations needed for the frequency range 5-6 GHz. If nothing is stated in this Chapter, the requirements, procedures and methods of the previous Chapters are applicable.



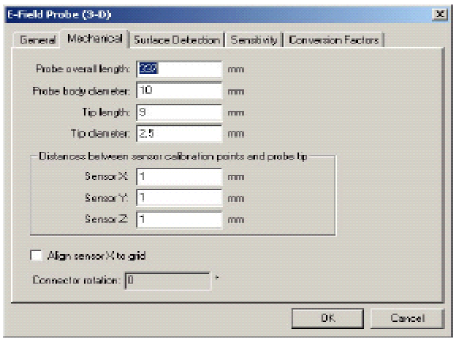
Most of the DASY items and requirements do not deviate from those for the frequency range below 3 GHz. However, due to the stronger gradients of the field distribution in the 5-6 GHz frequency range, adaptation is required for the scanning method as well as for the dosimetric probe type.

UL Apex Co., Ltd.
Head Office EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8116
Facsimile: +81 596 24 8124

26.2 Smallest Dosimetric Probe (EX3DV3)

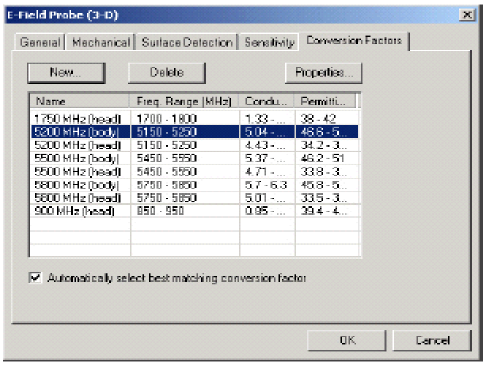
Within the framework of the new EUREKA project No. 2915 (SARSYS-BWP), SPEAG developed a new probe optimized for this frequency range. The new probe has a Tip diameter of 2.5 mm and a distance between sensor calibration point and probe tip (Sensor X,Y and Z) of 1.0 mm. With these dimensions, the EX3DV3 probe has superior performance for high precision measurements in field distributions with steep gradients.

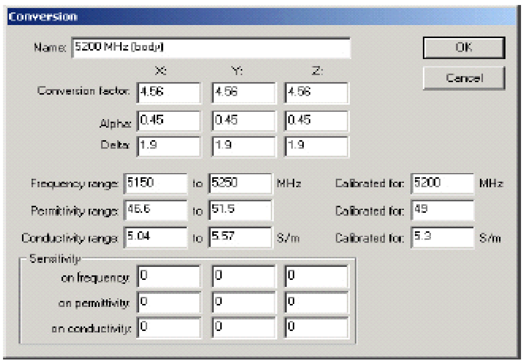
The EX3DV3 probe is fully compatible with the latest draft of IEC 62209 Part 2. It is the only probe enabling measurements at 5-6 GHz with a precision of better than 30% (uncertainty assessed according to the standards). The EX3DV3 probe is universally applicable for dosimetric assessments and is fully compatible with the mechanical detection system of DASY4.



The dimensions of the smallest dosimetric EX3DV3 probe are shown in the Mechanical tab in the dialog. Compared to the standard dosimetric probe, the EX3DV3 type has a reduced Tip diameter as well as smaller distance between sensor calibration point and probe tip (Sensor X,Y and Z) enabling SAR assessments as close as 1.5 mm from the shell-liquid interface.

Note: Please note that the standard ES3DV3 and especially the ET3DV6 dosimetric probes are not suitable for this frequency range. With these probes, the SAR measurement uncertainty can significantly exceed ±30%.





UL Apex Co., Ltd.
Head Office EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8116
Facsimile: +81 596 24 8124

The probe conversion factors in the 5-6 GHz frequency range were assessed in the setup based on the vertically standing waveguide type R58 (frequency band: 4.9 - 7.05 GHz). Due to the small waveguide dimensions, field disturbance by the probe could not be excluded and needs to be added to the uncertainty budget. Together with other error sources, the resulting probe calibration uncertainty for the EX3DV3 probe type was assessed to be ±6.6% (k=1) at Calibration Frequency and ±13.6% (k=1) for a narrow-band conversion factor (±50 MHz).

26.3 Tissue Simulating Liquids

In the current guidelines and draft standards for compliance testing of mobile phones (e.g., IEEE P1528, OET 65 Supplement C), the dielectric parameters suggested for head and body tissue simulating liquid are given only at 3.0 GHz and 5.8 GHz. As an intermediate solution, dielectric parameters for the frequencies between 5 to 5.8 GHz were obtained using linear interpolation (see Table 26.1).

SPEAG has developed suitable head (HSL5800) and body (MSL5800) tissue simulating liquids consisting of the following ingredients: deionized water, salt and a special composition including mineral oil and an emulgator. Dielectric parameters of these liquids were measured using a HP 85070B Dielectric Probe Kit in conjunction with HP 8753E Network Analyzer (30 kHz - 6 GHz). The differences with respect to the interpolated values were well within desired ± 5% for the whole 5 to 5.8 GHz range.

f (GHz)	Head Tissue		Body Tissue		Reference
	ϵ	σ	ϵ	σ	
3.0	38.5	2.40	52.0	2.73	Standard
5.8	35.3	5.27	48.2	6.00	Standard
5.0	36.2	4.45	49.3	5.07	Interpolated
5.1	36.1	4.55	49.1	5.18	Interpolated
5.2	36.0	4.66	49.0	5.30	Interpolated
5.3	35.9	4.76	48.9	5.42	Interpolated
5.4	35.8	4.86	48.7	5.53	Interpolated
5.5	35.6	4.96	48.6	5.65	Interpolated
5.6	35.5	5.07	48.5	5.77	Interpolated
5.7	35.4	5.17	48.3	5.88	Interpolated

Table 26.1: Standard and interpolated dielectric parameters for head and body tissue simulating liquid in the frequency range 3 to 5.8 GHz.

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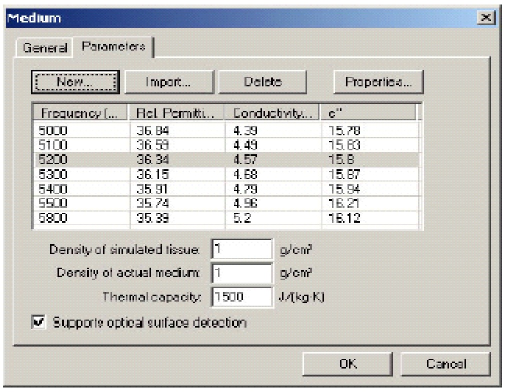

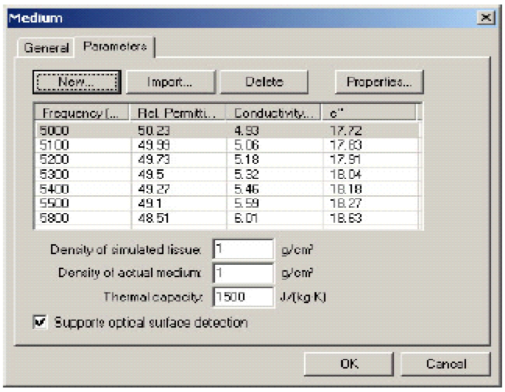

26.4 SAR Evaluation

26.4.1 Area Scan job

Due to the reduced penetration depth in the corresponding liquid (6.0 mm at 6 GHz), the distance between the measured points and phantom surface during the Area Scan needs to be reduced as well as the tolerance, i.e., it should be less than 4.0 mm with a variation of less than ±0.5 mm during the entire scan.

The recommend distance between the probe sensor and phantom surface is 1.5-2.0 mm.

26.4.2 Zoom Scan job

The strong decay would require that at least two measurement points are taken within the first 5 mm from the liquid-shell interface. The following setting for the Zoom Scan job are recommended for the best time vs. accuracy ratio:

- Grid Step size X and Y 4.3 mm
- Grid Step size Z 3.0 mm
- Grid Extent Z 21.0 mm
- Minimum distance of probe sensor to surface 1.5-2.0 mm

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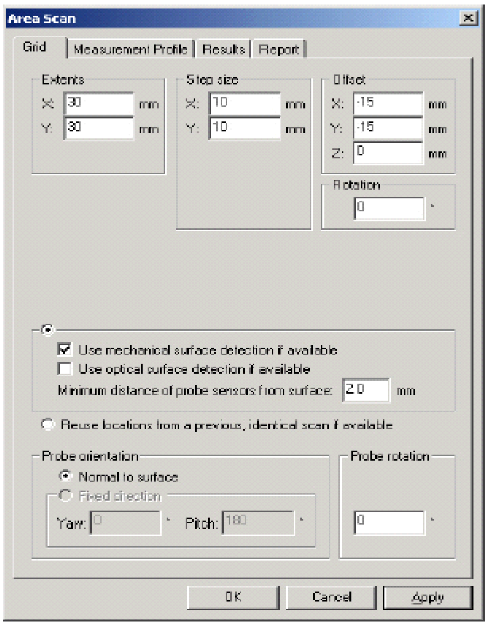

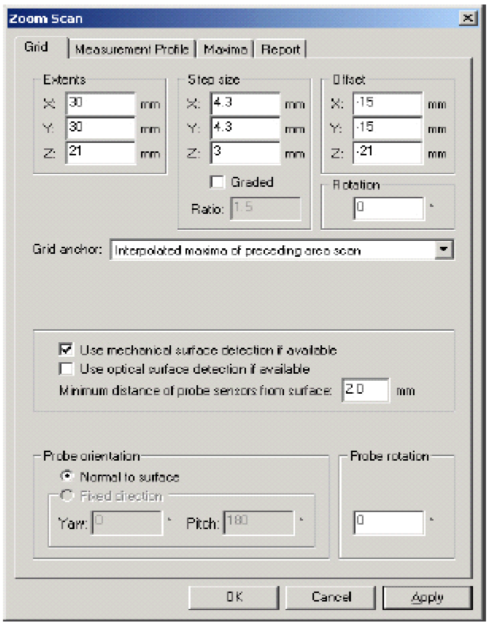

26.5 System Performance Check

For the preparation of the setup please refer to Chapter 15 System Performance Check.

Reference SAR values

The reference SAR values were calculated using finite-difference time-domain FDTD method (feed-point impedance set to 50 Ω) and the mechanical dimensions of the D5GHzV2 dipole (manufactured by SPEAG).

f (GHz)	Head Tissue			Body Tissue		
	SAR_{1g}	SAR_{10g}	SAR_{peak}	SAR_{1g}	SAR_{10g}	SAR_{peak}
5.0	72.9	20.7	285.6	68.1	19.2	260.3
5.1	74.6	21.1	297.5	78.8	19.6	272.3
5.2	76.5	21.6	310.3	71.8	20.1	284.7
5.8	78.0	21.9	340.9	74.1	20.5	324.7

Table 26.2: Numerical reference SAR values for D5GHzV2 dipole and flat phantom.

Uncertainty Budget for System Performance Check

The extended frequency range requires the same documentation including evaluation of the same uncertainty sources. In the following table, an updated uncertainty budget for the system performance check in the frequency range between 5-6 GHz is given.

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Telephone: +81 596 24 8116
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System Performance Check
for the 5 - 6 GHz range

Error Description	Tol. (± %)	Prob. dist.	Div.	(c_i) (1g)	(c_i) (10g)	Std. unc. (1g)	Std. unc. (10g)	(v_i)
Measurement System								
Probe Calibration	±6.6	N	1	1	1	±4.8 %	±6.6 %	∞
Axial Isotropy	±4.7	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
Hemispherical Isotropy	0	R	$\sqrt{3}$	1	1	0	0	∞
Boundary Effects	2.0	R	$\sqrt{3}$	1	1	±1.2 %	±1.2 %	∞
Linearity	±4.7	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
System Detection Limit	±1.0	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Readout Electronics	±1.0	N	1	1	1	±1.0 %	±1.0 %	∞
Response Time	0	R	$\sqrt{3}$	1	1	0	0	∞
Integration Time	0	R	$\sqrt{3}$	1	1	0	0	∞
RF Ambient Conditions	±3.0	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.8	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Probe Positioning	±5.7	N	1	1	1	±5.7 %	±5.7 %	∞
Algorithms for Max. SAR Eval.	±4.0	R	$\sqrt{3}$	1	1	±2.3 %	±2.3 %	∞
Dipole								
Dipole Axis to Liquid Distance	±2.0	R	$\sqrt{3}$	1	1	±1.2 %	±1.2 %	∞
Input power and SAR drift meas.	±4.7	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
Phantom and Tissue Param.								
Phantom Uncertainty	±4.0	R	$\sqrt{3}$	1	1	±2.3 %	±2.3 %	∞
Liquid Conductivity (target)	±5.0	R.	$\sqrt{3}$	0.64	0.43	±1.8 %	±1.2 %	∞
Liquid Conductivity (meas.)	±2.5	N	1	0.64	0.43	±1.6 %	±1.1 %	∞
Liquid Permittivity (target)	±5.0	R	$\sqrt{3}$	0.6	0.49	±1.7 %	±1.4 %	∞
Liquid Permittivity (meas.)	±2.5	N	1	0.6	0.49	±1.5 %	±1.2 %	∞
Combined Standard Uncertainty						±11.3 %	±11.1 %	∞
Coverage Factor for 95%		**kp=2**						
Expanded Uncertainty						**±22.6 %**	**±22.1 %**	

Table 26.3: Uncertainty of the system performance check in the 5-6 GHz range. Probe calibration error reflects uncertainty of the EX3DV3 probe conversion factor at Calibration Frequency.

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4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8116
Facsimile: +81 596 24 8124

26.6 Uncertainty Budget for Compliance Testings

The updated uncertainty budget for the compliance testing in the frequency range between 5-6 GHz is given in the table below.

DASY4 Uncertainty Budget
for the 5 - 6 GHz range

Error Description	Uncertainty value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±6.8 %	N	1	1	1	±6.8 %	±6.8 %	∞
Axial Isotropy	±4.7 %	R	$\sqrt{3}$	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	$\sqrt{3}$	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±2.0 %	R	$\sqrt{3}$	1	1	±1.2 %	±1.2 %	∞
Linearity	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Readout Electronics	±1.0 %	N	1	1	1	±1.0 %	±1.0 %	∞
Response Time	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	$\sqrt{3}$	1	1	±1.5 %	±1.5 %	∞
RF Ambient Conditions	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Probe Positioning	±5.7 %	N	1	1	1	±5.7 %	±5.7 %	∞
Max. SAR Eval.	±4.0 %	R	$\sqrt{3}$	1	1	±2.3 %	±2.3 %	∞
Test Sample Related								
Device Positioning	±2.9 %	N	1	1	1	±2.9 %	±2.9 %	145
Device Holder	±3.6 %	N	1	1	1	±3.6 %	±3.6 %	5
Power Drift	±5.0 %	R	$\sqrt{3}$	1	1	±2.9 %	±2.9 %	∞
Phantom and Setup								
Phantom Uncertainty	±4.0 %	R	$\sqrt{3}$	1	1	±2.3 %	±2.3 %	∞
Liquid Conductivity (target)	±5.0 %	R	$\sqrt{3}$	0.64	0.43	±1.8 %	±1.2 %	∞
Liquid Conductivity (meas.)	±2.5 %	N	1	0.64	0.43	±1.6 %	±1.1 %	∞
Liquid Permittivity (target)	±5.0 %	R	$\sqrt{3}$	0.6	0.49	±1.7 %	±1.4 %	∞
Liquid Permittivity (meas.)	±2.5 %	N	1	0.6	0.49	±1.5 %	±1.2 %	∞
Combined Std. Uncertainty						±12.8 %	±12.7 %	330
Expanded STD Uncertainty						**±25.7 %**	**±25.3 %**	

Table 26.4: Worst-Case uncertainty budget for DASY4 valid for the frequency range 5 - 6 GHz. Probe calibration error reflects uncertainty of the narrow-bandwidth EX3DV3 probe conversion factor (±50 MHz).

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Head Office EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8116
Facsimile: +81 596 24 8124

26.7 References

[1] IEEE Std. 1528-200X, *Draft CD 1.1* "Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques", December 2002.

[2] CENELEC EN 50361, "Basic Standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones", July 2001.

[3] IEC 62209, *Draft CD* "Procedure to measure the Specific Absorption Rate (SAR) for hand-held mobile wireless devices in the frequency range of 300 MHz to 3 GHz", November 2002.

[4] NIST, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Technical Note 1297 (TN 1297), United States Department of Commerce Technology Administration, National Institute of Standards and Technology, Gaithersburg, MD, 1994.

[5] NIS 81, "The Treatment of Uncertainty in EMC measurements", Edition 1, NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, TW11 0LW, England, 1994.

UL Apex Co., Ltd.
Head Office EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
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