

ATTACHMENT R – PROBE CALIBRATION DATA

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

Client **HCT (Dymstec)**

CALIBRATION CERTIFICATE

Object(s) **ET3DV6 - SN:1798**

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

Calibration date: **October 7, 2003**

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

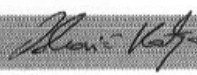
This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

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

Calibrated by:	Name	Function	Signature
	Nico Vetterli	Technician	

Approved by:	Name	Function	Signature
	Katja Pokovic	Laboratory Director	

Date issued: October 8, 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.

Schmid & Partner Engineering AG

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Probe ET3DV6

SN:1798

Manufactured: August 14, 2003
Last calibration: October 7, 2003

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

ET3DV6 SN:1798

October 7, 2003

DASY - Parameters of Probe: ET3DV6 SN:1798

Sensitivity in Free Space

Diode Compression

NormX	1.82 $\mu\text{V}/(\text{V}/\text{m})^2$	DCP X	96	mV
NormY	1.72 $\mu\text{V}/(\text{V}/\text{m})^2$	DCP Y	96	mV
NormZ	1.64 $\mu\text{V}/(\text{V}/\text{m})^2$	DCP Z	96	mV

Sensitivity in Tissue Simulating Liquid

Head 900 MHz $\epsilon_r = 41.5 \pm 5\%$ $\sigma = 0.97 \pm 5\%$ mho/m

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

ConvF X	6.6 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	6.6 $\pm 9.5\%$ (k=2)	Alpha	0.29
ConvF Z	6.6 $\pm 9.5\%$ (k=2)	Depth	3.00

Head 1800 MHz $\epsilon_r = 40.0 \pm 5\%$ $\sigma = 1.40 \pm 5\%$ mho/m

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

ConvF X	5.2 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	5.2 $\pm 9.5\%$ (k=2)	Alpha	0.44
ConvF Z	5.2 $\pm 9.5\%$ (k=2)	Depth	2.78

Boundary Effect

Head 900 MHz Typical SAR gradient: 5 % per mm

Probe Tip to Boundary		1 mm	2 mm
SAR _{be} [%]	Without Correction Algorithm	9.6	5.8
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	12.9	9.0
SAR _{be} [%]	With Correction Algorithm	0.2	0.2

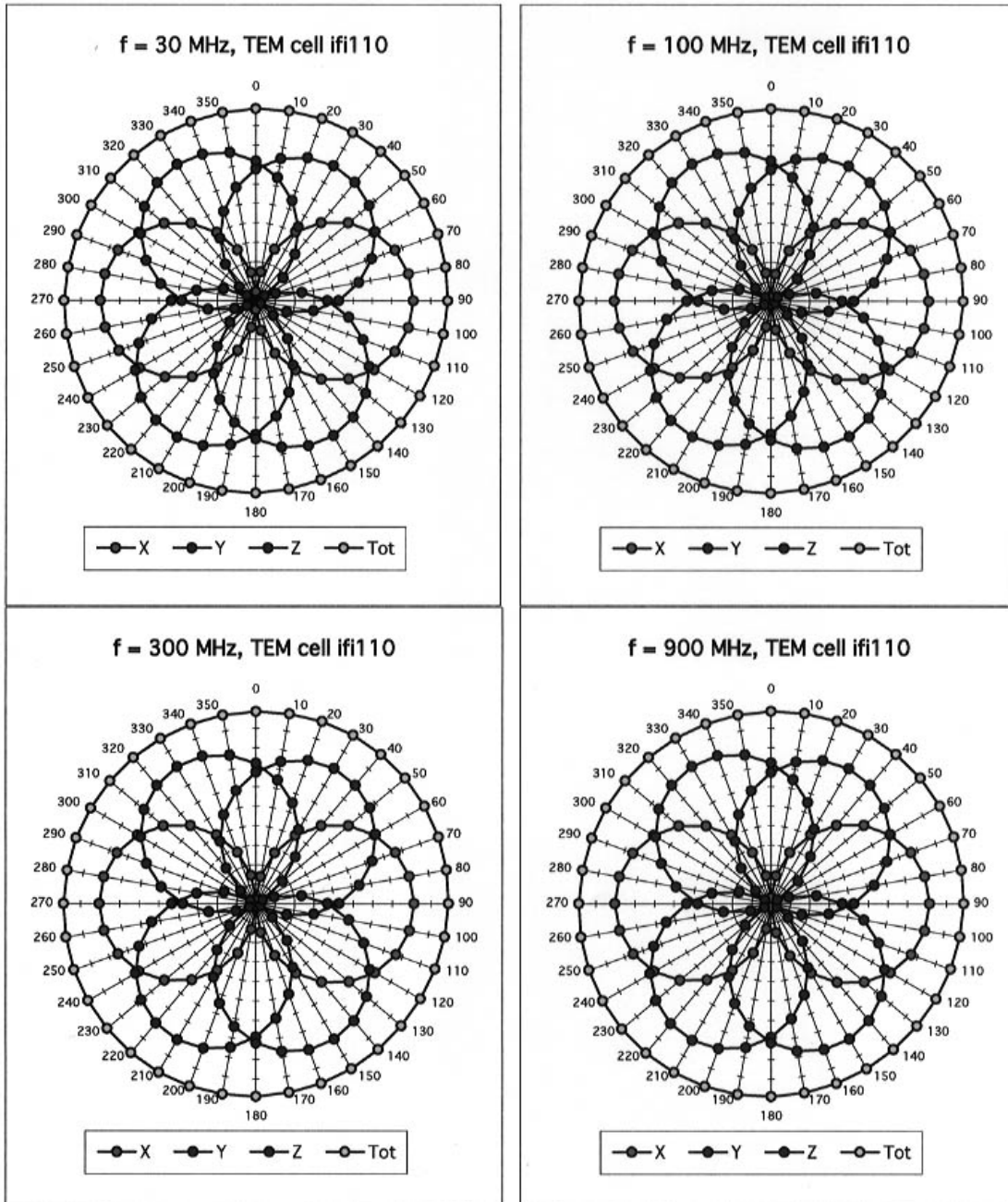
Sensor Offset

Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.7 $\pm$ 0.2	mm

ET3DV6 SN:1798

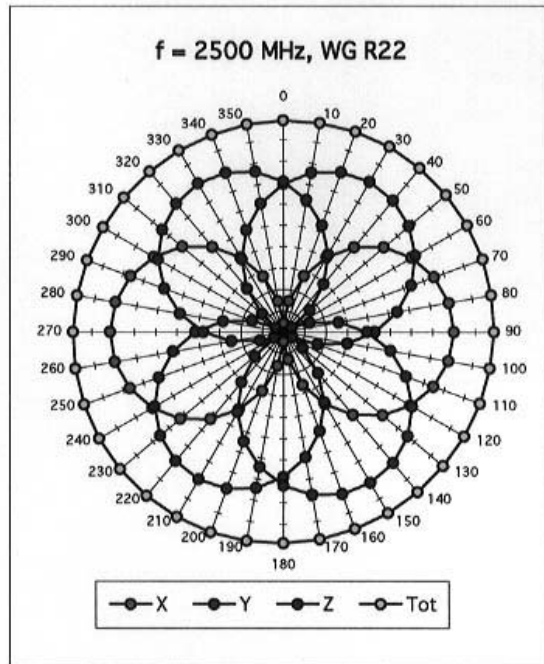
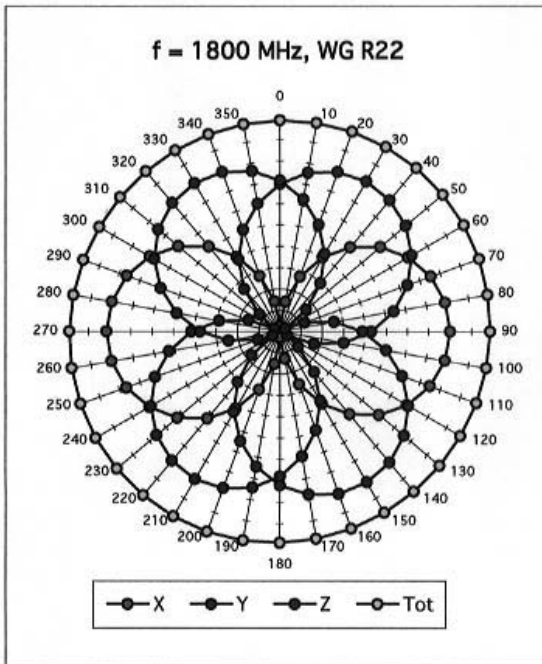
October 7, 2003

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

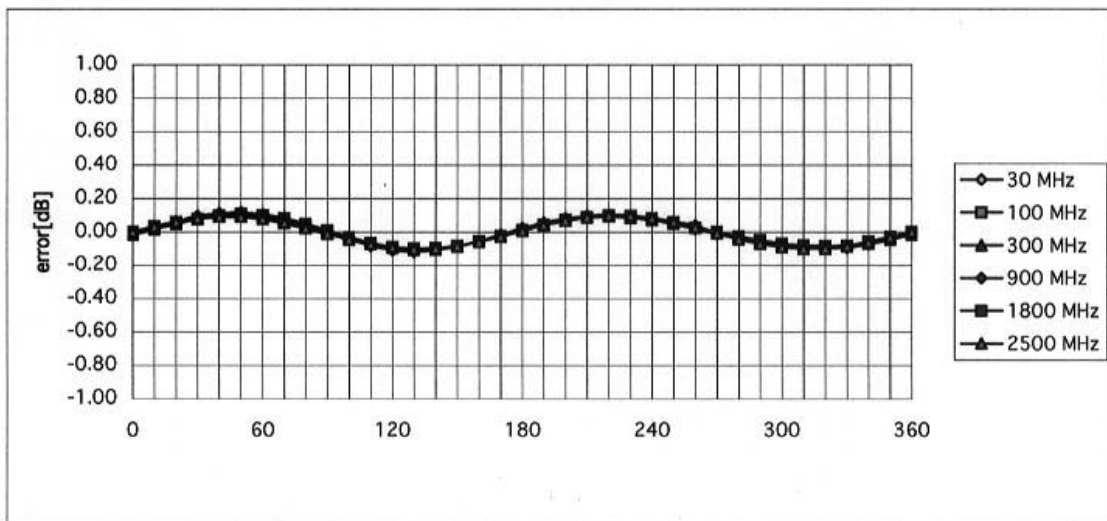


ET3DV6 SN:1798

October 7, 2003



Isotropy Error (ϕ), $\theta = 0^\circ$

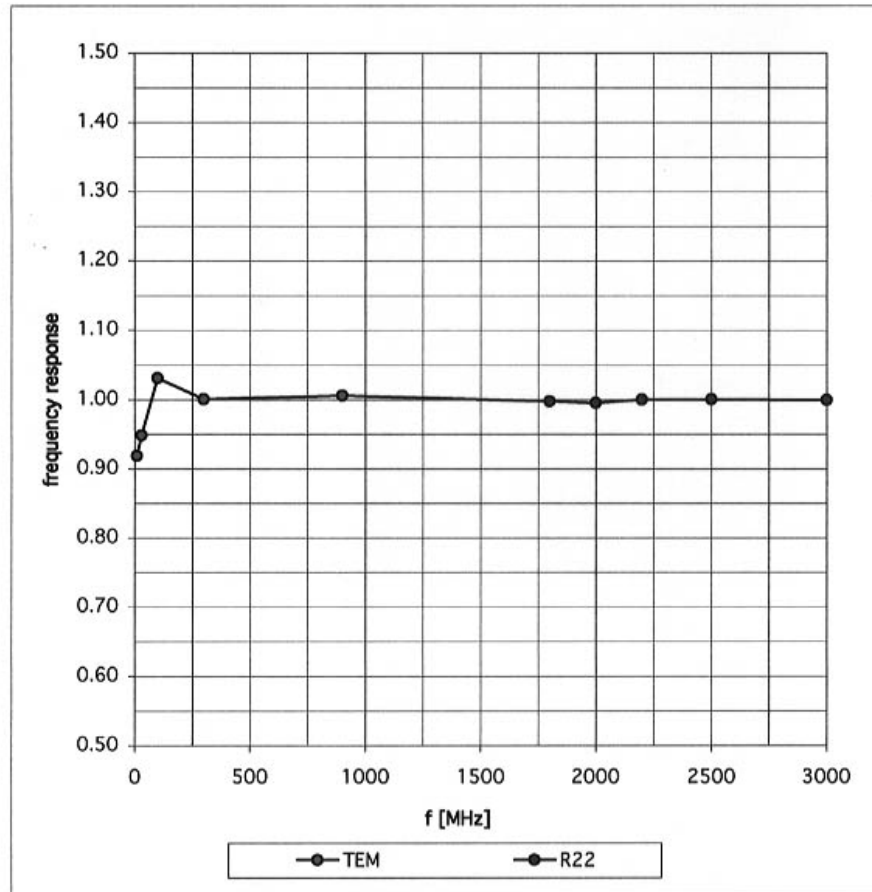


ET3DV6 SN:1798

October 7, 2003

Frequency Response of E-Field

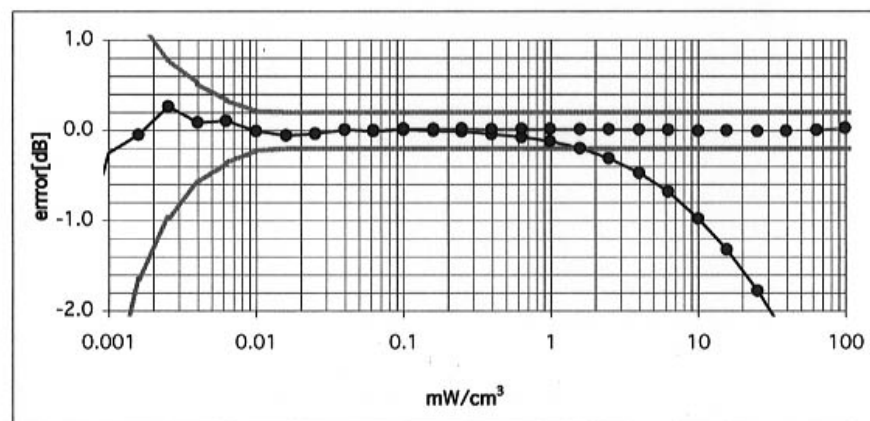
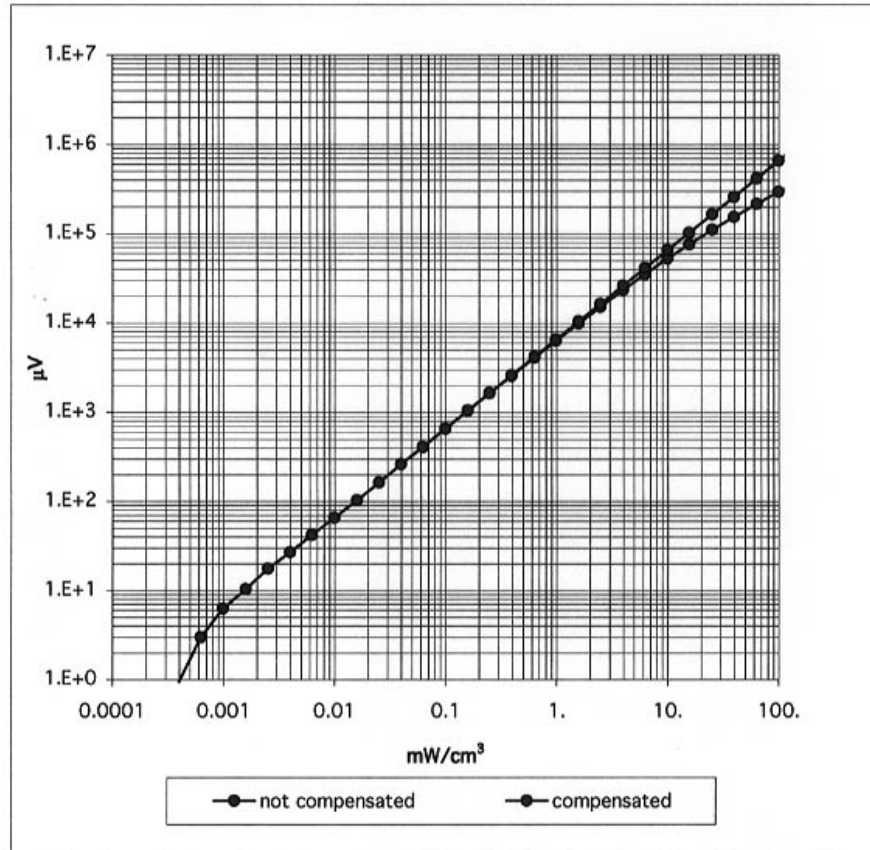
(TEM-Cell:ifi110, Waveguide R22)



ET3DV6 SN:1798

October 7, 2003

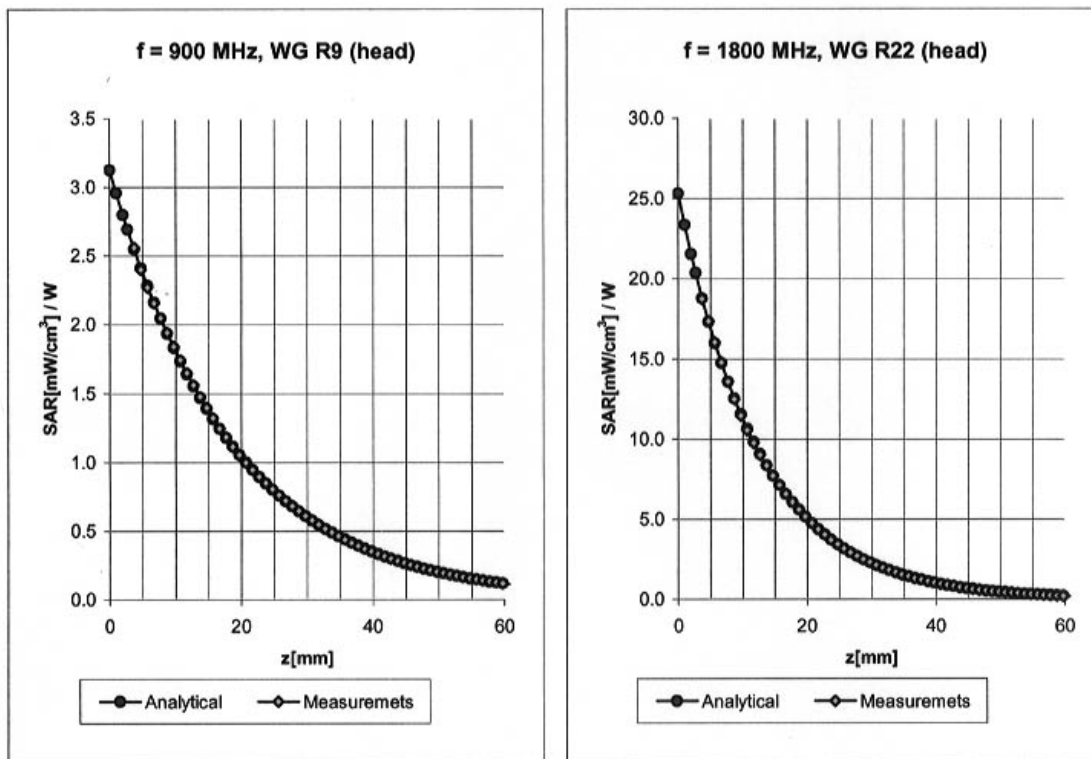
Dynamic Range f(SARhead) (Waveguide R22)



ET3DV6 SN:1798

October 7, 2003

Conversion Factor Assessment



Head 900 MHz $\epsilon_r = 41.5 \pm 5\%$ $\sigma = 0.97 \pm 5\%$ mho/m

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

ConvF X	$6.6 \pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	$6.6 \pm 9.5\%$ (k=2)	Alpha	0.29
ConvF Z	$6.6 \pm 9.5\%$ (k=2)	Depth	3.00

Head 1800 MHz $\epsilon_r = 40.0 \pm 5\%$ $\sigma = 1.40 \pm 5\%$ mho/m

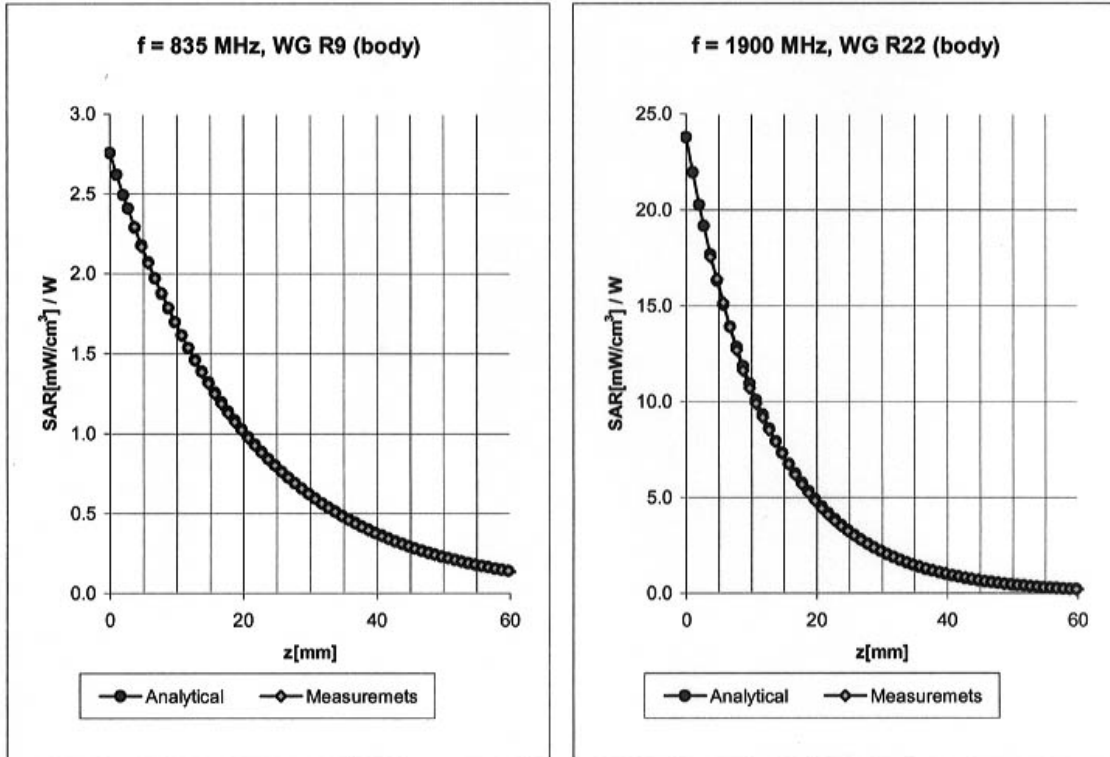
Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	$5.2 \pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	$5.2 \pm 9.5\%$ (k=2)	Alpha	0.44
ConvF Z	$5.2 \pm 9.5\%$ (k=2)	Depth	2.78

ET3DV6 SN:1798

October 7, 2003

Conversion Factor Assessment



Body 835 MHz $\epsilon_r = 55.2 \pm 5\%$ $\sigma = 0.97 \pm 5\%$ mho/m

Valid for f=750-950 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	6.3 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	6.3 $\pm 9.5\%$ (k=2)	Alpha	0.37
ConvF Z	6.3 $\pm 9.5\%$ (k=2)	Depth	2.50

Body 1900 MHz $\epsilon_r = 53.3 \pm 5\%$ $\sigma = 1.52 \pm 5\%$ mho/m

Valid for f=1800-2000 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

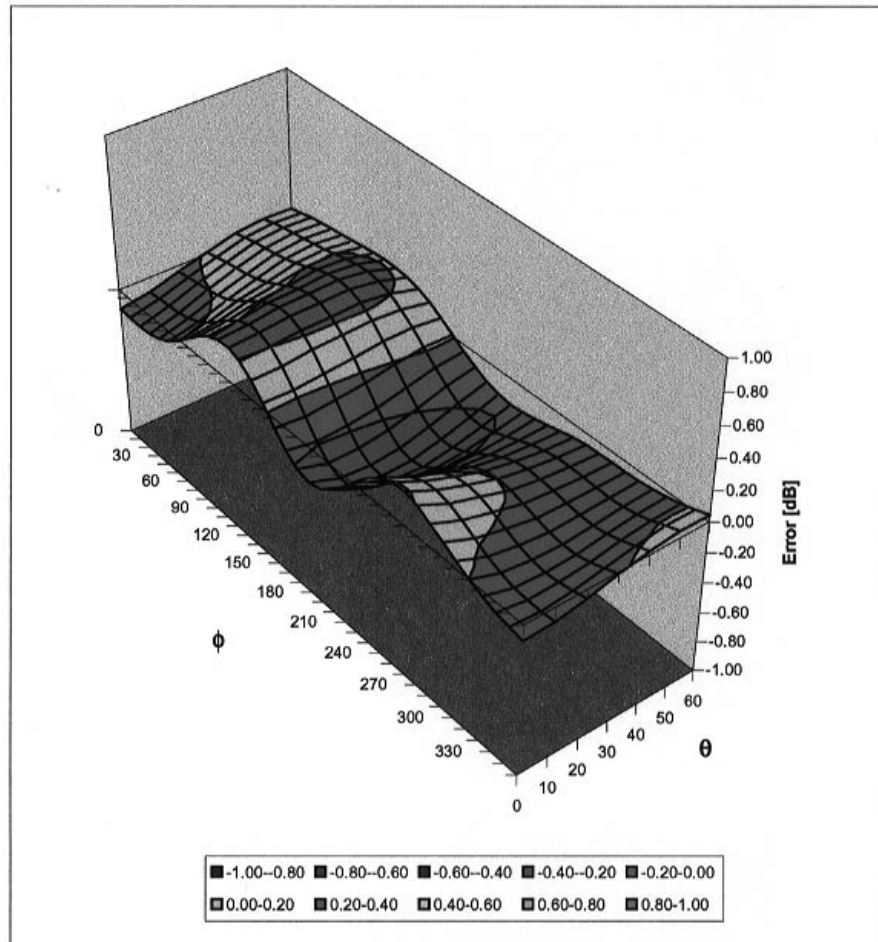
ConvF X	4.7 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	4.7 $\pm 9.5\%$ (k=2)	Alpha	0.58
ConvF Z	4.7 $\pm 9.5\%$ (k=2)	Depth	2.58

ET3DV6 SN:1798

October 7, 2003

Deviation from Isotropy in HSL

Error (θ, ϕ), $f = 900$ MHz



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Additional Conversion Factors

for Dosimetric E-Field Probe

Type:

ET3DV6

Serial Number:

1798

Place of Assessment:

Zurich

Date of Assessment:

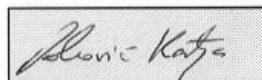
October 9, 2003

Probe Calibration Date:

October 7, 2003

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. Since the evaluation is coupled with measured conversion factors, it has to be recalculated yearly, i.e., following the re-calibration schedule of the probe. The uncertainty of the numerical assessment is based on the extrapolation from measured value at 900 MHz or at 1800 MHz.

Assessed by:



ET3DV6-SN:1798

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October 9, 2003

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Dosimetric E-Field Probe ET3DV6 SN:1798Conversion factor ($\pm$ standard deviation)450 MHz ConvF $7.5 \pm 8\%$

$\epsilon_r = 43.5 \pm 5\%$ $\sigma = 0.87 \pm 5\% \text{ mho/m}$ (head tissue)

450 MHz ConvF $7.6 \pm 8\%$

$\epsilon_r = 56.7 \pm 5\%$ $\sigma = 0.94 \pm 5\% \text{ mho/m}$ (body tissue)

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

Client **Hanwha (Dymstec)**

CALIBRATION CERTIFICATE

Object(s) **ET3DV6 - SN:1607**

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

Calibration date: **April 28, 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 E442	GB37480704	6-Nov-03 (METAS, No. 252-0254)	Nov-04
Power sensor HP 8481A	US37292783	6-Nov-03 (METAS, No. 252-0254)	Nov-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:	Nico Vetterli	Technician	
Approved by:	Katja Pokovic	Laboratory Director	

Date issued: April 28, 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 ET3DV6

SN:1607

Manufactured:	July 27, 2001
Last calibrated:	August 7, 2001
Recalibrated:	April 28, 2004

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

ET3DV6 SN:1607

April 28, 2004

DASY - Parameters of Probe: ET3DV6 SN:1607

Sensitivity in Free Space

NormX	1.74 $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	1.80 $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	1.74 $\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression^A

DCP X	90	mV
DCP Y	90	mV
DCP Z	90	mV

Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 7.

Boundary Effect

Head 900 MHz Typical SAR gradient: 5 % per mm

Sensor Center to Phantom Surface Distance	3.7 mm	4.7 mm
SAR _{be} [%] Without Correction Algorithm	8.8	4.4
SAR _{be} [%] With Correction Algorithm	0.0	0.1

Head 1800 MHz Typical SAR gradient: 10 % per mm

Sensor Center to Phantom Surface Distance	3.7 mm	4.7 mm
SAR _{be} [%] Without Correction Algorithm	14.5	9.8
SAR _{be} [%] With Correction Algorithm	0.2	0.2

Sensor Offset

Probe Tip to Sensor Center	2.7 mm
Optical Surface Detection	in tolerance

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%.

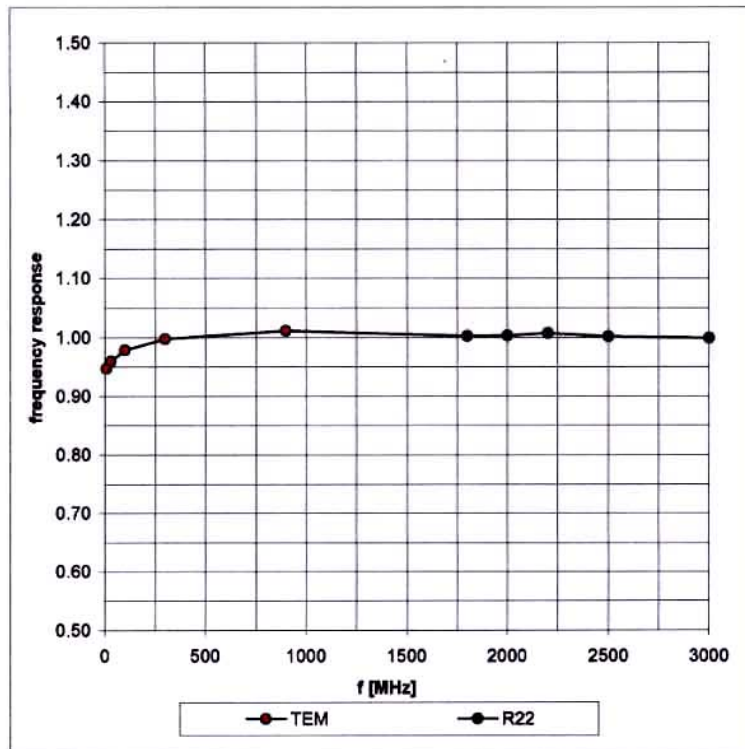
^A numerical linearization parameter: uncertainty not required

ET3DV6 SN:1607

April 28, 2004

Frequency Response of E-Field

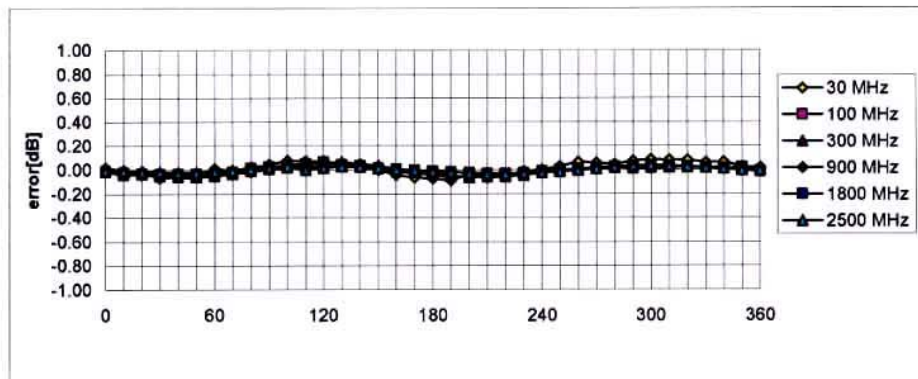
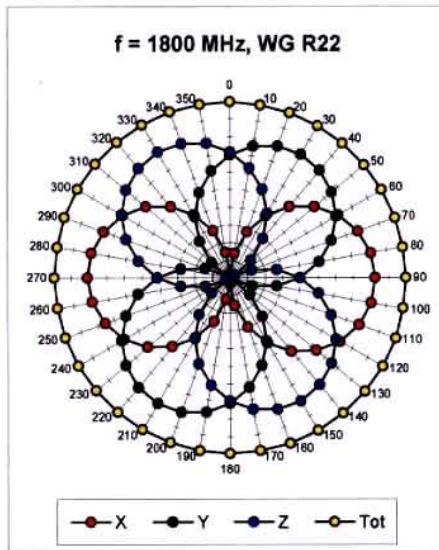
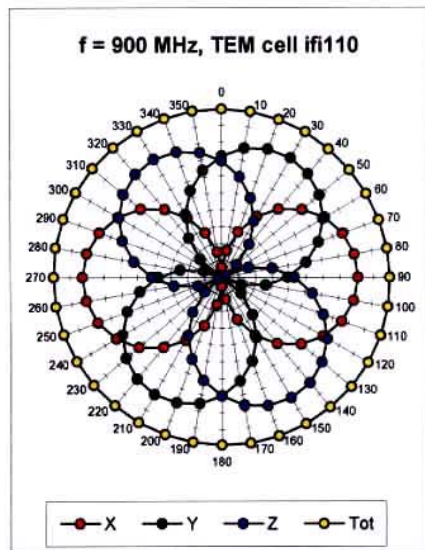
(TEM-Cell:ifi1110, Waveguide R22)



ET3DV6 SN:1607

April 28, 2004

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

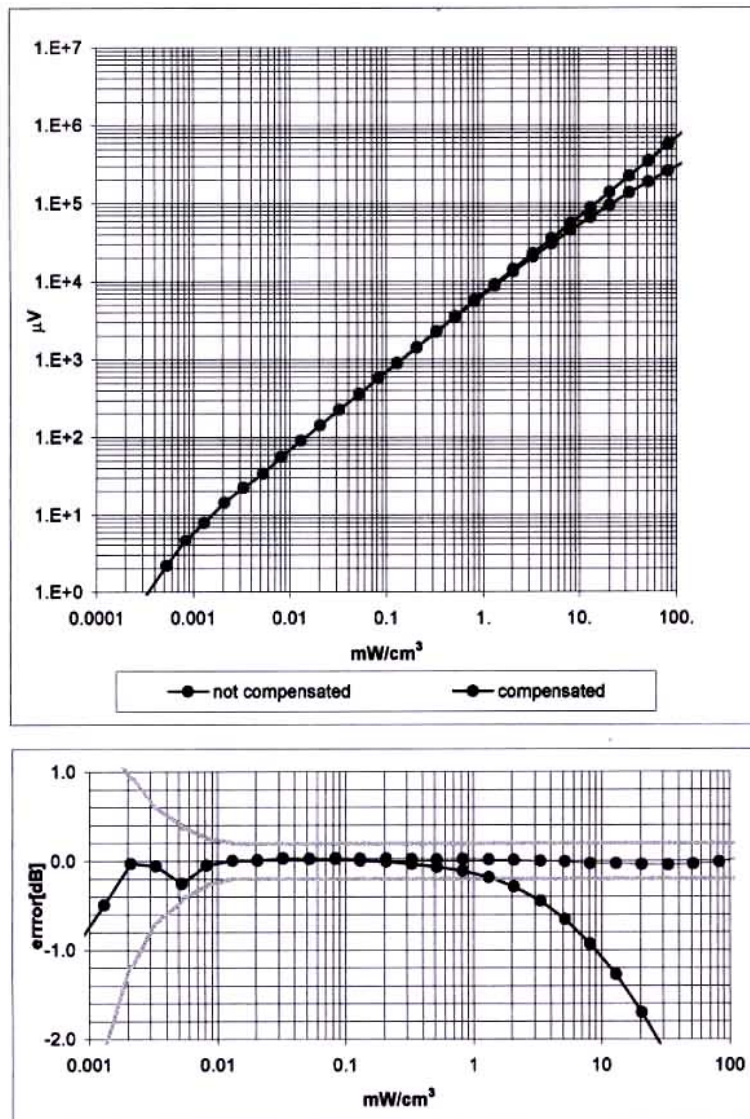


Axial Isotropy Error $< \pm 0.2$ dB

ET3DV6 SN:1607

April 28, 2004

Dynamic Range f(SAR_{head}) (Waveguide R22)

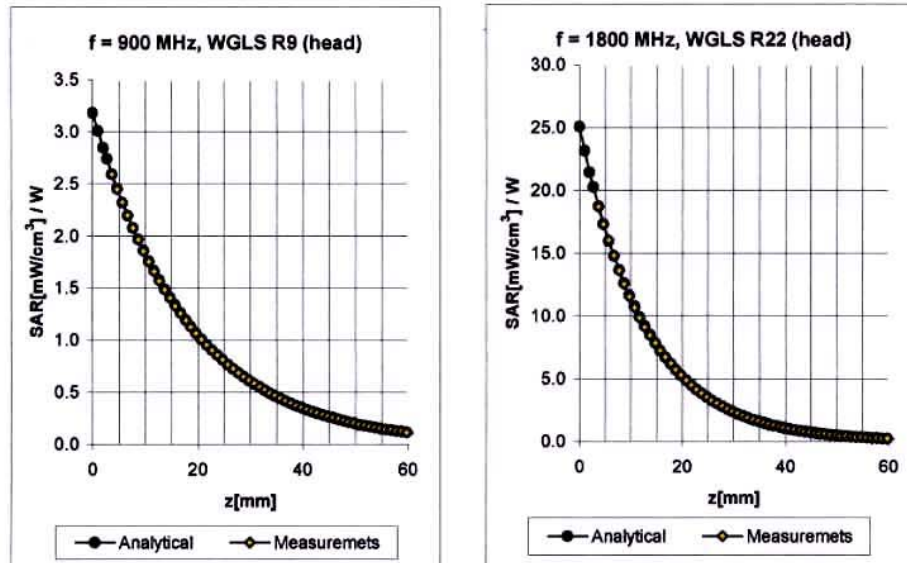


Probe Linearity < ± 0.2 dB

ET3DV6 SN:1607

April 28, 2004

Conversion Factor Assessment



f [MHz]	Validity [MHz] ^B	Tissue	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
900	800-1000	Head	41.5 ± 5%	0.97 ± 5%	0.81	1.60	6.22 ± 11.3% (k=2)
1800	1710-1910	Head	40.0 ± 5%	1.40 ± 5%	0.53	2.60	5.10 ± 11.7% (k=2)
835	750-950	Body	55.2 ± 5%	0.97 ± 5%	0.62	1.90	6.26 ± 11.9% (k=2)
1900	1800-2000	Body	53.3 ± 5%	1.52 ± 5%	0.63	2.67	4.54 ± 11.3% (k=2)

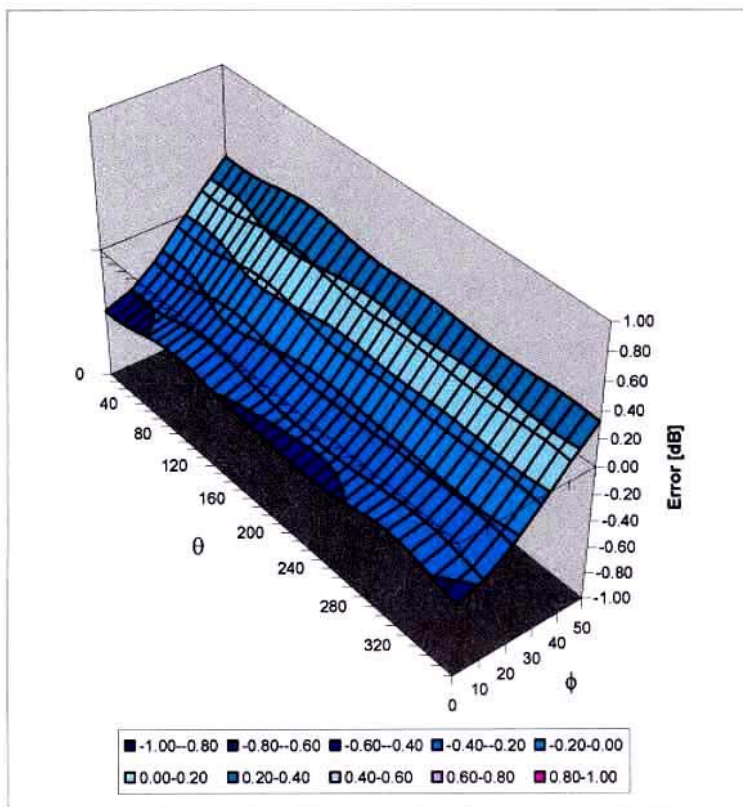
^B The total standard uncertainty is calculated as root-sum-square of standard uncertainty of the Conversion Factor at calibration frequency and the standard uncertainty for the indicated frequency band.

ET3DV6 SN:1607

April 28, 2004

Deviation from Isotropy in HSL

Error (θ, ϕ), $f = 900$ MHz



Spherical Isotropy Error < ± 0.4 dB

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Additional Conversion Factors

for Dosimetric E-Field Probe

Type:

ET3DV6

Serial Number:

1607

Place of Assessment:

Zurich

Date of Assessment:

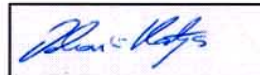
May 1, 2004

Probe Calibration Date:

April 28, 2004

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. Since the evaluation is coupled with measured conversion factors, it has to be recalculated yearly, i.e., following the re-calibration schedule of the probe. The uncertainty of the numerical assessment is based on the extrapolation from measured value at 900 MHz or at 1800 MHz.

Assessed by:



ET3DV6-SN:1607

Page 1 of 2

May 1, 2004

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Dosimetric E-Field Probe ET3DV6 SN:1607Conversion factor ($\pm$ standard deviation)450 MHz ConvF $7.3 \pm 8\%$

$\epsilon_r = 43.5 \pm 5\%$
 $\sigma = 0.87 \pm 5\%$ mho/m
(head tissue)

450 MHz ConvF $7.1 \pm 8\%$

$\epsilon_r = 56.7 \pm 5\%$
 $\sigma = 0.94 \pm 5\%$ mho/m
(body tissue)

Important Note:

For numerically assessed probe conversion factors, parameters Alpha and Delta in the DASY software must have the following entries: Alpha = 0 and Delta = 1.

Please see also Section 4.7 of the DASY4 Manual.