Deutscher Akkreditierungs Rat

TTI-P-G 158

Appendix for the Report

Dosimetric Assessment of the MSA EVOLUTION 5000 Transmitter

According to the FCC Requirements

Calibration Data

November 13, 2003

IMST GmbH
Carl-Friedrich-Gauß-Str. 2
D-47475 Kamp-Lintfort

Customer
MSA AUER
Thielemannstraße 1
12059 Berlin
Germany

Schmid & Partner
Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

Calibration Certificate

2450 MHz System Validation Dipole

Type:	**D2450V2**
Serial Number:	**709**
Place of Calibration:	**Zurich**
Date of Calibration:	**July 15, 2002**
Calibration Interval:	**24 months**

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

Calibrated by:	D. Vetter
Approved by:	Marie Katja

Schmid & Partner
Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

DASY3

Dipole Validation Kit

Type: D2450V2

Serial: 709

Manufactured: July 5, 2002
Calibrated: July 15, 2002

1. Measurement Conditions

The measurements were performed in the flat section of the new SAM twin phantom filled with head simulating solution of the following electrical parameters at 2450 MHz:

Relative permitivity	**38.3**	± 5%
Conductivity	**1.90 mho/m**	± 10%

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.0 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 20mm was aligned with the dipole. The 5x5x7 fine cube was chosen for cube integration. Probe isotropy errors were cancelled by measuring the SAR with normal and 90° turned probe orientations and averaging.
The dipole input power (forward power) was 250mW ± 3 %. The results are normalized to 1W input power.

2.1. SAR Measurement with DASY3 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the worst-case extrapolation are:

averaged over 1 cm^3 (1 g) of tissue: **58.0 mW/g**

averaged over 10 cm^3 (10 g) of tissue: **26.7 mW/g**

2.2 SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue: **54.8 mW/g**

averaged over 10 cm^3 (10 g) of tissue: **25.5 mW/g**

3. Dipole impedance and return loss

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	**1.159 ns**	(one direction)
Transmission factor:	**0.992**	(voltage transmission, one direction)

The dipole was positioned at the flat phantom sections according to section 1 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 2450 MHz:	Re{Z} = **51.6 Ω**
	Im {Z} = **1.7 Ω**
Return Loss at 2450 MHz	**- 33.0 dB**

4. Measurement Conditions

The measurements were performed in the flat section of the new SAM twin phantom filled with body simulating solution of the following electrical parameters at 2450 MHz:

Relative permitivity	**51.7**	± 5%
Conductivity	**2.01 mho/m**	± 10%

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 4.5 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 20mm was aligned with the dipole. The 5x5x7 fine cube was chosen for cube integration. Probe isotropy errors were cancelled by measuring the SAR with normal and 90° turned probe orientations and averaging.
The dipole input power (forward power) was 250mW ± 3 %. The results are normalized to 1W input power.

5.1. SAR Measurement with DASY3 System

Standard SAR-measurements were performed according to the measurement conditions described in section 4. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the worst-case extrapolation are:

averaged over 1 cm^3 (1 g) of tissue: **57.6 mW/g**

averaged over 10 cm^3 (10 g) of tissue: **26.8 mW/g**

5.2 SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 4. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue: **52.0 mW/g**

averaged over 10 cm^3 (10 g) of tissue: **25.0 mW/g**

6. Dipole impedance and return loss

The dipole was positioned at the flat phantom sections according to section 4 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 2450 MHz: $Re\{Z\} =$ **47.6 Ω**

$Im\{Z\} =$ **2.8 Ω**

Return Loss at 2450 MHz **- 28.5**

7. Handling

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

8. Design

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.

Small end caps have been added to the dipole arms in order to improve matching when loaded according to the position as explained in Section 1. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

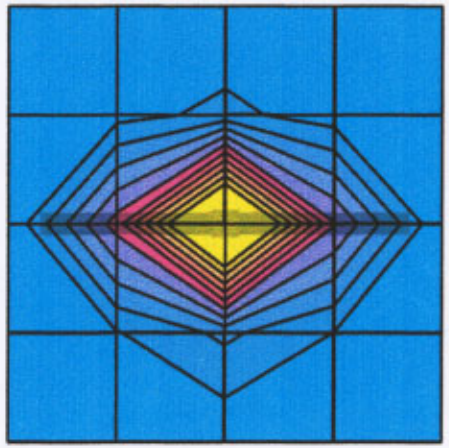
9. Power Test

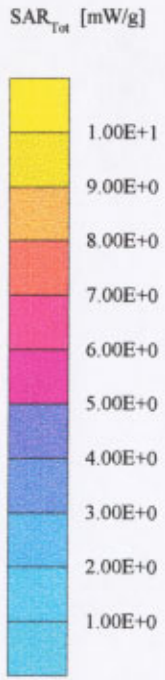
After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

07/10/02

Validation Dipole D2450V2 SN709, d = 10 mm

Frequency: 2450 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(5.00,5.00,5.00) at 2450 MHz; IEEE1528 2450 MHz: σ = 1.90 mho/m ε_r = 38.3 ρ = 1.00 g/cm³
Cubes (2): Peak: 29.8 mW/g ± 0.03 dB, SAR (1g): 14.5 mW/g ± 0.03 dB, SAR (10g): 6.68 mW/g ± 0.02 dB, (Worst-case extrapolation)
Penetration depth: 6.5 (6.3, 6.9) [mm]
Powerdrift: 0.01 dB

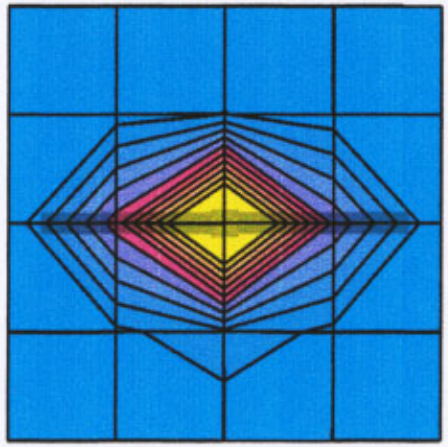


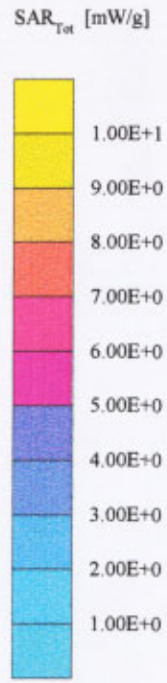


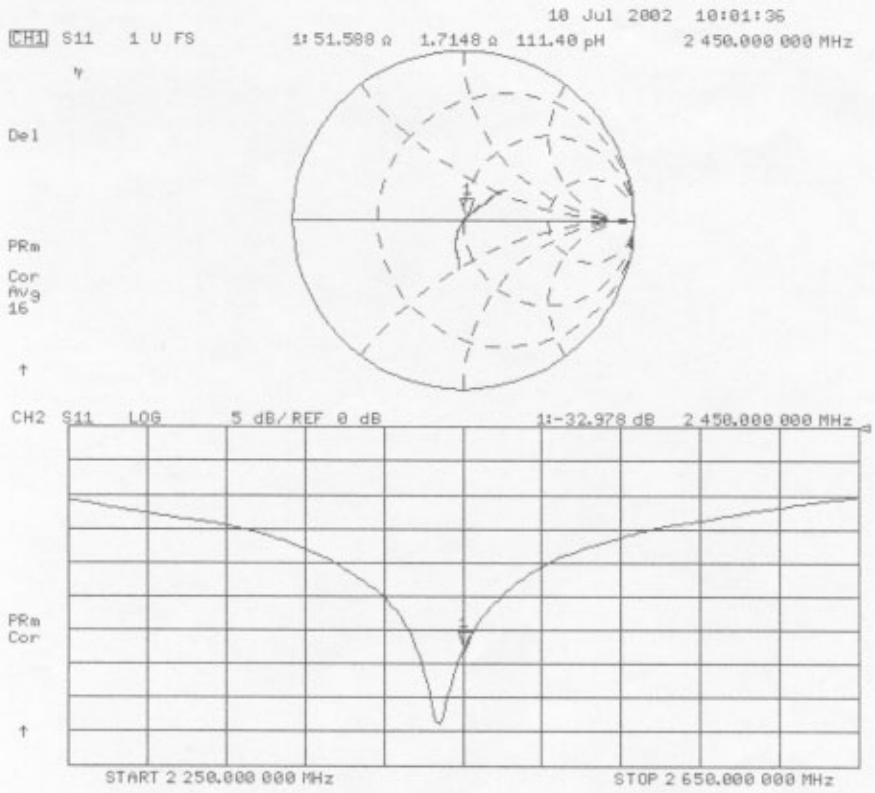
07/15/02

Validation Dipole D2450V2 SN709, d = 10 mm

Frequency: 2450 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(4.50,4.50,4.50) at 2450 MHz; IEEE1528 2450 MHz: σ = 2.01 mho/m ε_r = 51.7 ρ = 1.00 g/cm^3
Cubes (2): Peak: 28.8 mW/g ± 0.02 dB, SAR (1g): 14.4 mW/g ± 0.02 dB, SAR (10g): 6.71 mW/g ± 0.01 dB, (Worst-case extrapolation)
Penetration depth: 7.2 (6.9, 7.9) [mm]
Powerdrift: 0.01 dB



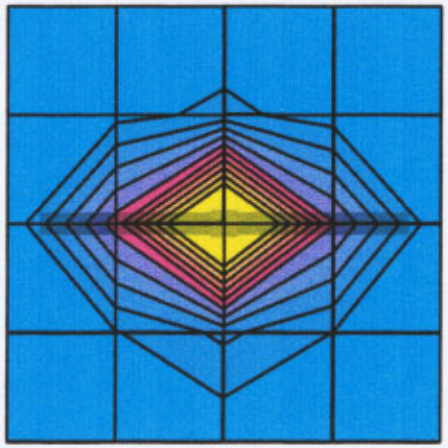


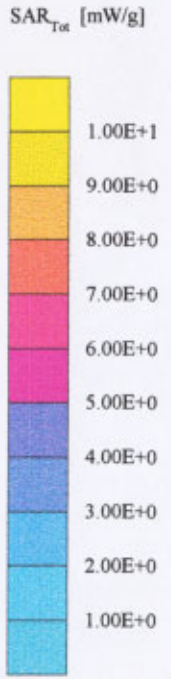

10 Jul 2002 10:01:36
CH1 S11 1 U FS
1: 51.588 Ω 1.7148 Ω 111.40 pH
2 450.000 000 MHz
Del
PRm
Cor
Avg
16
CH2 S11 LOG 5 dB/ REF 0 dB
1:-32.978 dB 2 450.000 000 MHz
PRm
Cor
START 2 250.000 000 MHz
STOP 2 650.000 000 MHz

07/10/02

Validation Dipole D2450V2 SN709, d = 10 mm

Frequency: 2450 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(5.00,5.00,5.00) at 2450 MHz; IEEE1528 2450 MHz: σ = 1.90 mho/m ε_r = 38.3 ρ = 1.00 g/cm^3
Cubes (2): Peak: 27.2 mW/g ± 0.03 dB, SAR (1g): 13.7 mW/g ± 0.03 dB, SAR (10g): 6.38 mW/g ± 0.02 dB, (Advanced extrapolation)
Penetration depth: 6.8 (6.6, 7.0) [mm]
Powerdrift: 0.01 dB

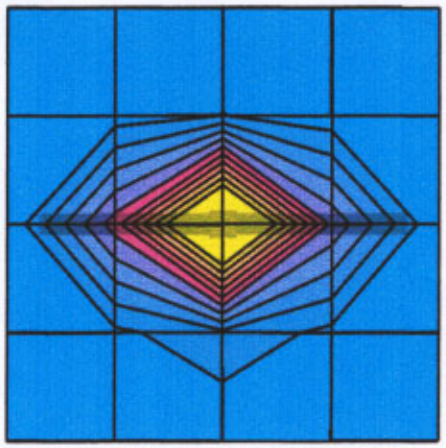


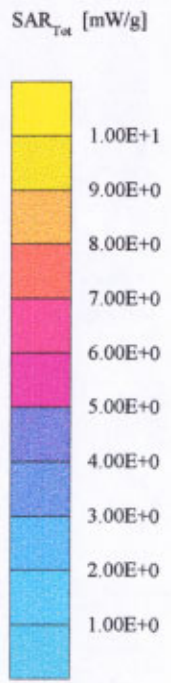


07/15/02

Validation Dipole D2450V2 SN709, d = 10 mm

Frequency: 2450 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(4.50,4.50,4.50) at 2450 MHz; IEEE1528 2450 MHz: σ = 2.01 mho/m ε_r = 51.7 ρ = 1.00 g/cm³
Cubes (2): Peak: 24.7 mW/g ± 0.02 dB, SAR (1g): 13.0 mW/g ± 0.02 dB, SAR (10g): 6.24 mW/g ± 0.01 dB, (Advanced extrapolation)
Penetration depth: 7.8 (7.7, 8.1) [mm]
Powerdrift: 0.01 dB

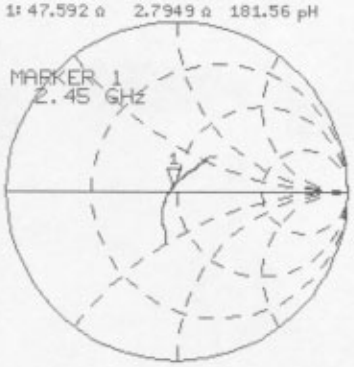




15 Jul 2002 09:44:33

CH1 S11 1 U FS 1: 47.592 Ω 2.7949 Ω 181.56 pH 2 450.000 000 MHz

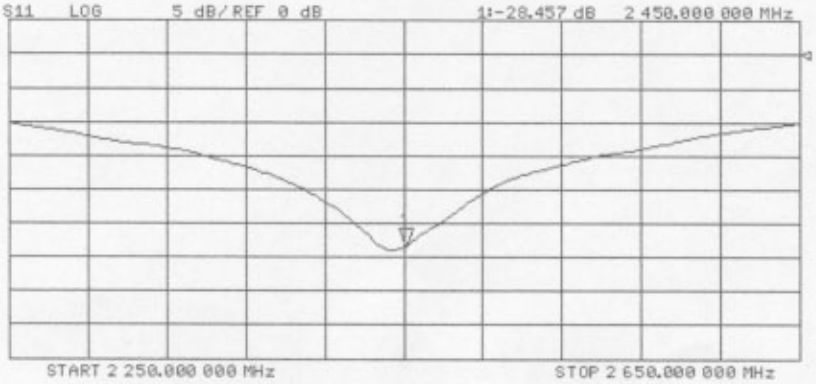
2450 Muscle



Del

PRm
Cor
Avg
16

CH2 S11 LOG 5 dB/ REF 0 dB 1: -28.457 dB 2 450.000 000 MHz



PRm
Cor

START 2 250.000 000 MHz STOP 2 650.000 000 MHz

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

Client **IMST**

CALIBRATION CERTIFICATE

Object(s)	ET3DV6 - SN:1579
Calibration procedure(s)	QA CAL-01.v2 Calibration procedure for dosimetric E-field probes
Calibration date:	May 15, 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
RF generator HP 8684C	US3642U01700	4-Aug-99 (SPEAG, in house check Aug-02)	In house check: Aug-05
Power sensor E4412A	MY41495277	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor HP 8481A	MY41092180	18-Sep-02 (Agilent, No. 20020918)	Sep-03
Power meter EPM E4419B	GB41293874	2-Apr-03 (METAS, No 252-0250)	Apr-04
Network Analyzer HP 8753E	US38432426	3-May-00 (Agilent, No. 8702K064602)	In house check: May 03
Fluke Process Calibrator Type 702	SN: 6295803	3-Sep-01 (ELCAL, No.2360)	Sep-03

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

Date issued: May 15, 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

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
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info@speag.com, http://www.speag.com

Probe ET3DV6

SN:1579

Manufactured:	May 7, 2001
Last calibration:	August 27, 2002
Recalibrated:	May 15, 2003

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ET3DV6 SN:1579

Sensitivity in Free Space

NormX	**1.65**	$\mu V/(V/m)^2$	DCP X	**94** mV
NormY	**1.59**	$\mu V/(V/m)^2$	DCP Y	**94** mV
NormZ	**1.58**	$\mu V/(V/m)^2$	DCP Z	**94** 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	**6.7** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.7** ± 9.5% (k=2)	Alpha	**0.34**
ConvF Z	**6.7** ± 9.5% (k=2)	Depth	**2.58**

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	**5.3** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.3** ± 9.5% (k=2)	Alpha	**0.45**
ConvF Z	**5.3** ± 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	9.2	5.3
SAR_{be} [%]	With Correction Algorithm	0.3	0.5

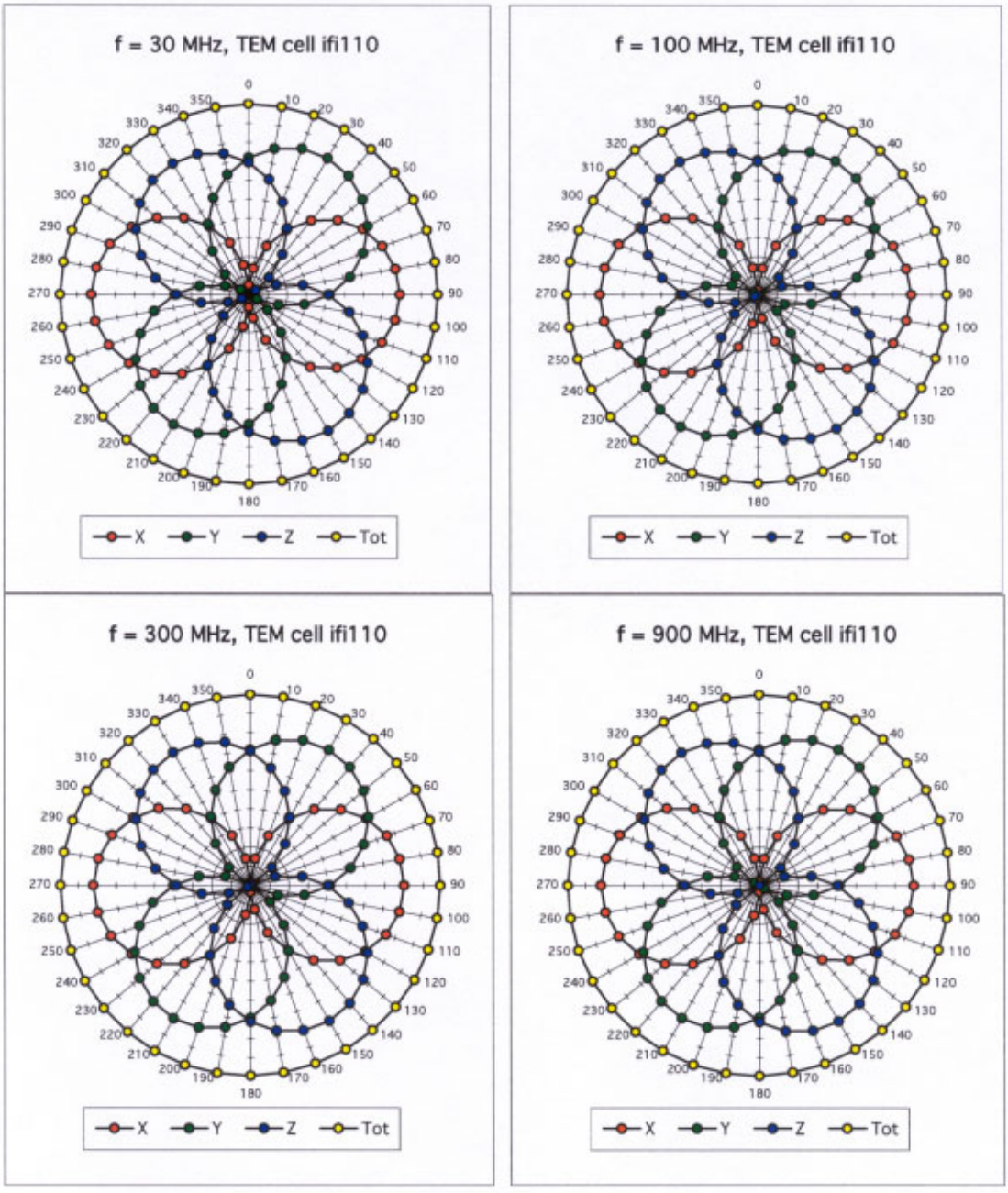
Head **1800 MHz** **Typical SAR gradient: 10 % per mm**

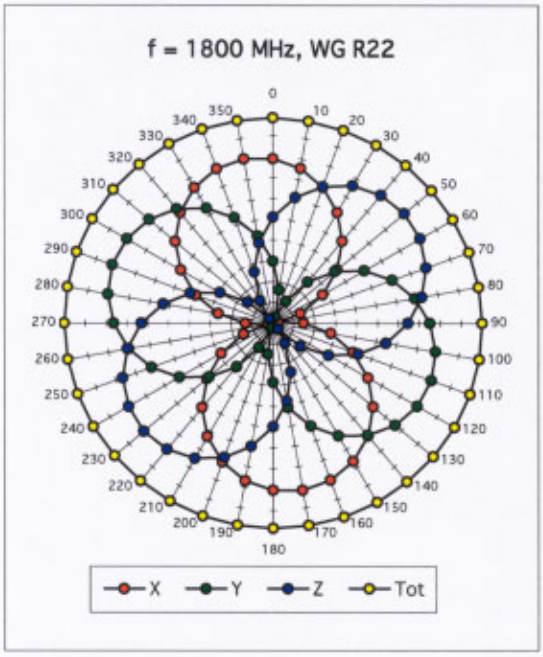
Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	13.2	9.3
SAR_{be} [%]	With Correction Algorithm	0.2	0.2

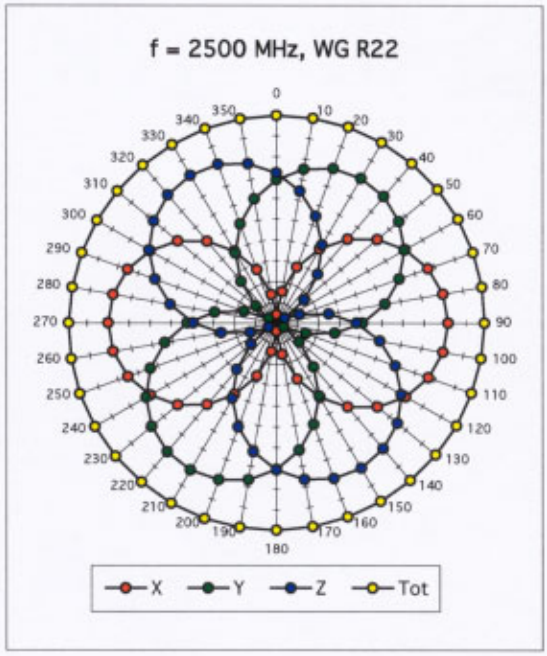
Sensor Offset

Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.1 ± 0.2**	mm

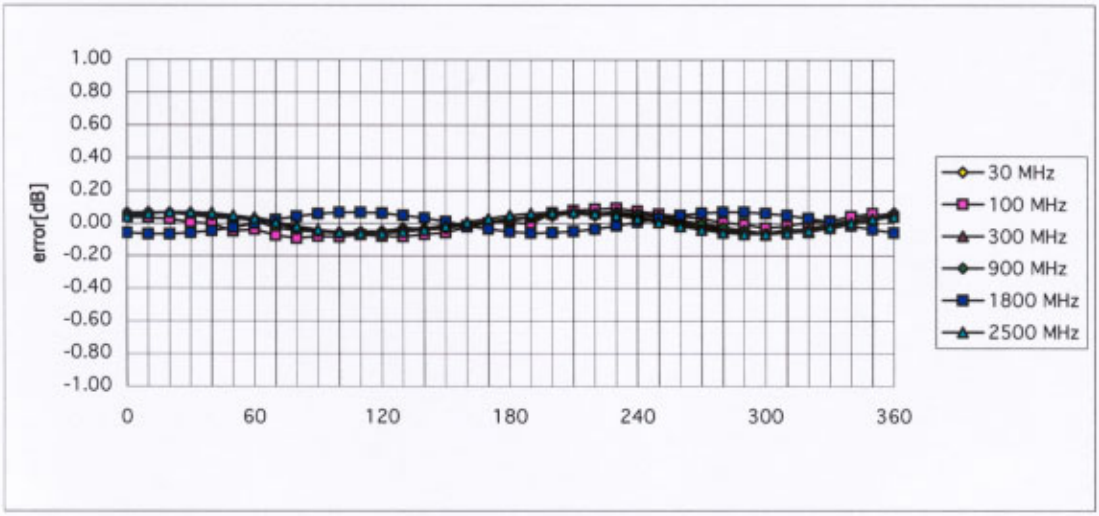
Receiving Pattern (ϕ), θ = 0°





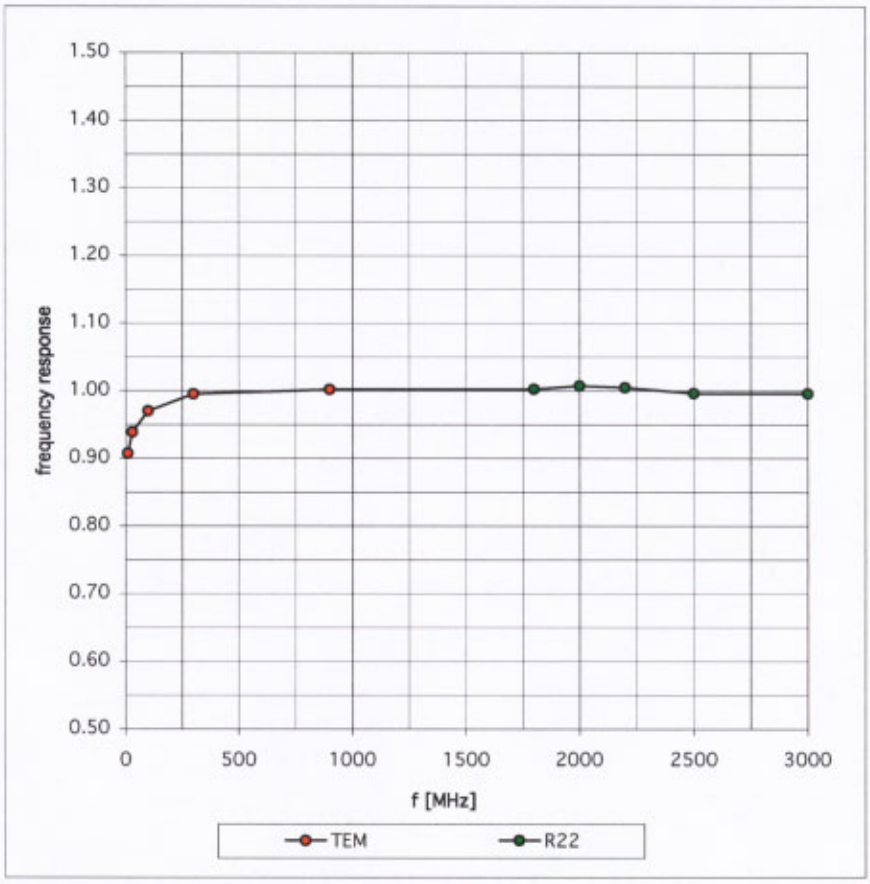


Isotropy Error (ϕ), θ = 0°



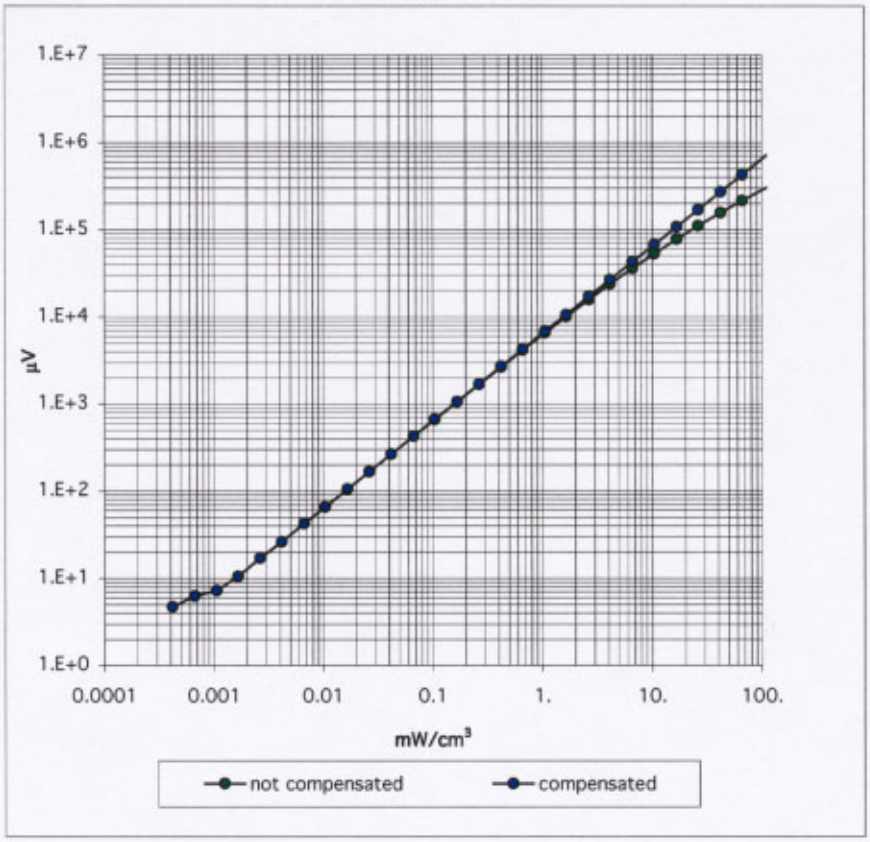
Frequency Response of E-Field

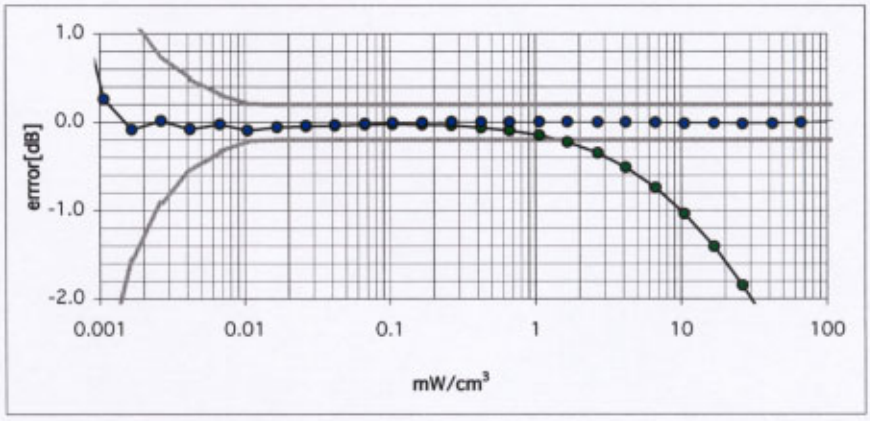
(TEM-Cell:ifi110, Waveguide R22)



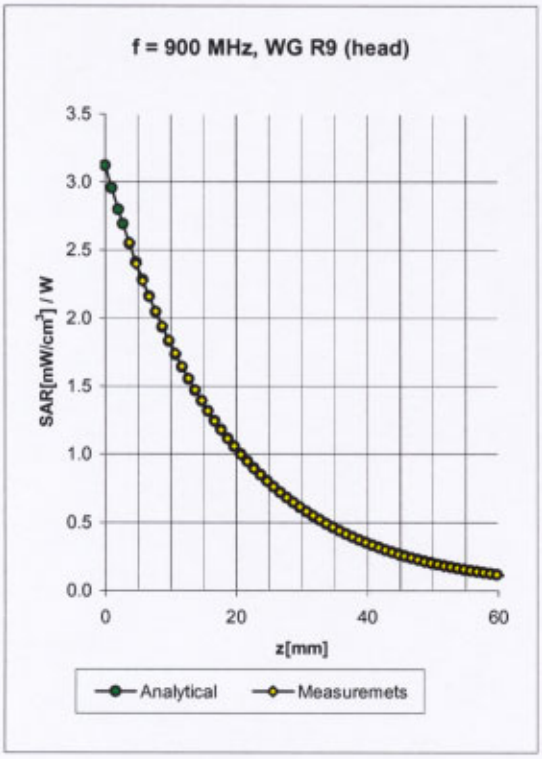
Dynamic Range f(SAR_{brain})

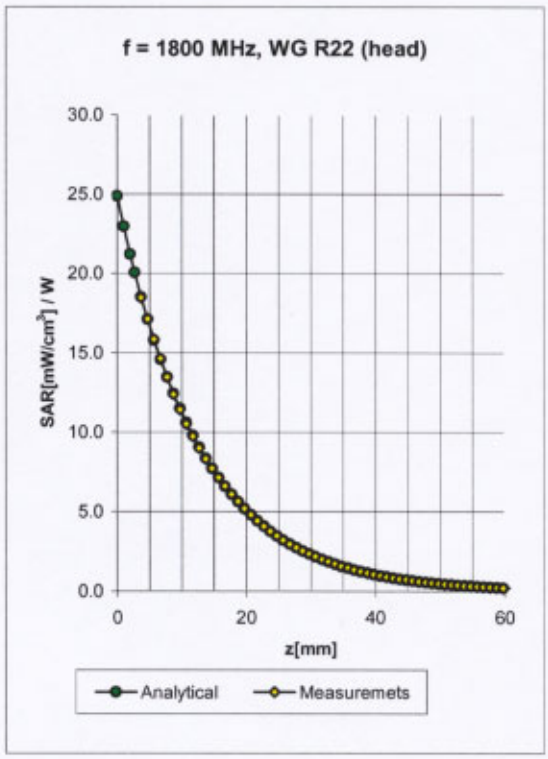
(Waveguide R22)





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

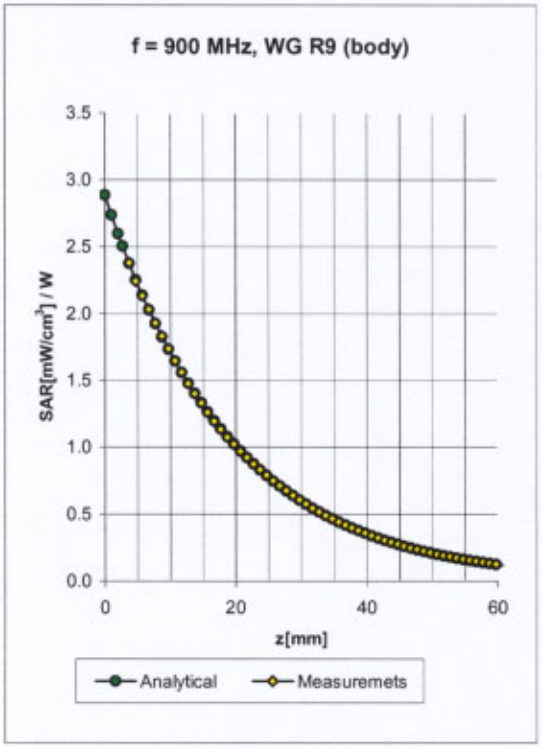
ConvF X	6.7 ± 9.5% (k=2)	Boundary effect:	
ConvF Y	6.7 ± 9.5% (k=2)	Alpha	**0.34**
ConvF Z	6.7 ± 9.5% (k=2)	Depth	**2.58**

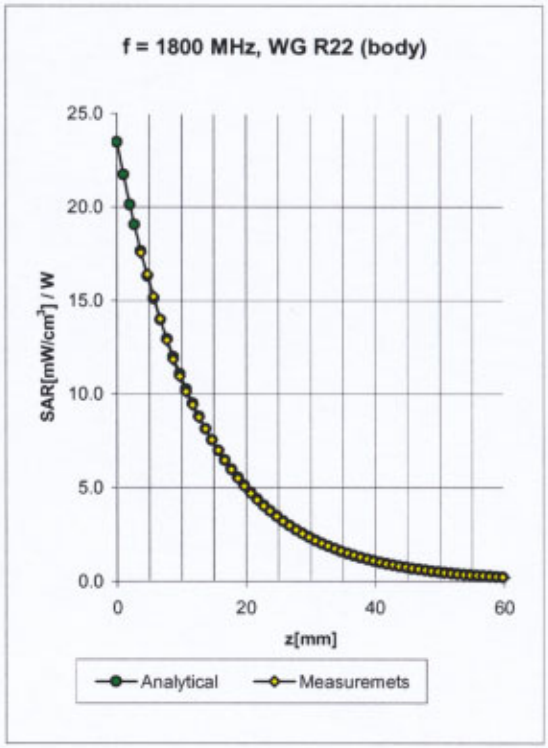
Head 1800 MHz ε_r = 40.0 ± 5% σ = 1.40 ± 5% mho/m

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

ConvF X	5.3 ± 9.5% (k=2)	Boundary effect:	
ConvF Y	5.3 ± 9.5% (k=2)	Alpha	**0.45**
ConvF Z	5.3 ± 9.5% (k=2)	Depth	**2.77**

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

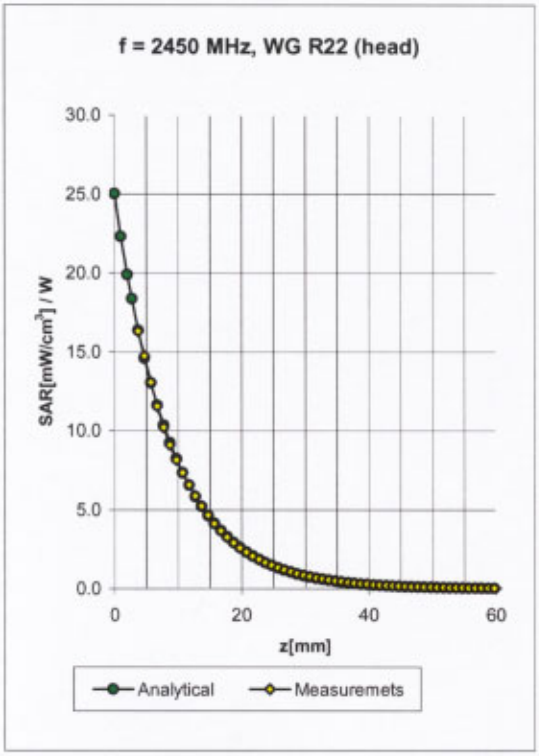
ConvF X	6.5 ± 9.5% (k=2)	Boundary effect:	
ConvF Y	6.5 ± 9.5% (k=2)	Alpha	0.37
ConvF Z	6.5 ± 9.5% (k=2)	Depth	2.52

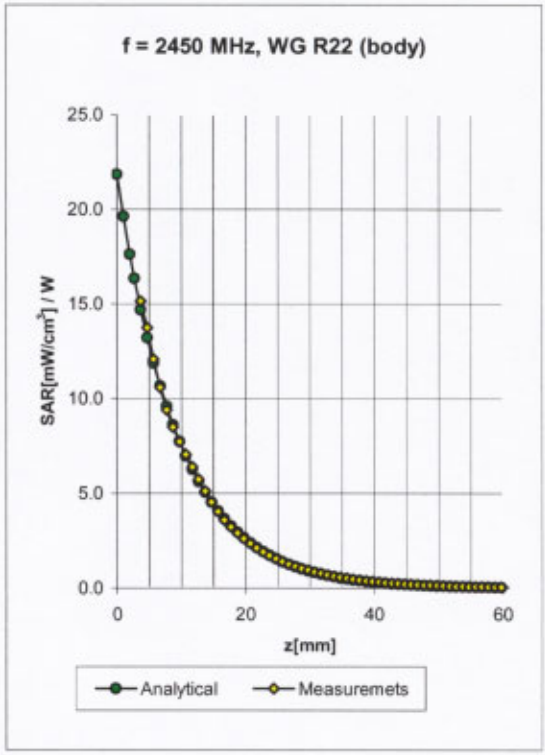
Body 1800 MHz ε_r = 53.3 ± 5% σ = 1.52 ± 5% mho/m

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

ConvF X	4.8 ± 9.5% (k=2)	Boundary effect:	
ConvF Y	4.8 ± 9.5% (k=2)	Alpha	0.53
ConvF Z	4.8 ± 9.5% (k=2)	Depth	2.66

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	4.8 ± 8.9% (k=2)	Boundary effect:	
ConvF Y	4.8 ± 8.9% (k=2)	Alpha	0.93
ConvF Z	4.8 ± 8.9% (k=2)	Depth	1.95

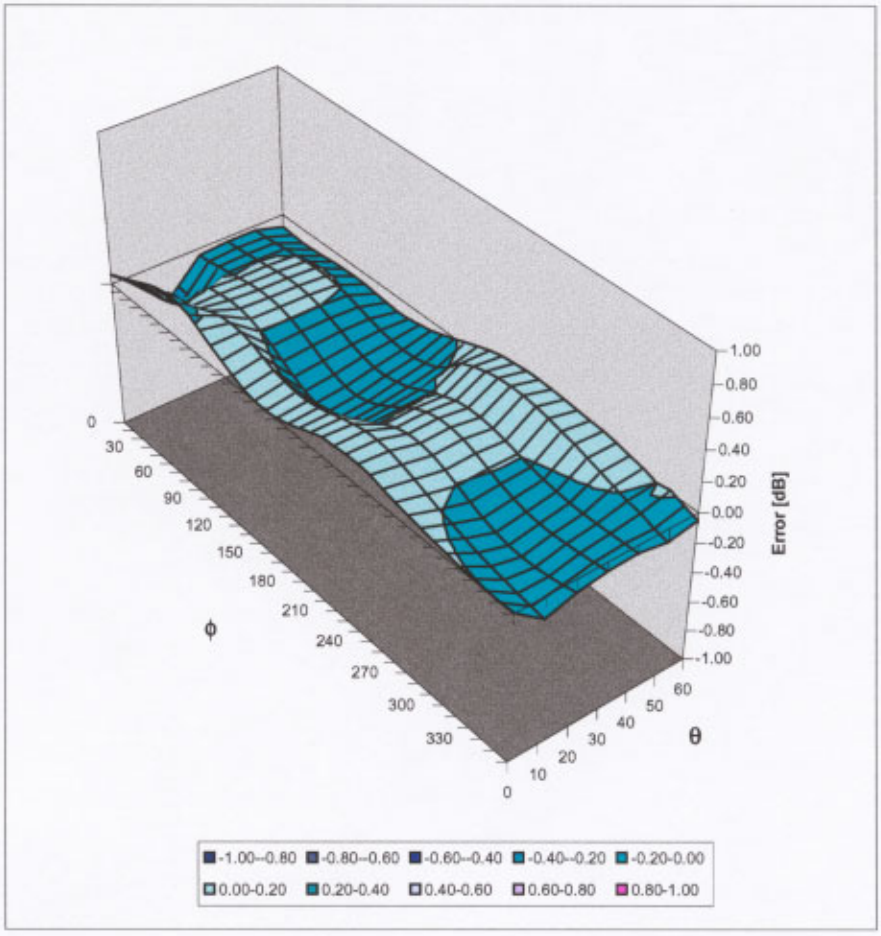
Body 2450 MHz ε_r = 52.7 ± 5% σ = 1.95 ± 5% mho/m

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

ConvF X	4.4 ± 8.9% (k=2)	Boundary effect:	
ConvF Y	4.4 ± 8.9% (k=2)	Alpha	1.35
ConvF Z	4.4 ± 8.9% (k=2)	Depth	1.50

Deviation from Isotropy in HSL

Error (θ,φ), f = 900 MHz



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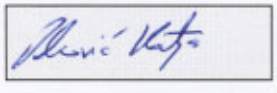
Additional Conversion Factors

for Dosimetric E-Field Probe

Type:	**ET3DV6**
Serial Number:	**1579**
Place of Assessment:	**Zurich**
Date of Assessment:	**May 19, 2003**
Probe Calibration Date:	**May 15, 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:



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Dosimetric E-Field Probe ET3DV6 SN:1579

Conversion factor (± standard deviation)

450 MHz	ConvF	**7.6 ± 8%**	ε_r = **43.5 ± 5%** σ = **0.87 ± 5% mho/m** (head tissue)
450 MHz	ConvF	**7.7 ± 8%**	ε_r = **56.7 ± 5%** σ = **0.94 ± 5% mho/m** (body tissue)