CALIBRATION DATA FROM RADIO FREQUENCY INVESTIGATION LTD.

Test of: Sendo Ltd.
Sendo X Tri Band Mobile Handset

(Body Measurements Only)

To: OET Bulletin 65 Supplement C: (2001-01)

Measurements were performed on the DASY4 System

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Calibration Data

This appendix contains the calibration data and certificates.

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A1185.

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

CHECKED 06/08/03

Client RFI

CALIBRATION CERTIFICATE

Object(s)	ET3DV6 - SN:1528
Calibration procedure(s)	QA CAL-01.v2 Calibration procedure for dosimetric E-field probes
Calibration date:	July 29, 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	US37390585	18-Oct-01 (Agilent, No. 24BR1033101)	In house check: Oct 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: July 29, 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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Phone +41 1 245 9700, Fax +41 1 245 9779
info@speag.com, http://www.speag.com

Probe ET3DV6

SN:1528

Manufactured:	March 21, 2000
Last calibration:	February 6, 2003
Recalibrated:	July 29, 2003

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ET3DV6 SN:1528

Sensitivity in Free Space

NormX	**1.51**	$\mu V/(V/m)^2$
NormY	**1.28**	$\mu V/(V/m)^2$
NormZ	**1.34**	$\mu V/(V/m)^2$

Diode Compression

DCP X	**99**	mV
DCP Y	**99**	mV
DCP Z	**99**	mV

Sensitivity in Tissue Simulating Liquid

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

Valid for f=855-945 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**6.3**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.3**	± 9.5% (k=2)	Alpha	**0.41**
ConvF Z	**6.3**	± 9.5% (k=2)	Depth	**2.46**

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

Valid for f=1710-1890 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**5.0**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.0**	± 9.5% (k=2)	Alpha	**0.51**
ConvF Z	**5.0**	± 9.5% (k=2)	Depth	**2.62**

Boundary Effect

Head **900 MHz** **Typical SAR gradient: 5 % per mm**

Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	10.2	6.0
SAR_{be} [%]	With Correction Algorithm	0.3	0.3

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

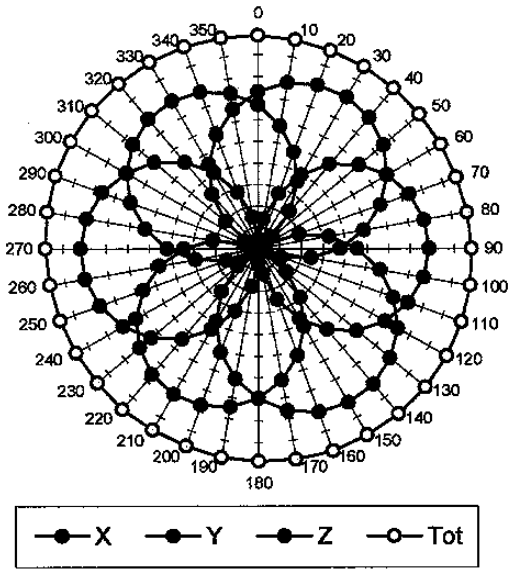
Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	13.9	9.2
SAR_{be} [%]	With Correction Algorithm	0.2	0.0

Sensor Offset

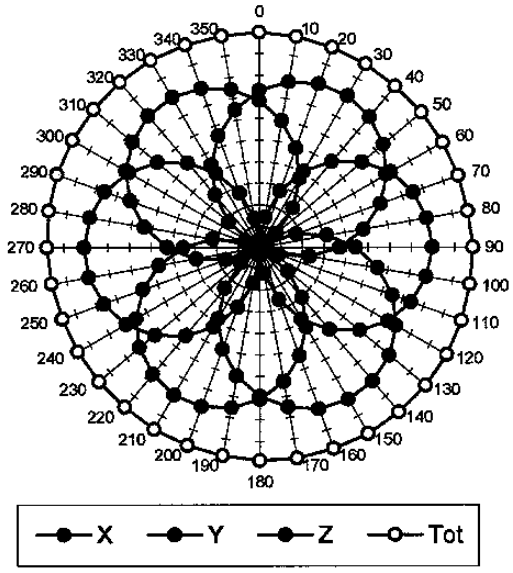
Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.6 ± 0.2**	mm

Receiving Pattern (ϕ , θ = 0°

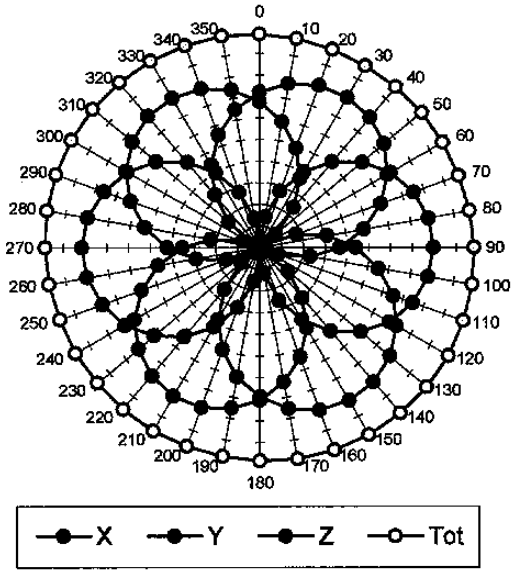
f = 30 MHz, TEM cell ifi110



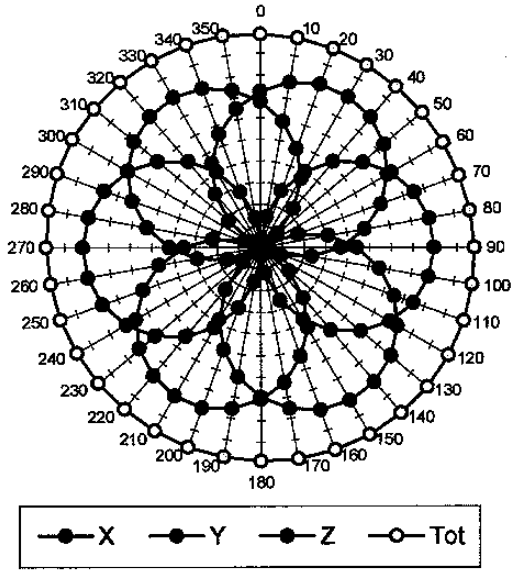
f = 100 MHz, TEM cell ifi110

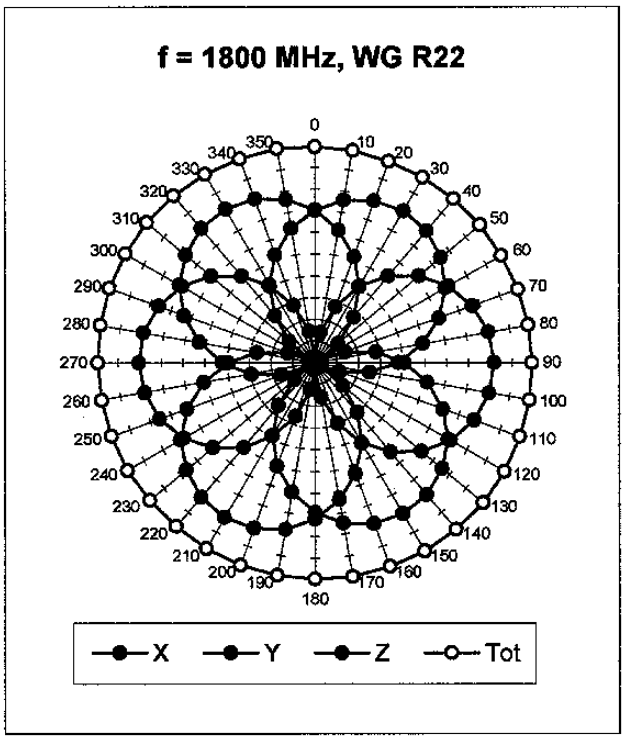


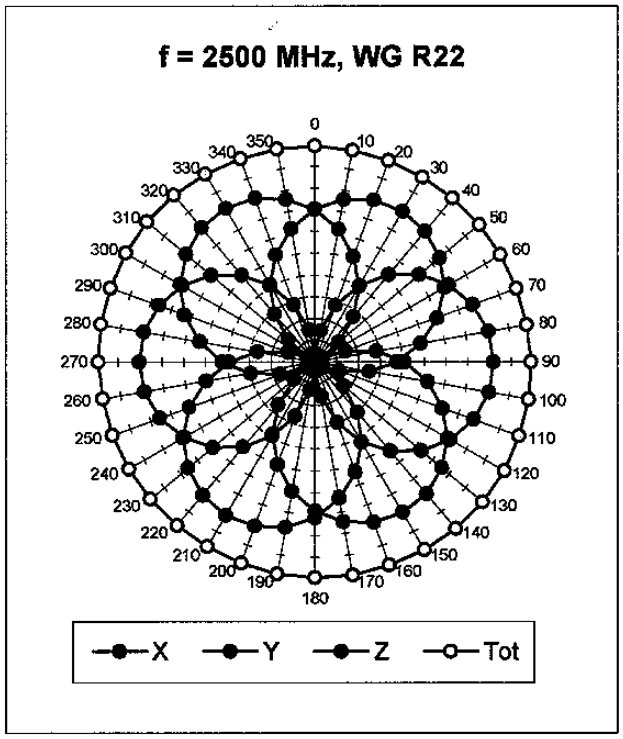
f = 300 MHz, TEM cell ifi110



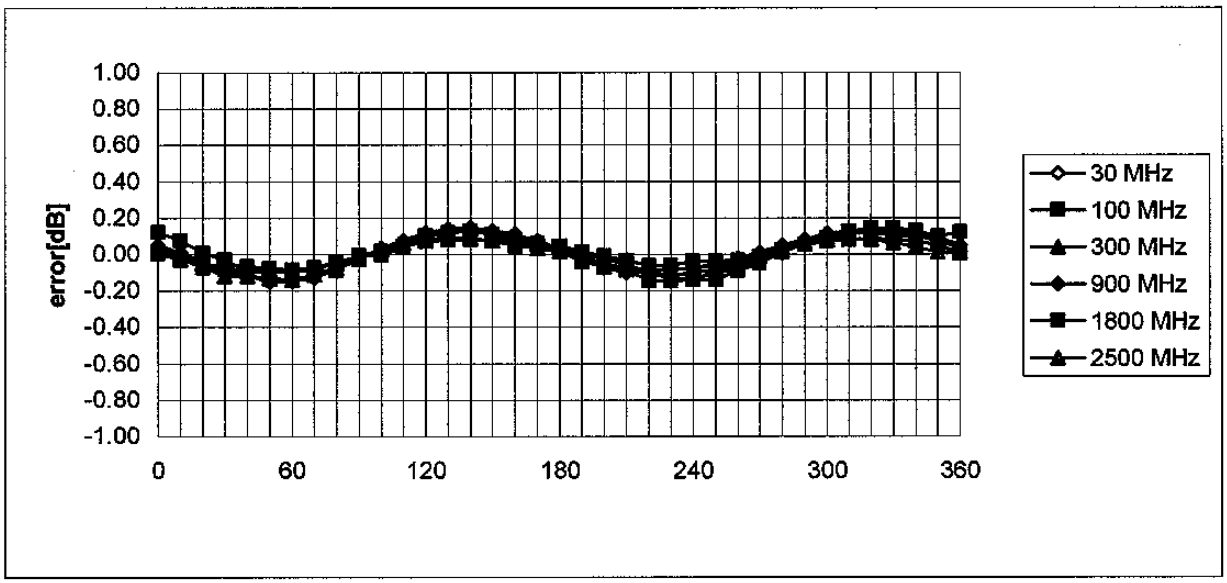
f = 900 MHz, TEM cell ifi110





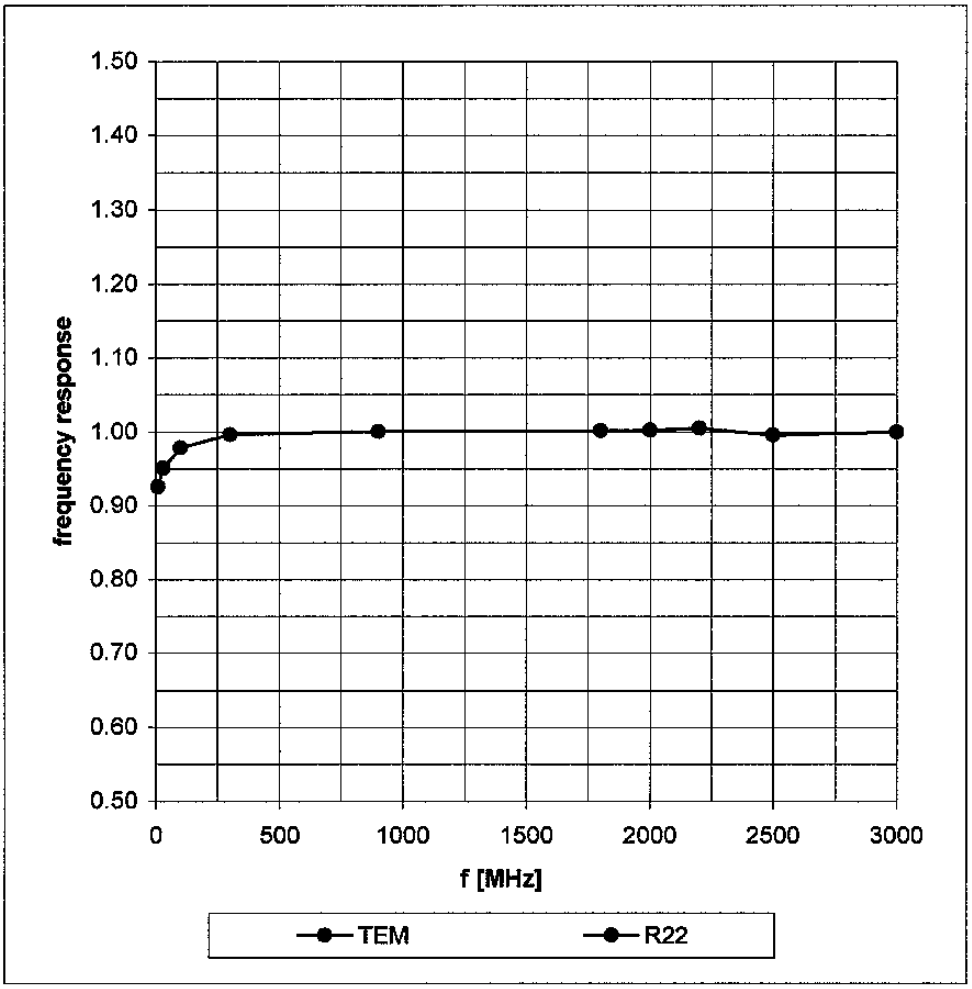


Isotropy Error (ϕ), θ = 0°



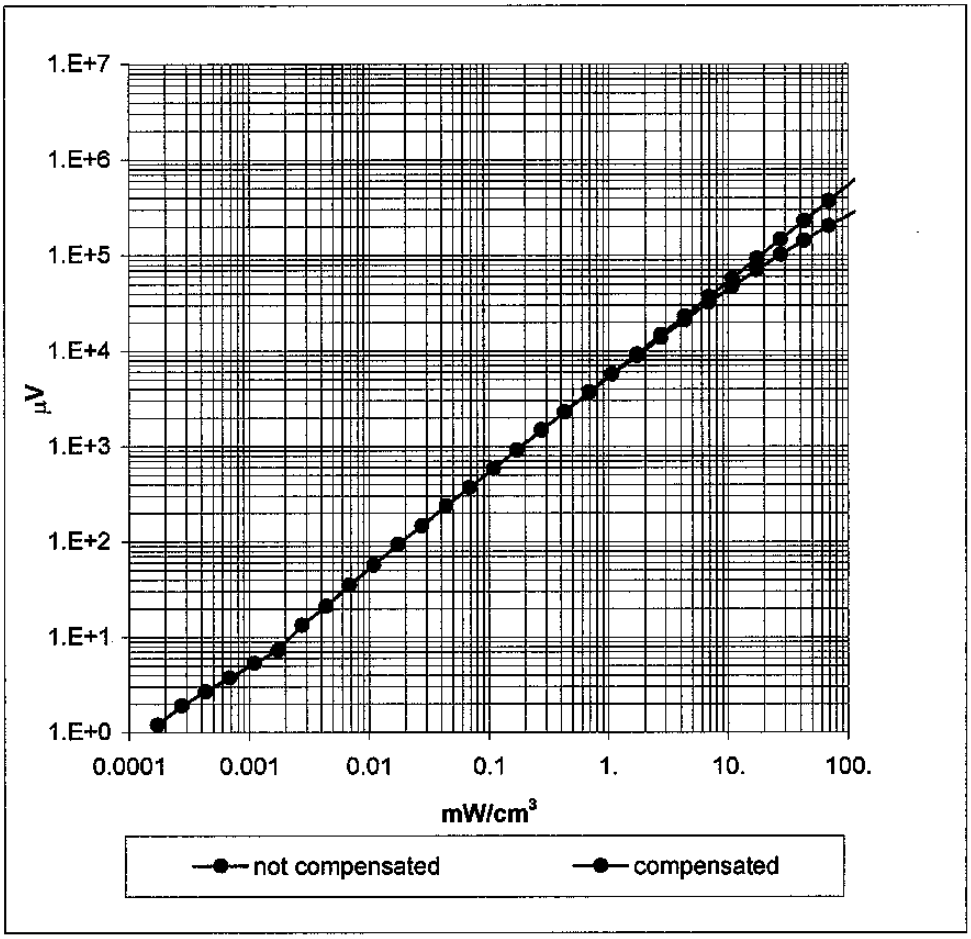
Frequency Response of E-Field

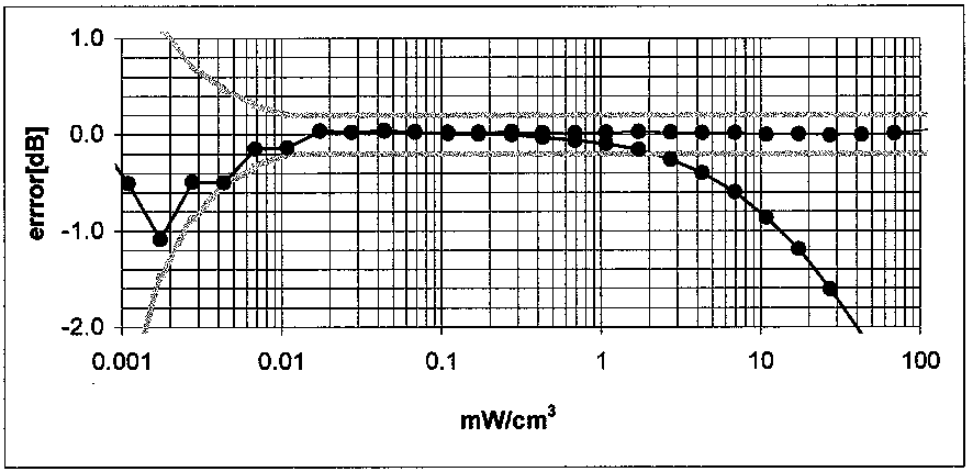
(TEM-Cell:ifi110, Waveguide R22)



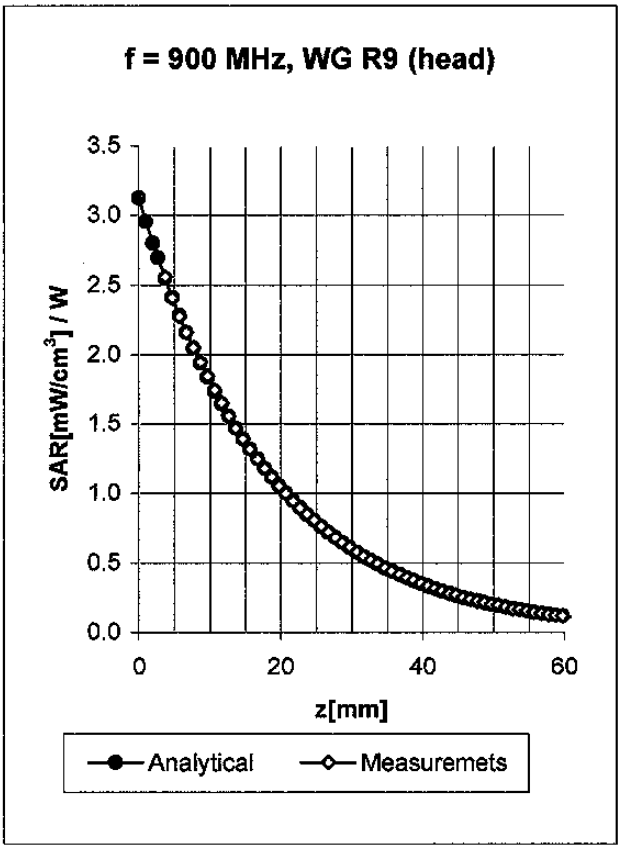
Dynamic Range f(SAR_{brain})

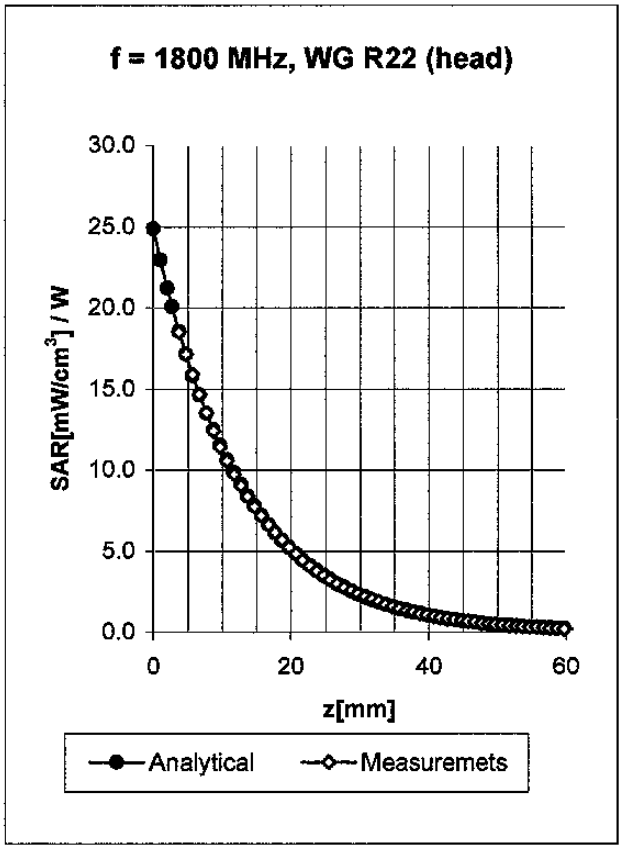
(Waveguide R22)





Conversion Factor Assessment





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

Valid for f=855-945 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

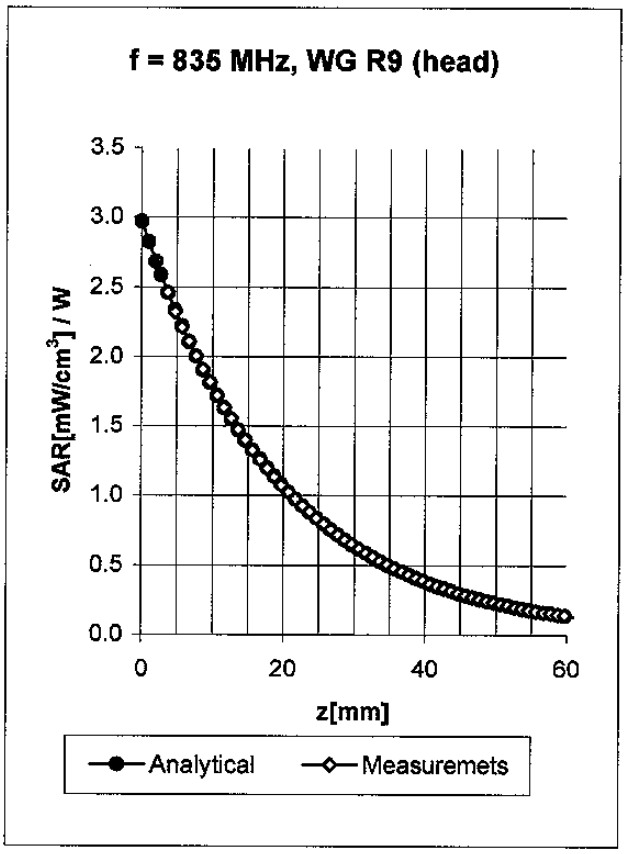
ConvF X	**6.3** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.3** ± 9.5% (k=2)	Alpha	**0.41**
ConvF Z	**6.3** ± 9.5% (k=2)	Depth	**2.46**

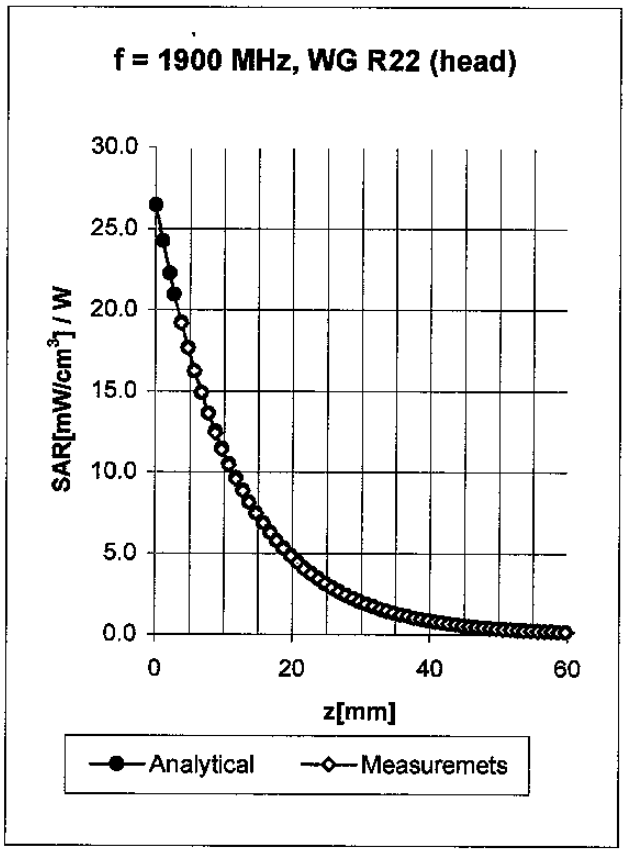
Head **1800 MHz** ε_r **= 40.0 ± 5%** σ **= 1.40 ± 5% mho/m**

Valid for f=1710-1890 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**5.0** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.0** ± 9.5% (k=2)	Alpha	**0.51**
ConvF Z	**5.0** ± 9.5% (k=2)	Depth	**2.62**

Conversion Factor Assessment





Head **835 MHz** ε_r **= 41.5 ± 5%** σ **= 0.90 ± 5% mho/m**

Valid for f=793-877 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

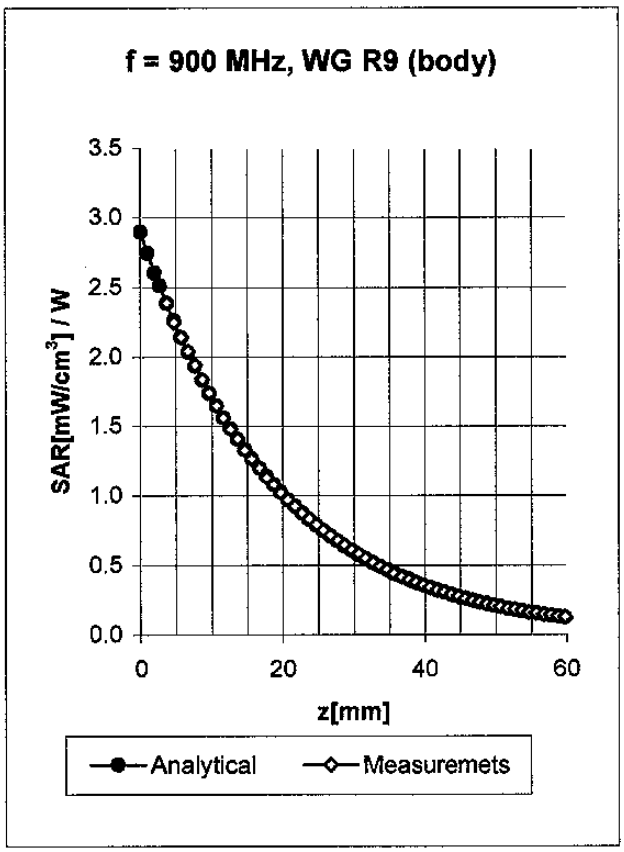
ConvF X	**6.4** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.4** ± 9.5% (k=2)	Alpha	**0.46**
ConvF Z	**6.4** ± 9.5% (k=2)	Depth	**2.20**

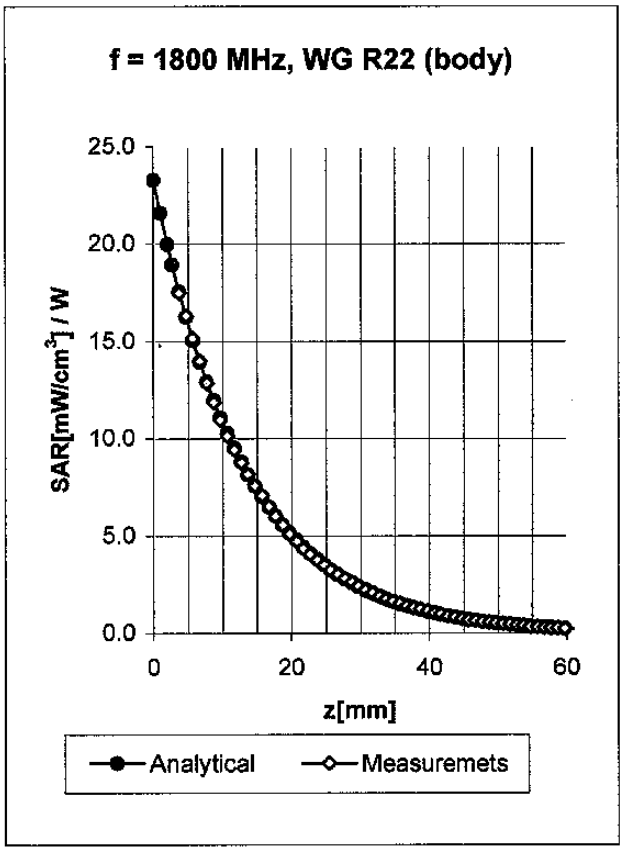
Head **1900 MHz** ε_r **= 40.0 ± 5%** σ **= 1.40 ± 5% mho/m**

Valid for f=1805-1995 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**4.8** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**4.8** ± 9.5% (k=2)	Alpha	**0.54**
ConvF Z	**4.8** ± 9.5% (k=2)	Depth	**2.58**

Conversion Factor Assessment





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

Valid for f=855-945 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

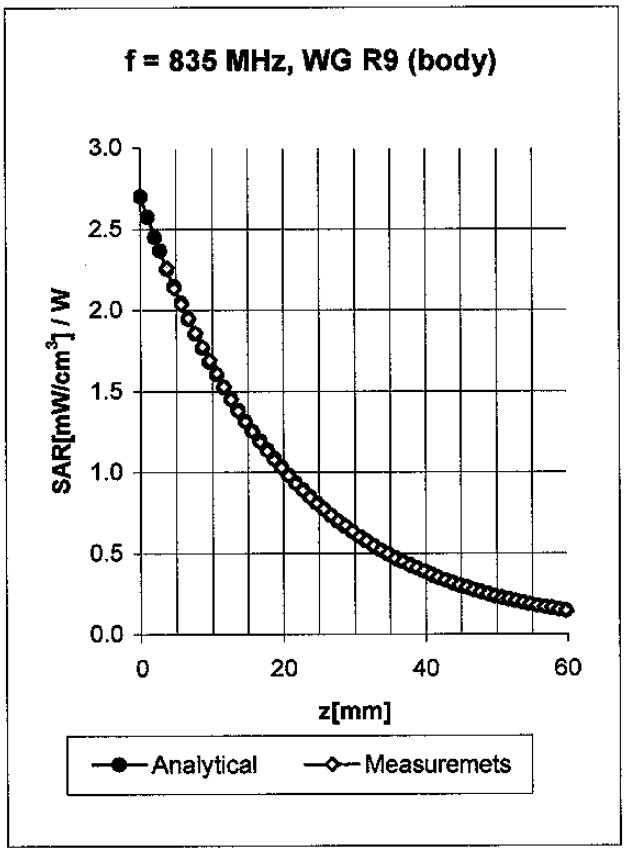
ConvF X	**6.2** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.2** ± 9.5% (k=2)	Alpha	**0.56**
ConvF Z	**6.2** ± 9.5% (k=2)	Depth	**2.08**

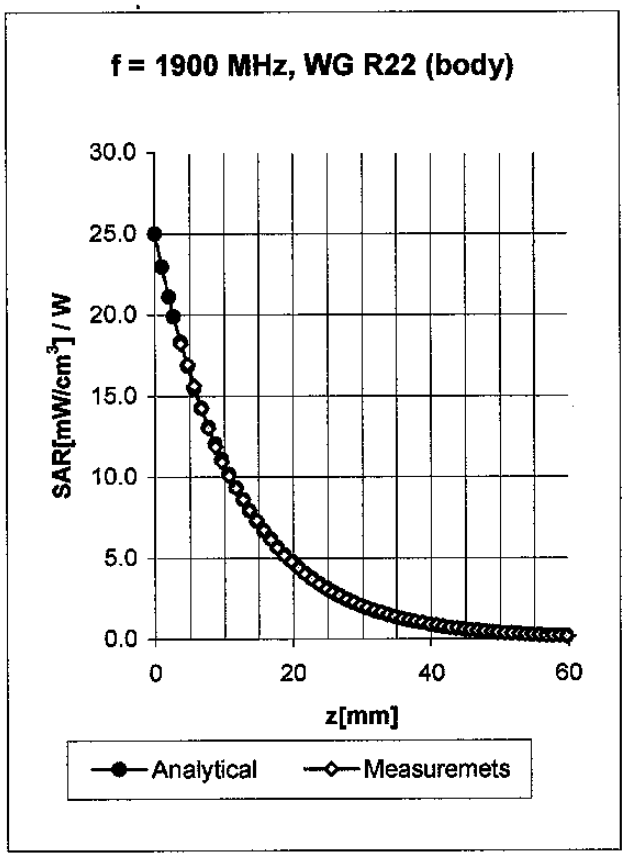
Body **1800 MHz** ε_r **= 53.3 ± 5%** σ **= 1.52 ± 5% mho/m**

Valid for f=1710-1890 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	**0.62**
ConvF Z	**4.7** ± 9.5% (k=2)	Depth	**2.59**

Conversion Factor Assessment





Body **835 MHz** ε_r **= 55.2 ± 5%** σ **= 0.97 ± 5% mho/m**

Valid for f=793-877 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

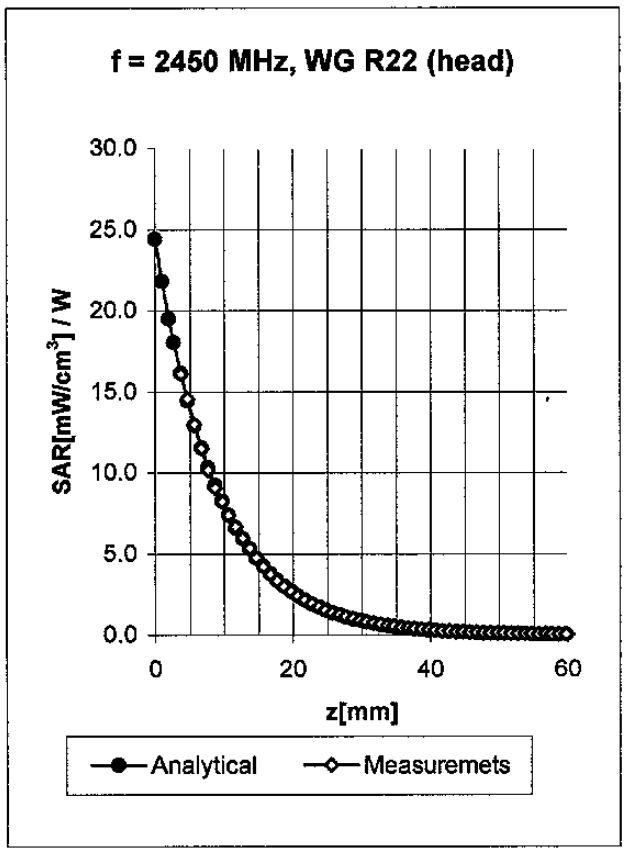
ConvF X	**6.3**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.3**	± 9.5% (k=2)	Alpha	**0.44**
ConvF Z	**6.3**	± 9.5% (k=2)	Depth	**2.40**

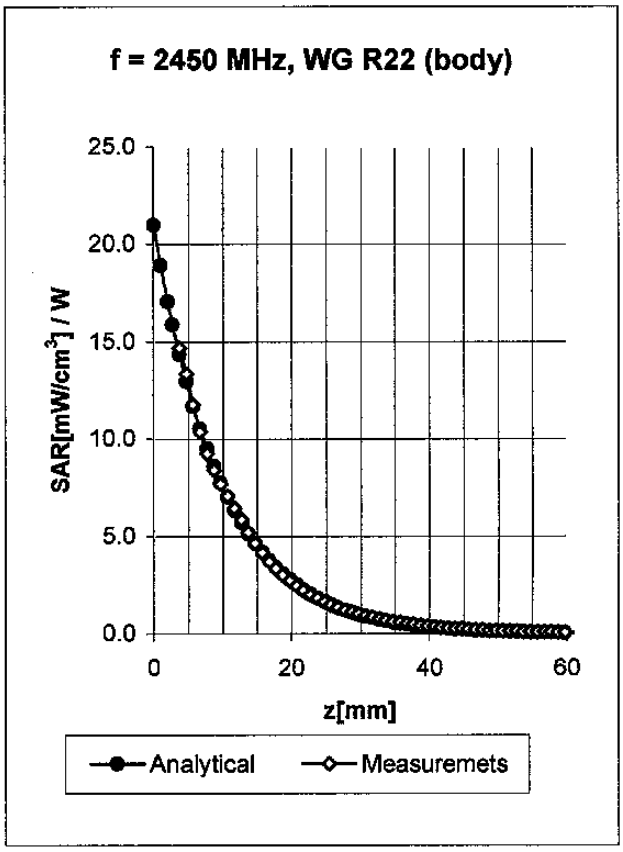
Body **1900 MHz** ε_r **= 53.3 ± 5%** σ **= 1.52 ± 5% mho/m**

Valid for f=1805-1995 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	**4.6**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**4.6**	± 9.5% (k=2)	Alpha	**0.65**
ConvF Z	**4.6**	± 9.5% (k=2)	Depth	**2.48**

Conversion Factor Assessment





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

Valid for f=2328-2573 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**4.6** ± 8.9% (k=2)	Boundary effect:	
ConvF Y	**4.6** ± 8.9% (k=2)	Alpha	**1.04**
ConvF Z	**4.6** ± 8.9% (k=2)	Depth	**1.85**

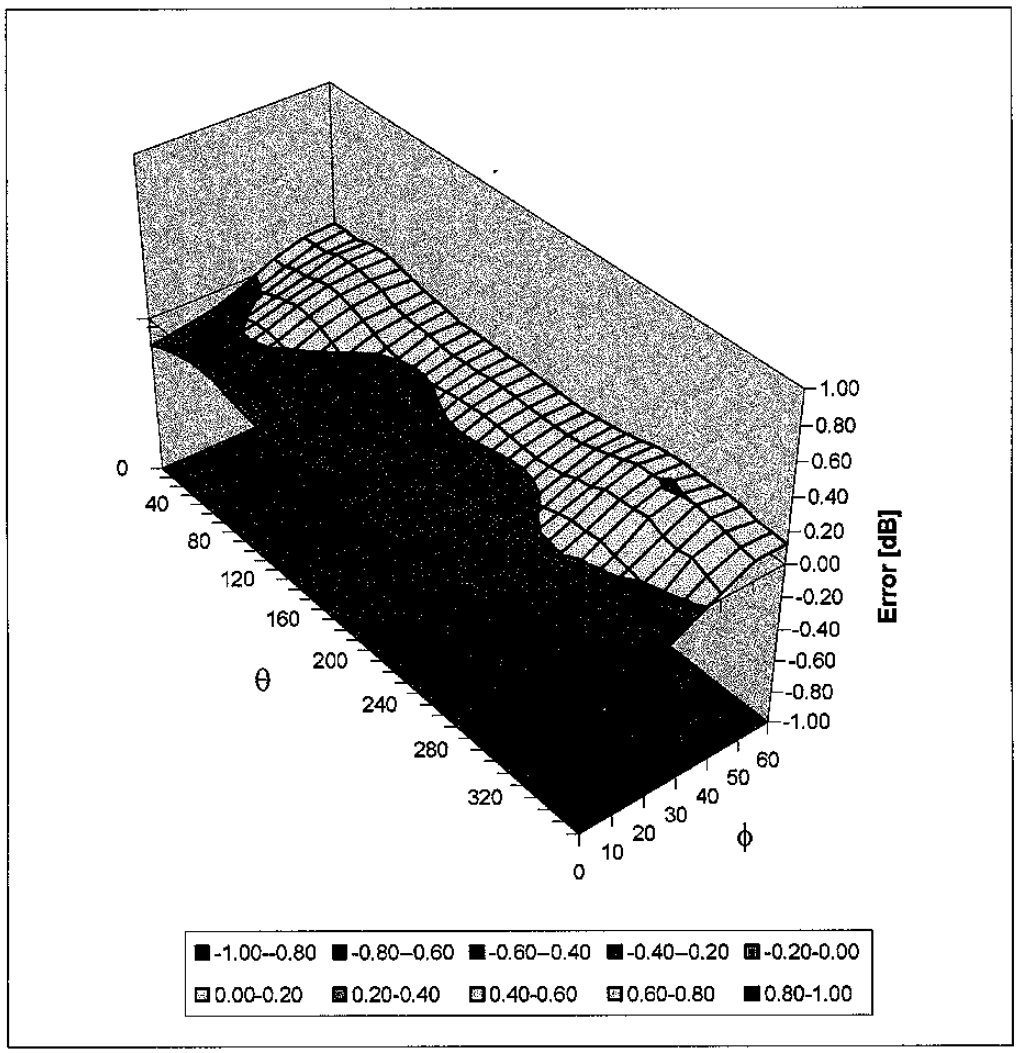
Body **2450** **MHz** ε_r **= 52.7 ± 5%** σ **= 1.95 ± 5% mho/m**

Valid for f=2328-2573 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	**4.3** ± 8.9% (k=2)	Boundary effect:	
ConvF Y	**4.3** ± 8.9% (k=2)	Alpha	**1.10**
ConvF Z	**4.3** ± 8.9% (k=2)	Depth	**1.75**

Deviation from Isotropy in HSL

Error (θϕ), f = 900 MHz



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

Cusc USD 23/05/03.

Client RFI

CALIBRATION CERTIFICATE

Object(s)	D1800V2 - SN:2d009
Calibration procedure(s)	QA CAL-05.v2 Calibration procedure for dipole validation kits
Calibration date:	May 14, 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 R&S SML-03	100698	27-Mar-2002 (R&S, No. 20-92389)	In house check: Mar-05
Power sensor HP 8481A	MY41092317	18-Oct-02 (Agilent, No. 20021018)	Oct-04
Power sensor HP 8481A	US37292783	30-Oct-02 (METAS, No. 252-0236)	Oct-03
Power meter EPM E442	GB37480704	30-Oct-02 (METAS, No. 252-0236)	Oct-03
Network Analyzer HP 8753E	US38432426	3-May-00 (Agilent, No. 8702K064602)	In house check: May 03

	Name	Function	Signature
Calibrated by:	Judith Mueller	Technician	
Approved by:	Katja Pokovic	Laboratory Director	

Date issued: May 14, 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

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info@speag.com, http://www.speag.com

DASY

Dipole Validation Kit

Type: D1800V2

Serial: 2d009

Manufactured: July 23, 2001
Calibrated: May 14, 2003

1. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with head simulating solution of the following electrical parameters at 1800 MHz:

Relative Dielectricity	**39.2**	± 5%
Conductivity	**1.36 mho/m**	± 5%

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 5.3 at 1800 MHz) was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was 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 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.
The dipole input power (forward power) was 250 mW ± 3 %. The results are normalized to 1W input power.

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:	**38.2 mW/g** ± 16.8 % (k=2)[1]
averaged over 10 cm^3 (10 g) of tissue:	**20.1 mW/g** ± 16.2 % (k=2)[1]

[1] validation uncertainty

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:	**1.184 ns**	(one direction)
Transmission factor:	**0.998**	(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 1800 MHz:	Re{Z} = **47.2 Ω**
	Im {Z} = **-8.4 Ω**
Return Loss at 1800 MHz	**-20.8 dB**

4. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with body simulating glycol solution of the following electrical parameters at 1800 MHz:

Relative Dielectricity	**51.6**	± 5%
Conductivity	**1.49 mho/m**	± 5%

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 5.0 at 1800 MHz) was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was 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 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.
The dipole input power (forward power) was 250 mW ± 3 %. The results are normalized to 1W input power.

5. 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:	**36.7 mW/g** ± 16.8 % (k=2)[2]
averaged over 10 cm^3 (10 g) of tissue:	**19.6 mW/g** ± 16.2 % (k=2)[2]

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 1800 MHz:	Re{Z} = **43.4 Ω**
	Im {Z} = **-8.8 Ω**
Return Loss at 1800 MHz	**-18.7 dB**

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.

9. Power Test

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

[2] validation uncertainty

Date/Time: 05/12/03 17:38:29

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN2d009_SN1507_HSL1800_120503.da4

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN2d009
Program: Dipole Calibration

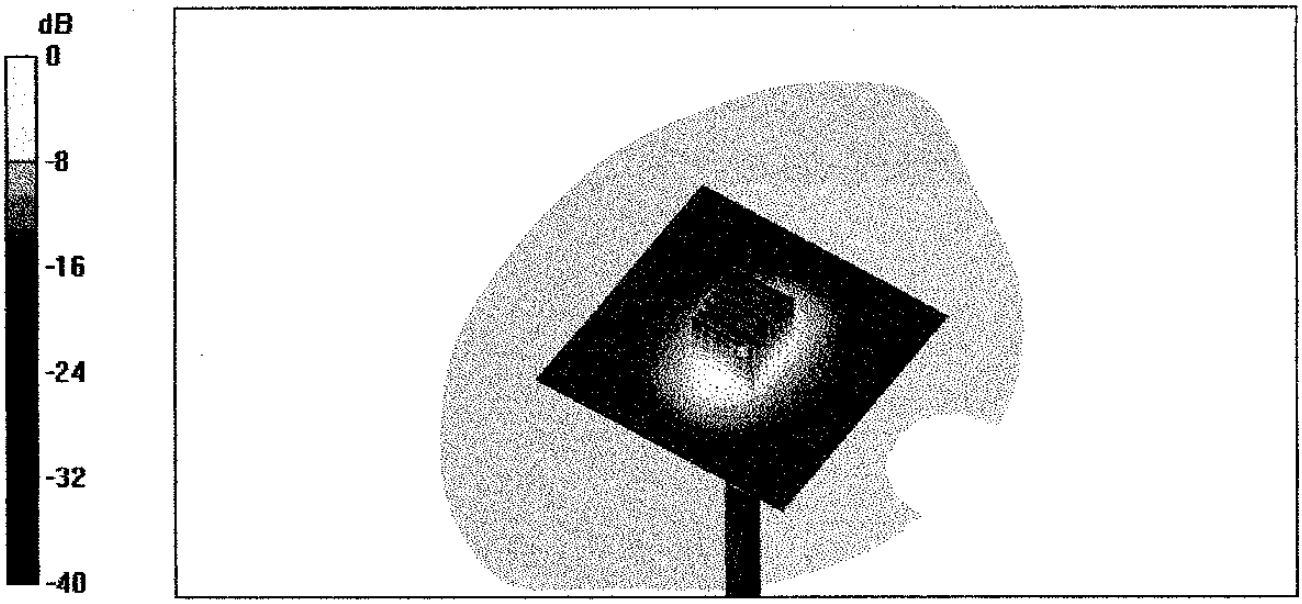
Communication System: CW-1800; Frequency: 1800 MHz;Duty Cycle: 1:1
Medium: HSL 1800 MHz (σ = 1.36 mho/m, ε_r = 39.22, ρ = 1000 kg/m^3)
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5.3, 5.3, 5.3); Calibrated: 1/18/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN411; Calibrated: 1/16/2003
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

Pin = 250 mW; d = 10 mm/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 93.7 V/m
Power Drift = -0.01 dB
Maximum value of SAR = 10.7 mW/g

Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 16.5 W/kg
SAR(1 g) = 9.56 mW/g; SAR(10 g) = 5.03 mW/g
Reference Value = 93.7 V/m
Power Drift = -0.01 dB
Maximum value of SAR = 10.7 mW/g



0 dB = 10.7mW/g

2d009

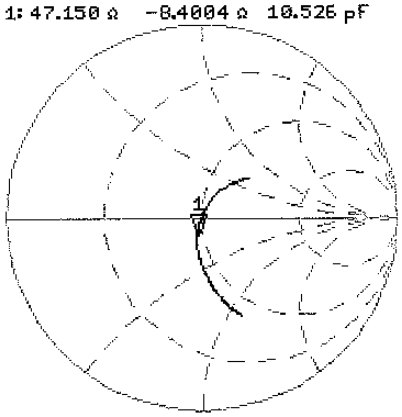
12 May 2003 12:13:43

CH1 S11 1 U FS 1: 47.150 Ω -8.4004 Ω 10.526 pF 1 800.000 000 MHz

Del

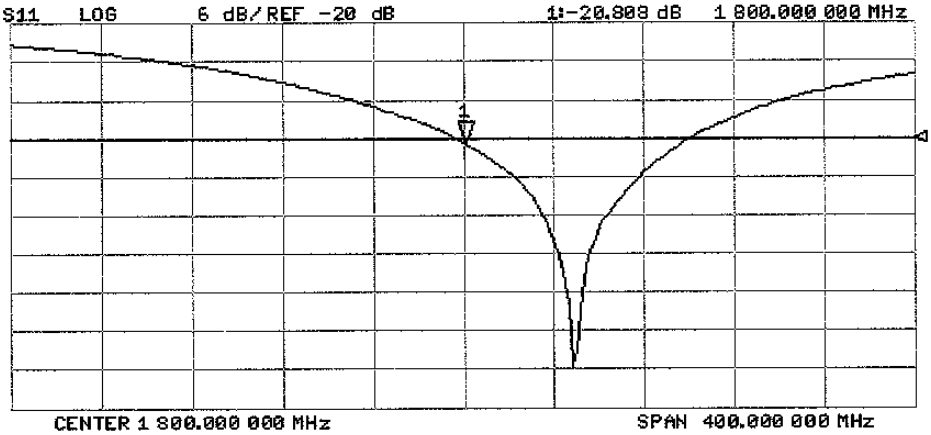
Cor

Avg
16



CH2 S11 LOG 6 dB/ REF -20 dB 1:-20.808 dB 1 800.000 000 MHz

Cor



CENTER 1 800.000 000 MHz SPAN 400.000 000 MHz

Date/Time: 05/14/03 12:55:22

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN2d009_SN1507_M1800_140503da4.da4

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN2d009
Program: Dipole Calibration

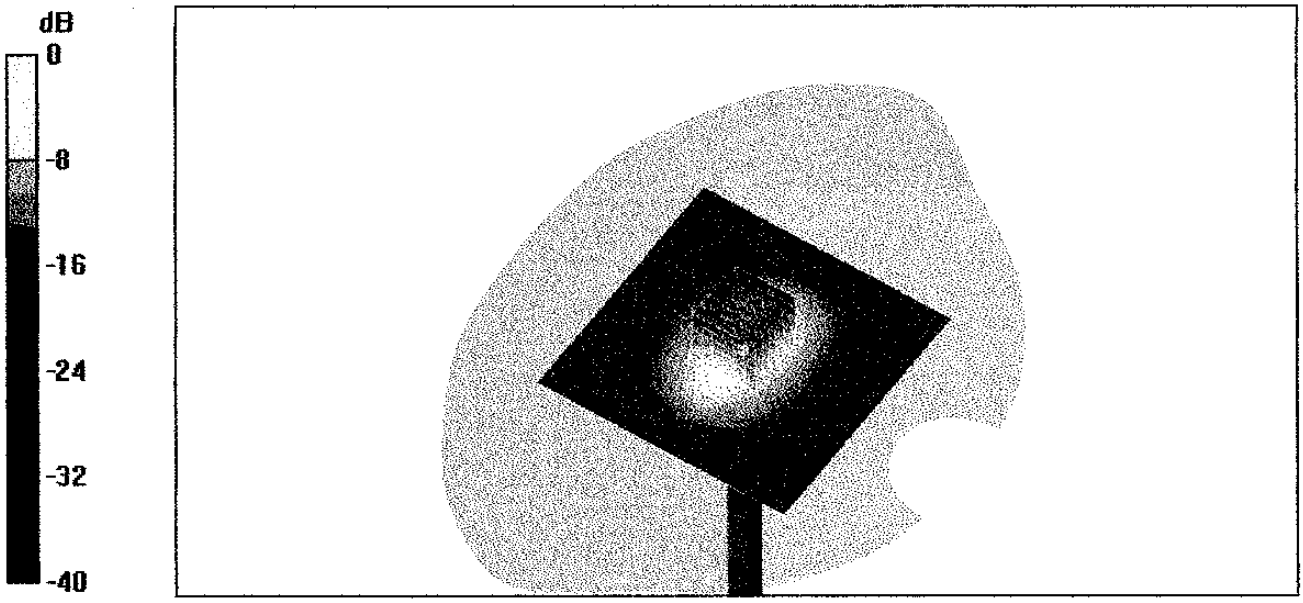
Communication System: CW-1800; Frequency: 1800 MHz;Duty Cycle: 1:1
Medium: Muscle 1800 MHz (σ = 1.49 mho/m, ε_r = 51.55, ρ = 1000 kg/m^3)
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5, 5, 5); Calibrated: 1/18/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN411; Calibrated: 1/16/2003
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- *Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115*

Pin = 250 mW; d = 10 mm/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 89.6 V/m
Power Drift = 0.02 dB
Maximum value of SAR = 10.3 mW/g

Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 15.1 W/kg
SAR(1 g) = 9.17 mW/g; SAR(10 g) = 4.9 mW/g
Reference Value = 89.6 V/m
Power Drift = 0.02 dB
Maximum value of SAR = 10.3 mW/g



0 dB = 10.3mW/g

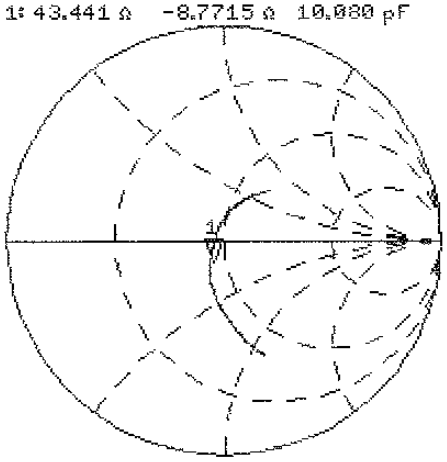
2d003
Body

14 May 2003 10:12:49

CH1 S11 1 U FS 1: 43.441 Ω -8.7715 Ω 10.080 pF 1 800.000 000 MHz

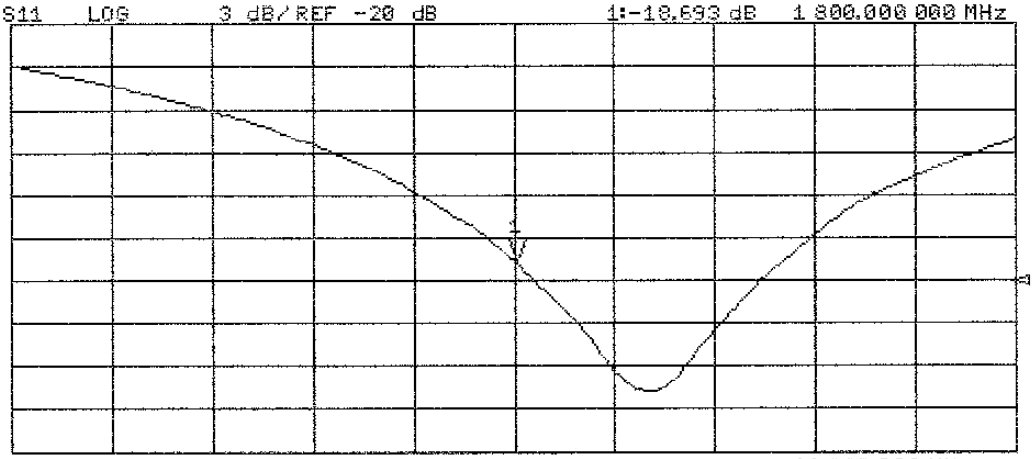
Del

PRm
Cor
Avg
16



CH2 S11 LOG 3 dB/ REF -20 dB 1:-18.693 dB 1 800.000 000 MHz

PRm
Cor



CENTER 1 900.000 000 MHz SPAN 400.000 000 MHz