ATTACHMENT R – PROBE CALIBRATION DATA

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

Client **Hyundai CT (Dymstec)**

CALIBRATION CERTIFICATE

Object(s) ET3DV6 - SN:1609

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

Calibration date: January 22, 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:	Nico Vetterli	Technician	
Approved by:	Katja Pokovic	Laboratory Director	

Date issued: January 23, 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.

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Probe ET3DV6

SN:1609

Manufactured:	July 27, 2001
Last calibrated:	June 20, 2002
Recalibrated:	January 22, 2004

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

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ET3DV6 SN:1609 January 22, 2004

DASY - Parameters of Probe: ET3DV6 SN:1609

Sensitivity in Free Space

Diode Compression[A]

NormX	1.72 μV/(V/m)^2	DCP X	96	mV
NormY	1.72 μV/(V/m)^2	DCP Y	96	mV
NormZ	1.72 μV/(V/m)^2	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		3.7 mm	4.7 mm
SAR_{be} [%]	Without Correction Algorithm	9.2	5.0
SAR_{be} [%]	With Correction Algorithm	0.1	0.2

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

Sensor to Surface Distance		3.7 mm	4.7 mm
SAR_{be} [%]	Without Correction Algorithm	13.5	9.3
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

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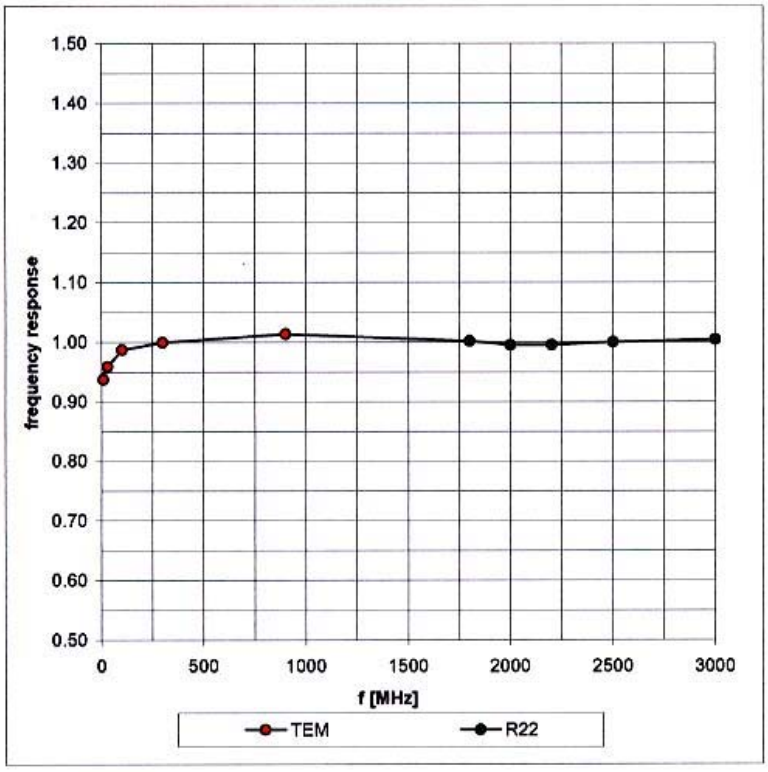
ET3DV6 SN:1609 January 22, 2004

Frequency Response of E-Field

(TEM-Cell:ifi110, Waveguide R22)



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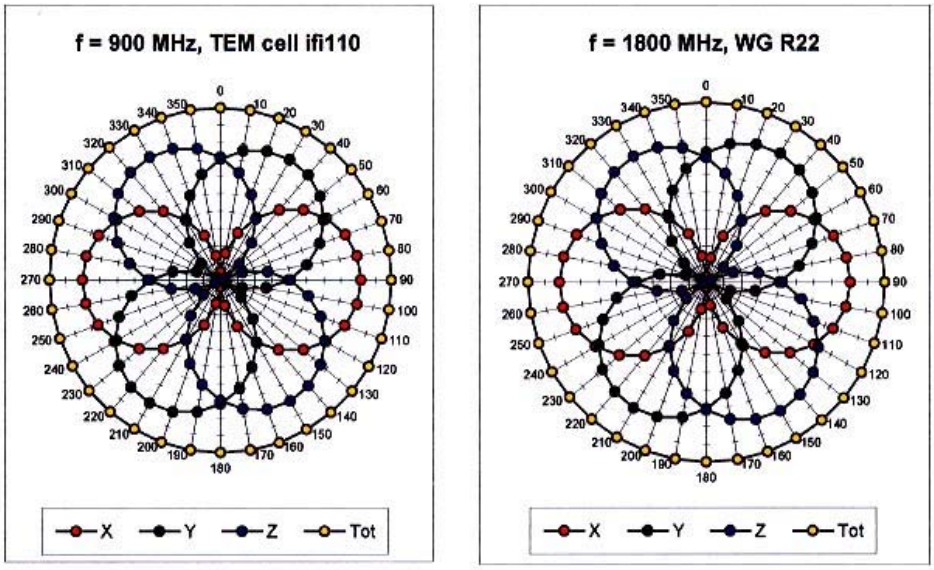
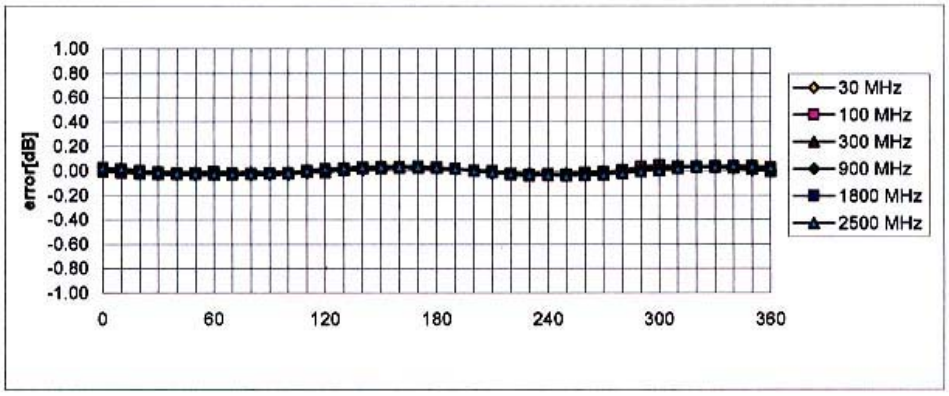
ET3DV6 SN:1609 **January 22, 2004**

Receiving Pattern (ϕ) , θ = 0°





Axial Isotropy Error < ± 0.2 dB

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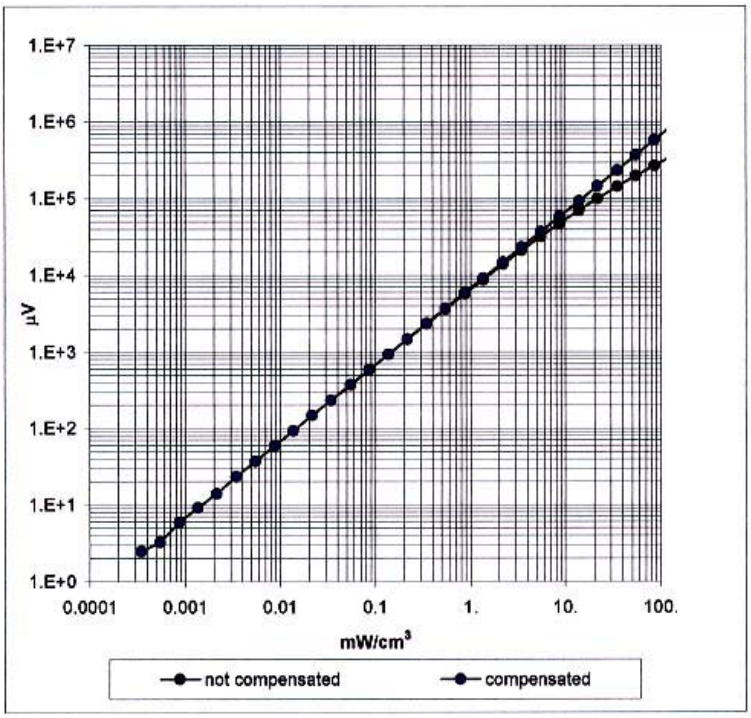
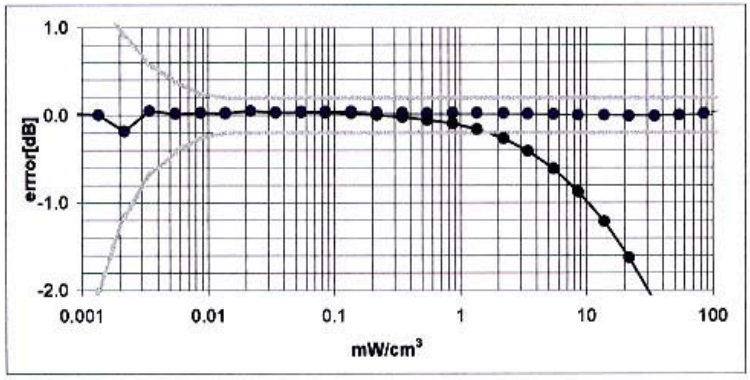
ET3DV6 SN:1609 January 22, 2004

Dynamic Range f(SAR_{head})

(Waveguide R22)





Probe Linearity < ± 0.2 dB

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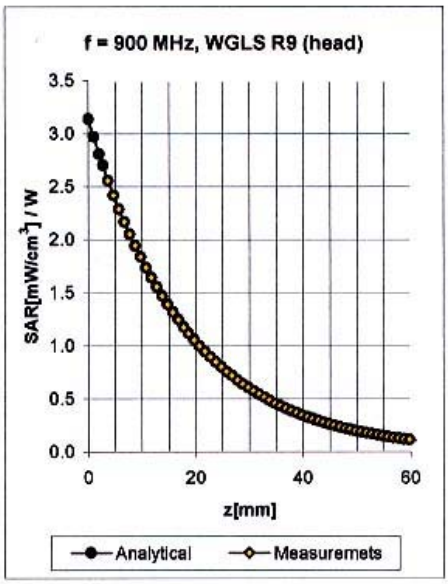
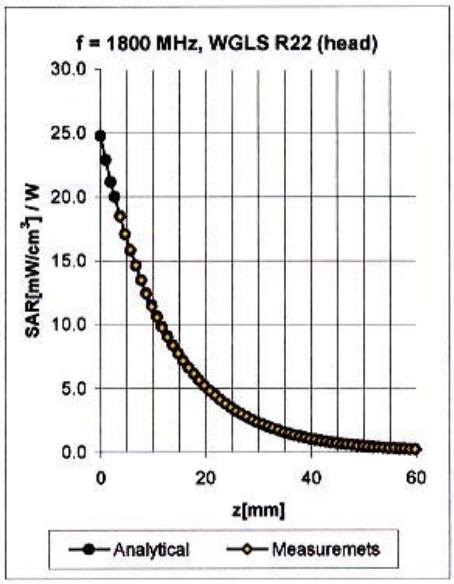
ET3DV6 SN:1609 January 22, 2004

Conversion Factor Assessment





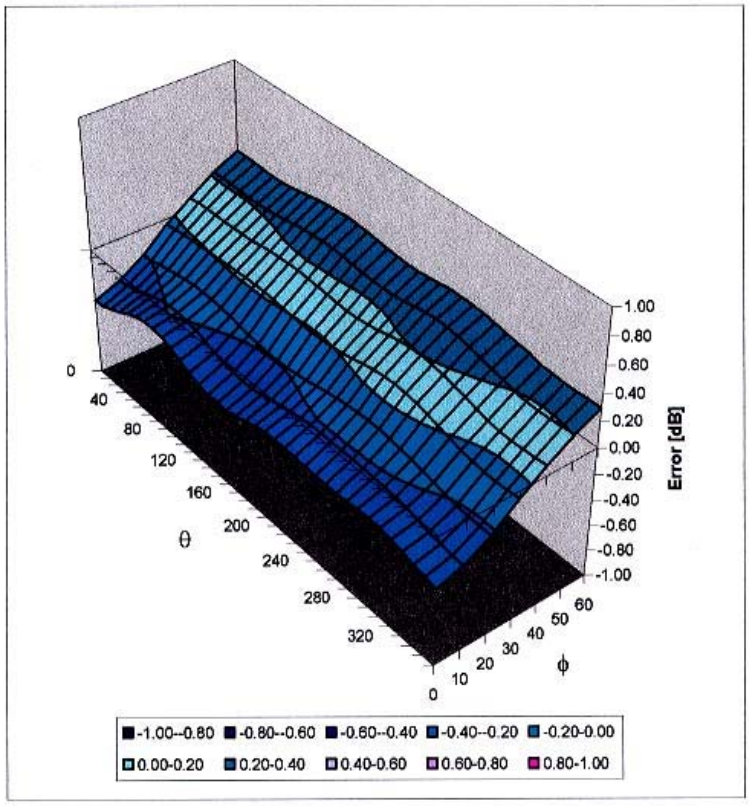
f [MHz]	Validity [MHz][B]	Tissue	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
450	400-500	Head	43.5 ± 5%	0.87 ± 5%	0.73	1.68	6.88 ± 15.9% (k=2)
900	800-1000	Head	41.5 ± 5%	0.97 ± 5%	0.58	1.90	6.62 ± 11.3% (k=2)
1800	1710-1910	Head	40.0 ± 5%	1.40 ± 5%	0.48	2.67	5.29 ± 11.7% (k=2)
2450	2400-2500	Head	39.2 ± 5%	1.80 ± 5%	1.06	1.82	4.83 ± 9.7% (k=2)
450	400-500	Body	56.7 ± 5%	0.94 ± 5%	0.96	1.50	6.73 ± 15.9% (k=2)
835	750-950	Body	55.2 ± 5%	0.97 ± 5%	0.47	2.20	6.57 ± 11.9% (k=2)
1900	1800-2000	Body	53.3 ± 5%	1.52 ± 5%	0.60	2.78	4.69 ± 11.3% (k=2)
2450	2400-2500	Body	52.7 ± 5%	1.95 ± 5%	1.48	1.47	4.62 ± 9.7% (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:1609 January 22, 2004

Deviation from Isotropy in HSL

Error (θ,ϕ), f = 900 MHz



Spherical Isotropy Error < ± 0.4 dB

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Calibration Laboratory of
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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

Diode Compression[A]

NormX	1.74 μV/(V/m)^2	DCP X	90	mV
NormY	1.80 μV/(V/m)^2	DCP Y	90	mV
NormZ	1.74 μV/(V/m)^2	DCP Z	90	mV

Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Plese 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

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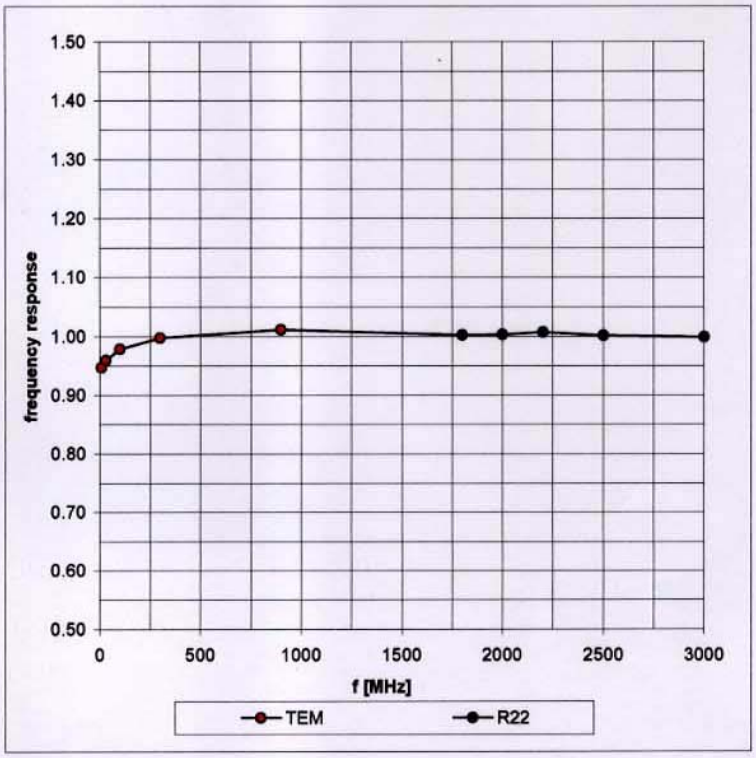
ET3DV6 SN:1607 April 28, 2004

Frequency Response of E-Field

(TEM-Cell:ifi110, Waveguide R22)



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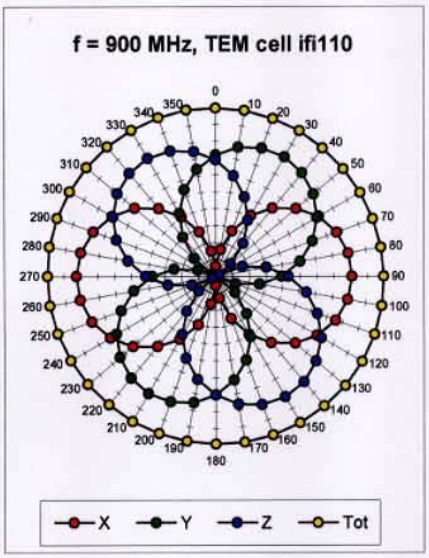
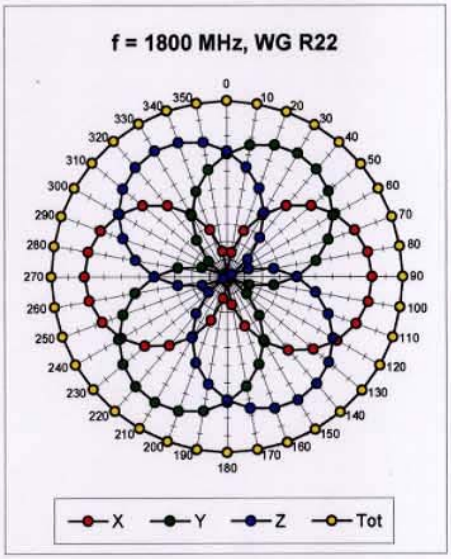
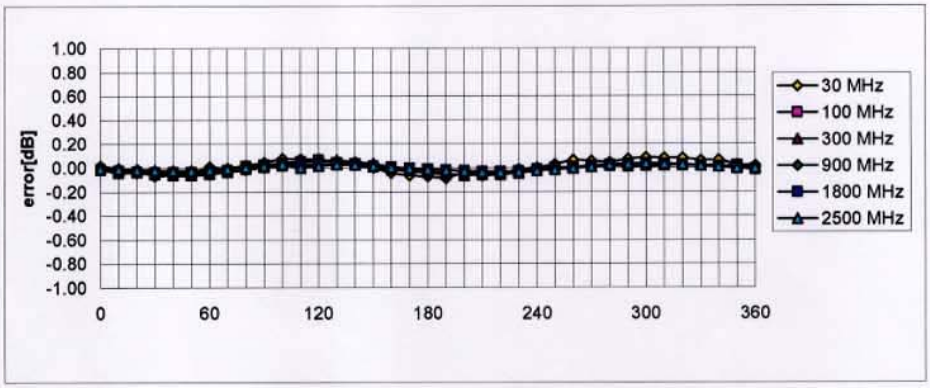
Receiving Pattern (ϕ) , θ = 0°







Axial Isotropy Error < ± 0.2 dB

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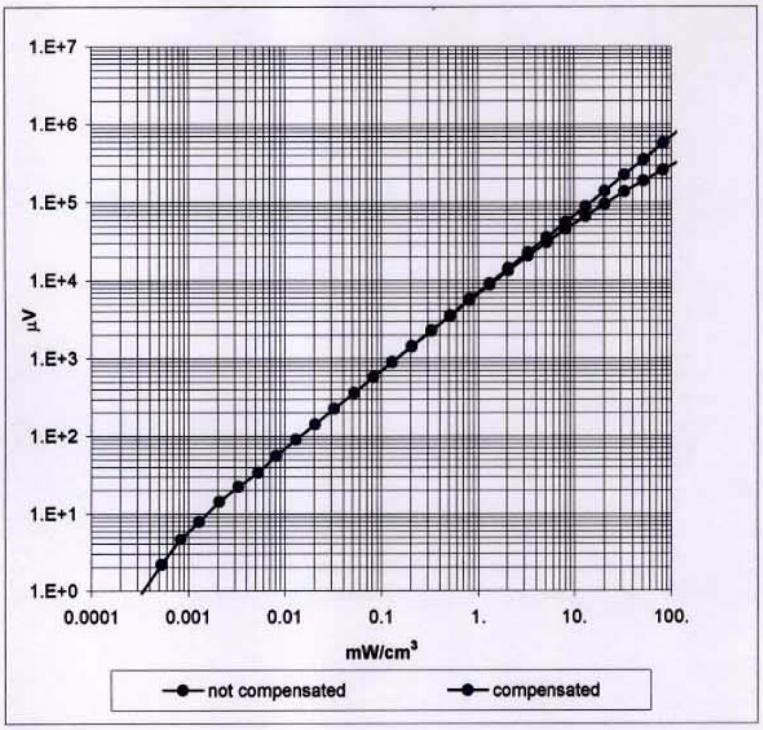
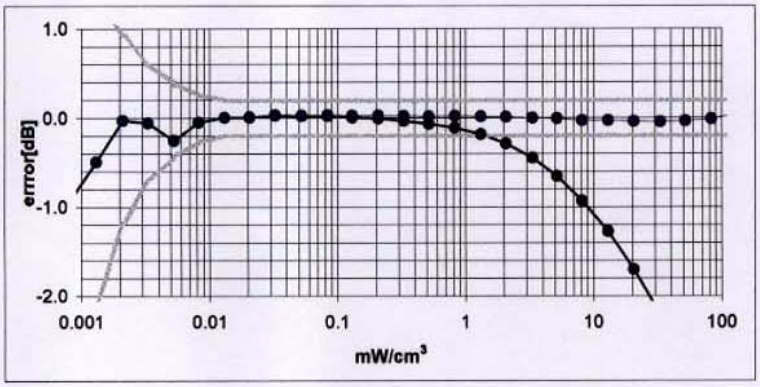
ET3DV6 SN:1607 April 28, 2004

Dynamic Range f(SAR_{head})

(Waveguide R22)

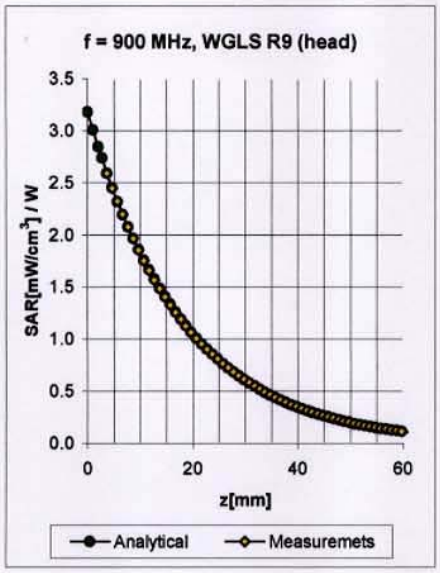


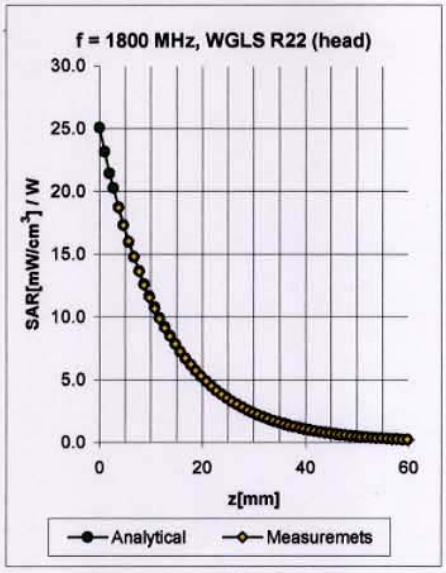


Probe Linearity < ± 0.2 dB

ET3DV6 SN:1607 April 28, 2004

Conversion Factor Assessment





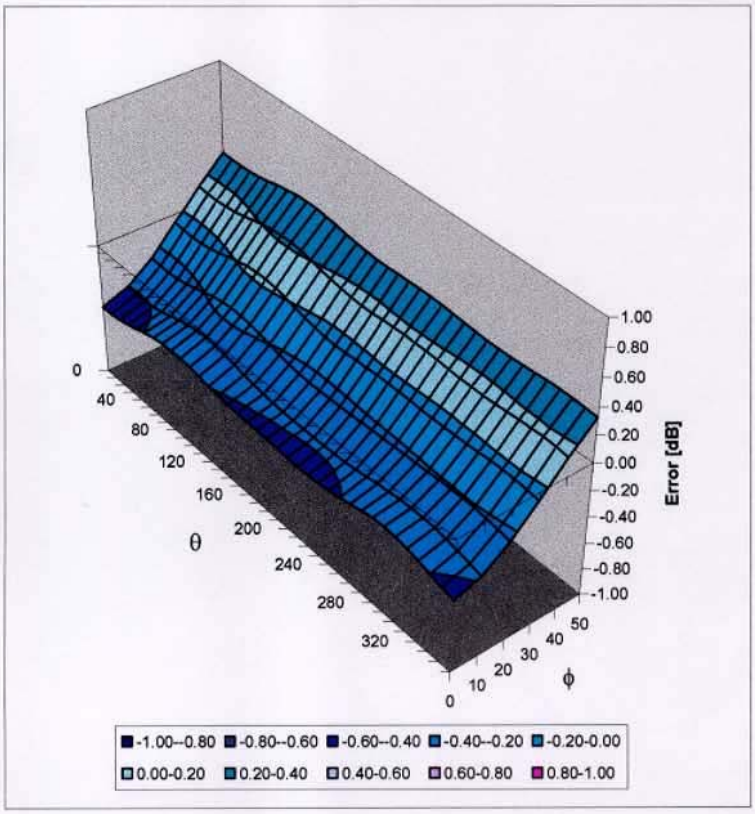
f [MHz]	Validity [MHz][B]	Tissue	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
900	800-1000	Head	41.5 ± 5%	0.97 ± 5%	0.81	1.60	6.22 ± 11.3% (k=2)
1800	1710-1910	Head	40.0 ± 5%	1.40 ± 5%	0.53	2.60	5.10 ± 11.7% (k=2)
835	750-950	Body	55.2 ± 5%	0.97 ± 5%	0.62	1.90	6.26 ± 11.9% (k=2)
1900	1800-2000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