Calibration Laboratory of
Schmid & Partner
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S Schweizerischer Kalibrierdienst
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Swiss Calibration Service

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Accreditation No.: **SCS 108**

Client **CCS**

Certificate No: **EX3-3686_Jan11**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3686

Calibration procedure(s): QA CAL-01.v7, QA CAL-12.v6, QA CAL-14.v3, QA CAL-23.v4 and QA CAL-25.v3
Calibration procedure for dosimetric E-field probes

Calibration date: January 24, 2011

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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	1-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41495277	1-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41498087	1-Apr-10 (No. 217-01136)	Apr-11
Reference 3 dB Attenuator	SN: S5054 (3c)	30-Mar-10 (No. 217-01159)	Mar-11
Reference 20 dB Attenuator	SN: S5086 (20b)	30-Mar-10 (No. 217-01161)	Mar-11
Reference 30 dB Attenuator	SN: S5129 (30b)	30-Mar-10 (No. 217-01160)	Mar-11
Reference Probe ES3DV2	SN: 3013	29-Dec-10 (No. ES3-3013_Dec10)	Dec-11
DAE4	SN: 660	20-Apr-10 (No. DAE4-660_Apr10)	Apr-11

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-10)	In house check: Oct-11

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

Issued: January 25, 2011

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Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization $\vartheta = 0$ ($f \le 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *Ax,y,z; Bx,y,z; Cx,y,z; VRx,y,z: A, B, C* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \le 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

Probe EX3DV4

SN:3686

Manufactured:	March 10, 2009
Last calibrated:	March 23, 2009
Recalibrated:	January 24, 2011

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 SN:3686

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.49	0.48	0.53	± 10.1%
DCP (mV)[B]	98.1	96.8	98.4	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dBuV	C	VR mV	Unc[E] (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	111.1	± 2.1 %
			Y	0.00	0.00	1.00	113.6	
			Z	0.00	0.00	1.00	114.9	

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] The uncertainties of NormX,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).

[B] Numerical linearization parameter: uncertainty not required.

[E] Uncertainty is determined using the maximum deviation from linear response applying recatangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 SN:3686

Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz]	Validity [MHz][C]	Permittivity	Conductivity	ConvF X	ConvF Y	ConvF Z	Alpha	Depth Unc (k=2)
450	± 50 / ± 100	43.5 ± 5%	0.87 ± 5%	9.27	9.27	9.27	0.11	1.00 ± 13.3%
750	± 50 / ± 100	41.9 ± 5%	0.89 ± 5%	9.06	9.06	9.06	0.64	0.66 ± 11.0%
835	± 50 / ± 100	41.5 ± 5%	0.90 ± 5%	8.65	8.65	8.65	0.62	0.68 ± 11.0%
900	± 50 / ± 100	41.5 ± 5%	0.97 ± 5%	8.54	8.54	8.54	0.50	0.73 ± 11.0%
1450	± 50 / ± 100	40.5 ± 5%	1.20 ± 5%	8.09	8.09	8.09	0.80	0.60 ± 11.0%
1640	± 50 / ± 100	40.3 ± 5%	1.29 ± 5%	7.79	7.79	7.79	0.62	0.66 ± 11.0%
1750	± 50 / ± 100	40.1 ± 5%	1.37 ± 5%	7.69	7.69	7.69	0.64	0.66 ± 11.0%
1900	± 50 / ± 100	40.0 ± 5%	1.40 ± 5%	7.42	7.42	7.42	0.58	0.63 ± 11.0%
1950	± 50 / ± 100	40.0 ± 5%	1.40 ± 5%	7.22	7.22	7.22	0.65	0.61 ± 11.0%
2000	± 50 / ± 100	40.0 ± 5%	1.40 ± 5%	7.39	7.39	7.39	0.54	0.66 ± 11.0%
2300	± 50 / ± 100	39.5 ± 5%	1.67 ± 5%	7.12	7.12	7.12	0.33	0.86 ± 11.0%
2450	± 50 / ± 100	39.2 ± 5%	1.80 ± 5%	6.82	6.82	6.82	0.22	1.18 ± 11.0%
2600	± 50 / ± 100	39.0 ± 5%	1.96 ± 5%	6.75	6.75	6.75	0.26	1.08 ± 11.0%
3500	± 50 / ± 100	37.9 ± 5%	2.91 ± 5%	6.42	6.42	6.42	0.40	1.20 ± 13.1%
3700	± 50 / ± 100	37.7 ± 5%	3.12 ± 5%	6.13	6.13	6.13	0.34	1.20 ± 13.1%
4950	± 50 / ± 100	36.3 ± 5%	4.40 ± 5%	4.75	4.75	4.75	0.40	1.80 ± 13.1%
5200	± 50 / ± 100	36.0 ± 5%	4.66 ± 5%	4.54	4.54	4.54	0.40	1.80 ± 13.1%
5300	± 50 / ± 100	35.9 ± 5%	4.76 ± 5%	4.35	4.35	4.35	0.40	1.80 ± 13.1%
5500	± 50 / ± 100	35.6 ± 5%	4.96 ± 5%	4.13	4.13	4.13	0.40	1.80 ± 13.1%
5600	± 50 / ± 100	35.5 ± 5%	5.07 ± 5%	3.96	3.96	3.96	0.45	1.80 ± 13.1%
5800	± 50 / ± 100	35.3 ± 5%	5.27 ± 5%	4.04	4.04	4.04	0.45	1.80 ± 13.1%

[C] The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band

DASY/EASY - Parameters of Probe: EX3DV4 SN:3686

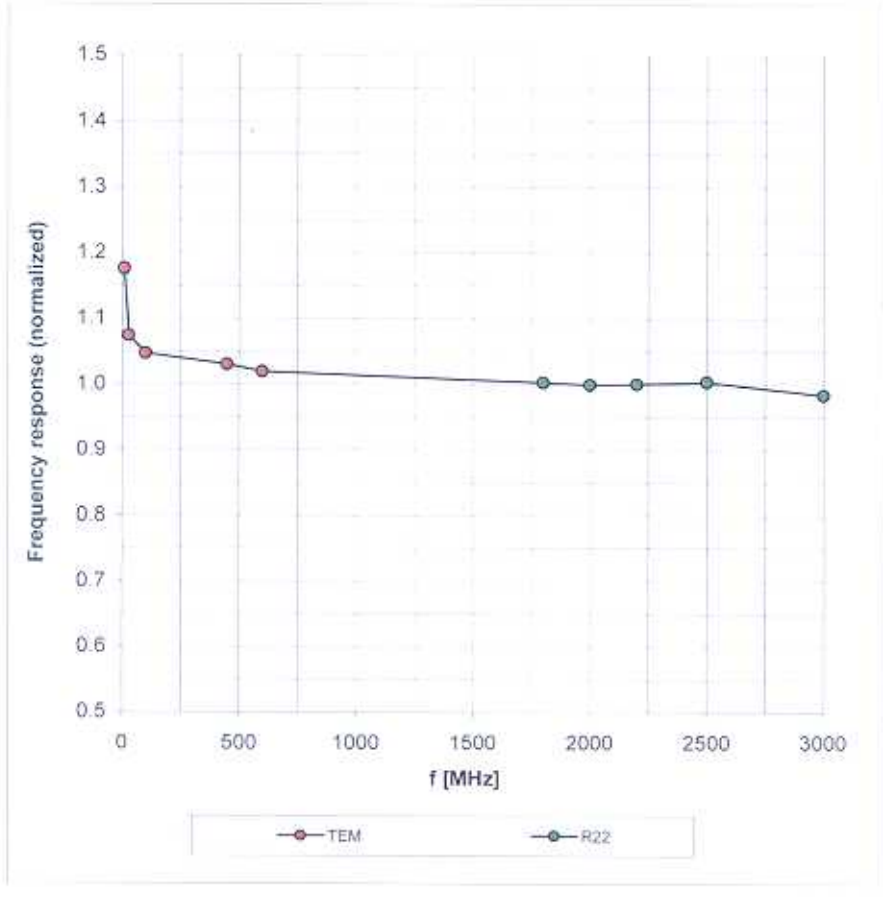
Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz]	Validity [MHz][C]	Permittivity	Conductivity	ConvF X	ConvF Y	ConvF Z	Alpha	Depth Unc (k=2)
450	± 50 / ± 100	56.7 ± 5%	0.94 ± 5%	9.77	9.77	9.77	0.03	1.00 ± 13.3%
750	± 50 / ± 100	55.5 ± 5%	0.96 ± 5%	8.87	8.87	8.87	0.54	0.74 ± 11.0%
835	± 50 / ± 100	55.2 ± 5%	0.97 ± 5%	8.78	8.78	8.78	0.74	0.66 ± 11.0%
900	± 50 / ± 100	55.0 ± 5%	1.05 ± 5%	8.61	8.61	8.61	0.60	0.74 ± 11.0%
1450	± 50 / ± 100	54.0 ± 5%	1.30 ± 5%	7.69	7.69	7.69	0.91	0.56 ± 11.0%
1640	± 50 / ± 100	53.8 ± 5%	1.40 ± 5%	7.64	7.64	7.64	0.90	0.57 ± 11.0%
1750	± 50 / ± 100	53.4 ± 5%	1.49 ± 5%	7.28	7.28	7.28	0.71	0.65 ± 11.0%
1900	± 50 / ± 100	53.3 ± 5%	1.52 ± 5%	6.99	6.99	6.99	0.73	0.65 ± 11.0%
1950	± 50 / ± 100	53.3 ± 5%	1.52 ± 5%	7.23	7.23	7.23	0.70	0.66 ± 11.0%
2000	± 50 / ± 100	53.3 ± 5%	1.52 ± 5%	7.12	7.12	7.12	0.63	0.72 ± 11.0%
2300	± 50 / ± 100	52.9 ± 5%	1.81 ± 5%	6.98	6.98	6.98	0.41	0.84 ± 11.0%
2450	± 50 / ± 100	52.7 ± 5%	1.95 ± 5%	6.86	6.86	6.86	0.47	0.78 ± 11.0%
2600	± 50 / ± 100	52.5 ± 5%	2.16 ± 5%	6.78	6.78	6.78	0.57	0.74 ± 11.0%
3500	± 50 / ± 100	51.3 ± 5%	3.31 ± 5%	6.06	6.06	6.06	0.30	1.30 ± 13.1%
3700	± 50 / ± 100	51.0 ± 5%	3.55 ± 5%	5.92	5.92	5.92	0.35	1.30 ± 13.1%
4950	± 50 / ± 100	49.4 ± 5%	5.01 ± 5%	4.12	4.12	4.12	0.50	1.90 ± 13.1%
5200	± 50 / ± 100	49.0 ± 5%	5.30 ± 5%	3.98	3.98	3.98	0.50	1.90 ± 13.1%
5300	± 50 / ± 100	48.9 ± 5%	5.42 ± 5%	3.70	3.70	3.70	0.52	1.90 ± 13.1%
5500	± 50 / ± 100	48.6 ± 5%	5.65 ± 5%	3.56	3.56	3.56	0.55	1.90 ± 13.1%
5600	± 50 / ± 100	48.5 ± 5%	5.77 ± 5%	3.29	3.29	3.29	0.60	1.90 ± 13.1%
5800	± 50 / ± 100	48.2 ± 5%	6.00 ± 5%	3.70	3.70	3.70	0.55	1.90 ± 13.1%

[C] The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

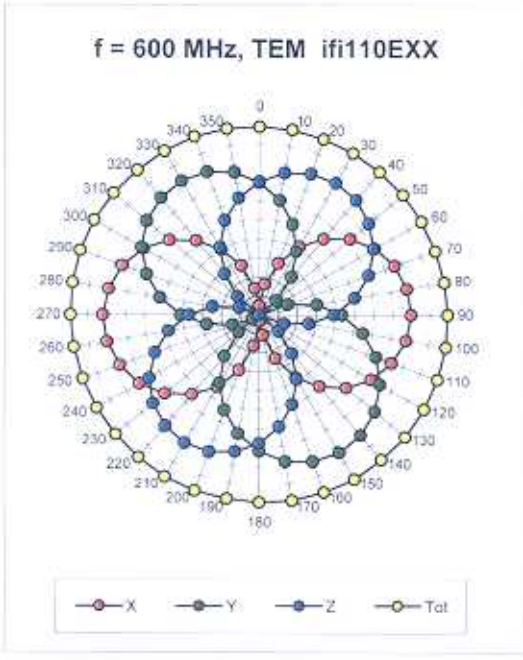
Frequency Response of E-Field

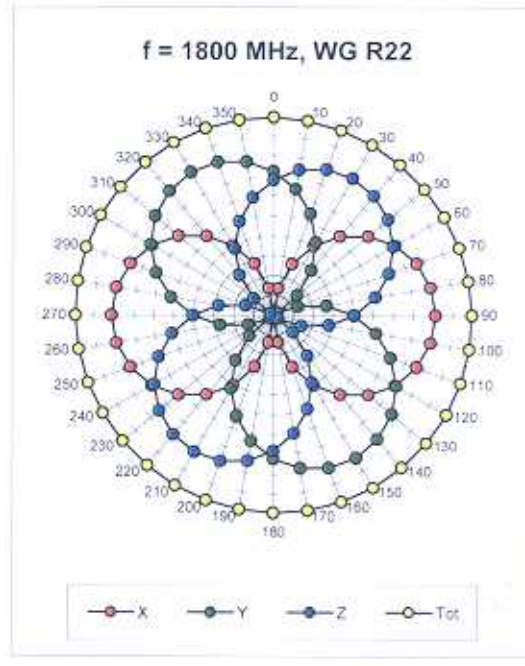
(TEM-Cell:ifi110 EXX, Waveguide: R22)

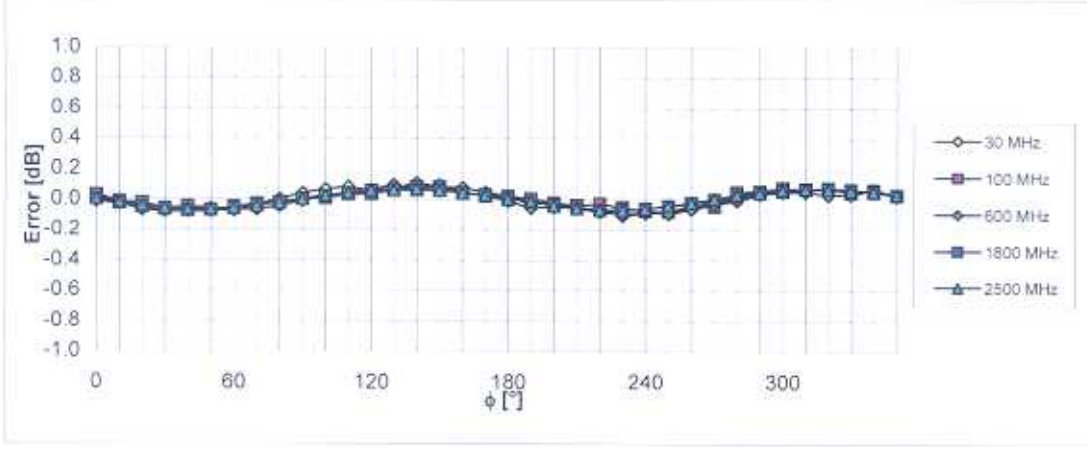


Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Receiving Pattern (ϕ), ϑ = 0°



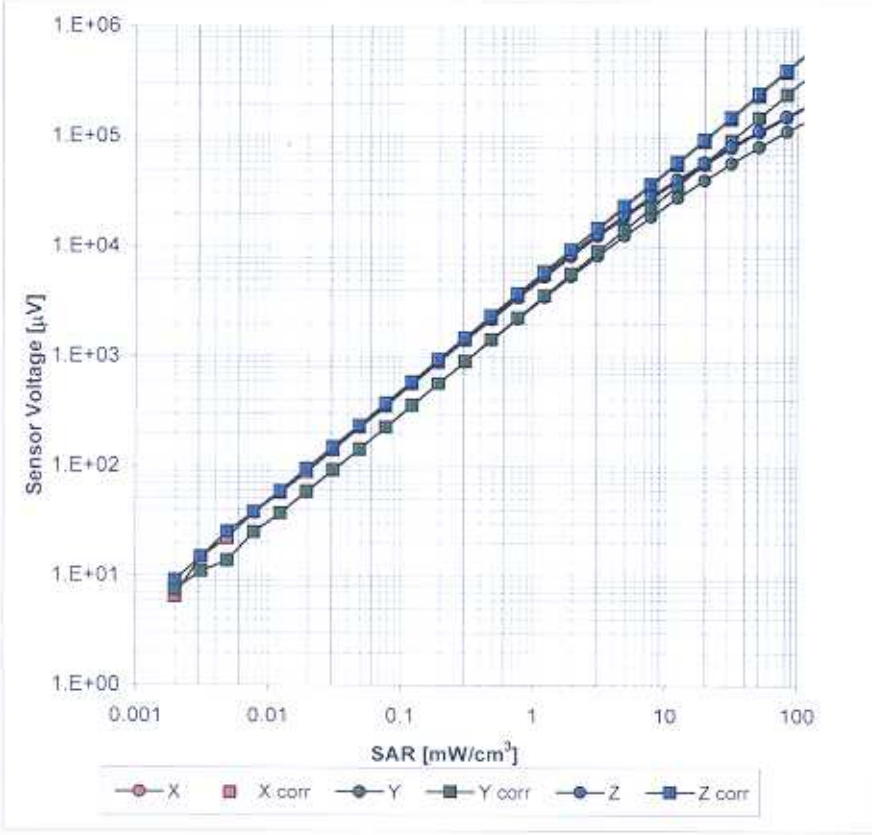


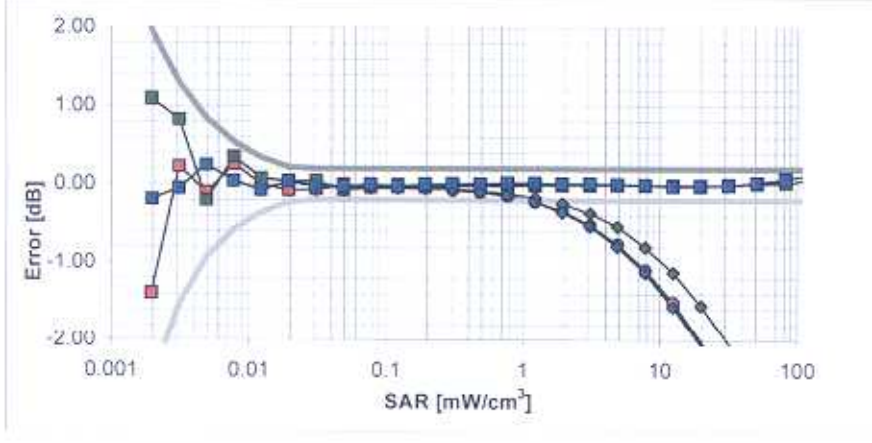


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

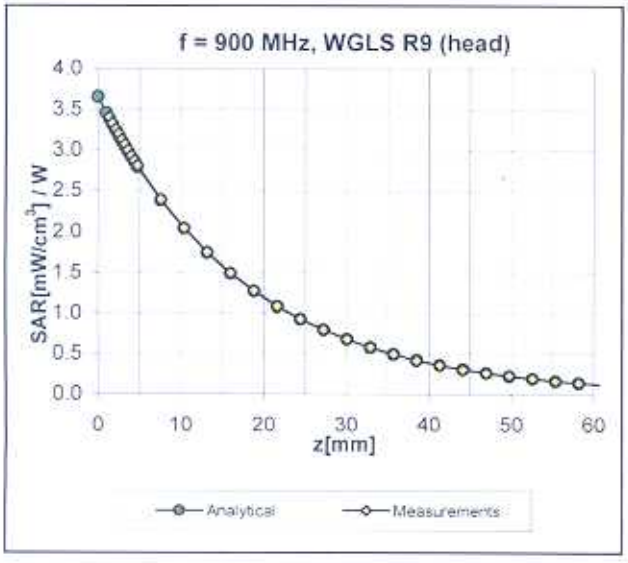
(TEM cell, f = 900 MHz)

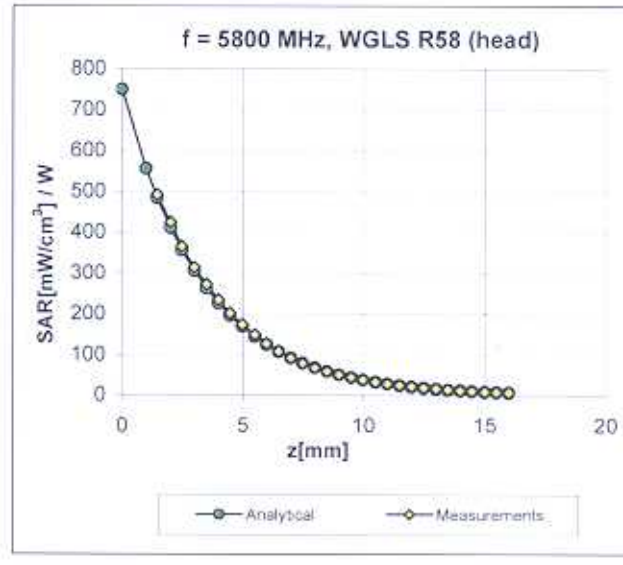




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

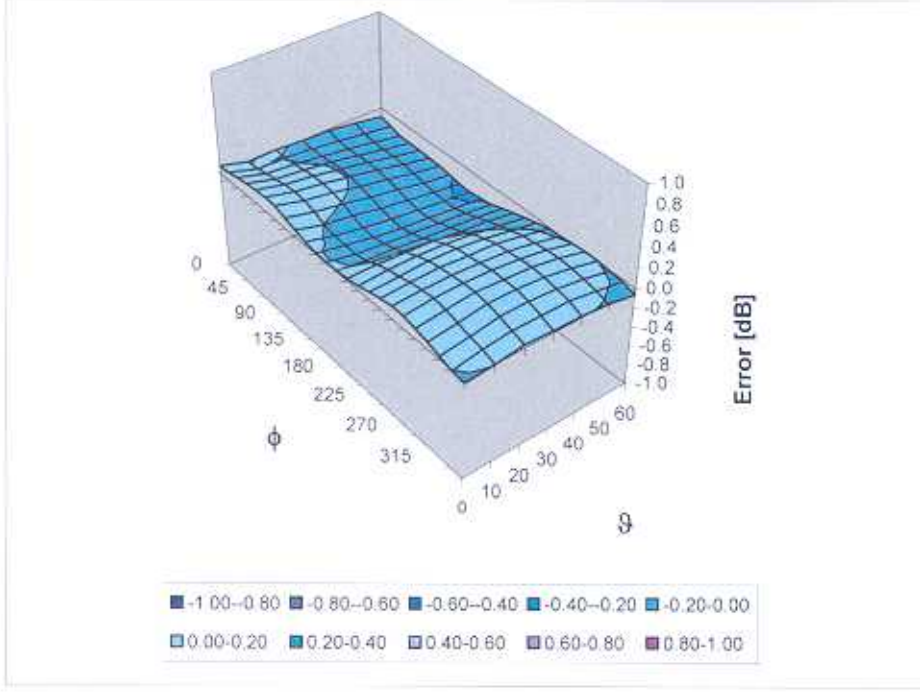
Conversion Factor Assessment





Deviation from Isotropy in HSL

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm