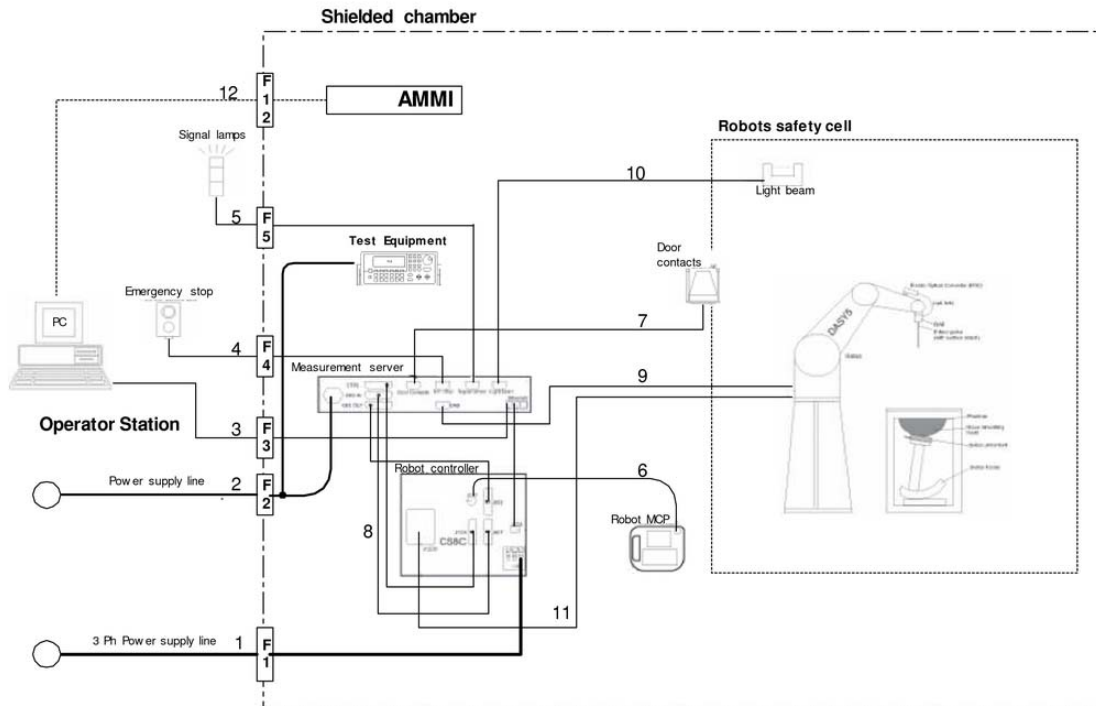


## APPENDIX 3 : System specifications

### 1. Configuration and peripherals



The DASYS5 system for performing compliance tests consist of the following items:

- a) A standard high precision 6-axis robot (Stäubli RX family) with controller and software.  
An arm extension for accommodating the data acquisition electronics (DAE).
- b) An isotropic field probe optimized and calibrated for the targeted measurement.
- c) A data acquisition electronic (DAE), which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- d) The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection.  
The EOC is connected to the measurement server.
- e) The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- f) The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- g) A computer running WinXP and the DASYS5 software.
- h) Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
- i) The phantom, the device holder and other accessories according to the targeted measurement.

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## 2. Specifications

### a) Robot TX60L

Number of Axes	:	6
Nominal Load	:	2 kg
Maximum Load	:	5kg
Reach	:	920mm
Repeatability	:	+/-0.03mm
Control Unit	:	CS8c
Programming Language	:	VAL3
Weight	:	52.2kg
Manufacture	:	Stäubli Robotics

### b) E-Field Probe

Model	:	ET3DV6	
Serial No.	:	1705, 1685	
Construction	:	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycol ether)	
Frequency	:	10 MHz to 2.3 GHz Linearity: $\pm 0.2$ dB (30 MHz to 2.3 GHz)	
Directivity	:	+/-0.2 dB in HSL (rotation around probe axis) +/-0.4 dB in tissue material (rotation normal probe axis)	<b>ET3DV6 E-field Probe</b>
Dynamic Range	:	5 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB	
Optical Surface Detection	:	$\pm 0.2$ mm repeatability in air and clear liquids over diffuse reflecting surfaces	
Dimensions	:	Overall length: 337 mm (Tip: 16 mm) Tip diameter: 6.8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.7 mm	
Application	:	General dosimetric measurements up to 2.3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms	
Manufacture	:	Schimid & Partner Engineering AG	

#### c)Data Acquisition Electronic (DAE4)

<b>Features</b>	:	Signal amplifier, multiplexer, A/D converter and control logic Serial optical link for communication with DASY5 embedded system (fully remote controlled) Two step probe touch detector for mechanical surface detection and emergency robot stop
<b>Measurement Range</b>	:	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
<b>Input Offset voltage</b>	:	< 5 $\mu$ V (with auto zero)
<b>Input Resistance</b>	:	200 M $\Omega$
<b>Input Bias Current</b>	:	< 50 fA
<b>Battery Power</b>	:	> 10 h of operation (with two 9.6 V NiMH accus)
<b>Dimension</b>	:	60 x 60 x 68 mm
<b>Manufacture</b>	:	Schimid & Partner Engineering AG

#### d)Electro-Optic Converter (EOC)

<b>Version</b>	:	EOC 61
<b>Description</b>	:	for TX60 robot arm, including proximity sensor
<b>Manufacture</b>	:	Schimid & Partner Engineering AG

#### e)DASY5 Measurement server

<b>Features</b>	:	Intel ULV Celeron 400MHz 128MB chip disk and 128MB RAM 16 Bit A/D converter for surface detection system Vacuum Fluorescent Display Robot Interface Serial link to DAE (with watchdog supervision) Door contact port (Possibility to connect a light curtain) Emergency stop port (to connect the remote control) Signal lamps port Light beam port Three Ethernet connection ports Two USB 2.0 Ports Two serial links Expansion port for future applications
<b>Dimensions (L x W x H)</b>	:	440 x 241 x 89 mm
<b>Manufacture</b>	:	Schimid & Partner Engineering AG

#### f) Light Beam Switches

<b>Version</b>	:	LB5
<b>Dimensions (L x H)</b>	:	110 x 80 mm
<b>Thickness</b>	:	12 mm
<b>Beam-length</b>	:	80 mm
<b>Manufacture</b>	:	Schimid & Partner Engineering AG

#### g)Software

<b>Item</b>	:	Dosimetric Assesment System DASY5
<b>Type No.</b>	:	SD 000 401A, SD 000 402A
<b>Software version No.</b>	:	DASY52, Version 52.6 (1)
<b>Manufacture / Origin</b>	:	Schimid & Partner Engineering AG

#### h)Robot Controll Unit

<b>Weight</b>	:	70 Kg
<b>AC Input Voltage</b>	:	selectable
<b>Manufacturer</b>	:	Stäubli Robotics

### i)Phantom and Device Holder

#### Phantom

<b>Type</b>	:	SAM Twin Phantom V4.0
<b>Description</b>	:	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.
<b>Material</b>	:	Vinylester, glass fiber reinforced (VE-GF)
<b>Shell Material</b>	:	Fiberglass
<b>Thickness</b>	:	2.0 +/-0.2 mm
<b>Dimensions</b>	:	Length: 1000 mm Width: 500 mm Height: adjustable feet
<b>Volume</b>	:	Approx. 25 liters
<b>Manufacture</b>	:	Schimid & Partner Engineering AG

<b>Type</b>	:	2mm Flat phantom ERI4.0
<b>Description</b>	:	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is supported by software version DASY4.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles.
<b>Material</b>	:	Vinylester, glass fiber reinforced (VE-GF)
<b>Shell Thickness</b>	:	2.0 ± 0.2 mm (sagging: <1%)
<b>Filling Volume</b>	:	approx. 30 liters
<b>Dimensions</b>	:	Major ellipse axis: 600 mm Minor axis: 400 mm
<b>Manufacture</b>	:	Schimid & Partner Engineering AG

#### Device Holder

In combination with the Twin SAM Phantom V4.0/V4.0c or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).

<b>Material</b>	:	POM
-----------------	---	-----

#### Laptio Extensions kit

Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM, ELI4 Phantoms.

<b>Material</b>	:	POM, Acrylic glass, Foam
-----------------	---	--------------------------

#### Urethane

For this measurement, the urethane foam was used as device holder.

**j) Simulated Tissues (Liquid)**

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Mixture (%)	Frequency (MHz)									
	450		900		1800		1950		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.91	46.21	40.29	50.75	55.24	70.17	55.41	69.79	55.0	68.64
Sugar	56.93	51.17	57.90	48.21	-	-	-	-	-	-
Cellulose	0.25	0.18	0.24	0.00	-	-	-	-	-	-
Salt (NaCl)	3.79	2.34	1.38	0.94	0.31	0.39	0.08	0.2	-	-
Preventol	0.12	0.08	0.18	0.10	-	-	-	-	-	-
DGMBE	-	-	-	-	44.45	29.44	44.51	30.0	45.0	31.37
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Note: DGMBE (Diethylenglycol-monobuthyl ether)

The simulated tissue (liquid) of 1800MHz was used for the test frequency of 1700MHz to 1800MHz.

Mixture (%)	Frequency (MHz)
	750
Tissue Type	Head and Body
Water	35-58%
Sugar	40-60%
Cellulose	<0.3%
Salt (NaCl)	0-6%
Preventol	0.1-0.7%
DGMBE	-

Mixture (%)	Frequency (MHz)	
	5800	
Tissue Type	Head	Body
Water	64.0	78.0
Mineral Oil	18.0	11.0
Emulsifiers	15.0	9.0
Additives and salt	3.0	2.0

**Decision on Simulated Tissues of 750MHz**

In the current standards (e.g., IEC62209-2, IEEE P1528, OET 65 Supplement C), the dielectric parameters suggested for head and body tissue simulating liquid are given at 450MHz and 835MHz. As an intermediate solution, dielectric parameters for the frequencies between 450 to 835MHz were obtained using linear interpolation. Therefore the dielectric parameter of 750MHz (The frequency for the validation) was decided as following.

f (MHz)	Head Tissue		Body Tissue		Reference
	$\epsilon_r$	$\sigma$ [mho/m]	$\epsilon_r$	$\sigma$ [mho/m]	
450	43.5	0.87	56.7	0.94	Standard
750	41.94	0.89	55.5	0.96	Interpolated
835	41.5	0.9	55.2	0.97	Standard

Standard and interpolated dielectric parameters for head and body tissue simulating liquid in the frequency range 450 to 835MHz.

### Decision on Simulated Tissues of 1640MHz and 1750MHz

In the current standards (e.g., IEC62209-2, IEEE P1528, OET 65 Supplement C), the dielectric parameters suggested for head and body tissue simulating liquid are given at 1610MHz and 1800MHz. As an intermediate solution, dielectric parameters for the frequencies between 1610 to 1800MHz were obtained using linear interpolation. Therefore the dielectric parameter of 1640MHz and 1750MHz(The frequency for the validation) were decided as following.

f (MHz)	Head Tissue		Body Tissue		Reference
	$\epsilon_r$	$\sigma$ [mho/m]	$\epsilon_r$	$\sigma$ [mho/m]	
1450	40.5	0.87	54.0	1.30	Standard
1610	40.3	1.29	53.8	1.40	Standard
1640	40.3	1.31	53.72	1.42	Interpolated
1750	40.08	1.37	53.43	1.49	Interpolated
1800	40.0	1.40	53.3	1.52	Standard

Standard and interpolated dielectric parameters for head and body tissue simulating liquid in the frequency range 1610 to 1800MHz.

### Decision on Simulated Tissues of 5GHz band

In the current standards (e.g., IEC62209-2, IEEE P1528, OET 65 Supplement C), the dielectric parameters suggested for head and body tissue simulating liquid are given at 3000MHz and 5800MHz. As an intermediate solution, dielectric parameters for the frequencies between 5000to 5800 MHz were obtained using linear interpolation. Therefore the dielectric parameters of 5200MHz,5300MHz,5600MHz and 5500MHz(The frequency for the validation) were decided as following.

f (MHz)	Head Tissue		Body Tissue		Reference
	$\epsilon_r$	$\sigma$ [mho/m]	$\epsilon_r$	$\sigma$ [mho/m]	
3000	38.5	2.40	52.0	2.73	Standard
5800	35.3	5.27	48.2	6.00	Standard
5000	36.2	4.45	49.3	5.07	Interpolated
5100	36.1	4.55	49.1	5.18	Interpolated
5200	36.0	4.66	49.0	5.30	Interpolated
5300	35.9	4.76	48.9	5.42	Interpolated
5400	35.8	4.86	48.7	5.53	Interpolated
5500	35.6	4.96	48.6	5.65	Interpolated
5600	35.5	5.07	48.5	5.77	Interpolated
5700	35.4	5.17	48.3	5.88	Interpolated

Standard and interpolated dielectric parameters for head and body tissue simulating liquid in the frequency range 3000 to 5800MHz.

3. Dosimetric E-Field Probe Calibration (ET3DV6, S/N: 1705)

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



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The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client PTT

Certificate No: ET3-1705\_Jun13

**CALIBRATION CERTIFICATE**

Object ET3DV6 - SN:1705

Calibration procedure(s) QA CAL-01.v8, QA CAL-12.v7, QA CAL-23.v4, QA CAL-25.v4  
Calibration procedure for dosimetric E-field probes

Calibration date: June 17, 2013

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	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: June 17, 2013

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

#### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ 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:

- 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
- 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:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* 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.
- DCP<sub>x,y,z</sub>**: 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.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D 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  $f \leq 800$  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 NORM<sub>x,y,z</sub> \* 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  $\pm 50$  MHz to  $\pm 100$  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.



ET3DV6 -- SN:1705

June 17, 2013

# Probe ET3DV6

## SN:1705

Manufactured: May 2, 2002  
Calibrated: June 17, 2013

Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

ET3DV6- SN:1705

June 17, 2013

## DASY/EASY - Parameters of Probe: ET3DV6 - SN:1705

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	1.32	1.46	1.44	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	98.4	98.2	96.9	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>C</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	156.3	$\pm 2.7 \%$
		Y	0.0	0.0	1.0		175.8	
		Z	0.0	0.0	1.0		165.2	

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%.

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>C</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

ET3DV6- SN:1705

June 17, 2013

## DASY/EASY - Parameters of Probe: ET3DV6 - SN:1705

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
300	45.3	0.87	7.60	7.60	7.60	0.29	1.32	± 13.4 %
450	43.5	0.87	7.23	7.23	7.23	0.26	2.50	± 13.4 %
650	42.5	0.89	6.94	6.94	6.94	0.20	2.25	± 13.4 %
835	41.5	0.90	6.22	6.22	6.22	0.28	2.77	± 12.0 %
900	41.5	0.97	6.14	6.14	6.14	0.29	2.78	± 12.0 %
1450	40.5	1.20	5.55	5.55	5.55	0.73	2.41	± 12.0 %
1640	40.3	1.29	5.45	5.45	5.45	0.80	2.34	± 12.0 %
1750	40.1	1.37	5.27	5.27	5.27	0.77	2.31	± 12.0 %
1900	40.0	1.40	5.02	5.02	5.02	0.80	1.83	± 12.0 %
1950	40.0	1.40	4.87	4.87	4.87	0.80	1.86	± 12.0 %

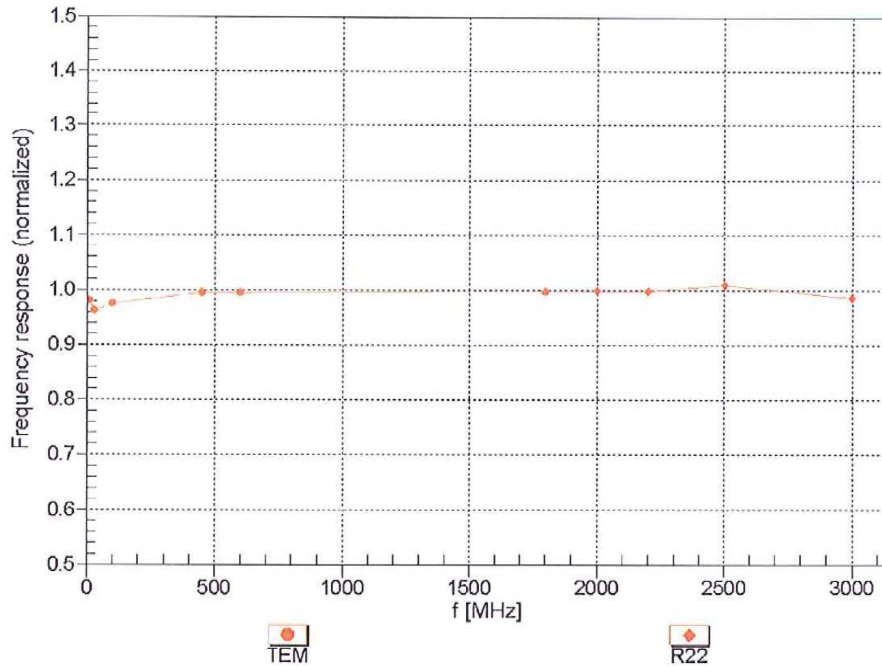
<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

ET3DV6-SN:1705

June 17, 2013

## Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

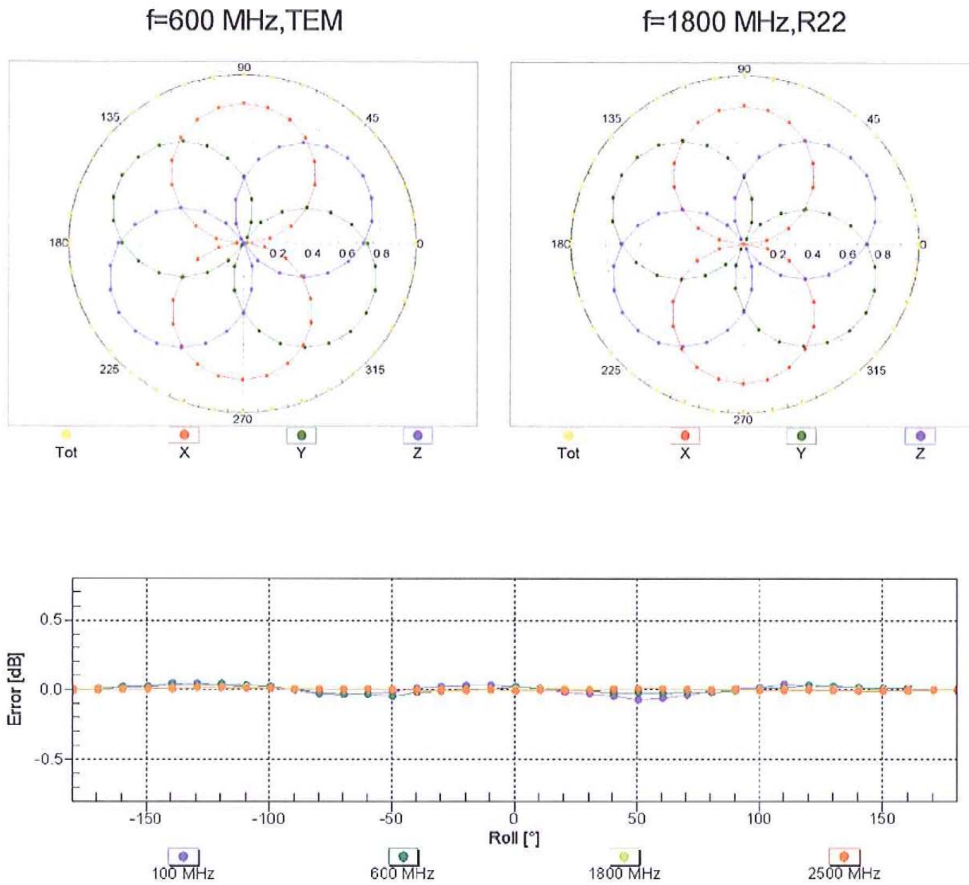


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

ET3DV6- SN:1705

June 17, 2013

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

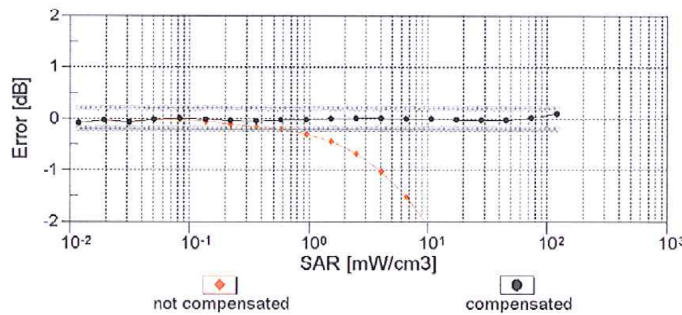
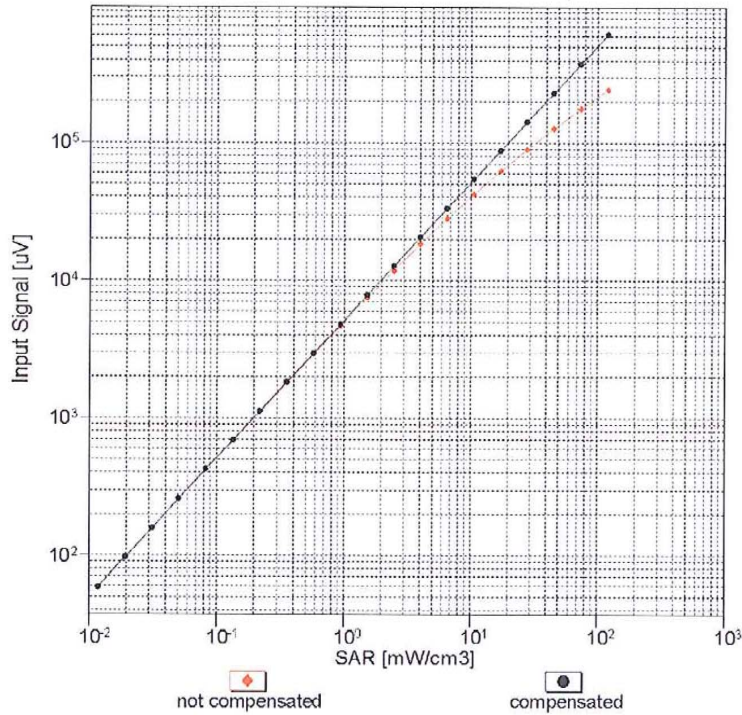


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

ET3DV6- SN:1705

June 17, 2013

### Dynamic Range $f(SAR_{head})$ (TEM cell, $f = 900$ MHz)

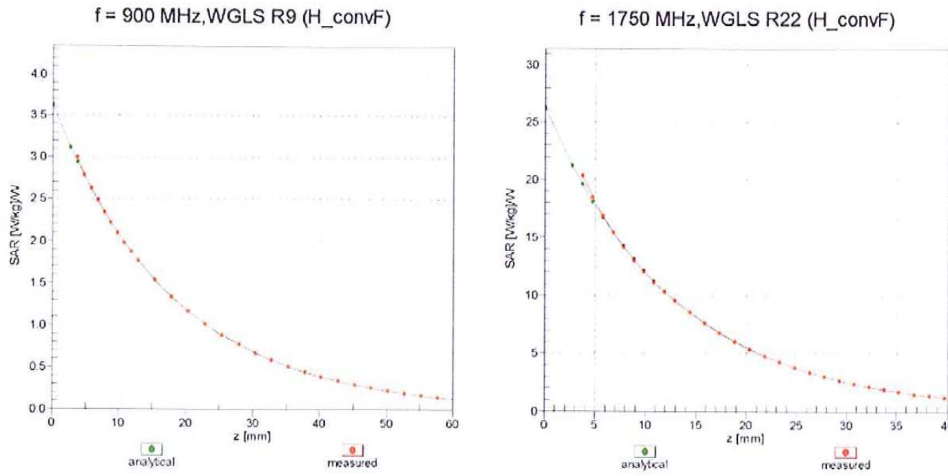


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

ET3DV6-SN:1705

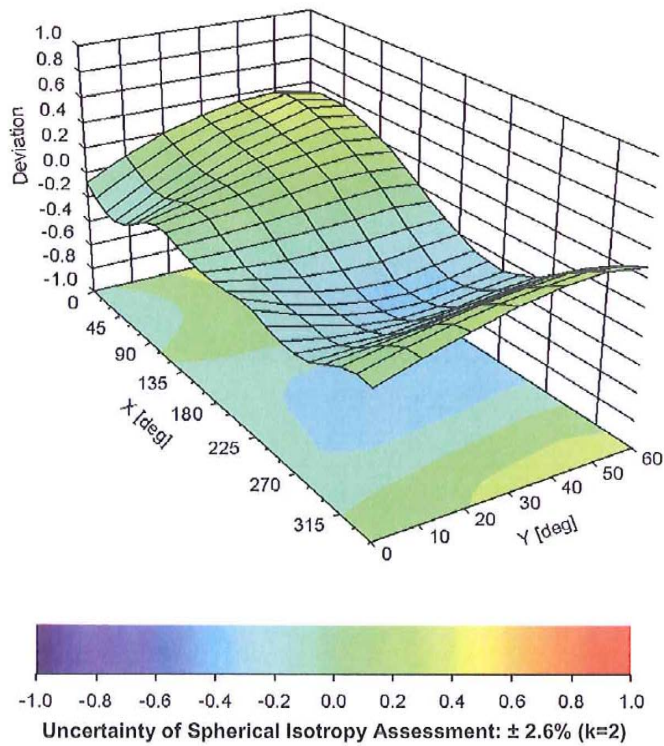
June 17, 2013

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

Error ( $\phi$ ,  $\vartheta$ ), f = 900 MHz



ET3DV6-SN:1705

June 17, 2013

## DASY/EASY - Parameters of Probe: ET3DV6 - SN:1705

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	0.5
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	enabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	6.8 mm
Probe Tip to Sensor X Calibration Point	2.7 mm
Probe Tip to Sensor Y Calibration Point	2.7 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	4 mm



4. Dosimetric E-Field Probe Calibration (ET3DV6, S/N: 1685)

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



S Schweizerischer Kalibrierdienst  
S Service suisse d'étalonnage  
S Servizio svizzero di taratura  
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **UL Japan (PTT)**

Certificate No: **ET3-1685\_Jul13**

**CALIBRATION CERTIFICATE**

Object **ET3DV6 - SN:1685**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-12.v7, QA CAL-23.v4, QA CAL-25.v4  
Calibration procedure for dosimetric E-field probes**

Calibration date: **July 19, 2013**

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	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrali	Laboratory Technician	
Approved by:	Katja Pokvcic	Technical Manager	

Issued: July 19, 2013

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

**Calibration Laboratory of  
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Engineering AG**  
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**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

#### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ 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:

- 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
- 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:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* 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.
- DCP<sub>x,y,z</sub>**: 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.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>; A, B, C, D** 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  $f \leq 800$  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 NORM<sub>x,y,z</sub> \* 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  $\pm 50$  MHz to  $\pm 100$  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.

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# Probe ET3DV6

## SN:1685

Manufactured: April 3, 2002  
Calibrated: July 19, 2013

Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

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## DASY/EASY - Parameters of Probe: ET3DV6 - SN:1685

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	1.64	1.71	1.64	± 10.1 %
DCP (mV) <sup>B</sup>	100.0	97.8	98.5	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	140.0	±3.8 %
		Y	0.0	0.0	1.0		141.3	
		Z	0.0	0.0	1.0		135.7	

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%.

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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## DASY/EASY - Parameters of Probe: ET3DV6 - SN:1685

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
300	45.3	0.87	8.39	8.39	8.39	0.31	1.61	± 13.4 %
450	43.5	0.87	7.50	7.50	7.50	0.22	2.26	± 13.4 %
650	42.5	0.89	7.34	7.34	7.34	0.18	1.97	± 13.4 %
1450	40.5	1.20	5.57	5.57	5.57	0.44	2.47	± 12.0 %
1640	40.3	1.29	5.56	5.56	5.56	0.50	2.63	± 12.0 %

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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## DASY/EASY - Parameters of Probe: ET3DV6 - SN:1685

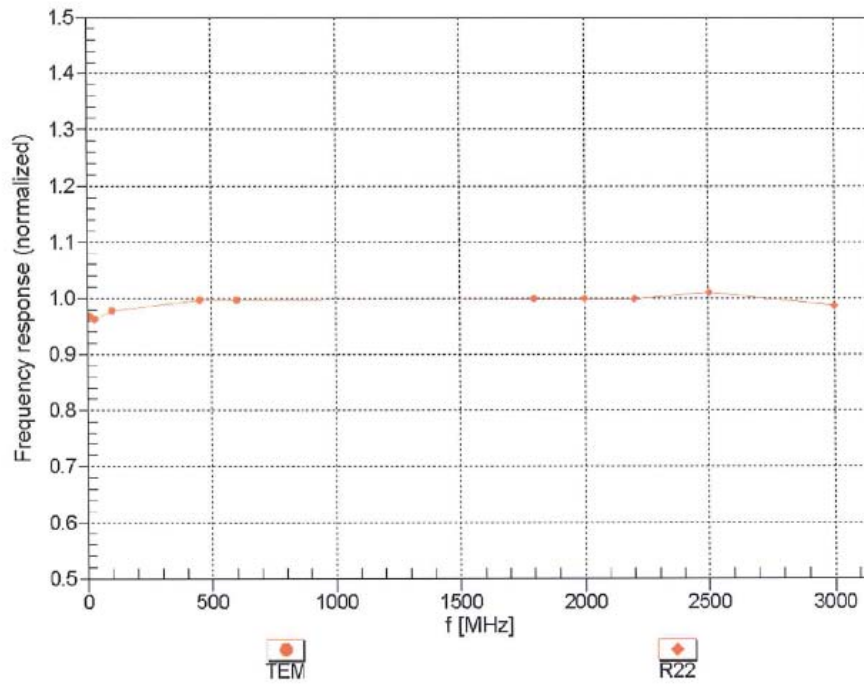
### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
300	58.2	0.92	8.09	8.09	8.09	0.25	1.84	± 13.4 %
450	56.7	0.94	8.05	8.05	8.05	0.16	2.20	± 13.4 %
650	55.9	0.96	7.28	7.28	7.28	0.10	1.20	± 13.4 %
1450	54.0	1.30	5.22	5.22	5.22	0.80	1.35	± 12.0 %
1640	53.8	1.40	5.05	5.05	5.05	0.67	2.56	± 12.0 %

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

### Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



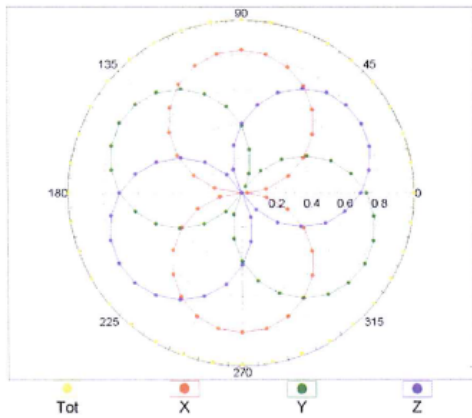
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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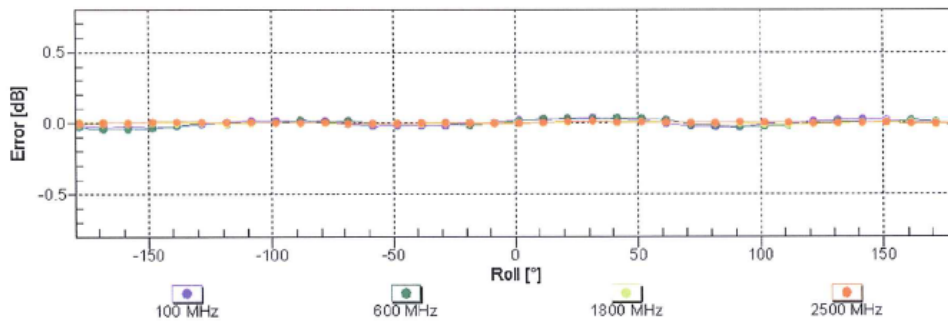
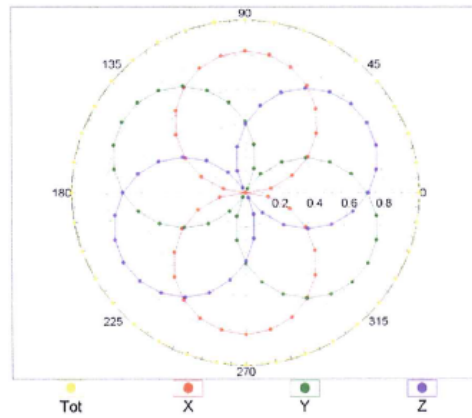
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## Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$

f=600 MHz,TEM



f=1800 MHz,R22



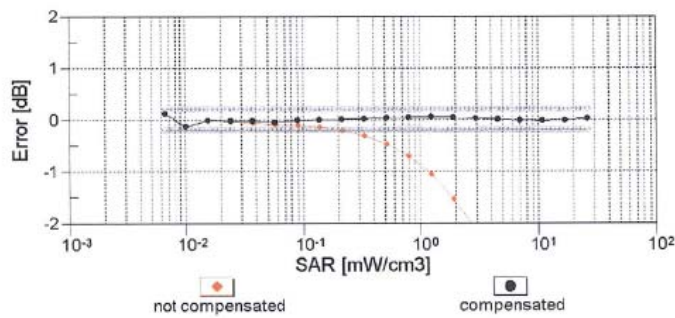
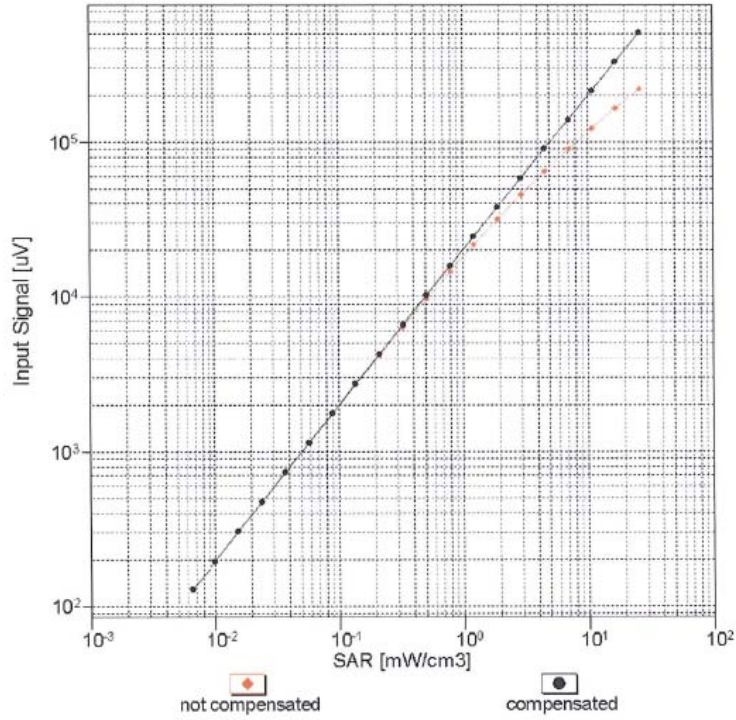
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)



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### Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f = 900 MHz)

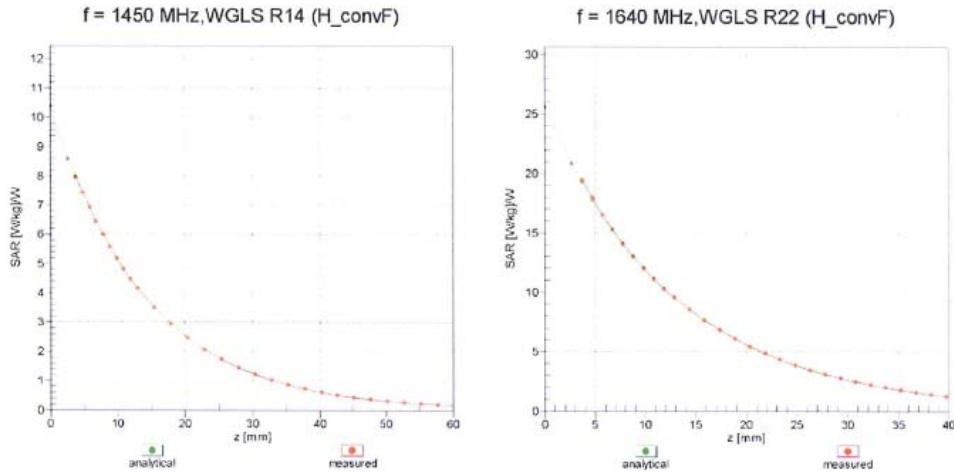


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

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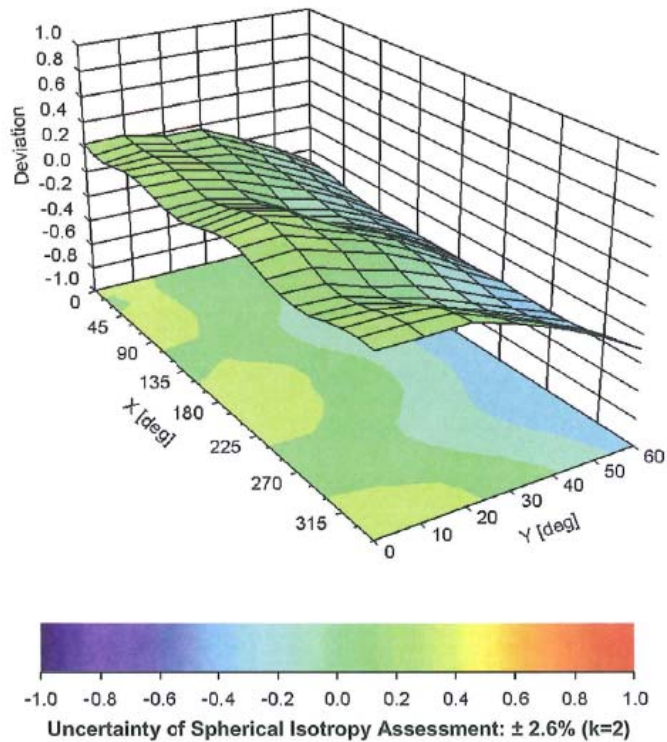
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## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

Error ( $\phi$ ,  $\theta$ ), f = 900 MHz



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## DASY/EASY - Parameters of Probe: ET3DV6 - SN:1685

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-88.4
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	enabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	6.8 mm
Probe Tip to Sensor X Calibration Point	2.7 mm
Probe Tip to Sensor Y Calibration Point	2.7 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	4 mm