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**Appendix for the Report**  
**Dosimetric Assessment of the**  
**Panasonic KX-TGA651**  
**(FCC ID: ACJ96NKX-TGA651)**  
**According to the FCC Requirements**

**Calibration Data**

November 17, 2009

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

Customer  
Panasonic Communications Co., Ltd.  
1 -62, 4 - chome, Minoshima, Hakata - Ku  
Fukuoka 812-8531 Japan



Accredited by the Swiss Accreditation Service (SAS)  
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **IMST**

Certificate No: **EX3-3536\_Sep09**

## CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3536**

Calibration procedure(s) **QA CAL-01.v6, QA CAL-14.v3, QA CAL-23.v3 and QA CAL-25.v2  
Calibration procedure for dosimetric E-field probes**

Calibration date: **September 18, 2009**

Condition of the calibrated item **In Tolerance**

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  $(22 \pm 3)^\circ\text{C}$  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-09 (No. 217-01030)	Apr-10
Power sensor E4412A	MY41495277	1-Apr-09 (No. 217-01030)	Apr-10
Power sensor E4412A	MY41498087	1-Apr-09 (No. 217-01030)	Apr-10
Reference 3 dB Attenuator	SN: S5054 (3c)	31-Mar-09 (No. 217-01026)	Mar-10
Reference 20 dB Attenuator	SN: S5086 (20b)	31-Mar-09 (No. 217-01028)	Mar-10
Reference 30 dB Attenuator	SN: S5129 (30b)	31-Mar-09 (No. 217-01027)	Mar-10
Reference Probe ES3DV2	SN: 3013	2-Jan-09 (No. ES3-3013_Jan09)	Jan-10
DAE4	SN: 660	9-Sep-08 (No. DAE4-660_Sep08)	Sep-09
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-08)	In house check: Oct-09

Calibrated by:	Name <b>Katja Pokovic</b>	Function <b>Technical Manager</b>	Signature 
Approved by:	Name <b>Niels Kuster</b>	Function <b>Quality Manager</b>	

Issued: September 18, 2009

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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
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 effect 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 (no uncertainty required). DCP does not depend on frequency nor media.
- 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.

# Probe EX3DV4

## SN:3536

Manufactured:	April 30, 2004
Last calibrated:	September 19, 2008
Recalibrated:	September 18, 2009

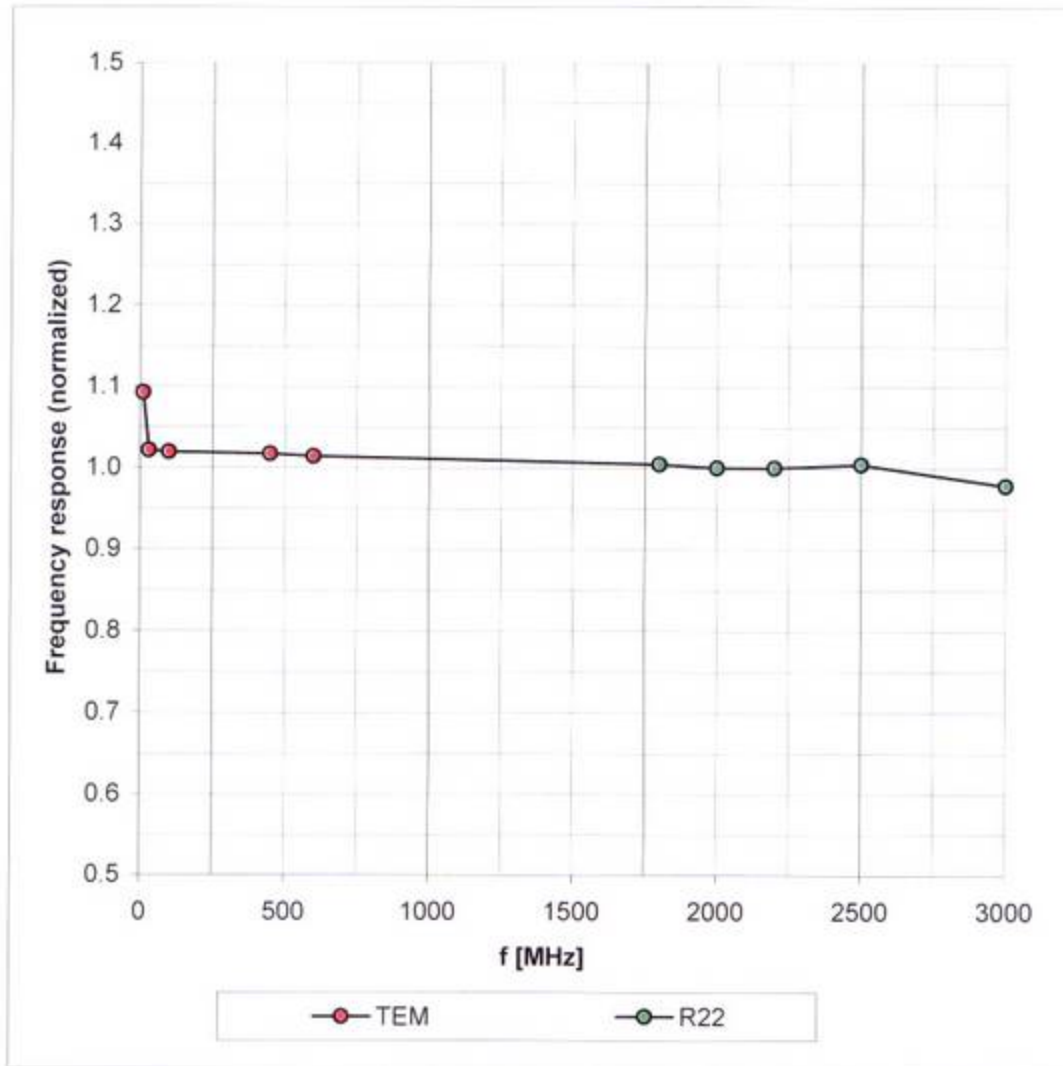
Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)



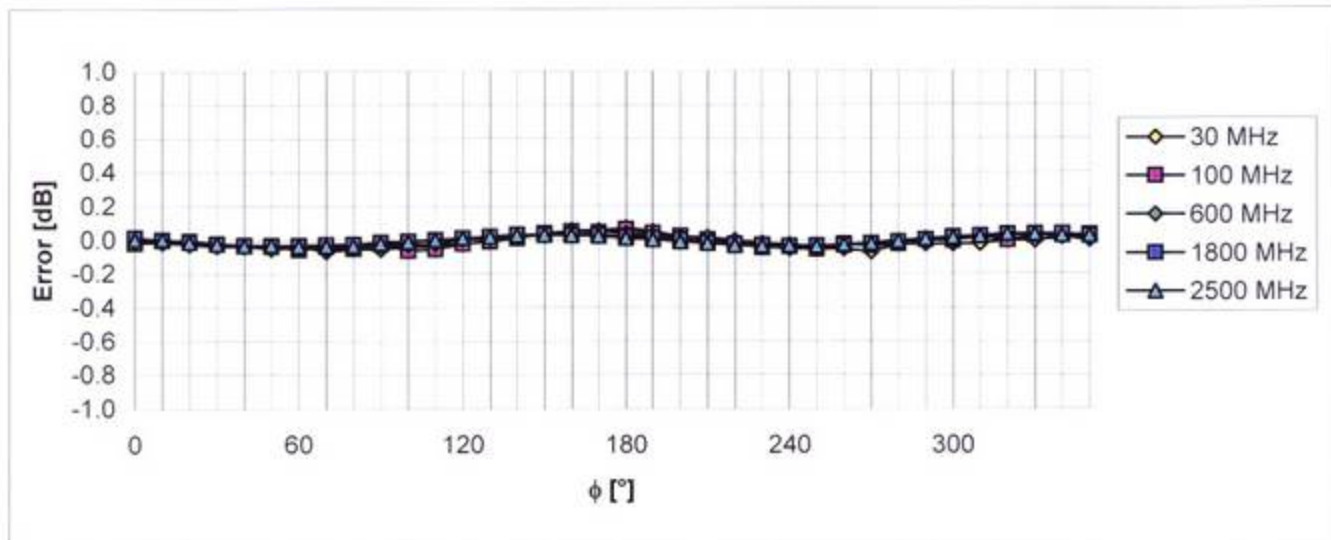
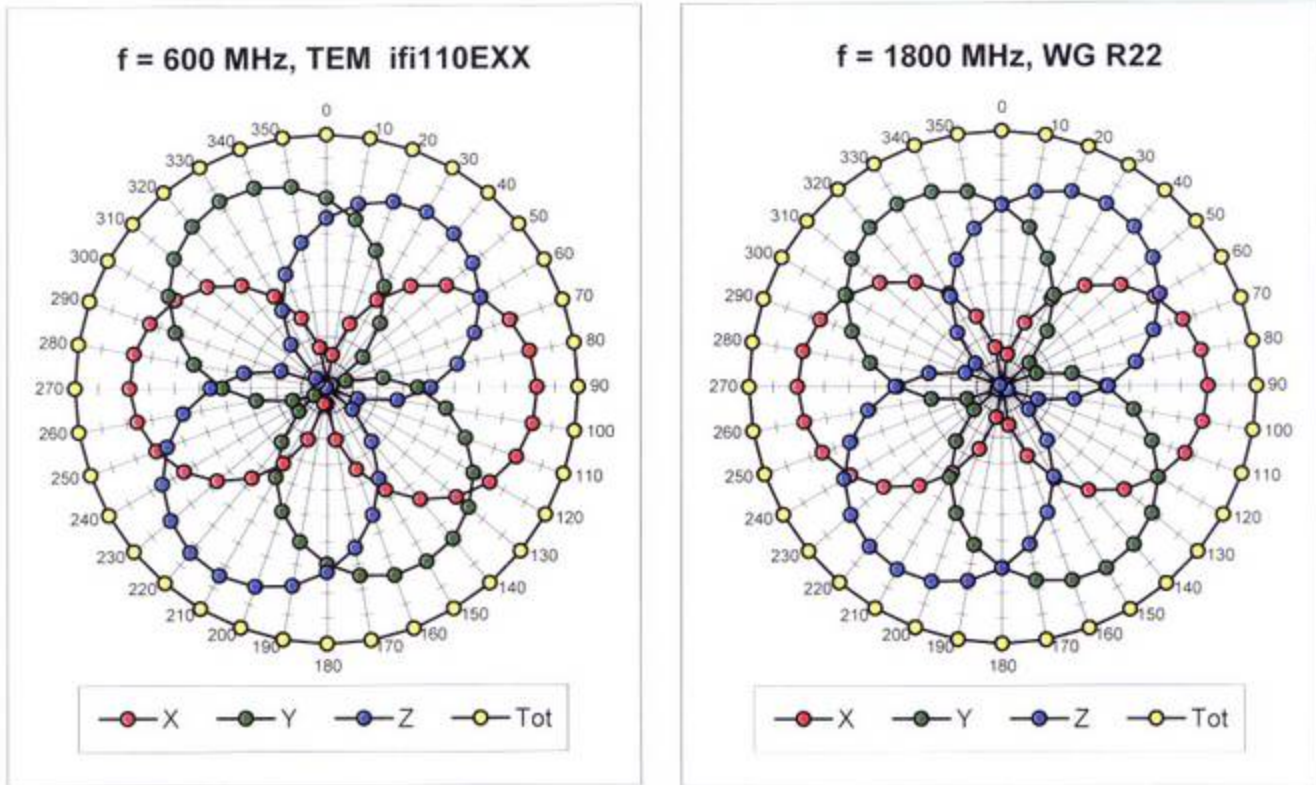
# Frequency Response of E-Field

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



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

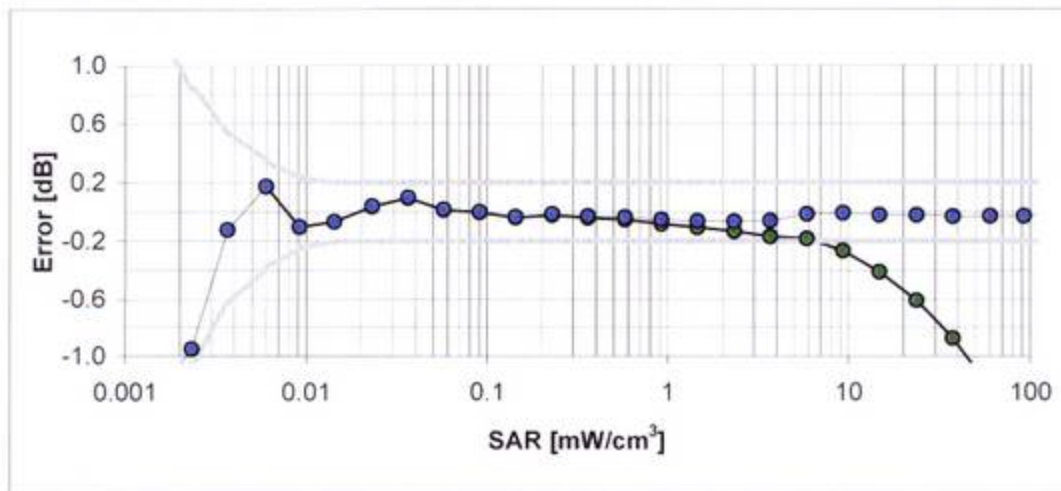
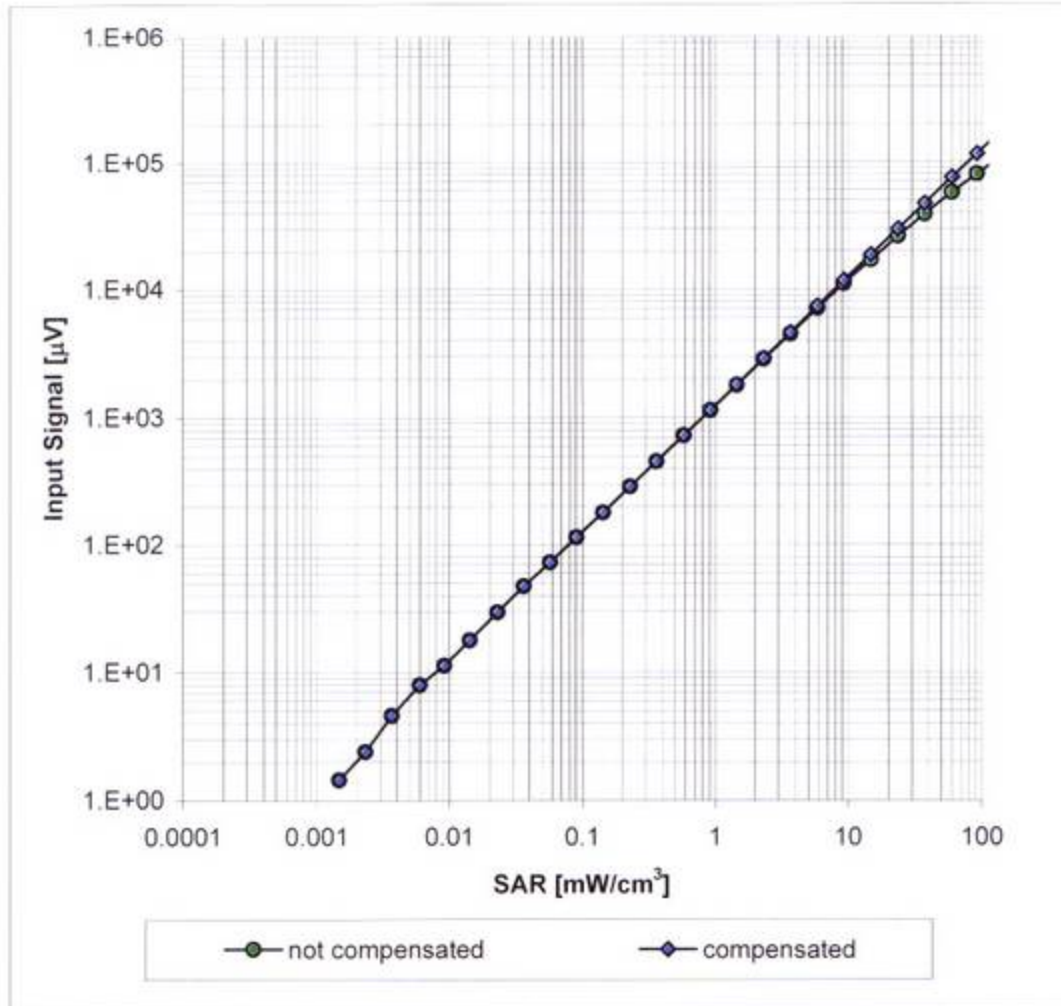
### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



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

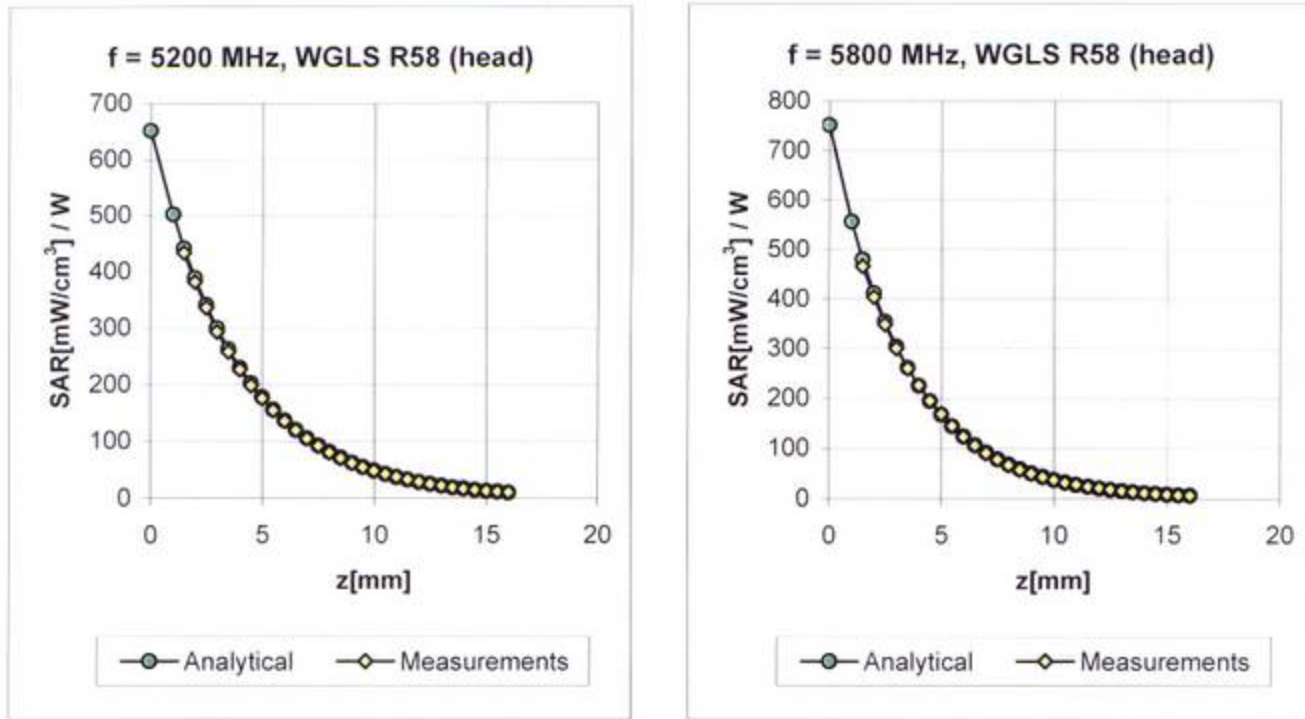
## Dynamic Range f(SAR<sub>head</sub>)

(Waveguide R22, f = 1800 MHz)



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

### Conversion Factor Assessment

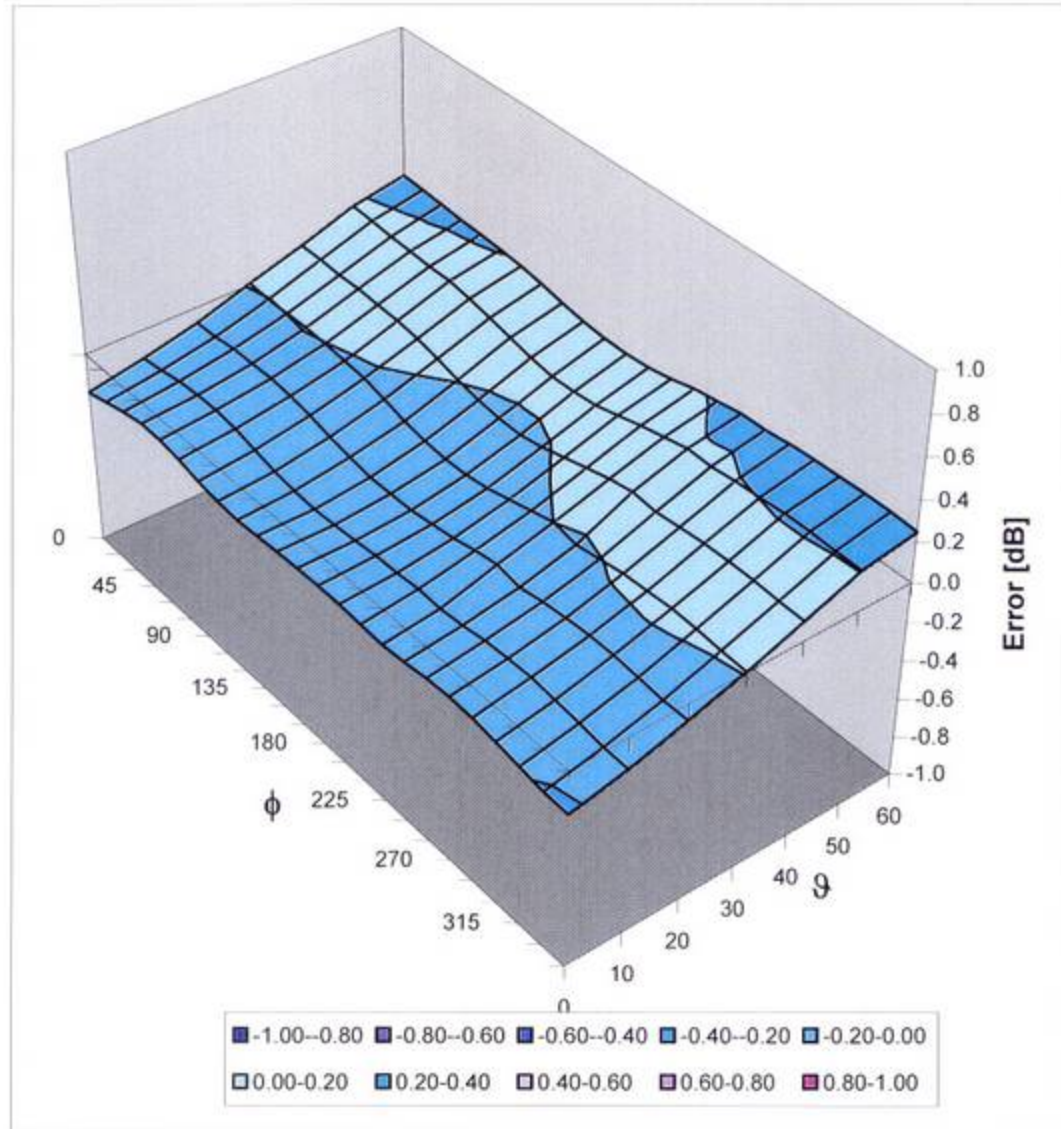


f [MHz]	Validity [MHz] <sup>c</sup>	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
1950	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.58	0.69	7.95 ± 11.0% (k=2)
2450	± 50 / ± 100	Head	39.2 ± 5%	1.80 ± 5%	0.31	0.96	7.59 ± 11.0% (k=2)
2600	± 50 / ± 100	Head	39.0 ± 5%	1.96 ± 5%	0.35	0.96	7.52 ± 11.0% (k=2)
3500	± 50 / ± 100	Head	37.9 ± 5%	2.91 ± 5%	0.32	1.10	7.50 ± 13.1% (k=2)
5200	± 50 / ± 100	Head	36.0 ± 5%	4.66 ± 5%	0.39	1.90	5.24 ± 13.1% (k=2)
5300	± 50 / ± 101	Head	35.9 ± 5%	4.76 ± 5%	0.38	1.90	4.96 ± 13.1% (k=2)
5600	± 50 / ± 101	Head	35.5 ± 5%	5.07 ± 5%	0.38	1.90	4.93 ± 13.1% (k=2)
5800	± 50 / ± 100	Head	35.3 ± 5%	5.27 ± 5%	0.48	1.90	4.63 ± 13.1% (k=2)
1950	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.52	0.79	8.11 ± 11.0% (k=2)
2450	± 50 / ± 100	Body	52.7 ± 5%	1.95 ± 5%	0.45	0.78	7.57 ± 11.0% (k=2)
2600	± 50 / ± 100	Body	52.5 ± 5%	2.16 ± 5%	0.32	1.06	7.55 ± 11.0% (k=2)
3500	± 50 / ± 100	Body	51.3 ± 5%	3.31 ± 5%	0.26	1.55	6.75 ± 13.1% (k=2)
5200	± 50 / ± 100	Body	49.0 ± 5%	5.30 ± 5%	0.50	1.95	4.54 ± 13.1% (k=2)
5300	± 50 / ± 101	Body	48.5 ± 5%	5.42 ± 5%	0.50	1.95	4.37 ± 13.1% (k=2)
5600	± 50 / ± 101	Body	48.5 ± 5%	5.77 ± 5%	0.50	1.95	4.22 ± 13.1% (k=2)
5800	± 50 / ± 100	Body	48.2 ± 5%	6.00 ± 5%	0.62	1.95	4.20 ± 13.1% (k=2)

<sup>c</sup> 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.

### Deviation from Isotropy in HSL

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



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  ( $k=2$ )



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Accreditation No.: **SCS 108**

Client **IMST**

Certificate No: **ET3-1669\_Feb09**

**CALIBRATION CERTIFICATE**

Object **ET3DV6R - SN:1669**

Calibration procedure(s) **QA CAL-01.v6, QA CAL-12.v5 and QA CAL-23.v3  
Calibration procedure for dosimetric E-field probes**

Calibration date: **February 10, 2009**

Condition of the calibrated item **In Tolerance**

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All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

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Reference 20 dB Attenuator	SN: S5086 (20b)	31-Mar-08 (No. 217-00787)	Apr-09
Reference 30 dB Attenuator	SN: S5129 (30b)	1-Jul-08 (No. 217-00866)	Jul-09
Reference Probe ES3DV2	SN: 3013	2-Jan-09 (No. ES3-3013_Jan09)	Jan-10
DAE4	SN: 660	9-Sep-08 (No. DAE4-660_Sep08)	Sep-09
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Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-08)	In house check: Oct-09

Calibrated by: **Katja Pokovic** (Name) / **Technical Manager** (Function) / *[Signature]* (Signature)

Approved by: **Niels Kuster** (Name) / **Quality Manager** (Function) / *[Signature]* (Signature)

Issued: February 10, 2009

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- 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 ET3DV6R

## SN:1669

Manufactured:	February 8, 2002
Last calibrated:	February 15, 2007
Recalibrated:	February 10, 2009

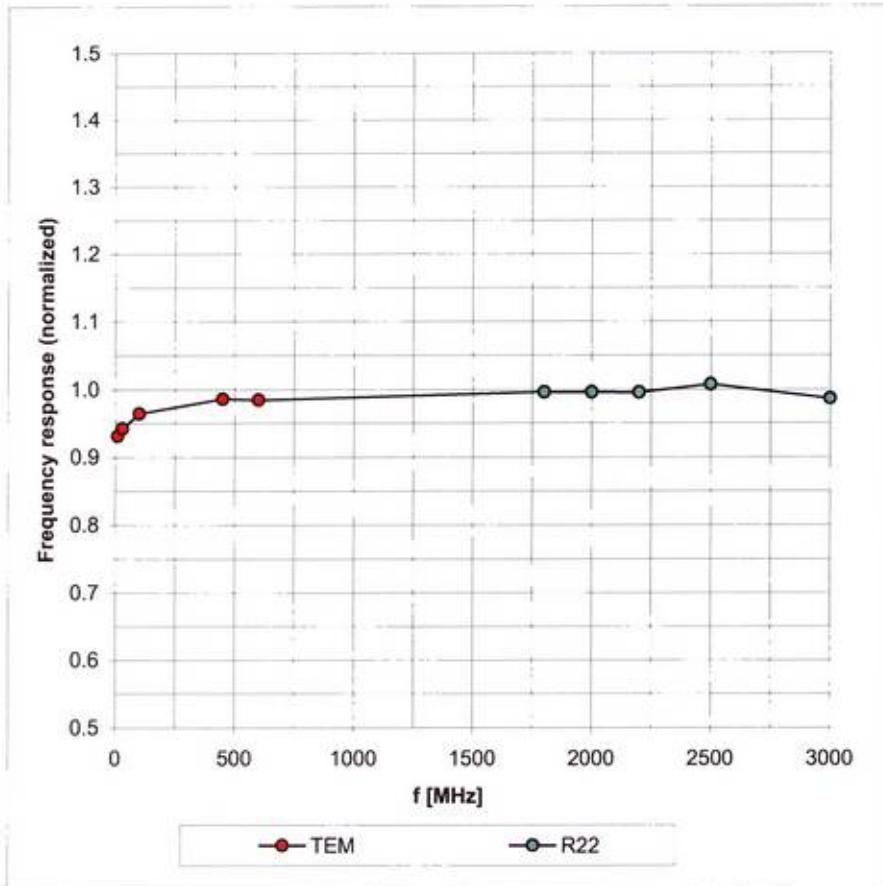
Calibrated for DASYS Systems

(Note: non-compatible with DASYS2 system!)



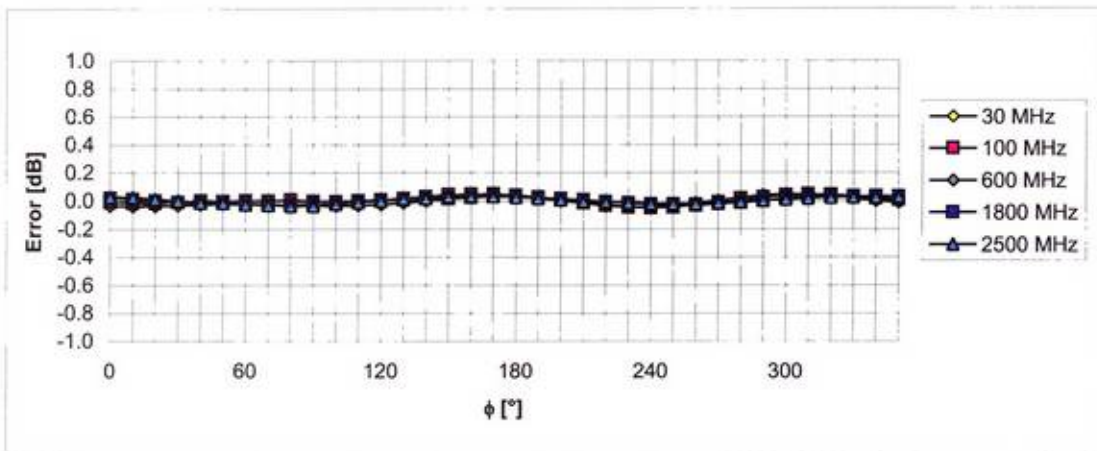
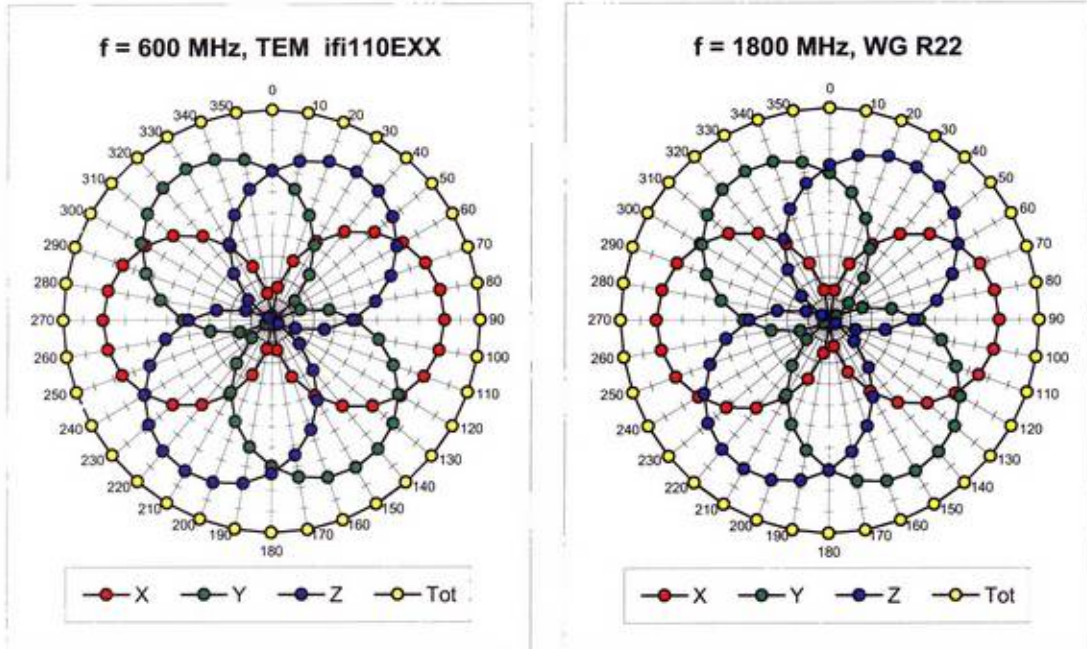
### Frequency Response of E-Field

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



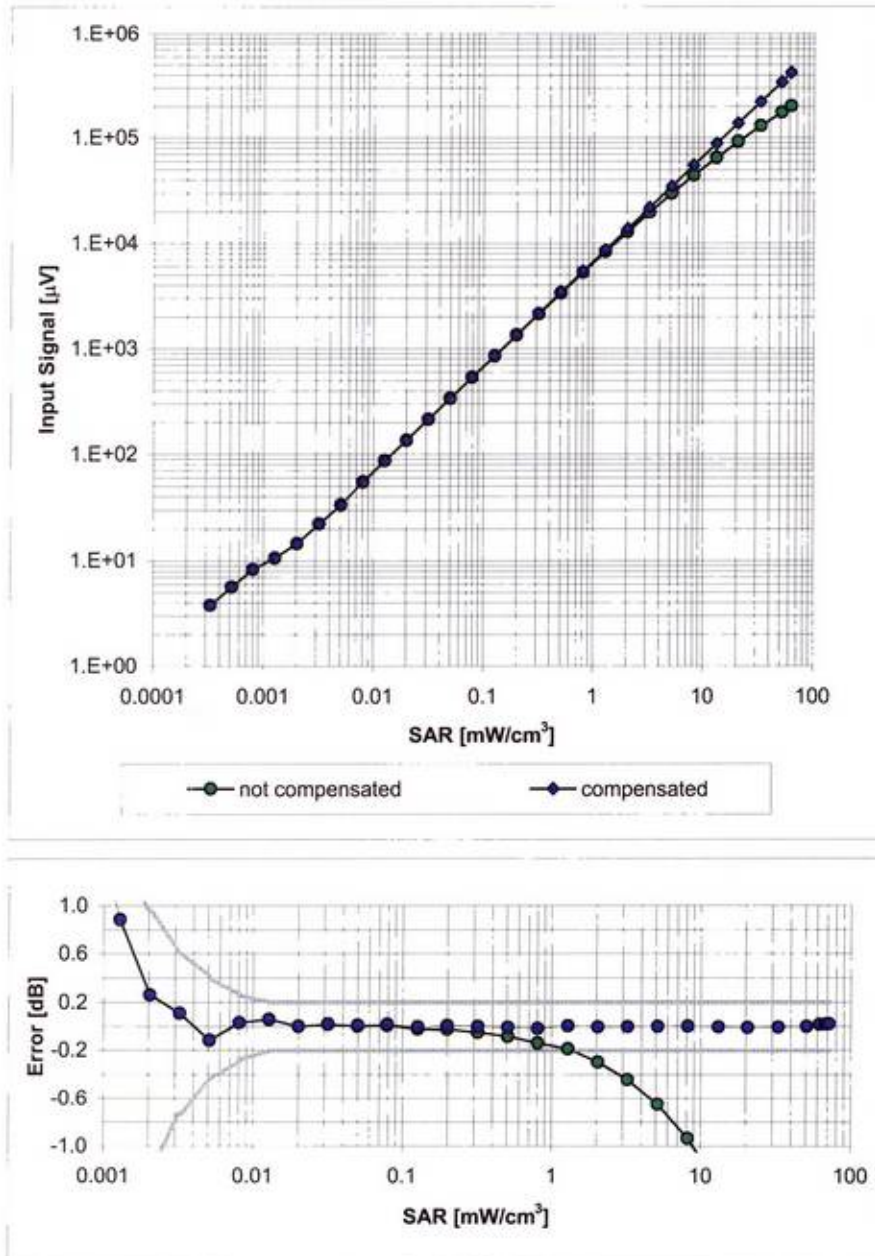
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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



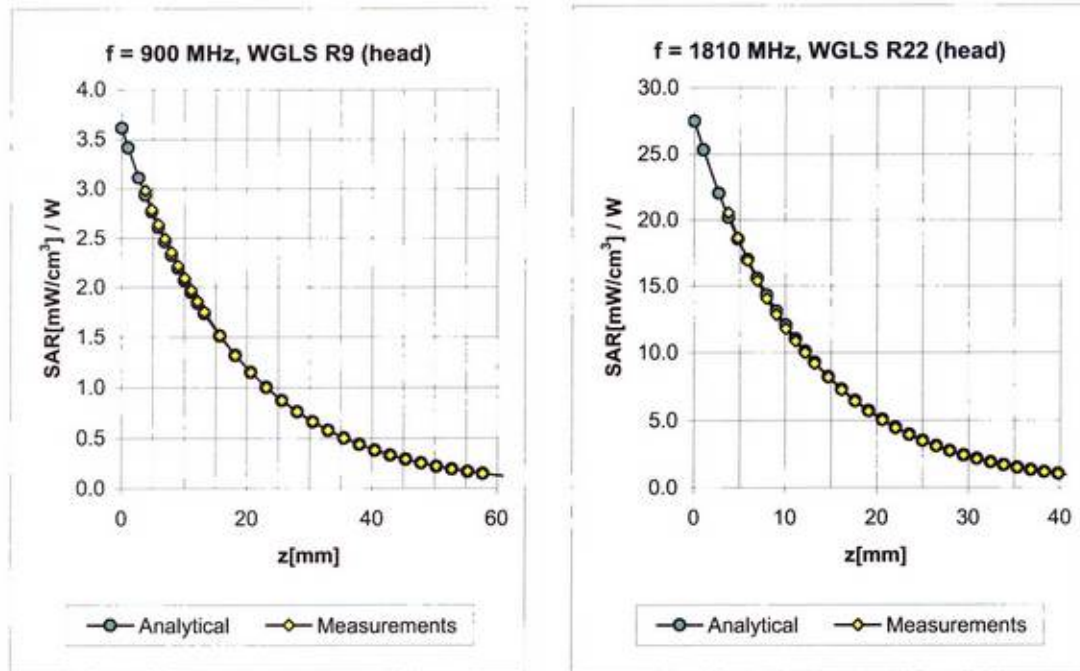
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

### Dynamic Range $f(SAR_{head})$ (Waveguide R22, $f = 1800$ MHz)



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

## Conversion Factor Assessment

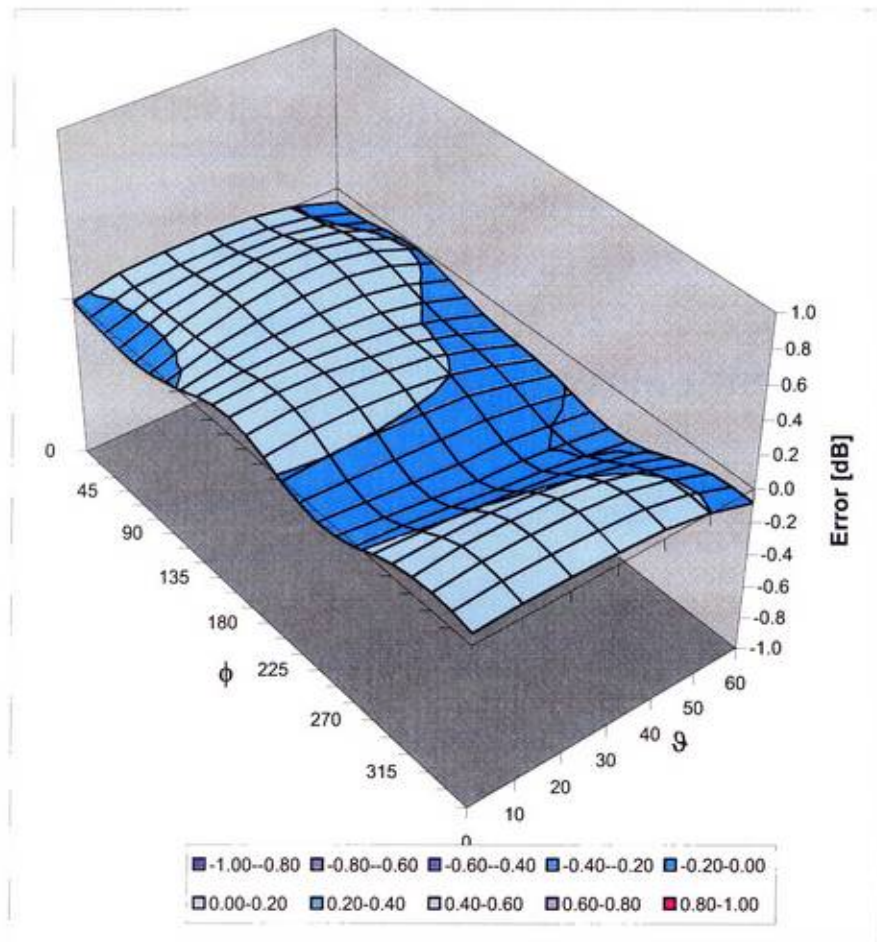


f [MHz]	Validity [MHz] <sup>c</sup>	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
450	± 50 / ± 100	Head	43.5 ± 5%	0.87 ± 5%	0.38	1.91	6.90 ± 13.3% (k=2)
900	± 50 / ± 100	Head	41.5 ± 5%	0.97 ± 5%	0.38	2.38	5.98 ± 11.0% (k=2)
1810	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.54	2.52	5.11 ± 11.0% (k=2)
1950	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.70	2.15	4.88 ± 11.0% (k=2)
450	± 50 / ± 100	Body	56.7 ± 5%	0.94 ± 5%	0.29	1.88	7.29 ± 13.3% (k=2)
900	± 50 / ± 100	Body	55.0 ± 5%	1.05 ± 5%	0.30	3.09	5.89 ± 11.0% (k=2)
1810	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.84	2.03	4.69 ± 11.0% (k=2)
1950	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.99	1.76	4.66 ± 11.0% (k=2)

<sup>c</sup> 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.

## Deviation from Isotropy in HSL

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



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  ( $k=2$ )

DAT-P-152/98-01

### Calibration Certificate

Certificate No: Cal\_D1900V2\_SN5d051\_0909  
 Object: D1900V2 SN: 5d051  
 Date of Calibration: September 09, 2009  
 Next Calibration: September 2011  
 Object Condition: In Tolerance

**Calibration Equipment used:**

Test Equipment	Serial Number	Last calibration	Calibrated by	Next calibration
Powermeter E4416A	GB41050414	Dec 08	Agilent Techn. (ISO/IEC 17025, 1-1784162174-1)	Dec 10
Power Sensor E9301H	US40010212	Dec 08	Agilent Techn. (ISO/IEC 17025, 1-1784041195-1)	Dec 10
Powermeter E4417A	GB41050441	Dec 08	Agilent Techn. (ISO/IEC 17025, 1-1674038198-1)	Dec 10
Power Sensor E9301A	MY41495584	Dec 08	Agilent Techn. (ISO/IEC 17025, 1-1784041307-1)	Dec 10
Network Analyzer E5071C	MY46103220	Aug 09	Rohde& Schwarz (14967-DKD-00201- 2009-08)	Aug 10
Reference Probe ET3DV6	SN 1669	Feb 09	SPEAG, No ET3- 1669_Feb09	Feb 10
DAE3	SN 335	Feb 09	SPEAG, No DAE3- 335_Feb09	Feb 10

**Calibration is performed according the following standards:****IEEE 1528-2003**

"IEEE Recommended Practice for Determining the Peak Spatial - Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Technique", 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 3GHz)", February 2005

**Federal Communications Commission Office of Engineering & Technologies (FCCOET)**

"Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:** DASY 4 System Handbook

prepared by:



Alexander Rahn  
test engineer

reviewed by:



André van den Bosch  
quality assurance engineer

Measurement Conditions		
DASY Version:	Dasy 4;	V4.7
Phantom:	SAM Phantom	1340
Distance Dipole Center – TSL:	10mm	With spacer
Zoom Scan res.	dx, dy, dz = 5mm	
Frequency:	1900 MHz $\pm$ 1MHz	

Head TSL Parameters			
	Temperature	Permittivity	Conductivity
Nominal Head TSL Parameters	22.0	40.0	1.40
Measured Head TSL Parameters	22.0	40.3 $\pm$ 6%	1.45 S/m $\pm$ 6%

SAR result with Head TSL			
Averaged over 1g	SAR measured	250mW input power	9.10 mW/g
	SAR normalized	normalized to 1W	36.40 mW/g
	SAR for nominal Head TSL parameters	normalized to 1W	<b>35.90 mW/g <math>\pm</math> 16.5 % (k=2)</b>
Averaged over 10g	SAR measured	250mW input power	4.76 mW/g
	SAR normalized	normalized to 1W	19.04 mW/g
	SAR for nominal Head TSL parameters	normalized to 1W	<b>18.96 mW/g <math>\pm</math> 16.5 % (k=2)</b>

Body TSL Parameters			
	Temperature	Permittivity	Conductivity
Nominal Body TSL Parameters	22.0	53.30	1.52
Measured Body TSL Parameters	22.0	52.90 ± 6%	1.54 S/m ± 6%

SAR result with Body TSL			
Averaged over 1g	SAR measured	250mW input power	9.42 mW/g
	SAR normalized	normalized to 1W	37.68 mW/g
	SAR for nominal Body TSL parameters	normalized to 1W	<b>37.28 mW/g ± 16.5 % (k=2)</b>
Averaged over 10g	SAR measured	250mW input power	4.97 mW/g
	SAR normalized	normalized to 1W	19.88 mW/g
	SAR for nominal Body TSL parameters	normalized to 1W	<b>19.77 mW/g ± 16.5 % (k=2)</b>

General Antenna Parameters		
Antenna Parameters with Head TSL	Impedance, transformed to feed point	48.2 jΩ - 1.3 jΩ
	Return Loss	-33.0 dB
Antenna Parameter with Body TSL	Impedance, transformed to feed point	53.9 jΩ - 0.4 jΩ
	Return Loss	-28.3 dB

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured. 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.

Additional EUT Data	
Manufactured by:	SPEAG
Manufactured on:	January 15, 1998

**SAR result with Head TSL**

Test Laboratory: IMST GmbH, DASY Blue (I); File Name: [090909\\_b\\_1669.da4](#)

DUT: Dipole 1900 MHz SN: 5d051; Type: D1900V2; Serial: D1900V2 - SN5d051

Program Name: System Performance Check at 1900 MHz

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.45$  mho/m;  $\epsilon_r = 40.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6R - SN1669; ConvF(5.11, 5.11, 5.11); Calibrated: 10.02.2009

- Sensor-Surface: 4mm (Mechanical Surface Detection)

- Electronics: DAE3 Sn335; Calibrated: 09.02.2009

- Phantom: SAM Glycol 1176; Type: Speag; Serial: 1176

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**d=10mm, Pin=250mW/Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 10.4 mW/g

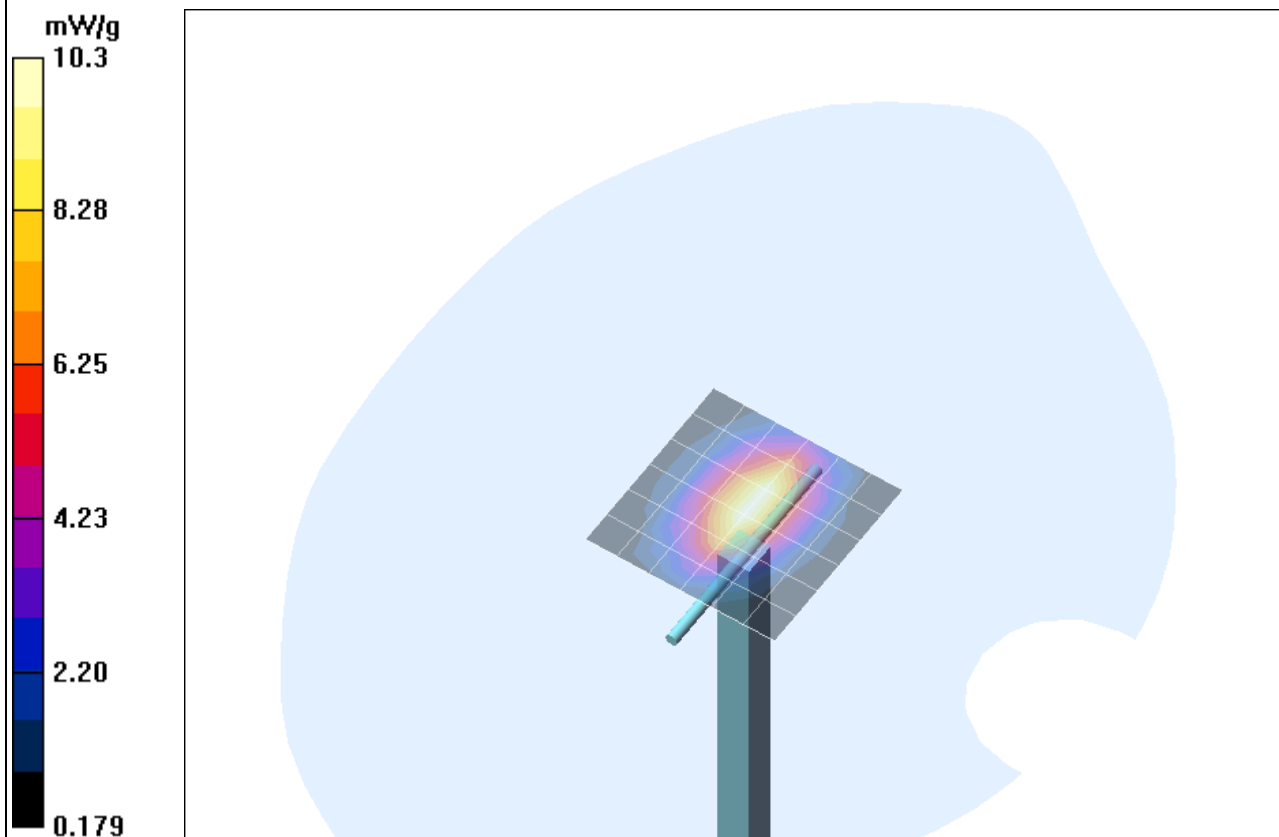
**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 91.3 V/m; Power Drift = -0.152 dB

Peak SAR (extrapolated) = 15.9 W/kg

**SAR(1 g) = 9.1 mW/g; SAR(10 g) = 4.76 mW/g**

Maximum value of SAR (measured) = 10.3 mW/g



**SAR result with Body TSL**

Test Laboratory: IMST GmbH, DASY Blue (I); File Name: [090909\\_b\\_1669.da4](#)

DUT: Dipole 1900 MHz SN: 5d051; Type: D1900V2; Serial: D1900V2 - SN5d051  
Program Name: System Performance Check at 1900 MHz

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.54$  mho/m;  $\epsilon_r = 52.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6R - SN1669; ConvF(4.69, 4.69, 4.69); Calibrated: 10.02.2009
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn335; Calibrated: 09.02.2009
- Phantom: SAM Glycol 1176; Type: Speag; Serial: 1176
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**d=10mm, Pin=250mW/Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 10.1 mW/g

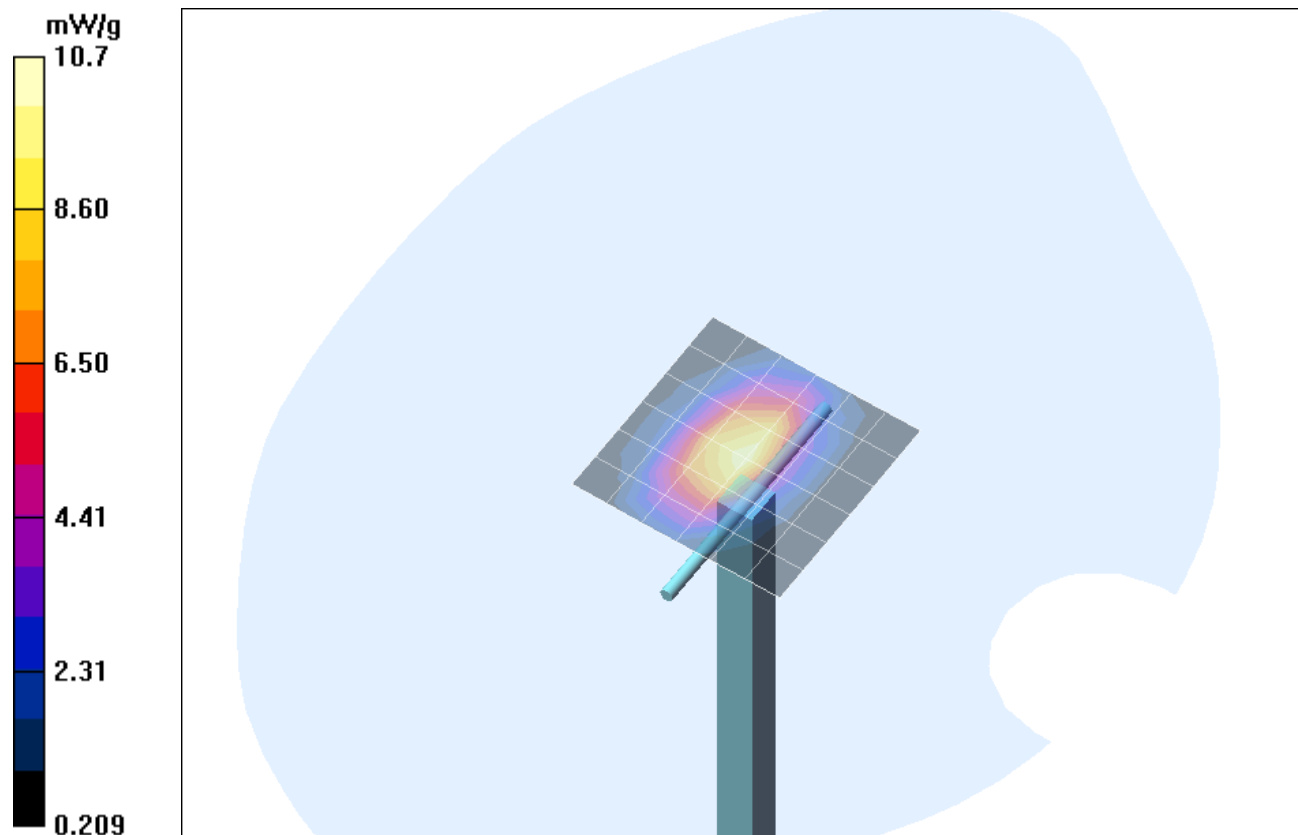
**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 86.1 V/m; Power Drift = -0.064 dB

Peak SAR (extrapolated) = 16.5 W/kg

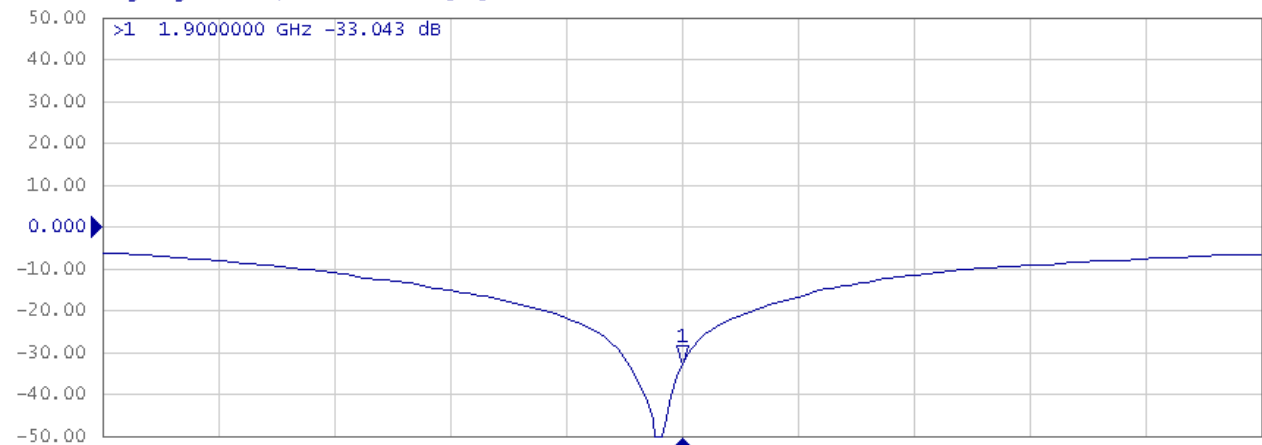
**SAR(1 g) = 9.42 mW/g; SAR(10 g) = 4.97 mW/g**

Maximum value of SAR (measured) = 10.7 mW/g



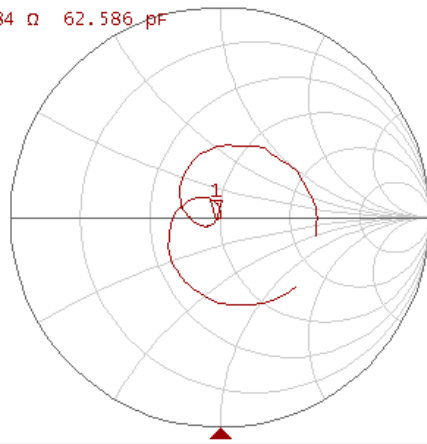
### Impedance Measurements Plot for Head TSL

Tr1 S11 Log Mag 10.00dB/ Ref 0.000dB [F1]



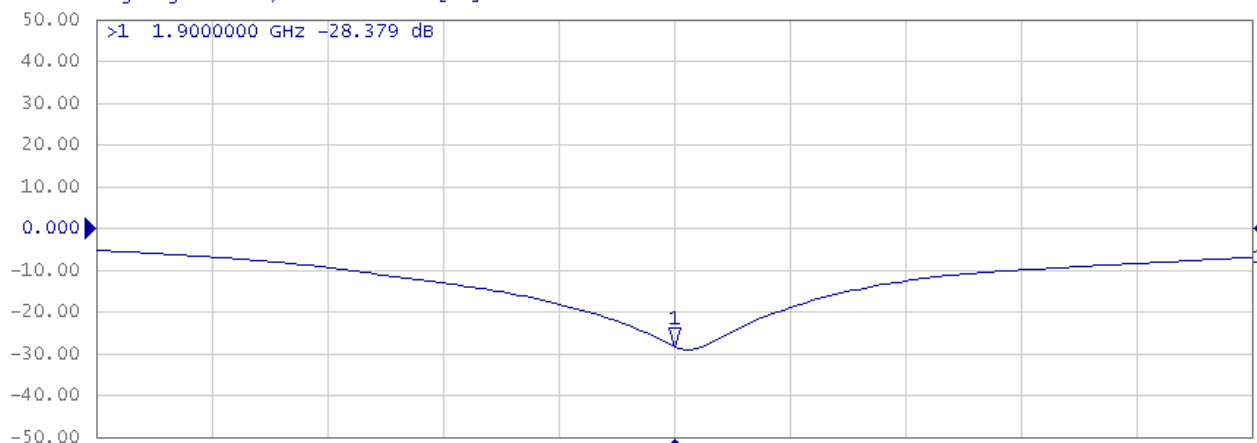
▶ Tr2 S11 Smith (R+jX) Scale 1.000U [F1]

>1 1.9000000 GHz 48.267  $\Omega$  -1.3384  $\Omega$  62.586 pF



### Impedance Measurements Plot for Body TSL

Tr1 S11 Log Mag 10.00dB/ Ref 0.000dB [F1]



► Tr2 S11 Smith (R+jX) scale 1.000u [F1]

>1 1.9000000 GHz 53.938  $\Omega$  -425.83 m $\Omega$  196.71 pF

