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Iultilateral Agreement for the DT&C (Dymst		certificates	
lient DT&C (Dymst	tec)		
		Certificate No:	EX3-3930 Jul14
CALIBRATION	CERTIFICATI		
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Dbject	EX3DV4 - SN:39	30	
	2/08/4-011.00		
Calibration procedure(s)		0A CAL-12.v9, QA CAL-14.v4, QA	CAL-23.v5,
	QA CAL-25.v6	duna fan daaimakis E faldaa i	
	Calibration proce	dure for dosimetric E-field probes	
	1 1 00 0044		
Calibration date:	July 22, 2014		
	RTE critical for calibration)		
Jalibration Equipment used (Ma	&TE critical for calibration)		
	&TE critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
Primary Standards		Cal Date (Certificate No.) 03-Apr-14 (No. 217-01911)	Scheduled Calibration Apr-15
Primary Standards Power meter E4419B	ID	acceleration of the second	and the second se
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator	ID GB41293874 MY41498087 SN: S5054 (3c)	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915)	Apr-15 Apr-15 Apr-15
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5277 (20x)	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01915)	Apr-15 Apr-15 Apr-15 Apr-15
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5277 (20x) SN: S5129 (30b)	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01919) 03-Apr-14 (No. 217-01920)	Apr-15 Apr-15 Apr-15 Apr-15 Apr-15
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5277 (20x) SN: S5129 (30b) SN: 3013	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01919) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13)	Apr-15           Apr-15           Apr-15           Apr-15           Apr-15           Apr-14
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5277 (20x) SN: S5129 (30b)	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01919) 03-Apr-14 (No. 217-01920)	Apr-15 Apr-15 Apr-15 Apr-15 Apr-15
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5277 (20x) SN: S5129 (30b) SN: 3013	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01919) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13)	Apr-15           Apr-15           Apr-15           Apr-15           Apr-15           Apr-14
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5277 (20x) SN: S5129 (30b) SN: 3013 SN: 660	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13) 13-Dec-13 (No. DAE4-660_Dec13)	Apr-15 Apr-15 Apr-15 Apr-15 Apr-15 Dec-14 Dec-14
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S55277 (20x) SN: S5129 (30b) SN: 3013 SN: 660 ID	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13) 13-Dec-13 (No. DAE4-660_Dec13) Check Date (in house)	Apr-15           Apr-15           Apr-15           Apr-15           Apr-15           Dec-14           Dec-14           Scheduled Check
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13) 13-Dec-13 (No. DAE4-660_Dec13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-13)	Apr-15 Apr-15 Apr-15 Apr-15 Apr-15 Dec-14 Dec-14 Scheduled Check In house check: Apr-16 In house check: Oct-14
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 20 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585 Name	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13) 13-Dec-13 (No. DAE4-660_Dec13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-13) Function	Apr-15           Apr-15           Apr-15           Apr-15           Apr-15           Dec-14           Dec-14           Scheduled Check           In house check: Apr-16
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 20 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13) 13-Dec-13 (No. DAE4-660_Dec13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-13)	Apr-15 Apr-15 Apr-15 Apr-15 Apr-15 Dec-14 Dec-14 Scheduled Check In house check: Apr-16 In house check: Oct-14 Signature
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 20 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585 Name	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13) 13-Dec-13 (No. DAE4-660_Dec13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-13) Function	Apr-15 Apr-15 Apr-15 Apr-15 Apr-15 Dec-14 Dec-14 Scheduled Check In house check: Apr-16 In house check: Oct-14 Signature
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 20 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E Calibrated by:	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585 Name	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13) 13-Dec-13 (No. DAE4-660_Dec13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-13) Function	Apr-15 Apr-15 Apr-15 Apr-15 Apr-15 Dec-14 Dec-14 Scheduled Check In house check: Apr-16 In house check: Oct-14 Signature
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5277 (20x) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585 Name Jeton Kastrati	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13) 13-Dec-13 (No. DAE4-660_Dec13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Apr-13) Function Laboratory Technician	Apr-15 Apr-15 Apr-15 Apr-15 Apr-15 Dec-14 Dec-14 Scheduled Check In house check: Apr-16 In house check: Oct-14 Signature
Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 20 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E Calibrated by:	ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5277 (20x) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585 Name Jeton Kastrati	03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01911) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01915) 03-Apr-14 (No. 217-01920) 30-Dec-13 (No. ES3-3013_Dec13) 13-Dec-13 (No. DAE4-660_Dec13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Apr-13) Function Laboratory Technician	Apr-15 Apr-15 Apr-15 Apr-15 Apr-15 Dec-14 Dec-14 Scheduled Check In house check: Apr-16 In house check: Oct-14 Signature

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



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Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service

Accreditation No.: SCS 108

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

G	ossary:	
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Ciobbuly.	
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, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization 9	9 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
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

#### Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013 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, v.z: Assessed for E-field polarization 9 = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz; R22 wavequide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E<sup>2</sup>-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.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: 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 ≤ 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.
- Connector Angle: The angle is assessed using the information gained by determining the NORMx (no uncertainty required).

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# Probe EX3DV4

## SN:3930

Manufactured: July Calibrated: July

July 24, 2013 July 22, 2014

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

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## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3930

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	0.42	0.48	0.43	± 10.1 %
DCP (mV) <sup>B</sup>	104.7	98.8	102.7	

#### **Modulation Calibration Parameters**

UID	Communication System Name		A dB	B dBõV	С	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	mV 128.6 136.8	±2.7 %
		Y	0.0	0.0	1.0		136.8	
		Z	0.0	0.0	1.0		131.1	

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: EX3DV4 - SN:3930

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
300	45.3	0.87	11.86	11.86	11.86	0.08	1.10	± 13.3 %
450	43.5	0.87	11.32	11.32	11.32	0.15	2.10	± 13.3 %
600	42.7	0.88	11.21	11.21	11.21	0.08	1.20	± 13.3 %
750	41.9	0.89	10.41	10.41	10.41	0.28	1.11	± 12.0 %
835	41.5	0.90	10.04	10.04	10.04	0.80	0.63	± 12.0 %
900	41.5	0.97	9.82	9.82	9.82	0.80	0.61	± 12.0 %
1750	40.1	1.37	9.02	9.02	9.02	0.31	0.97	± 12.0 %
1900	40.0	1.40	8.53	8.53	8.53	0.65	0.66	± 12.0 %
2300	39.5	1.67	8.10	8.10	8.10	0.57	0.69	± 12.0 %
2450	39.2	1.80	7.56	7.56	7.56	0.35	0.93	± 12.0 %
2600	39.0	1.96	7.45	7.45	7.45	0.40	0.87	± 12.0 %
3500	37.9	2.91	7.17	7.17	7.17	0.41	1.06	± 13.1 %
5200	36.0	4.66	5.14	5.14	5.14	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.81	4.81	4.81	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.92	4.92	4.92	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.76	4.76	4.76	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.71	4.71	4.71	0.40	1.80	± 13.1 %

Calibration Parameter Determined in Head Tissue Simulating Media

<sup>C</sup> Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters (s and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to  $\pm$  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  $\pm$  5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters. <sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3930

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
300	58.2	0.92	11.65	11.65	11.65	0.08	1.25	± 13.3 %
450	56.7	0.94	11.83	11.83	11.83	0.08	1.75	± 13.3 %
600	56.1	0.95	10.89	10.89	10.89	0.05	1.20	± 13.3 %
750	55.5	0.96	10.07	10.07	10.07	0.77	0.64	± 12.0 %
835	55.2	0.97	10.07	10.07	10.07	0.80	0.65	± 12.0 %
900	55.0	1.05	9.82	9.82	9.82	0.80	0.61	± 12.0 %
1750	53.4	1.49	7.89	7.89	7.89	0.41	0.85	± 12.0 %
1900	53.3	1.52	7.55	7.55	7.55	0.55	0.71	± 12.0 %
2300	52.9	1.81	7.39	7.39	7.39	0.40	0.87	± 12.0 %
2450	52.7	1.95	7.12	7.12	7.12	0.80	0.58	± 12.0 %
2600	52.5	2.16	7.04	7.04	7.04	0.80	0.50	± 12.0 %
3500	51.3	3.31	6.78	6.78	6.78	0.74	0.69	± 13.1 %
5200	49.0	5.30	4.67	4.67	4.67	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.49	4.49	4.49	0.45	1.90	± 13.1 %
5500	48.6	5.65	4.19	4.19	4.19	0.45	1.90	± 13.1 %
5600	48.5	5.77	4.06	4.06	4.06	0.45	1.90	± 13.1 %
5800	48.2	6.00	4.21	4.21	4.21	0.50	1.90	± 13.1 %

Calibration Parameter Determined in Body Tissue Simulating Media

<sup>c</sup> Frequency validity above 300 MHz of  $\pm$  100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to  $\pm$  50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is  $\pm$  10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to  $\pm$  110 MHz.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to  $\pm$  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  $\pm$  5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>6</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

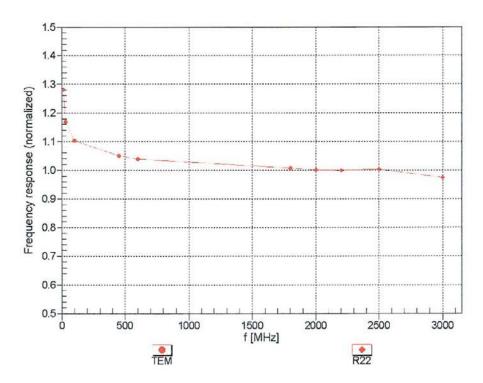
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## Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



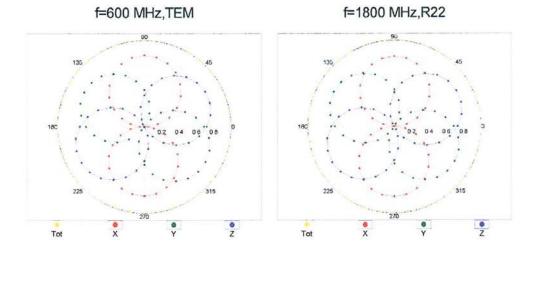
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

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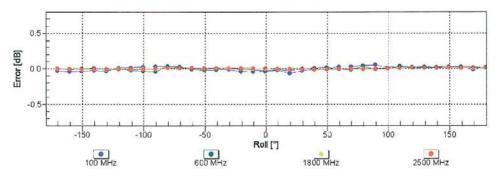
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## Receiving Pattern ( $\phi$ ), $\vartheta = 0^{\circ}$



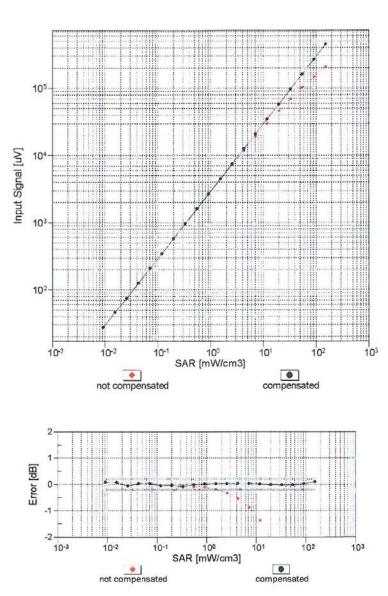
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f<sub>eval</sub>= 1900 MHz)

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

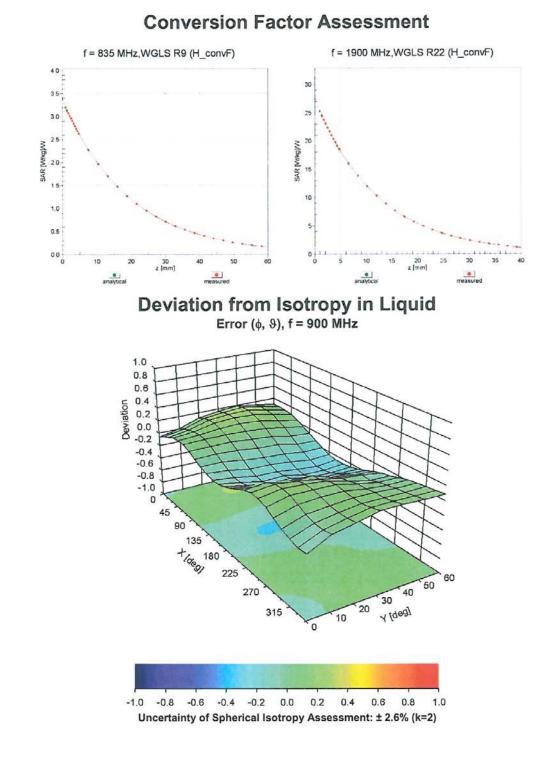
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Dt&C



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## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3930

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-60.7
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	1.4 mm

Certificate No: EX3-3930\_Jul14

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



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

Accreditation No.: SCS 0108

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

Client DT&C (Dymstec)

Certificate No: EX3-3930\_Jul15

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	CERTIFICATE	-						
Dbject	EX3DV4 - SN:393	30						
Calibration procedure(s)	QA CAL-25.v6	A CAL-12.v9, QA CAL-14.v4, QA dure for dosimetric E-field probes	CAL-23.v5,					
Calibration date:	July 22, 2015							
The measurements and the uno	ertainties with confidence projected in the closed laboratory	nal standards, which realize the physical units obability are given on the following pages and y facility: environment temperature (22 ± 3)°C a	are part of the certificate.					
Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration					
Power meter E4419B	G841293874	01-Apr-15 (No. 217-02128)	Mar-16					
Power sensor E4412A	MY41498087	01-Apr-15 (No. 217-02128)	Mar-16					
Reference 3 dB Attenuator	SN: \$5054 (3c)	01-Apr-15 (No. 217-02129)	Mar-16					
Reference 20 dB Attenuator	SN: 55277 (20x)	01-Apr-15 (No. 217-02132)	Mar-16					
Reference 30 dB Attenuator	SN: S5129 (30b)	01-Apr-15 (No. 217-02133)	Mar-16					
Reference Probe ES3DV2	SN: 3013	30-Dec-14 (No. ES3-3013_Dec14)	Dec-15					
DAE4	SN: 660	14-Jan-15 (No. DAE4-660, Jan15)	Jan-16					
President Chandrade	ID	Check Date (in house)	Scheduled Check					
Secondary Standards			and the second se					
	U\$3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16					
RF generator HP 8648C Network Analyzer HP 8753E	US3642U01700 US37390585	4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-14)	In house check: Apr-16 In house check: Oct-15					
RF generator HP 8648C								
RF generator HP 8648C Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-14)	In house check: Oct-15					
RF generator HP 8648C Network Analyzer HP 8753E Calibrated by:	US37390585 Name	18-Oct-01 (in house check Oct-14) Function	In house check: Oct-15					
RF generator HP 8648C	US37390585 Name Claudio Leubler	18-Oct-01 (in house check Oct-14) Function Laboratory Technician	In house check: Oct-15					

Certificate No: EX3-3930\_Jul15

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



S Schweizerischer Kalibrierdienst

- C Service suisse d'étalonnage Servizio svizzero di taratura
- S Swiss Calibration Service

Accreditation No.: SCS 0108

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

#### Glossary:

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, D	modulation dependent linearization parameters
Polarization o	e rotation around probe axis
Polarization 8	3 rotation around an axis that is in the plane normal to probe axis (at measurement center),
	i.e., 3 = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

#### Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- Techniques", June 2013 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
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field polarization 9 = 0 (f < 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 affect the E<sup>2</sup>-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.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z; 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 ≤ 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.
- Connector Angle: The angle is assessed using the information gained by determining the NORMx (no uncertainty required).

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July 22, 2015

# Probe EX3DV4

## SN:3930

Manufactured: July 24, 2013 Calibrated: July 22, 2015

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

Certificate No: EX3-3930\_Jul15

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July 22, 2015

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3930

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m) <sup>2</sup> ) <sup>A</sup>	0.42	0.49	0.43	± 10.1 %
DCP (mV) <sup>8</sup>	103.0	101.6	103.2	

## Modulation Calibration Parameters

UID	Communication System Name		A dB	B dBõV	С	D dB	VR mV	Unc <sup>e</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	126.3	±3.0 %
		Y	0.0	0.0	1.0		129.8	
		Z	0.0	0.0	1.0		123.7	

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

<sup>1</sup> Numerical linearization parameter: uncertainty not required. <sup>2</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: EX3DV4 - SN:3930

f (MHz) c	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>0</sup> (mm)	Unc (k=2)
300	45.3	0.87	12.04	12.04	12.04	0.10	1.30	± 13.3 %
450	43.5	0.87	10.94	10.94	10.94	0.17	2.06	± 13.3 %
600	42.7	0.88	10.75	10.75	10.75	0.12	1.30	± 13.3 %
750	41.9	0.89	10.19	10.19	10.19	0.29	1.05	± 12.0 %
835	41.5	0.90	9.81	9.81	9.81	0.28	1.16	± 12.0 %
900	41.5	0.97	9.59	9.59	9.59	0.28	1.20	± 12.0 %
1750	40.1	1.37	8.64	8.64	8.64	0.50	0.90	± 12.0 %
1900	40.0	1.40	8.30	8.30	8.30	0.38	0.85	± 12.0 %
2300	39.5	1.67	7.85	7.85	7.85	0.32	0.86	± 12.0 %
2450	39.2	1.80	7.37	7.37	7.37	0.30	0.95	± 12.0 %
2600	39.0	1.96	7.26	7.26	7.26	0.33	0.92	± 12.0 %
3500	37.9	2.91	6.98	6.98	6.98	0.28	1.30	± 13.1 %
5200	36.0	4.66	5.24	5.24	5.24	0.30	1.80	± 13.1 %
5300	35.9	4.76	4.98	4.98	4.98	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.89	4.89	4.89	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.61	4.61	4.61	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.66	4.66	4.66	0.40	1.80	± 13.1 %

Calibration Parameter Determined in Head Tissue Simulating Media

<sup>C</sup> Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency

below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Addres 5 GHz incluency validity can be extended to ± 110 MHz. <sup>7</sup> At frequencies below 3 GHz, the validity of tissue parameters (*z* and *o*) 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 (*z* and *o*) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters. <sup>9</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip discussed.

diameter from the boundary.

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## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3930

alibration	Parameter De		Body TIS	ssue aim	· · · · · · · · · · · · · · · · · ·	Unc		
f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	(k=2)
300	58.2	0.92	11.45	11.45	11.45	0.10	1.20	± 13.3 %
450	56.7	0.94	11.35	11.35	11.35	0.12	1.60	± 13.3 %
600	56.1	0.95	10.76	10.76	10.76	0.05	1.20	± 13.3 %
750	55.5	0.96	9.64	9.64	9.64	0.27	1.20	± 12.0 %
835	55.2	0.97	9.49	9.49	9.49	0.21	1.42	± 12.0 %
900	55.0	1.05	9.48	9.48	9.48	0.53	0.80	± 12.0 %
1750	53.4	1.49	8.03	8.03	8.03	0.44	0.80	± 12.0 %
1900	53.3	1.52	7.78	7.78	7.78	0.42	0.85	± 12.0 %
2300	52.9	1.81	7.64	7.64	7.64	0.38	0.85	± 12.0 %
2450	52.7	1.95	7.31	7.31	7.31	0.31	0.90	± 12.0 %
2600	52.5	2.16	7.11	7.11	7.11	0.28	0.92	± 12.0 %
3500	51.3	3.31	6.47	6.47	6.47	0.28	1.53	± 13.1 %
5200	49.0	5.30	4.76	4.76	4.76	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.56	4.56	4.56	0.40	1.90	± 13.1 %
5500	48.6	5.65	4.11	4.11	4.11	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.93	3.93	3.93	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.20	4.20	4.20	0.50	1.90	± 13.1 %

## Calibration Parameter Determined in Body Tissue Simulating Media

<sup>C</sup> Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
<sup>r</sup> A frequencies below 3 GHz, the validity of tissue parameters (s and d) 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 (c and d) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
<sup>a</sup> Apha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

diameter from the boundary.

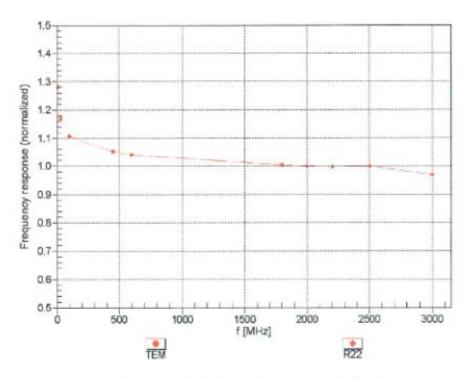
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## Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



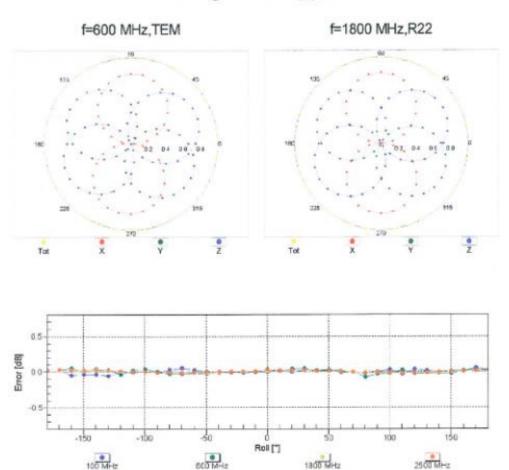
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

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## 

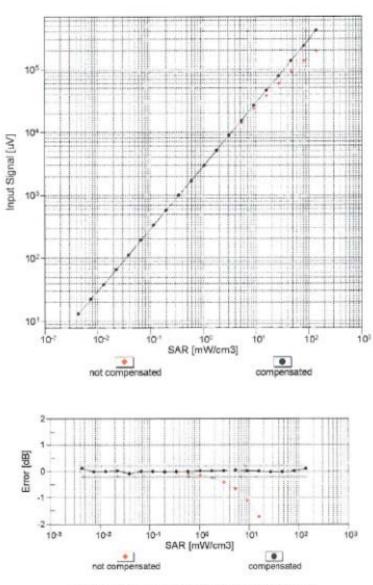
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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Dynamic Range f(SAR<sub>head</sub>) (TEM cell, f<sub>eval</sub>= 1900 MHz)

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

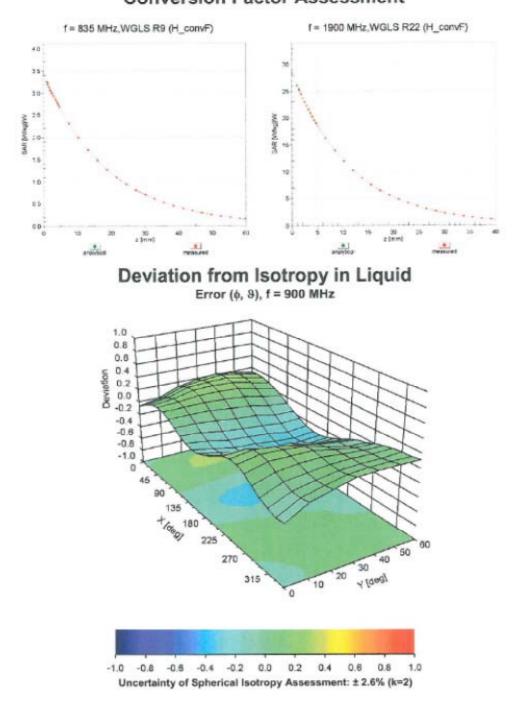
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## **Conversion Factor Assessment**

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## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3930

## Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	120.4
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	1.4 mm

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ccredited by the Swiss Accredi he Swiss Accreditation Servi			reditation No.: SCS 0108
lient DT&C (Dymst			ES3-3327_Sep15
CALIBRATION	CERTIFICAT	E	
Object	ES3DV3 - SN:33	27	1. A. J
Calibration procedure(s)		QA CAL-12.v9, QA CAL-23.v5, QA dure for dosimetric E-field probes	CAL-25.v6
Calibration date:	September 2, 20	15	
The measurements and the unc		to both the control of the control pages and the facility: environment temperature (22 $\pm$ 3)°C is	
	ucted in the closed laborator	ry facility: environment temperature (22 ± 3)°C (	
All calibrations have been cond Celibration Equipment used (Mi Primary Standards	ucted in the closed laborate &TE critical for calibration)	ry facility: environment temperature (22 ± 3)°C ( Cal Date (Certificate No.)	and humidity < 70%.
Il calibrations have been cond Celibration Equipment used (Mi Primary Standards Power meter E4419B	ucted in the closed laborator &TE critical for calibration) ID GB41293874	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128)	and humidity < 70%. Scheduled Calibration Mar-15
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E4419B Power sensor E4412A	ID GB41293874 MY41498087	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128)	Scheduled Calibration Mar-16 Mar-16
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator	ID GB41293874 MY414980B7 SN: S5054 (3c)	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128)	Scheduled Calibration Mer-16 Mar-16 Mar-16
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator	ID GB41293674 MY41498087 SN: S5054 (3c) SN: S5057 (20x)	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02132)	Scheduled Calibration Mer-16 Mar-16 Mar-16 Mar-18
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator	ID GB41293674 MY41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5129 (30b)	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02133)	Scheduled Calibration Mer-16 Mar-16 Mar-16
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power mater E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator	ID GB41293674 MY41498087 SN: S5054 (3c) SN: S5057 (20x)	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02132)	Scheduled Calibration Mar-15 Mar-16 Mar-16 Mar-16 Mar-16 Mar-16 Mar-16 Mar-16
All calibrations have been cond Calibration Equipment used (Ma Primery Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 20 dB Attenuator Reference Probe ES3DV2 DAE4	ucted in the closed laborator &TE critical for calibration) ID GB41293674 MY41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5129 (30b) SN: 3013	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02129) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02133) 30-Dec-14 (No. ES3-3013_Dec14)	Scheduled Calibration Mar-15 Mar-16 Mar-16 Mar-16 Mar-16 Mar-16 Mar-16 Dec-15
All calibrations have been cond Calibration Equipment used (Ma Primery Standards Power meter E4419B Power sensor E4412A Reference 30 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards	Ucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087 SN: 55054 (3c) SN: 55054 (3c) SN: 55129 (30b) SN: 3013 SN: 660	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02133) 30-Dec-14 (No. E33-3013_Dec14) 14-Jan-15 (No. DAE4-860_Jan15)	and humidity < 70%. Scheduled Calibration Mar-16 Mar-16 Mar-16 Mar-16 Mar-16 Dec-15 Jan-16
All calibrations have been cond Calibration Equipment used (M4 Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	ucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087 SN: 55054 (3c) SN: 55054 (3c) SN: 55129 (30b) SN: 3013 SN: 660 ID	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02129) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02133) 30-Dec-14 (No. ES3-3013_Dec14) 14-Jan-15 (No. DAE4-660_Jan15) Check Date (in house)	and humidity < 70%. Scheduled Calibration Mar-16 Mar-16 Mar-16 Mar-16 Mar-16 Dec-15 Jan-16 Scheduled Check
All calibrations have been cond Calibration Equipment used (MA Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	ucted in the closed laborator &TE critical for calibration) ID GB41293674 M*41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 650 ID US3642U01700 US37390585 Name	Cal Date (Certificate No.) Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02138) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02133) 30-Dec-14 (No. ES3-3013_Dec14) 14-Jan-15 (No. DAE4-660_Jan15) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-14) Function	Scheduled Calibration Mar-16 Mar-16 Mar-16 Mar-16 Mar-16 Mar-16 Dec-15 Jan-16 Scheduled Check In house check: Apr-16
All calibrations have been cond Calibration Equipment used (MA Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	ucted in the closed laborator &TE critical for calibration) ID GB41293874 MY41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 660 ID US3842U01700 US37390585	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02133) 30-Dec-14 (No. ES3-3013, Dec14) 14-Jan-15 (No. DAE4-860, Jan15) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Act-14) Function	and humidity < 70%. Scheduled Calibration Mer-16 Mar-16 Mar-16 Mar-16 Mar-16 Dec-15 Jan-16 Scheduled Check In house check: Apr-16 In house check: Oct-15 Signature
All calibrations have been cond	ucted in the closed laborator &TE critical for calibration) ID GB41293674 M*41498087 SN: S5054 (3c) SN: S5054 (3c) SN: S5129 (30b) SN: 3013 SN: 650 ID US3642U01700 US37390585 Name	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-02133) 30-Dec-14 (No. ES3-3013, Dec14) 14-Jan-15 (No. DAE4-860, Jan15) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Act-14) Function	and humidity < 70%. Scheduled Calibration Mar-16 Mar-16 Mar-16 Mar-16 Mar-18 Dec-15 Jan-16 Scheduled Check In house check: Apr-16 In house check: Oct-15

Certificate No: ES3-3327\_Sep15

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



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- Swiss Calibration Service

Accreditation No.: SCS 0108

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

#### Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diade compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\phi$	φ rotation around probe axis
Polarization 9	8 rotation around an axis that is in the plane normal to probe axis (at measurement center),
	i.e., 9 = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Connector Angle

#### Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Methods Applied and Interpretation of Parameters:

- NORMx, y.z: Assessed for E-field polarization 8 = 0 (f ≤ 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 affect the E2-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.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z; 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 ≤ 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.
- Connector Angle: The angle is assessed using the information gained by determining the NORMx (no uncertainty required).

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# Probe ES3DV3

## SN:3327

Manufactured: Repaired: Calibrated: January 10, 2012 August 25, 2015 September 2, 2015

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

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## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3327

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m) <sup>2</sup> ) <sup>A</sup>	1.19	1.21	1.12	± 10.1 %
DCP (mV) <sup>8</sup>	103.3	104.9	104.7	

#### Modulation Calibration Parameters

UID	Communication System Name		A	В	С	D	VR	Unc <sup>E</sup>
			dB	dBõV		dB	mV	(k=2)
0	CW	X	0.0	0.0	1.0	0.00	204.1	±3.5 %
		Y	0.0	0.0	1.0		212.0	
		Z	0.0	0.0	1.0		202.2	

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 Norm X,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).
<sup>9</sup> Numerical linearization parameter: uncertainty not required.
<sup>6</sup> Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the field unknown. field value.

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## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3327

f (MHz) <sup>c</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>8</sup>	Depth <sup>C</sup> (mm)	Unc (k=2)
450	43.5	0.87	6.82	6.82	6.82	0.21	1.95	± 13.3 %
600	42.7	0.88	6.67	6.67	6.67	0.14	1.20	± 13.3 %
750	41.9	0.89	6.40	6.40	6.40	0.33	1.81	± 12.0 %
835	41.5	0.90	6.26	6.26	6.26	0.28	2.05	± 12.0 %
900	41.5	0.97	6.11	6.11	6.11	0.26	2.21	± 12.0 %
1750	40.1	1.37	5.26	5.26	5.26	0.61	1.31	± 12.0 %
1900	40.0	1.40	5.10	5.10	5.10	0.50	1.49	± 12.0 %
2300	39.5	1.67	4.78	4.78	4.78	0.60	1.40	± 12.0 %
2450	39.2	1.80	4.51	4.51	4.51	0.80	1.25	± 12.0 %
2600	39.0	1.96	4.38	4.38	4.38	0.80	1.28	± 12.0 %

#### Calibration Parameter Determined in Head Tissue Simulating Media

<sup>C</sup> Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters (c and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies below 3 GHz, the validity of tissue parameters.

measured SARY values. At frequencies above 3 GHz, the validity of bissue parameters (c and d) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters. <sup>6</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3327

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>6</sup>	Depth <sup>G</sup> (mm)	Unc (k=2)
450	56.7	0.94	6.86	6.86	6.86	0.12	1.30	± 13.3 %
600	56.1	0.95	6.64	6.64	6.64	0.05	1.20	± 13.3 %
750	55.5	0.96	6.39	6.39	6.39	0.26	2.06	± 12.0 %
835	55.2	0.97	6.25	6.25	6.25	0.66	1.35	± 12.0 %
900	55.0	1.05	6.20	6.20	6.20	0.53	1.43	± 12.0 %
1750	53.4	1.49	4.91	4.91	4.91	0.48	1.64	± 12.0 %
1900	53.3	1.52	4.73	4.73	4.73	0.46	1.66	± 12.0 %
2300	52.9	1.81	4.49	4.49	4.49	0.68	1.34	± 12.0 %
2450	52.7	1.95	4.35	4.35	4.35	0.80	1.13	± 12.0 %
2600	52.5	2.16	4.21	4.21	4.21	0.80	0.80	± 12.0 %

#### Calibration Parameter Determined in Body Tissue Simulating Media

<sup>c</sup> Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz. The validity of tissue parameters (s and o) 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 (c and o) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters. <sup>6</sup> AlphaDepth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

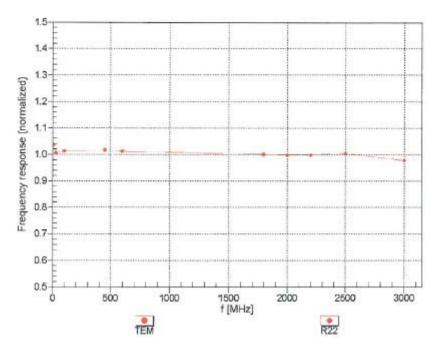
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## Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



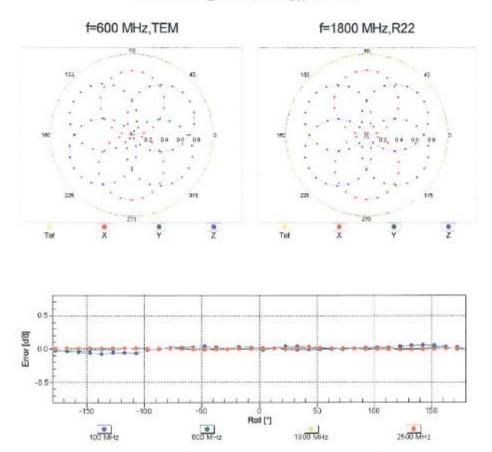


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## 

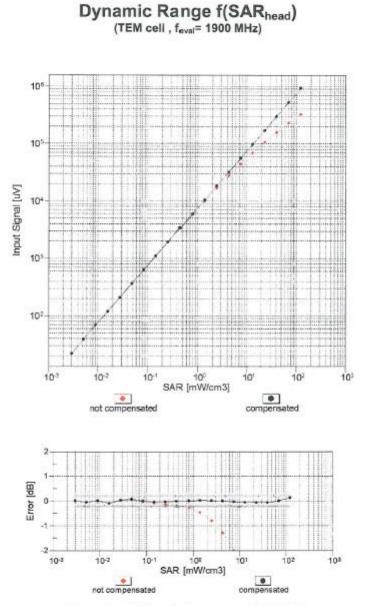
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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

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**Conversion Factor Assessment** f = 835 MHz, WGLS R9 (H\_convF) f = 1900 MHz, WGLS R22 (H\_convF) 40 10 36 30 25 SAR (Mrs)/W 70 15 15 10 1.0 6 2.6 00 U 10 10 15 20 #[mm] 2100 anaytoa an minimum reasured Deviation from Isotropy in Liquid Error (0, 9), f = 900 MHz 1.0 0.8 0.6 uogeiva0 0.2 0.0 -0.2 0.4 -0.4 -0.6 -0.8 -1.0 0 45 90 135 +/0001180 225 40 30 270 20 4 (deg) 315 10 0 -1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.5 0.8 1.0 Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

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## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3327

## Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	102.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

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## Attachment 2. – Dipole Calibration Data





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Accreditation No.: SCS 108

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

Client DT&C (Dymstec) Certificate No: D835V2-4d159\_Nov14

Object	D835V2 - SN: 40	1159	
Calibration procedure(s)	QA CAL-05.v9 Calibration proce	edure for dipole validation kits abo	ove 700 MHz
Calibration date:	November 19, 20	014	
The measurements and the unce	ertainties with confidence p	ional standards, which realize the physical un robability are given on the following pages ar ry facility: environment temperature $(22 \pm 3)^{\circ}$	nd are part of the certificate.
rimary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
	ID # GB37480704	Cal Date (Certificate No.) 07-Oct-14 (No. 217-02020)	Scheduled Calibration Oct-15
ower meter EPM-442A			
ower meter EPM-442A ower sensor HP 8481A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A eference 20 dB Attenuator	GB37480704 US37292783 MY41092317 SN: 5058 (20k)	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020)	Oct-15 Oct-15
Vower meter EPM-442A Vower sensor HP 8481A Vower sensor HP 8481A Reference 20 dB Attenuator Vpe-N mismatch combination	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02021) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921)	Oct-15 Oct-15 Oct-15
ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A teference 20 dB Attenuator ype-N mismatch combination teference Probe ES3DV3	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13)	Oct-15 Oct-15 Oct-15 Apr-15 Apr-15 Dec-14
Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02021) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921)	Oct-15 Oct-15 Oct-15 Apr-15 Apr-15
Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 18-Aug-14 (No. DAE4-601_Aug14)	Oct-15 Oct-15 Oct-15 Apr-15 Apr-15 Dec-14
Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13)	Oct-15 Oct-15 Oct-15 Apr-15 Apr-15 Dec-14 Aug-15
Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID #	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 18-Aug-14 (No. DAE4-601_Aug14) Check Date (in house)	Oct-15 Oct-15 Oct-15 Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check
Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 18-Aug-14 (No. DAE4-601_Aug14) Check Date (in house) 04-Aug-99 (in house check Oct-13)	Oct-15 Oct-15 Oct-15 Apr-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16
Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards RF generator R&S SMT-06 Network Analyzer HP 8753E	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 18-Aug-14 (No. DAE4-601_Aug14) Check Date (in house) 04-Aug-99 (in house check Oct-13) 18-Oct-01 (in house check Oct-14)	Oct-15 Oct-15 Oct-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16 In house check: Oct-15 Signature
Primary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Becondary Standards RF generator R&S SMT-06 Network Analyzer HP 8753E Calibrated by:	GB37480704 US37292783 MY41092317 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # 100005 US37390585 S4206 Name	07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 07-Oct-14 (No. 217-02020) 03-Apr-14 (No. 217-01918) 03-Apr-14 (No. 217-01921) 30-Dec-13 (No. ES3-3205_Dec13) 18-Aug-14 (No. DAE4-601_Aug14) Check Date (in house) 04-Aug-99 (in house check Oct-13) 18-Oct-01 (in house check Oct-14) Function	Oct-15 Oct-15 Oct-15 Apr-15 Dec-14 Aug-15 Scheduled Check In house check: Oct-16 In house check: Oct-15

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Swiss Calibration Service

Accreditation No.: SCS 108

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

## Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

## Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Additional Documentation:

d) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole
  positioned under the liquid filled phantom. The impedance stated is transformed from the
  measurement at the SMA connector to the feed point. The Return Loss ensures low
  reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

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%.

Certificate No: D835V2-4d159\_Nov14

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### Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz ± 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.2 ± 6 %	0.91 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.19 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAN averaged over 10 cm (10 g) of head 15L	condition	
SAR averaged over 10 cm (10 g) of head TSL	250 mW input power	1.51 W/kg

## **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.5 ± 6 %	1.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	12222	

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.49 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.64 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	1.63 W/kg

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## Appendix (Additional assessments outside the scope of SCS108)

## Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.4 Ω - 1.1 jΩ	
Return Loss	- 29.2 dB	

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.5 Ω - 4.3 jΩ	_
Return Loss	- 25.9 dB	

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.440 ns
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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. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

Manufactured by	SPEAG	
Manufactured on	December 28, 2012	



## **DASY5 Validation Report for Head TSL**

Date: 19.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d159

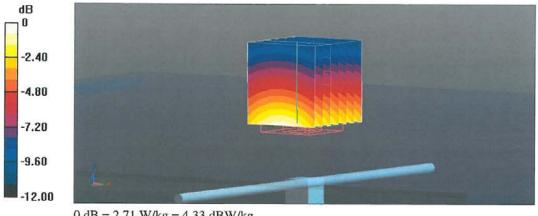
Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma = 0.91 \text{ S/m}$ ;  $\varepsilon_r = 41.2$ ;  $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.22, 6.22, 6.22); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection) •
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

## Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 56.72 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 3.44 W/kg SAR(1 g) = 2.32 W/kg; SAR(10 g) = 1.51 W/kg Maximum value of SAR (measured) = 2.71 W/kg



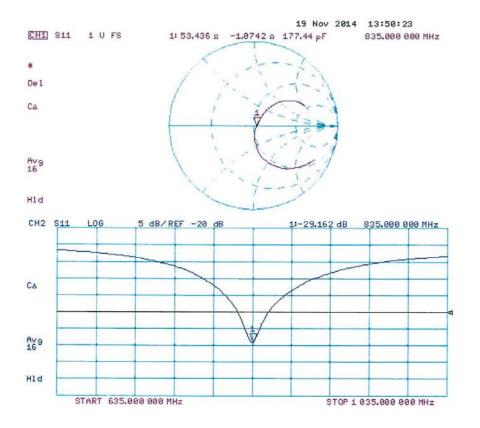
0 dB = 2.71 W/kg = 4.33 dBW/kg

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## Impedance Measurement Plot for Head TSL



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## **DASY5 Validation Report for Body TSL**

Date: 18.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d159

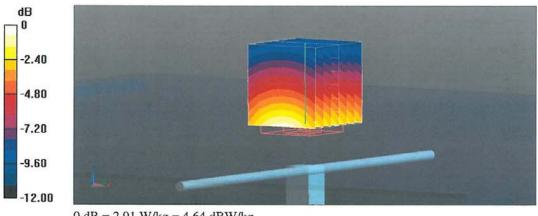
Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 1.01 S/m;  $\epsilon_r$  = 54.5;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.09, 6.09, 6.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

## Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 55.34 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 3.68 W/kg SAR(1 g) = 2.49 W/kg; SAR(10 g) = 1.63 W/kg Maximum value of SAR (measured) = 2.91 W/kg



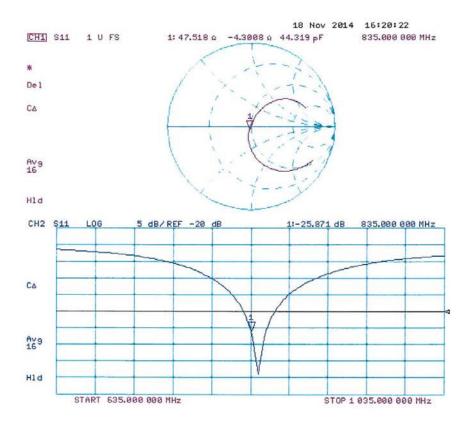
0 dB = 2.91 W/kg = 4.64 dBW/kg

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## Impedance Measurement Plot for Body TSL



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