

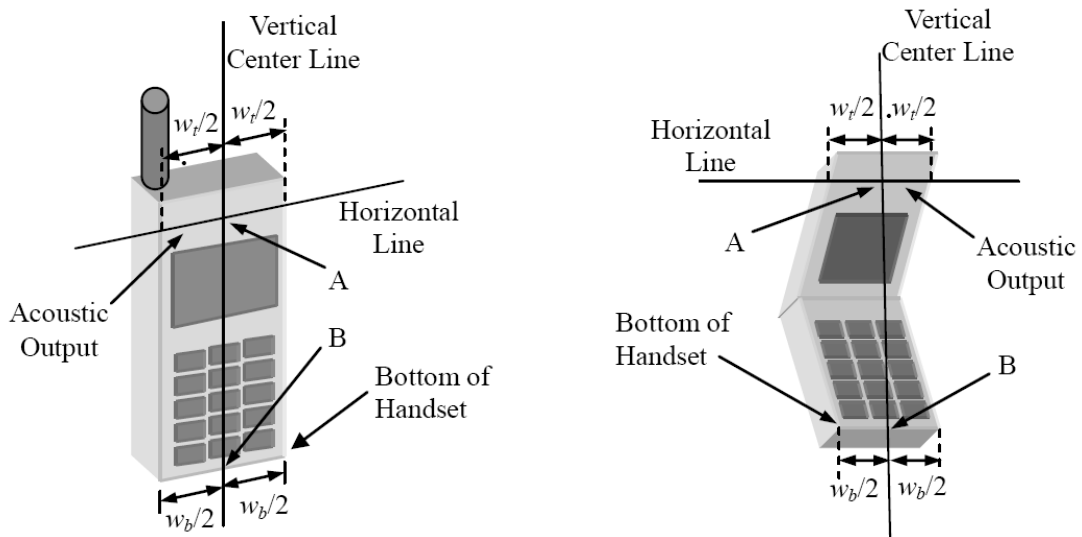


Picture C.10: SAM Twin Phantom

ANNEX D Position of the wireless device in relation to the phantom

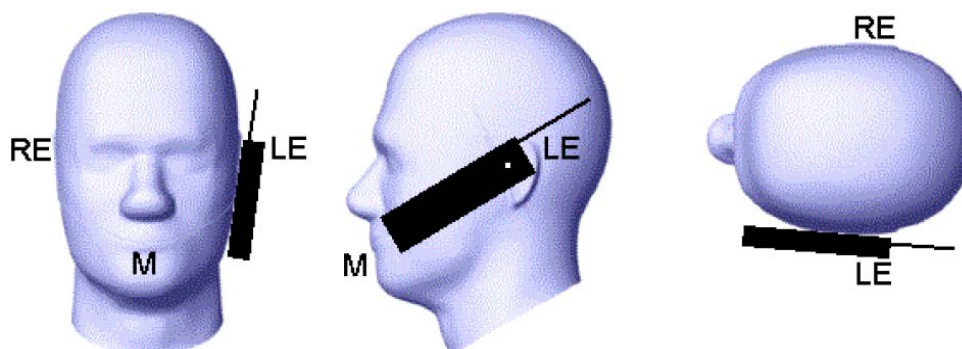
D.1 General considerations

This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.

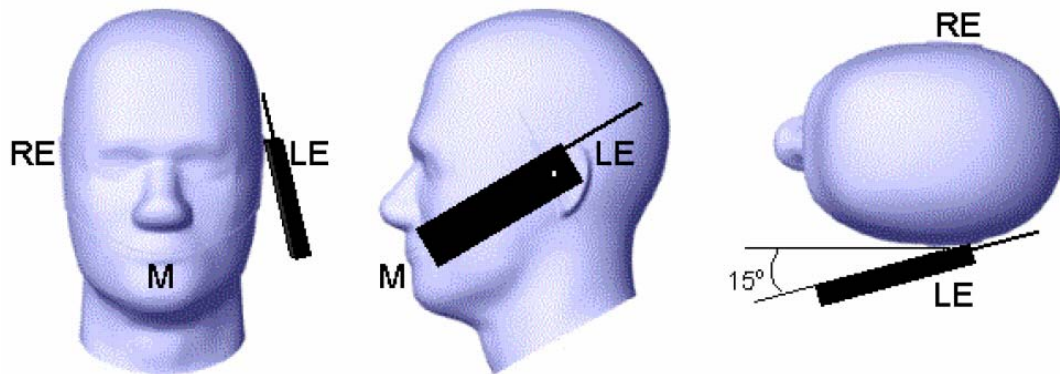


- w_t Width of the handset at the level of the acoustic
- w_b Width of the bottom of the handset
- A Midpoint of the width w_t of the handset at the level of the acoustic output
- B Midpoint of the width w_b of the bottom of the handset

Picture D.1-a Typical “fixed” case handset Picture D.1-b Typical “clam-shell” case handset



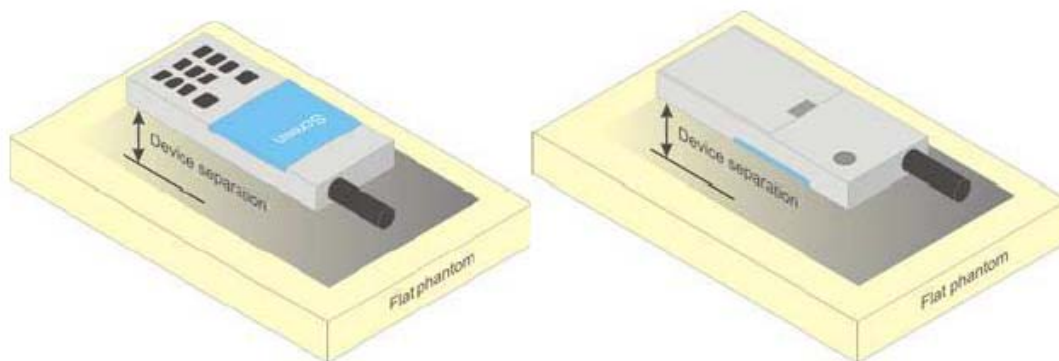
Picture D.2 Cheek position of the wireless device on the left side of SAM



Picture D.3 Tilt position of the wireless device on the left side of SAM

D.2 Body-worn device

A typical example of a body-worn device is a mobile phone, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.

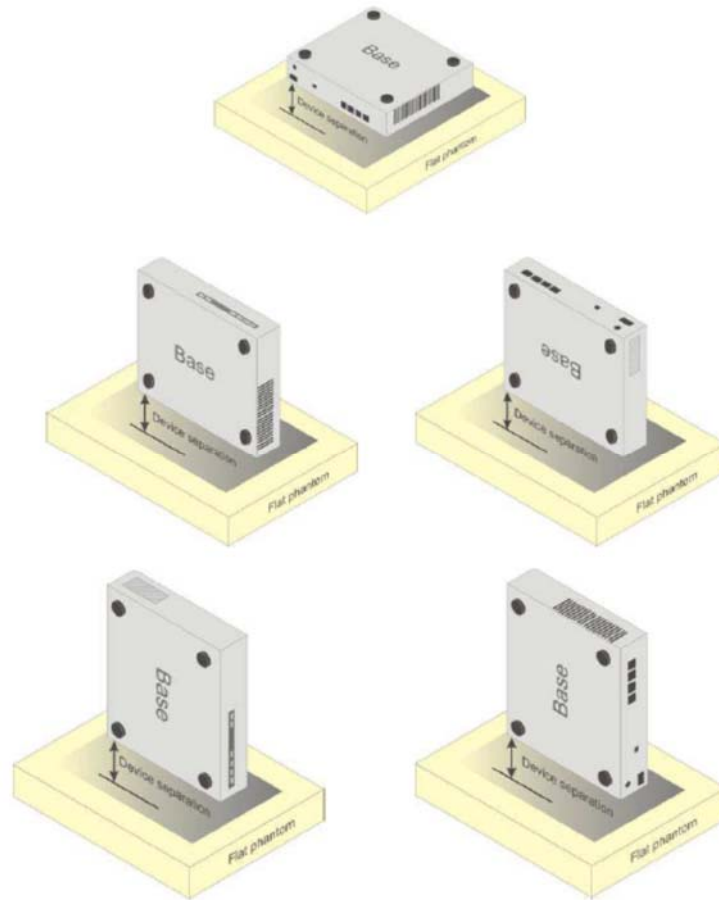


Picture D.4 Test positions for body-worn devices

D.3 Desktop device

A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used.

The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions, tests shall be performed for all antenna positions specified. Picture 8.5 show positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.



Picture D.5 Test positions for desktop devices

D.4 DUT Setup Photos



Picture D.6

ANNEX E Equivalent Media Recipes

The liquid used for the frequency range of 800-3000 MHz consisted of water, sugar, salt, preventol, glycol monobutyl and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table E.1 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

Table E.1: Composition of the Tissue Equivalent Matter

Frequency (MHz)	835 Head	835 Body	1900 Head	1900 Body	2450 Head	2450 Body	5800 Head	5800 Body
Ingredients (% by weight)								
Water	41.45	52.5	55.242	69.91	58.79	72.60	65.53	65.53
Sugar	56.0	45.0	\	\	\	\	\	\
Salt	1.45	1.4	0.306	0.13	0.06	0.18	\	\
Preventol	0.1	0.1	\	\	\	\	\	\
Cellulose	1.0	1.0	\	\	\	\	\	\
Glycol Monobutyl	\	\	44.452	29.96	41.15	27.22	\	\
Diethylenglycol monohexylether	\	\	\	\	\	\	17.24	17.24
Triton X-100	\	\	\	\	\	\	17.24	17.24
Dielectric Parameters Target Value	$\epsilon=41.5$ $\sigma=0.90$	$\epsilon=55.2$ $\sigma=0.97$	$\epsilon=40.0$ $\sigma=1.40$	$\epsilon=53.3$ $\sigma=1.52$	$\epsilon=39.2$ $\sigma=1.80$	$\epsilon=52.7$ $\sigma=1.95$	$\epsilon=35.3$ $\sigma=5.27$	$\epsilon=48.2$ $\sigma=6.00$

Note: There are a little adjustment respectively for 750, 1750, 2600, 5200, 5300 and 5600 based on the recipe of closest frequency in table E.1.

ANNEX F System Validation

The SAR system must be validated against its performance specifications before it is deployed. When SAR probes, system components or software are changed, upgraded or recalibrated, these must be validated with the SAR system(s) that operates with such components.

Table F.1: System Validation for 7464

Probe SN.	Liquid name	Validation date	Frequency point	Status (OK or Not)
7464	Head 750MHz	Sep.26,2017	750 MHz	OK
7464	Head 850MHz	Sep.26,2017	850 MHz	OK
7464	Head 900MHz	Sep.26,2017	900 MHz	OK
7464	Head 1750MHz	Sep.26,2017	1750 MHz	OK
7464	Head 1810MHz	Sep.26,2017	1810 MHz	OK
7464	Head 1900MHz	Sep.27,2017	1900 MHz	OK
7464	Head 1950MHz	Sep.27,2017	1950 MHz	OK
7464	Head 2000MHz	Sep.27,2017	2000 MHz	OK
7464	Head 2100MHz	Sep.27,2017	2100 MHz	OK
7464	Head 2300MHz	Sep.27,2017	2300 MHz	OK
7464	Head 2450MHz	Sep.27,2017	2450 MHz	OK
7464	Head 2550MHz	Sep.28,2017	2550 MHz	OK
7464	Head 2600MHz	Sep.28,2017	2600 MHz	OK
7464	Head 3500MHz	Sep.28,2017	3500 MHz	OK
7464	Head 3700MHz	Sep.28,2017	3700 MHz	OK
7464	Head 5200MHz	Sep.28,2017	5200 MHz	OK
7464	Head 5500MHz	Sep.28,2017	5500 MHz	OK
7464	Head 5800MHz	Sep.28,2017	5800 MHz	OK
7464	Body 750MHz	Sep.28,2017	750 MHz	OK
7464	Body 850MHz	Sep.25,2017	850 MHz	OK
7464	Body 900MHz	Sep.25,2017	900 MHz	OK
7464	Body 1750MHz	Sep.25,2017	1750 MHz	OK
7464	Body 1810MHz	Sep.25,2017	1810 MHz	OK
7464	Body 1900MHz	Sep.25,2017	1900 MHz	OK
7464	Body 1950MHz	Sep.25,2017	1950 MHz	OK
7464	Body 2000MHz	Sep.29,2017	2000 MHz	OK
7464	Body 2100MHz	Sep.29,2017	2100 MHz	OK
7464	Body 2300MHz	Sep.29,2017	2300 MHz	OK
7464	Body 2450MHz	Sep.29,2017	2450 MHz	OK
7464	Body 2550MHz	Sep.29,2017	2550 MHz	OK
7464	Body 2600MHz	Sep.29,2017	2600 MHz	OK
7464	Body 3500MHz	Sep.24,2017	3500 MHz	OK
7464	Body 3700MHz	Sep.24,2017	3700 MHz	OK
7464	Body 5200MHz	Sep.24,2017	5200 MHz	OK
7464	Body 5500MHz	Sep.24,2017	5500 MHz	OK
7464	Body 5800MHz	Sep.24,2017	5800 MHz	OK

ANNEX G Probe Calibration Certificate

Probe 7464 Calibration Certificate

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



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

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

Accreditation No.: SCS 0108

Client **CTTL-BJ (Auden)**

Certificate No: **EX3-7464_Sep17**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:7464**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5,
QA CAL-25.v6
Calibration procedure for dosimetric E-field probes**

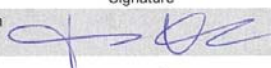

Calibration date: **September 12, 2017**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02525)	Apr-18
Reference 20 dB Attenuator	SN: S5277 (20x)	07-Apr-17 (No. 217-02528)	Apr-18
Reference Probe ES3DV2	SN: 3013	31-Dec-16 (No. ES3-3013_Dec16)	Dec-17
DAE4	SN: 660	7-Dec-16 (No. DAE4-660_Dec16)	Dec-17
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

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

Issued: September 12, 2017

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

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



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
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The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,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 ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis
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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- 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:

- **NORM_{x,y,z}:** Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E^2 -field uncertainty inside TSL (see below ConvF).
- **NORM(f)_{x,y,z} = NORM_{x,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.
- **DCP_{x,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
- **A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,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 $f \leq 800$ 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_{x,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 NORM_x (no uncertainty required).



EX3DV4 – SN:7464

September 12, 2017

Probe EX3DV4

SN:7464

Manufactured: September 6, 2016
Calibrated: September 12, 2017

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

EX3DV4- SN:7464

September 12, 2017

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7464

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.45	0.43	0.45	$\pm 10.1 \%$
DCP (mV) ^B	101.6	99.3	99.7	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	150.5	$\pm 3.3 \%$
		Y	0.0	0.0	1.0		144.7	
		Z	0.0	0.0	1.0		147.0	

Note: For details on UID parameters see Appendix.

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 $\text{ms}\cdot\text{V}^{-2}$	T2 $\text{ms}\cdot\text{V}^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
X	57.86	441.1	37.02	12.02	0.826	5.039	0.00	0.727	1.006
Y	59.82	453.4	36.65	14.84	0.468	5.100	0.25	0.626	1.007
Z	65.01	497.8	37.35	15.97	1.043	5.073	0.00	0.801	1.008

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

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

^B Numerical linearization parameter; uncertainty not required.

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



EX3DV4- SN:7464

September 12, 2017

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7464

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth (mm) ^G	Unc (k=2)
150	52.3	0.76	12.20	12.20	12.20	0.00	1.00	± 13.3 %
300	45.3	0.87	11.77	11.77	11.77	0.09	1.20	± 13.3 %
450	43.5	0.87	11.17	11.17	11.17	0.15	1.20	± 13.3 %
750	41.9	0.89	10.57	10.57	10.57	0.53	0.80	± 12.0 %
835	41.5	0.90	10.28	10.28	10.28	0.48	0.80	± 12.0 %
900	41.5	0.97	10.03	10.03	10.03	0.28	1.09	± 12.0 %
1450	40.5	1.20	9.05	9.05	9.05	0.37	0.80	± 12.0 %
1640	40.2	1.31	8.82	8.82	8.82	0.35	0.80	± 12.0 %
1750	40.1	1.37	8.70	8.70	8.70	0.38	0.80	± 12.0 %
1810	40.0	1.40	8.42	8.42	8.42	0.32	0.85	± 12.0 %
1900	40.0	1.40	8.39	8.39	8.39	0.35	0.80	± 12.0 %
2000	40.0	1.40	8.39	8.39	8.39	0.32	0.89	± 12.0 %
2100	39.8	1.49	8.54	8.54	8.54	0.27	0.86	± 12.0 %
2300	39.5	1.67	8.40	8.40	8.40	0.34	0.95	± 12.0 %
2450	39.2	1.80	7.89	7.89	7.89	0.34	0.93	± 12.0 %
2600	39.0	1.96	7.76	7.76	7.76	0.37	0.92	± 12.0 %
3500	37.9	2.91	7.40	7.40	7.40	0.41	0.94	± 13.1 %
3700	37.7	3.12	7.11	7.11	7.11	0.50	0.84	± 13.1 %
5200	36.0	4.66	5.82	5.82	5.82	0.35	1.80	± 13.1 %
5250	35.9	4.71	5.68	5.68	5.68	0.35	1.80	± 13.1 %
5300	35.9	4.76	5.53	5.53	5.53	0.35	1.80	± 13.1 %
5500	35.6	4.96	5.21	5.21	5.21	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.98	4.98	4.98	0.40	1.80	± 13.1 %
5750	35.4	5.22	5.04	5.04	5.04	0.40	1.80	± 13.1 %
5800	35.3	5.27	5.11	5.11	5.11	0.40	1.80	± 13.1 %

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) 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 (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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 lip diameter from the boundary.



EX3DV4- SN:7464

September 12, 2017

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7464

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth (mm) ^G	Unc (k=2)
150	61.9	0.80	12.19	12.19	12.19	0.00	1.00	± 13.3 %
300	58.2	0.92	11.32	11.32	11.32	0.06	1.20	± 13.3 %
450	56.7	0.94	11.05	11.05	11.05	0.09	1.20	± 13.3 %
750	55.5	0.96	10.63	10.63	10.63	0.49	0.88	± 12.0 %
835	55.2	0.97	10.21	10.21	10.21	0.45	0.80	± 12.0 %
900	55.0	1.05	10.17	10.17	10.17	0.42	0.80	± 12.0 %
1450	54.0	1.30	9.18	9.18	9.18	0.36	0.80	± 12.0 %
1640	53.7	1.42	9.12	9.12	9.12	0.38	0.80	± 12.0 %
1750	53.4	1.49	8.60	8.60	8.60	0.44	0.80	± 12.0 %
1810	53.3	1.52	8.45	8.45	8.45	0.41	0.80	± 12.0 %
1900	53.3	1.52	8.32	8.32	8.32	0.42	0.80	± 12.0 %
2000	53.3	1.52	8.24	8.24	8.24	0.39	0.80	± 12.0 %
2100	53.2	1.62	8.38	8.38	8.38	0.40	0.80	± 12.0 %
2300	52.9	1.81	8.30	8.30	8.30	0.42	0.93	± 12.0 %
2450	52.7	1.95	8.09	8.09	8.09	0.34	0.95	± 12.0 %
2600	52.5	2.16	7.84	7.84	7.84	0.30	0.97	± 12.0 %
3500	51.3	3.31	7.06	7.06	7.06	0.68	0.70	± 13.1 %
3700	51.0	3.55	6.99	6.99	6.99	0.85	0.60	± 13.1 %
5200	49.0	5.30	5.39	5.39	5.39	0.35	1.90	± 13.1 %
5250	48.9	5.36	5.29	5.29	5.29	0.35	1.90	± 13.1 %
5300	48.9	5.42	5.19	5.19	5.19	0.35	1.90	± 13.1 %
5500	48.6	5.65	4.61	4.61	4.61	0.40	1.90	± 13.1 %
5600	48.5	5.77	4.50	4.50	4.50	0.40	1.90	± 13.1 %
5750	48.3	5.94	4.59	4.59	4.59	0.40	1.90	± 13.1 %
5800	48.2	6.00	4.67	4.67	4.67	0.40	1.90	± 13.1 %

^C 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.

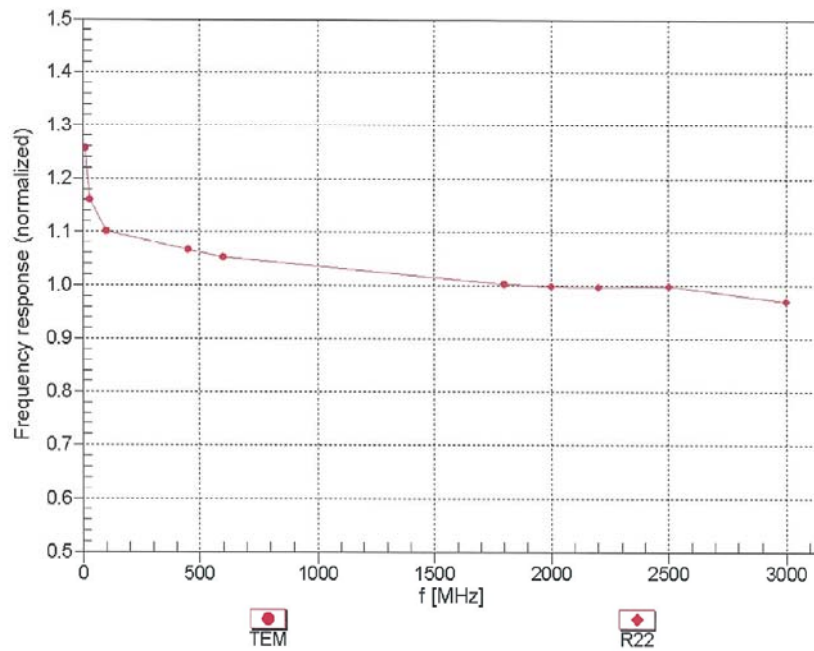
^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

EX3DV4- SN:7464

September 12, 2017

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



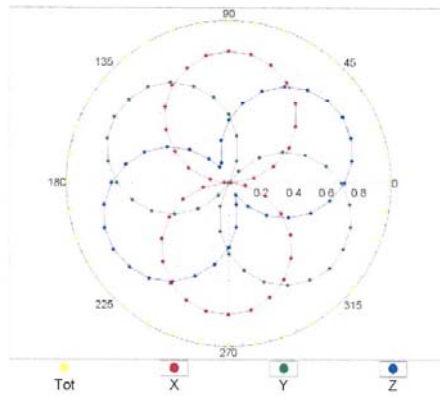
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

EX3DV4- SN:7464

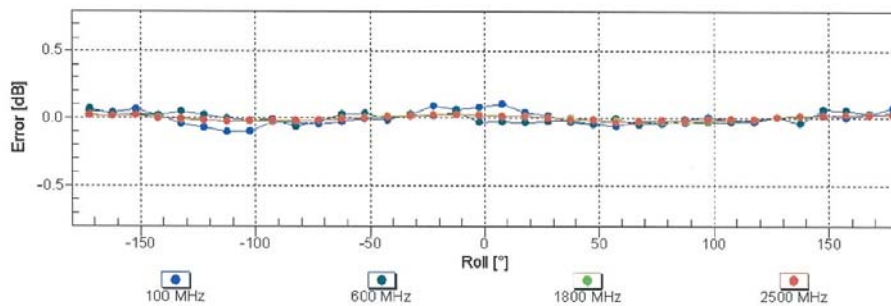
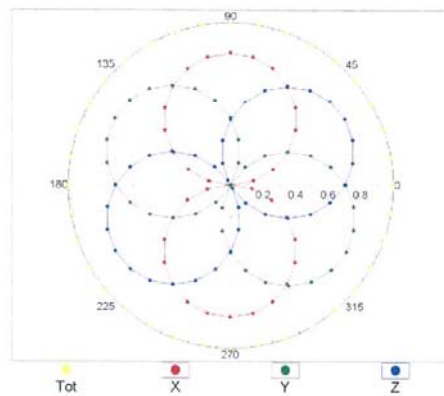
September 12, 2017

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

f=600 MHz, TEM



f=1800 MHz, R22

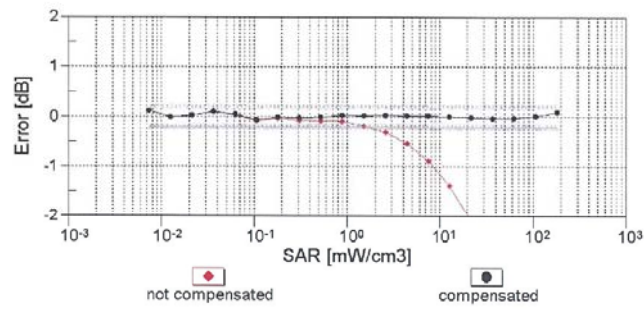
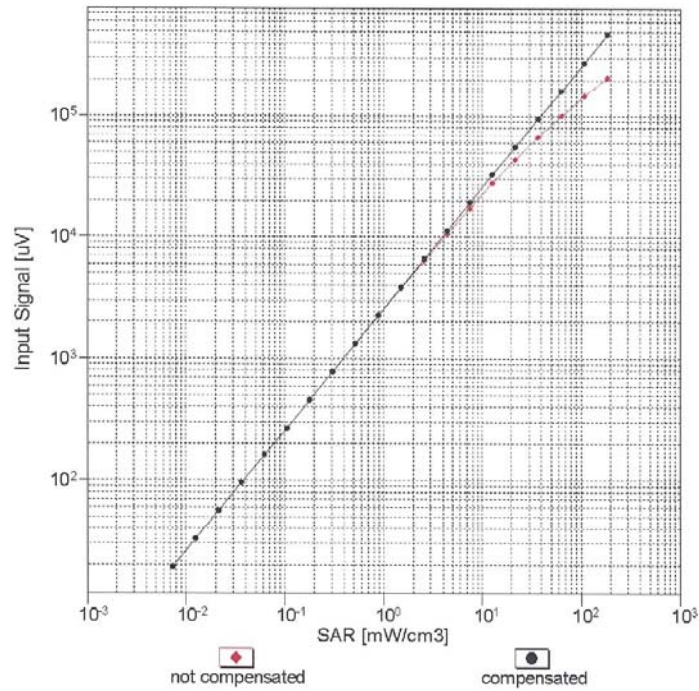


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

EX3DV4- SN:7464

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Dynamic Range $f(SAR_{head})$ (TEM cell, $f_{eval} = 1900$ MHz)

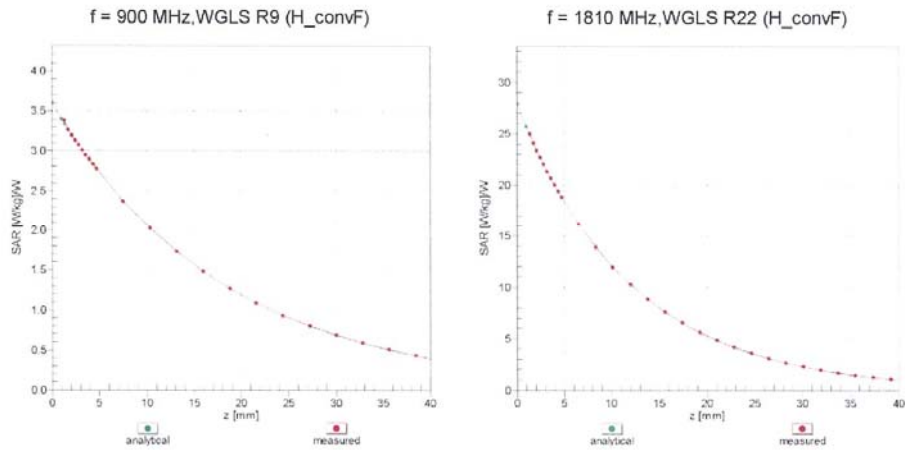


Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

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Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, ϑ), f = 900 MHz

