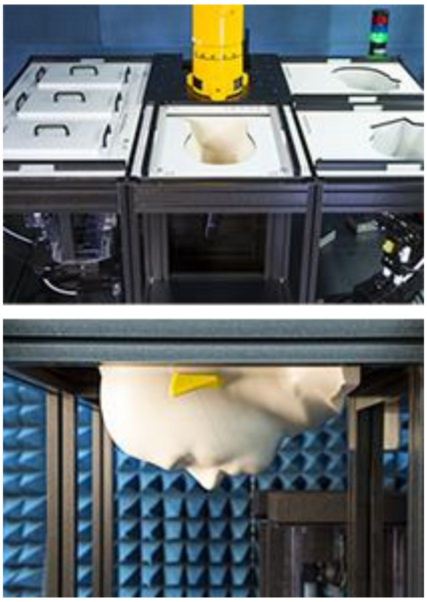
C.4.5 Phantom

The SAM Face Down Phantom V10 allows assessment of the exposure of the face and in particular the eyes for handheld devices operated in front of the face. e.g., video phones, cameras, organizers, etc. It is manufactured from high precision injection molded polypropylene. The Mounting Device for Transmitters including extensions kit can be used to position the device.

Material	Epoxy based
Liquid Compatibility	The phantom shell is compatible with SPEAG tissue simulating liquids (sugar and oil based). Use of other liquids may render the phantom warranty void (see note or consult SPEAG support).
Shell Thickness	2 ± 0.2 mm (6 mm at ear point)
Head Shape	Standard compatible SAM head.



Picture C.7: Face Down Phantom

ANNEX D Equivalent Media Recipes

The liquid used for the frequency range of 800-6000 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 D.1: Composition of the Tissue Equivalent Matter

Frequency (MHz)	835Head	835Body	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	ε=41.5 σ=0.90	ε=55.2 σ=0.97	ε=40.0 σ=1.40	ε=53.3 σ=1.52	ε=39.2 σ=1.80	ε=52.7 σ=1.95	ε=35.3 σ=5.27	ε=48.2 σ=6.00

ANNEX E 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 E.1: System Validation for 3617

Probe SN.	Liquid name	Validation date	Frequency point	Status (OK or Not)
3617	Head 750MHz	Feb.19,2017	750 MHz	OK
3617	Head 835MHz	Feb.19,2017	850 MHz	OK
3617	Head 900MHz	Feb.18,2017	900 MHz	OK
3617	Head 1750MHz	Feb.17,2017	1750 MHz	OK
3617	Head 1810MHz	Feb.17,2017	1810 MHz	OK
3617	Head 1900MHz	Feb.16,2017	1900 MHz	OK
3617	Head 2000MHz	Feb.16,2017	2000 MHz	OK
3617	Head 2100MHz	Feb.16,2017	2100 MHz	OK
3617	Head 2300MHz	Feb.15,2017	2300 MHz	OK
3617	Head 2450MHz	Feb.15,2017	2450 MHz	OK
3617	Head 2600MHz	Feb.15,2017	2600 MHz	OK
3617	Head 3500MHz	Feb.14,2017	3500 MHz	OK
3617	Head 3700MHz	Feb.14,2017	3700 MHz	OK
3617	Head 5200MHz	Feb.13,2017	5200 MHz	OK
3617	Head 5300MHz	Feb.13,2017	5300 MHz	OK
3617	Head 5500MHz	Feb.13,2017	5500 MHz	OK
3617	Head 5600MHz	Feb.13,2017	5600 MHz	OK
3617	Head 5800MHz	Feb.13,2017	5800 MHz	OK
3617	Body 750MHz	Feb.19,2017	750 MHz	OK
3617	Body 835MHz	Feb.19,2017	850 MHz	OK
3617	Body 900MHz	Feb.18,2017	900 MHz	OK
3617	Body 1750MHz	Feb.17,2017	1750 MHz	OK
3617	Body 1810MHz	Feb.17,2017	1810 MHz	OK
3617	Body 1900MHz	Feb.16,2017	1900 MHz	OK
3617	Body 2000MHz	Feb.16,2017	2000 MHz	OK
3617	Body 2100MHz	Feb.16,2017	2100 MHz	OK
3617	Body 2300MHz	Feb.15,2017	2300 MHz	OK
3617	Body 2450MHz	Feb.15,2017	2450 MHz	OK
3617	Body 2600MHz	Feb.15,2017	2600 MHz	OK
3617	Body 3500MHz	Feb.14,2017	3500 MHz	OK
3617	Body 3700MHz	Feb.14,2017	3700 MHz	OK
3617	Body 5200MHz	Feb.13,2017	5200 MHz	OK
3617	Body 5300MHz	Feb.13,2017	5300 MHz	OK
3617	Body 5500MHz	Feb.13,2017	5500 MHz	OK
3617	Body 5600MHz	Feb.13,2017	5600 MHz	OK
3617	Body 5800MHz	Feb.13,2017	5800 MHz	OK

ANNEX F Probe Calibration Certificate

Probe 3617 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
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 (Auden)**

Certificate No: **EX3-3617_Jan17**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3617

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: January 23, 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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
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: January 26, 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
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**

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 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., ϑ = 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
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 ϑ = 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^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *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).

Probe EX3DV4

SN:3617

Manufactured: May 3, 2007
Calibrated: January 23, 2017

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3617

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.34	0.21	0.32	± 10.1 %
DCP (mV)[B]	97.4	95.3	98.0	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	131.8	±3.5 %
		Y	0.0	0.0	1.0		144.0	
		Z	0.0	0.0	1.0		147.7	

Note: For details on UID parameters see Appendix.

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 $ms.V^{-2}$	T2 $ms.V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
X	50.79	376	35.26	10.33	1.155	4.964	1.834	0.242	1.006
Y	46.63	357.6	37.37	11.72	1.223	4.997	1.258	0.519	1.005
Z	52.46	395.6	36.35	13.43	1.057	4.999	0.95	0.401	1.006

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.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3617

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 [G] (mm)	Unc (k=2)
150	52.3	0.76	12.04	12.04	12.04	0.00	1.00	± 13.3 %
300	45.3	0.87	11.35	11.35	11.35	0.09	1.20	± 13.3 %
450	43.5	0.87	10.69	10.69	10.69	0.13	1.20	± 13.3 %
750	41.9	0.89	10.05	10.05	10.05	0.42	0.80	± 12.0 %
835	41.5	0.90	9.73	9.73	9.73	0.44	0.83	± 12.0 %
900	41.5	0.97	9.59	9.59	9.59	0.43	0.80	± 12.0 %
1450	40.5	1.20	8.83	8.83	8.83	0.39	0.80	± 12.0 %
1640	40.3	1.29	8.65	8.65	8.65	0.27	0.80	± 12.0 %
1750	40.1	1.37	8.49	8.49	8.49	0.33	0.80	± 12.0 %
1810	40.0	1.40	8.22	8.22	8.22	0.26	0.80	± 12.0 %
1900	40.0	1.40	8.26	8.26	8.26	0.31	0.80	± 12.0 %
2000	40.0	1.40	8.25	8.25	8.25	0.30	0.80	± 12.0 %
2100	39.8	1.49	8.45	8.45	8.45	0.22	0.80	± 12.0 %
2300	39.5	1.67	7.87	7.87	7.87	0.39	0.80	± 12.0 %
2450	39.2	1.80	7.74	7.74	7.74	0.31	0.91	± 12.0 %
2600	39.0	1.96	7.30	7.30	7.30	0.36	0.80	± 12.0 %
3500	37.9	2.91	7.38	7.38	7.38	0.30	1.20	± 13.1 %
3700	37.7	3.12	6.95	6.95	6.95	0.25	1.20	± 13.1 %
5200	36.0	4.66	5.90	5.90	5.90	0.30	1.80	± 13.1 %
5300	35.9	4.76	5.58	5.58	5.58	0.35	1.80	± 13.1 %
5500	35.6	4.96	5.22	5.22	5.22	0.40	1.80	± 13.1 %
5600	35.5	5.07	5.08	5.08	5.08	0.40	1.80	± 13.1 %
5800	35.3	5.27	5.20	5.20	5.20	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 tip diameter from the boundary.