

6 Test Conditions and Results

6.1 Recipes for Tissue Simulating Liquids

Body Tissue Simulating Liquids					
Ingredient	M 450-B weight (%)	M 900-B weight (%)	M 1800-B weight (%)	M 1950-A weight (%)	M 2450-B weight (%)
Water	46.21	50.75	70.17	69.79	68.64
Sugar	51.17	48.21			
Cellulose	0.18				
Salt	2.34		0.39	0.2	
Preventol	0.08	0.1			
DGBE			29.44	30	31.37
Head Tissue Simulating Liquids					
Ingredient	HSL 450-A weight (%)	HSL 900-B weight (%)	HSL 1800-F weight (%)	HSL 1950-B weight (%)	HSL 2450-B weight (%)
Water	38.91	40.29	55.24	55.41	55
Sugar	56.93	57.9			
Cellulose	0.25	0.24			
Salt	3.79	1.38	0.31	0.08	
Preventol	0.12	0.18			
DGBE			44.45	44.51	45

Water: deionized water, resistivity $\geq 16 \text{ M}\Omega$

Sugar: refined white sugar

Salt: pure NaCl

Cellulose: Hydroxyethyl-cellulose

Preservative: Preventol D-7

DGBE: Diethylenglycol-monobuthyl ether

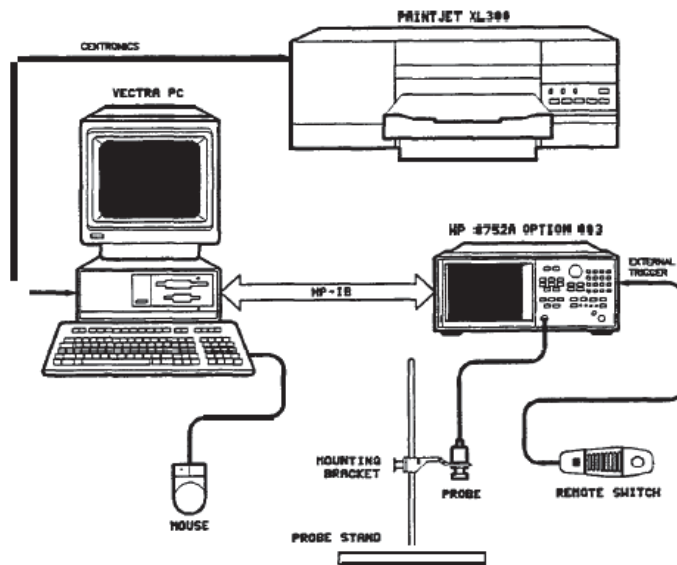
The parameters for the different frequencies are defined in the corresponding compliance standards (e.g., IEEE 1528-2003, IEC 62209-1)

The HBBL3-6GHz and MBBL 3-6 GHz liquids are direct from Speag.

6.2 Test Conditions and Results – Tissue Validation

Tissue Validation acc. to 865664 D01 SAR Measurement 100 MHz to 6 GHz / ISED RSS-102					Verdict: PASS
Test according to measurement reference		Reference Method			
		865664 D01 SAR Measurement 100 MHz to 6 GHz			
Target Values					
Frequency [MHz]	Head		Body		Permitted tolerance [%]
	Relative dielectric constant ϵ_r	Conductivity σ [S/m]	Relative dielectric constant ϵ_r	Conductivity σ [S/m]	
150	52.3	0.76	61.9	0.80	$\leq \pm 5$
300	45.3	0.87	58.2	0.92	$\leq \pm 5$
450	43.5	0.87	56.7	0.94	$\leq \pm 5$
835	41.5	0.90	55.2	0.97	$\leq \pm 5$
900	41.5	0.97	55.0	1.05	$\leq \pm 5$
915	41.5	0.98	55.0	1.06	$\leq \pm 5$
1450	40.5	1.20	54.0	1.30	$\leq \pm 5$
1610	40.3	1.29	53.8	1.40	$\leq \pm 5$
1800 – 2000	40.0	1.40	53.3	1.52	$\leq \pm 5$
2450	39.2	1.80	52.7	1.95	$\leq \pm 5$
3000	38.5	2.40	52.0	2.73	$\leq \pm 5$
5200	36.0	4.66	49.0	5.30	$\leq \pm 5$
5500	35.6	4.96	48.6	5.65	$\leq \pm 5$
5800	35.3	5.27	48.2	6.00	$\leq \pm 5$

Test setup

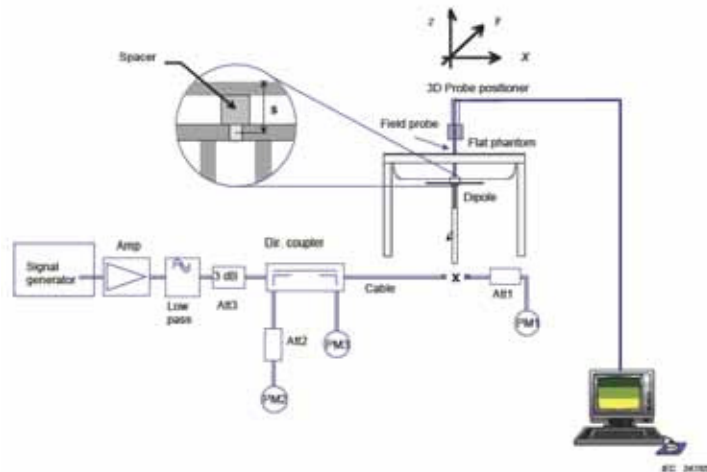


Test procedure

1. The dielectric probe kit is calibrated using the standards air, short circuit and deionized water
2. The tissue simulating liquid is measured using the dielectric probe
3. Target values are compared to the measurement values and deviations are determined

TISSUE VALIDATION									
Room Temperature [°C]					22.5				
Tissue	Freq. [MHz]	Measured ϵ_r	Target ϵ_r *	$\Delta \epsilon_r$ [%] **	Measured σ [S/m]	Target σ [S/m] *	$\Delta \sigma$ [%] **	Operator	Date
HSL-900	900	41.65	41.50	00.36	0.97	0.97	00.00	M. Handrik	10.01.2017
HSL-900	824.2	42.72	41.55	02.82	0.89	0.90	-01.11	M. Handrik	10.01.2017
HSL-900	836.6	42.54	41.50	02.51	0.90	0.90	00.00	M. Handrik	10.01.2017
HSL-900	848.0	42.42	41.50	02.22	0.91	0.91	00.00	M. Handrik	10.01.2017
MSL-900	900	52.97	55.0	-03.69	1.02	1.05	-02.86	M. Handrik	12.01.2017
MSL-900	824.2	53.75	55.24	-02.70	0.94	0.97	-03.09	M. Handrik	12.01.2017
MSL-900	836.6	53.61	55.20	-02.88	0.95	0.97	-02.06	M. Handrik	12.01.2017
MSL-900	848.0	53.51	55.16	-02.99	0.96	0.99	-03.03	M. Handrik	12.01.2017
MSL-900	900	52.61	55.00	-04.35	1.02	1.05	-02.86	M. Handrik	17.01.2017
MSL-900	824.2	53.41	55.24	-03.31	0.94	0.97	-03.09	M. Handrik	17.01.2017
MSL-900	836.4	53.38	55.20	-03.30	0.94	0.97	-03.09	M. Handrik	17.01.2017
MSL-900	848.0	53.38	55.16	-03.23	0.94	0.99	-05.00	M. Handrik	17.01.2017
HSL-900	900	40.00	41.5	-03.61	0.93	0.97	-04.12	M. Handrik	16.01.2017
HSL-1900	1900	38.71	40.0	-03.23	1.40	1.40	00.00	M. Handrik	17.01.2017
HSL-1900	1850.2	38.77	40.0	-03.07	1.34	1.40	-04.29	M. Handrik	17.01.2017
HSL-1900	1880	38.78	40.0	-03.05	1.40	1.40	00.00	M. Handrik	17.01.2017
HSL-1900	1909.8	38.68	40.0	-03.30	1.40	1.40	00.00	M. Handrik	17.01.2017
MSL-1900	1900	53.16	53.30	-00.26	1.50	1.52	-01.32	M. Handrik	18.01.2017
MSL-1900	1852.6	53.33	53.30	00.06	1.44	1.52	-05.00	M. Handrik	18.01.2017
MSL-1900	1880.0	53.21	53.30	-00.17	1.48	1.52	-02.63	M. Handrik	18.01.2017
MSL-1900	1907.4	53.14	53.30	-00.30	1.50	1.52	-01.32	M. Handrik	18.01.2017
MSL-2450	2450	50.85	52.70	-03.51	2.01	1.95	03.08	M. Handrik	24.01.2017
MSL-2450	2402	50.95	52.76	-03.43	1.94	1.90	02.11	M. Handrik	24.01.2017
MSL-2450	2441	50.89	52.71	-03.45	2.00	1.94	03.09	M. Handrik	24.01.2017
MSL-2450	2480	50.72	52.66	-03.68	2.06	1.99	03.52	M. Handrik	24.01.2017
* The target tissue dielectric properties of the corresponding basic SAR measurement standard apply									
** The deviation has to be 5% or lower									

6.3 Test Conditions and Results – System Validation

System Validation acc. to 865664 D01 SAR Measurement 100 MHz to 6 GHz / ISED RSS-102		Verdict: PASS
Test according to measurement reference	Reference Method	
	865664 D01 SAR Measurement 100 MHz to 6 GHz / IEEE 1528	
Test frequency range	Tested frequencies	
	2450 MHz , 5200 MHz	
Test mode	unmodulated CW	
Target Values		
Frequency [MHz]	Target SAR value [W/kg (1g)]	Permitted tolerance [%]
HSL 900	2.71 @ 250mW	≤ ±10
MSL 900	2.80 @ 250mW	≤ ±10
HSL 1900	10.0 @ 250mW	≤ ±10
MSL 1900	10.2 @ 250mW	≤ ±10
MSL 2450	12.5 @ 250mW	≤ ±10
The target reference values are taken from the calibration sheets (see annex)		
Test setup		
		
Test procedure		
1. The dipole antenna input power is set to 250mW 2. The reference dipole is positioned under the phantom 3. With the dipole antenna powered the SAR value is measured 4. The measured SAR values are compared to the target SAR values		

SYSTEM VALIDATION – 1g									
Room Temperature [°C]					22.5				
TSL	Validation Dipole	Measurement Phantom	Validation Frequency [MHz]	Input Power [mW]	Measured SAR (1g) [W/kg]	Target SAR (1g) [W/kg] *	Δ SAR (1g) [%] **	Operator	Date
HSL-900	D900V2	SAM Twin	900	250 mW	2.77	2.71	02.21	M. Handrik	10.01.2017
HSL-900	D900V2	SAM Twin	900	250 mW	2.72	2.71	00.37	M. Handrik	11.01.2017
MSL-900	D900V2	ELI 4	900	250 mW	2.77	2.80	-01.07	M. Handrik	12.01.2017
MSL-900	D900V2	ELI 4	900	250 mW	2.80	2.80	00.00	M. Handrik	13.01.2017
MSL-900	D900V2	ELI 4	900	250 mW	2.76	2.80	-01.43	M. Handrik	17.01.2017
HSL-1900	D1900V2	SAM Twin	1900	250 mW	10.7	10.0	07.00	M. Handrik	18.01.2017
MSL-1900	D1900V2	ELI 4	1900	250 mW	10.3	10.2	00.98	M. Handrik	18.01.2017
MSL-1900	D1900V2	ELI 4	1900	250 mW	10.2	10.2	00.00	M. Handrik	19.01.2017
MSL 2450	D2450V2	ELI 4	2450	250 mW	13.3	12.5	06.40	M. Handrik	24.01.2017
* See calibration documents of system validation dipole									
** The deviation has to be 10% or lower									

6.4 Test Conditions and Results – Standalone SAR Measurement

Standalone SAR acc. to 865664 D01 SAR Measurement 100 MHz to 6 GHz / ISED RSS-102		Verdict: PASS
Test according to measurement reference	Reference Method	
	865664 D01 SAR Measurement 100 MHz to 6 GHz / ISED RSS-102 Issue 5	
Room temperature	22.0 – 22.6 °C	
Liquid depth	15.5 cm	
Environment	general public	
Limits		
Region	Occupational SAR values [W/kg]	General public SAR values [W/kg]
Whole body average SAR	0.4	0.08
Localized SAR (Head and trunk) SAR averaging mass = 1g	8	1.6
Localized SAR (Limbs) SAR averaging mass = 10g	20	4

SINGLE TRANSMITTER SAR EVALUATION 1g - Localized SAR (Head and trunk)											
Room Temperature [°C]						22.5					
Mode	***Position	TSL	Phant.	Ch.	Freq. [MHz]	Power Drift [dB]	Measured SAR (1g) [W/kg]	Power Scaling Factor*	Reported SAR (1g) [W/kg] **	Operator	Date
GSM 850	FRONT	HSL-900	SAM Twin	128	824.2	-0.08	0.064	1.585	0.101	M. Handrik	10.01.2017
GSM 1900	FRONT	HSL-1900	SAM Twin	661	1880	0.03	0.019	1.585	0.030	M. Handrik	18.01.2017
FDD V	FRONT	HSL-900	SAM Twin	4182	836.6	-0.03	0.067	1.585	0.106	M. Handrik	11.01.2017
FDD II	FRONT	HSL-1900	SAM Twin	9263	1852.6	-0.06	0.141	1.585	0.223	M. Handrik	18.01.2017
* Scaling factor = Max. conducted power (including tune up tolerance) / measured conducted power											
** Reported SAR = Measured SAR * Scaling Factor											

SINGLE TRANSMITTER SAR EVALUATION 10g - Localized SAR (Limbs)											
Room Temperature [°C]						22.5					
Mode	***Position	TSL	Phant.	Ch.	Freq. [MHz]	Power Drift [dB]	Measured SAR (1g) [W/kg]	Power Scaling Factor*	Reported SAR (10g) [W/kg] **	Operator	Date
GSM 850	BOTTOM	MSL-900	ELI 4	128	824.2	-0.08	0.345	1.585	0.547	M. Handrik	17.01.2017
GSM 850	TOP	MSL-900	ELI 4	128	824.2	0.04	0.028	1.585	0.044	M. Handrik	17.01.2017
GSM 850	LEFT	MSL-900	ELI 4	128	824.2	0.0	0.024	1.585	0.038	M. Handrik	17.01.2017
GSM 850	RIGHT	MSL-900	ELI 4	128	824.2	0.07	0.016	1.585	0.025	M. Handrik	17.01.2017
GSM 850	BACK	MSL-900	ELI 4	128	824.2	-0.07	0.084	1.585	0.133	M. Handrik	17.01.2017
GSM 1900	BOTTOM	MSL-1900	ELI 4	661	1880	-0.1	0.054	1.585	0.086	M. Handrik	19.01.2017
GSM 1900	TOP	MSL-1800	ELI 4	661	1880	-0.03	0.017	1.585	0.027	M. Handrik	19.01.2017
GSM 1900	LEFT	MSL-1900	ELI 4	661	1880	0.02	0.003	1.585	0.005	M. Handrik	19.01.2017
GSM 1900	RIGHT	MSL-1900	ELI 4	661	1880	-0.03	0.004	1.585	0.006	M. Handrik	19.01.2017
GSM 1900	BACK	MSL-1900	ELI 4	661	1880	0.03	0.020	1.585	0.032	M. Handrik	19.01.2017
FDD V	BOTTOM	MSL-900	ELI 4	4132	826.4	-0.06	1.11	1.585	1.759	M. Handrik	17.01.2017
FDD V	BOTTOM	MSL-900	ELI 4	4182	836.6	-0.08	1.22	1.585	1.934	M. Handrik	12.01.2017
FDD V	BOTTOM	MSL-900	ELI 4	4233	846.6	0.00	1.03	1.585	1.633	M. Handrik	17.01.2017
FDD V	TOP	MSL-900	ELI 4	4182	836.6	-0.05	0.047	1.585	0.074	M. Handrik	12.01.2017
FDD V	LEFT	MSL-900	ELI 4	4182	836.6	-0.07	0.060	1.585	0.095	M. Handrik	13.01.2017
FDD V	RIGHT	MSL-900	ELI 4	4182	836.6	-0.06	0.120	1.585	0.190	M. Handrik	13.01.2017
FDD V	BACK	MSL-900	ELI 4	4182	836.6	-0.04	0.402	1.585	0.637	M. Handrik	13.01.2017
FDD II	BOTTOM	MSL-1900	ELI 4	9263	1852.6	-0.07	1.35	1.585	2.140	M. Handrik	18.01.2017
FDD II	BOTTOM	MSL-1900	ELI 4	9400	1880	-0.04	1.09	1.585	1.728	M. Handrik	18.01.2017
FDD II	BOTTOM	MSL-1900	ELI 4	9537	1907.4	-0.0	1.2	1.585	1.902	M. Handrik	18.01.2017
FDD II	TOP	MSL-1900	ELI 4	9263	1907.4	0.08	0.098	1.585	0.155	M. Handrik	18.01.2017
FDD II	LEFT	MSL-1900	ELI 4	9263	1907.4	0.09	0.202	1.585	0.320	M. Handrik	18.01.2017
FDD II	RIGHT	MSL-1900	ELI 4	9263	1907.4	-0.01	0.151	1.585	0.239	M. Handrik	19.01.2017
FDD II	BACK	MSL-1900	ELI 4	9263	1907.4	0.00	0.359	1.585	0.569	M. Handrik	19.01.2017
Bluetooth	TOP	MSL-2450	ELI 4	0	2402	-0.06	0.003	1.585	0.005	M. Handrik	24.01.2017
Bluetooth	BOTTOM	MSL-2450	ELI 4	0	2402	-0.08	0.006	1.585	0.010	M. Handrik	24.01.2017
Bluetooth	BACK	MSL-2450	ELI 4	0	2402	-0.00	0.013	1.585	0.021	M. Handrik	24.01.2017

Test Report No.: G0M-1612-6168-TFC093SR-V01

Eurofins Product Service GmbH
Storkower Str. 38c, D-15526 Reichenwalde, Germany

Bluetooth LE	BACK	MSL-2450	ELI 4	39	2480	-0.09	0.009	1.413	0.013	M. Handrik	24.01.2017
Bluetooth LE	BOTTOM	MSL-2450	ELI 4	39	2480	0.03	0.001	1.413	0.001	M. Handrik	24.01.2017
Bluetooth LE	TOP	MSL-2450	ELI 4	39	2480	0.00	0.002	1.413	0.003	M. Handrik	24.01.2017
* Scaling factor = Max. conducted power (including tune up tolerance) / measured conducted power ** Reported SAR = Measured SAR * Scaling Factor											

According to KDB 865664 D02 v01r01 only the SAR plots for the highest SAR results for each EUT configuration and operating condition are given in the “SAR Results” part of the report.

ANNEX A Calibration Documents



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **Eurofins**

Certificate No: **D900V2-164_Sep15**

CALIBRATION CERTIFICATE

Object **D900V2 - SN:164**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **September 30, 2015**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 7349	30-Dec-14 (No. EX3-7349_Dec14)	Dec-15
DAE4	SN: 601	17-Aug-15 (No. DAE4-601_Aug15)	Aug-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-18
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by: **Name** **Leif Klysner** **Function** **Laboratory Technician**

Approved by: **Katja Pokovic** **Technical Manager**

Signature

Issued: October 1, 2015

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

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:

- 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
- 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
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- 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%.

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	900 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.97 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	41.6 $\pm$ 6 %	0.96 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.71 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	10.9 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.73 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.96 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.0	1.05 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.6 $\pm$ 6 %	1.03 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.80 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	11.3 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.81 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	7.29 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.1 Ω - 5.0 j Ω
Return Loss	- 25.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.0 Ω - 6.5 j Ω
Return Loss	- 21.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.408 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	May 16, 2002

DASY5 Validation Report for Head TSL

Date: 30.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN:164

Communication System: UID 0 - CW; Frequency: 900 MHz

Medium parameters used: $f = 900 \text{ MHz}$; $\sigma = 0.96 \text{ S/m}$; $\epsilon_r = 41.6$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- 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:

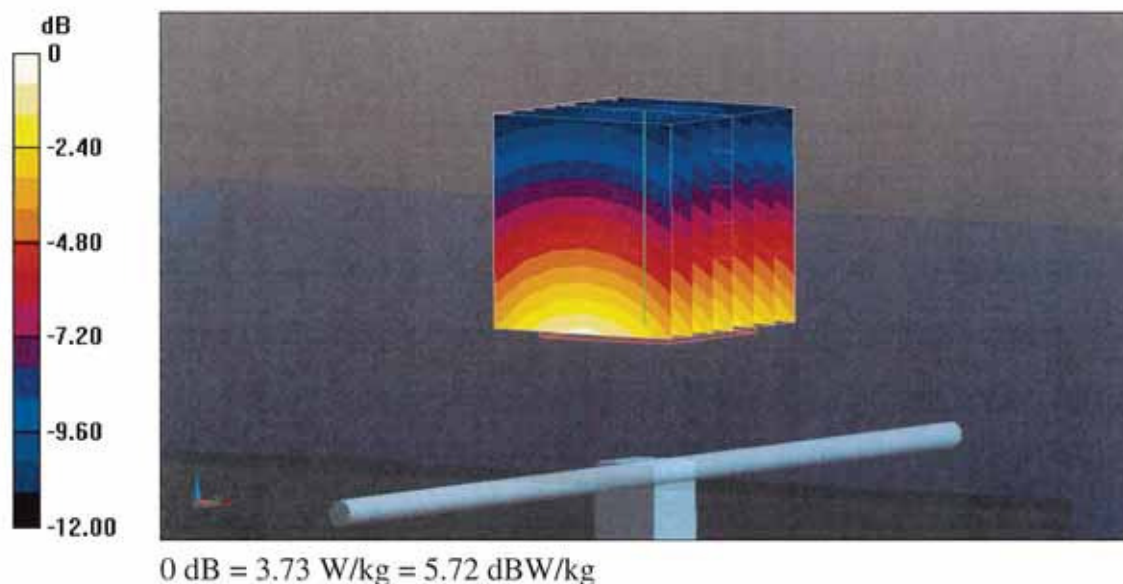
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 64.45 V/m; Power Drift = 0.02 dB

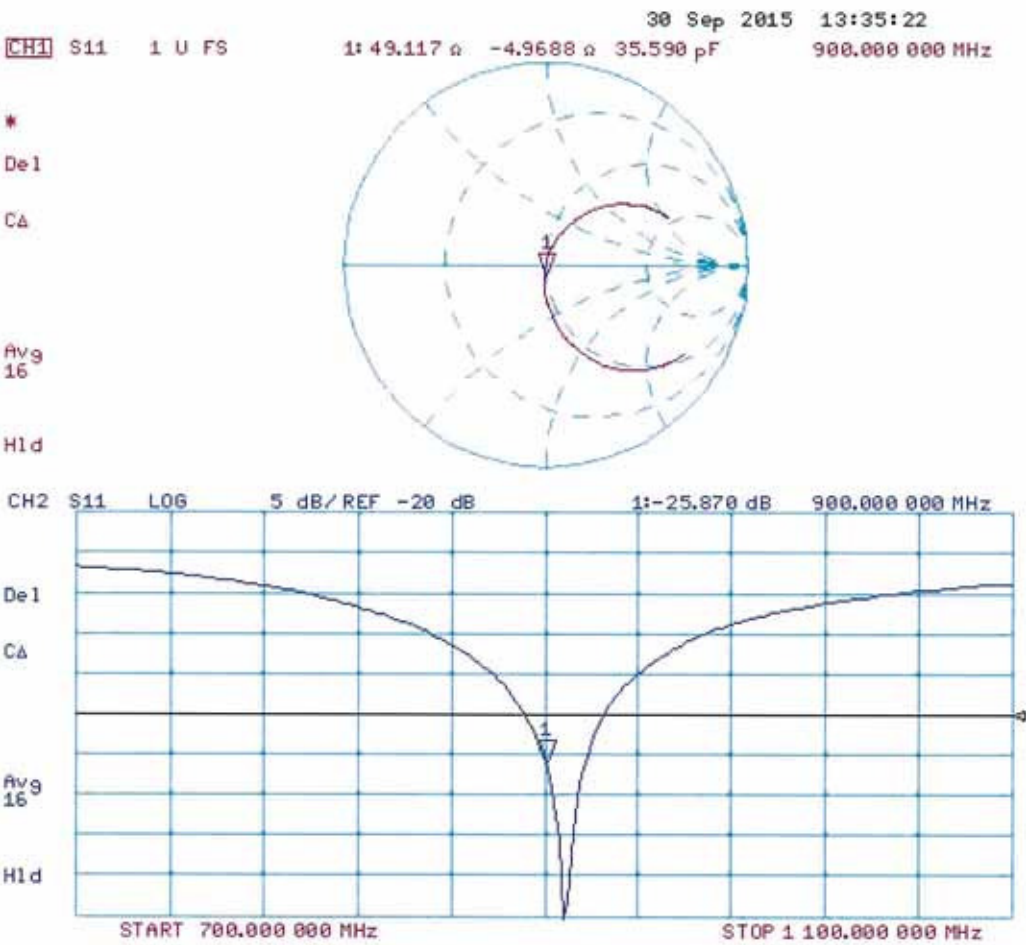
Peak SAR (extrapolated) = 4.28 W/kg

SAR(1 g) = 2.71 W/kg; SAR(10 g) = 1.73 W/kg

Maximum value of SAR (measured) = 3.73 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 30.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN:164

Communication System: UID 0 - CW; Frequency: 900 MHz

Medium parameters used: $f = 900$ MHz; $\sigma = 1.03$ S/m; $\epsilon_r = 53.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.39, 9.39, 9.39); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- 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:

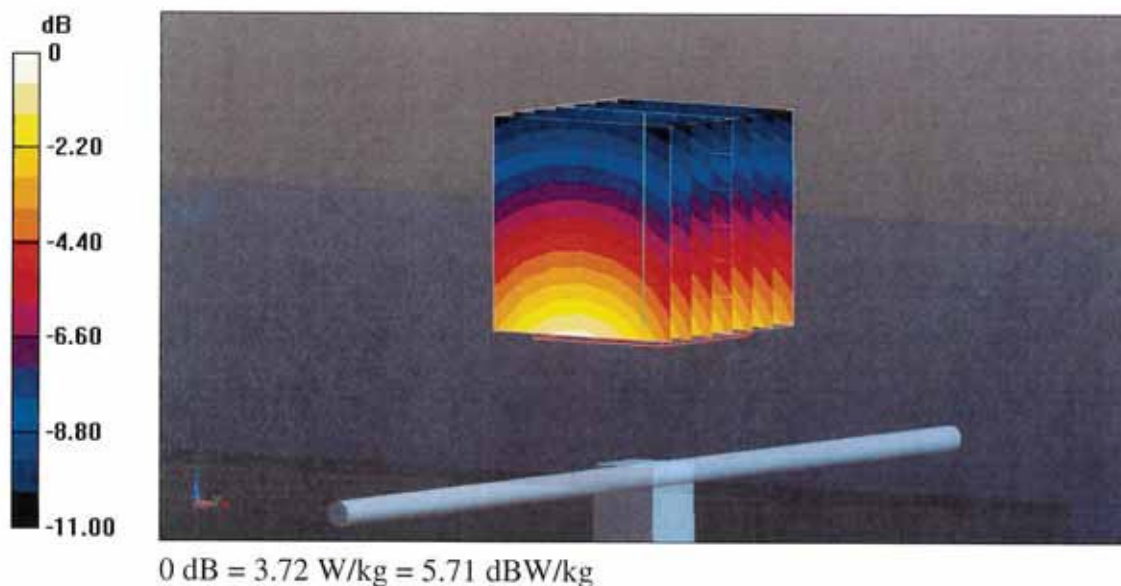
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 63.07 V/m; Power Drift = 0.01 dB

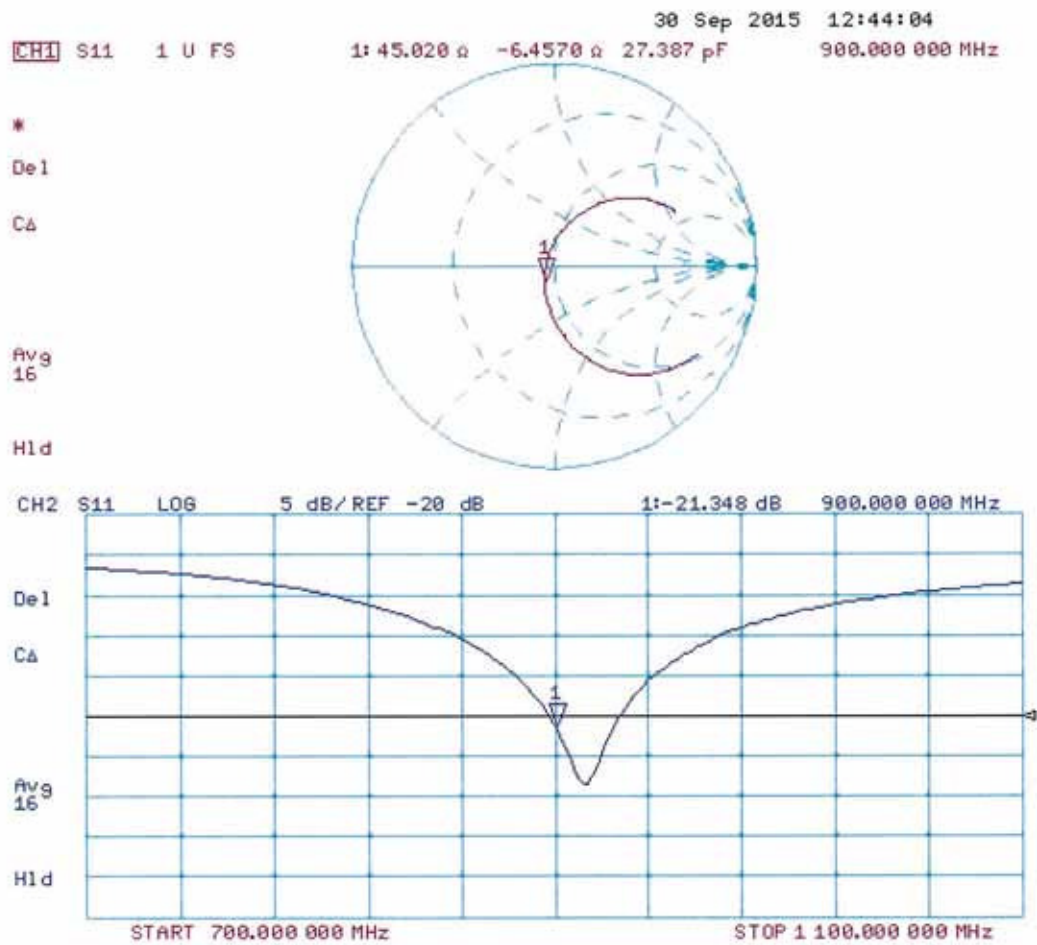
Peak SAR (extrapolated) = 4.18 W/kg

SAR(1 g) = 2.8 W/kg; SAR(10 g) = 1.81 W/kg

Maximum value of SAR (measured) = 3.72 W/kg



Impedance Measurement Plot for Body TSL





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 **Eurofins**

Certificate No: **D1900V2-5d025_Sep15**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN:5d025**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **September 29, 2015**

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 EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 7349	30-Dec-14 (No. EX3-7349_Dec14)	Dec-15
DAE4	SN: 601	17-Aug-15 (No. DAE4-601_Aug15)	Aug-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-18
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by: **Leif Klysner** **Leif Klysner** **Leif Klysner**
 Name Function Signature
 Leif Klysner Laboratory Technician

Approved by: **Katja Pokovic** **Katja Pokovic** **Katja Pokovic**
 Name Function Signature
 Katja Pokovic Technical Manager

Issued: September 30, 2015

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



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Accreditation No.: **SCS 0108**

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:

- 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
- 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
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- 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%.

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	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	39.3 $\pm$ 6 %	1.38 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.2 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.21 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.9 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	52.6 $\pm$ 6 %	1.52 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.7 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.38 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.5 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.7 Ω + 4.9 j Ω
Return Loss	- 25.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.4 Ω + 5.9 j Ω
Return Loss	- 24.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 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	July 29, 2002

DASY5 Validation Report for Head TSL

Date: 29.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d025

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.38$ S/m; $\epsilon_r = 39.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.14, 8.14, 8.14); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

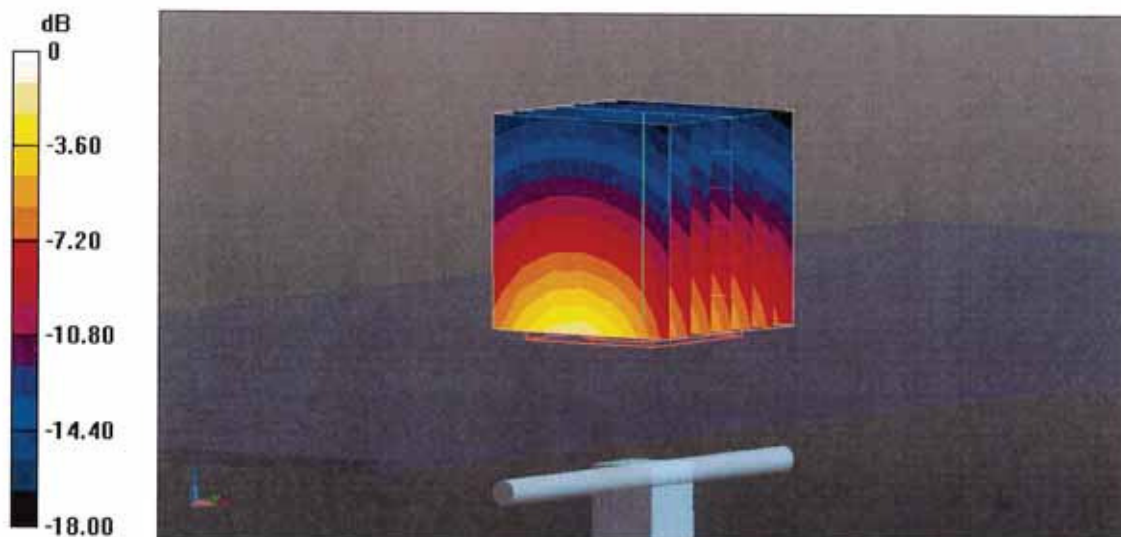
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 109.8 V/m; Power Drift = 0.05 dB

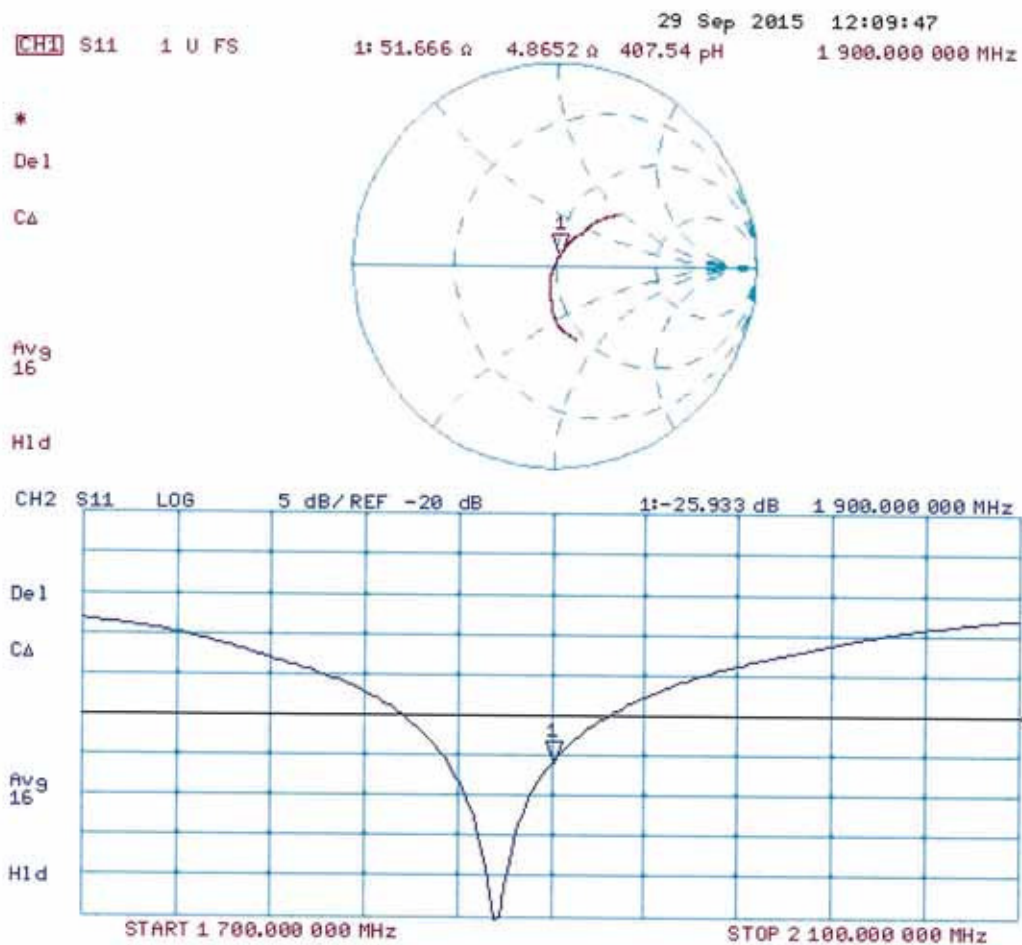
Peak SAR (extrapolated) = 18.9 W/kg

SAR(1 g) = 10 W/kg; SAR(10 g) = 5.21 W/kg

Maximum value of SAR (measured) = 15.6 W/kg



Impedance Measurement Plot for Head TSL



Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d025

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.52$ S/m; $\epsilon_r = 52.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.9, 7.9, 7.9); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

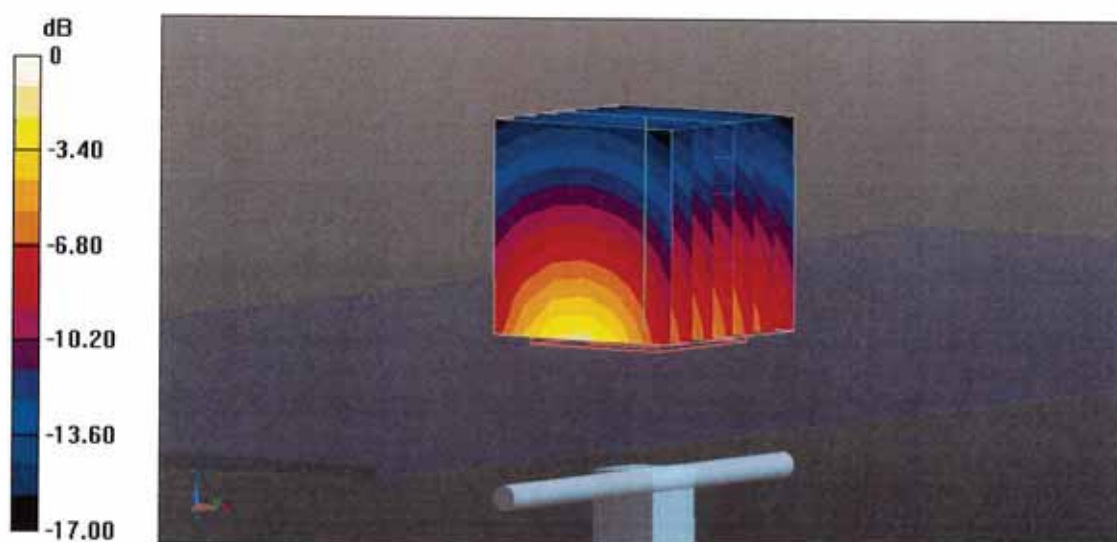
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 104.6 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 18.2 W/kg

SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.38 W/kg

Maximum value of SAR (measured) = 15.4 W/kg



0 dB = 15.4 W/kg = 11.88 dBW/kg

Impedance Measurement Plot for Body TSL

