# 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 |

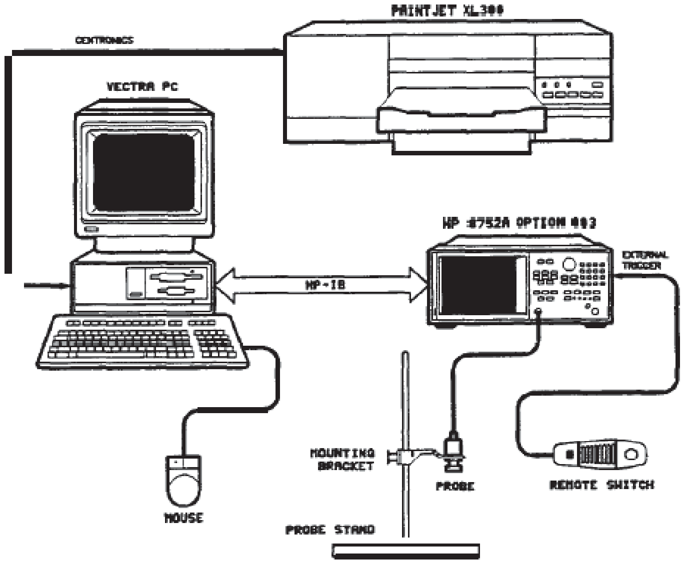
Water: deionized water, resistivity ≥ 16 MΩ
Sugar: refined white sugar
Salt: pure NaCl
Cellulose: Hydroxyethyl-cellulose
Preservative: Preventol D-7
DGBE: Diethylenglycol-monobuthyl ether

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 $\varepsilon_r$ | Conductivity σ [S/m] | Relative dielectric constant $\varepsilon_r$ | Conductivity σ [S/m] | |
| 150 | 52.3 | 0.76 | 61.9 | 0.80 | ≤ ±5 |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 | ≤ ±5 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 | ≤ ±5 |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 | ≤ ±5 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 | ≤ ±5 |
| 915 | 41.5 | 0.98 | 55.0 | 1.06 | ≤ ±5 |
| 1450 | 40.5 | 1.20 | 54.0 | 1.30 | ≤ ±5 |
| 1610 | 40.3 | 1.29 | 53.8 | 1.40 | ≤ ±5 |
| 1800 – 2000 | 40.0 | 1.40 | 53.3 | 1.52 | ≤ ±5 |
| 2450 | 39.2 | 1.80 | 52.7 | 1.95 | ≤ ±5 |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 | ≤ ±5 |
| 5200 | 36.0 | 4.66 | 49.0 | 5.30 | ≤ ±5 |
| 5500 | 35.6 | 4.96 | 48.6 | 5.65 | ≤ ±5 |
| 5800 | 35.3 | 5.27 | 48.2 | 6.00 | ≤ ±5 |

| Test setup |
|---|
|   |

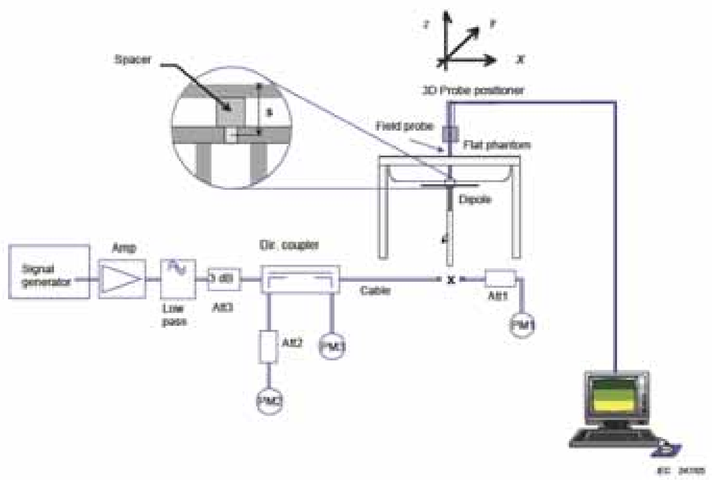
| Test procedure |
|---|
| 1. The dielectric probe kit is calibrated using the standards air, short circuit and deionized water<br>2. The tissue simulating liquid is measured using the dielectric probe<br>3. Target values are compared to the measurement values and deviations are determined |

| TISSUE VALIDATION | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Room Temperature [°C] | | | | | 22.5 | | | | |
| Tissue | Freq. [MHz] | Measured $\varepsilon_r$ | Target $\varepsilon_r$ * | Δ $\varepsilon_r$ [%] ** | Measured σ [S/m] | Target σ [S/m] * | Δ σ [%] ** | 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 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 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

**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

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: **D900V2-164_Sep15**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D900V2 - SN:164 |
| Calibration procedure(s) | QA CAL-05.v9<br>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 ± 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 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Leif Klysner | Laboratory Technician | Leif Klysner |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: October 1, 2015

## 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) 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"

## Additional Documentation:

e) 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 ± 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 ± 0.2) °C | 41.6 ± 6 % | 0.96 mho/m ± 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 ± 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 ± 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 ± 0.2) °C | 53.6 ± 6 % | 1.03 mho/m ± 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 ± 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 ± 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 jΩ |
| Return Loss | - 25.9 dB |

### Antenna Parameters with Body TSL

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

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.408 ns |

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**

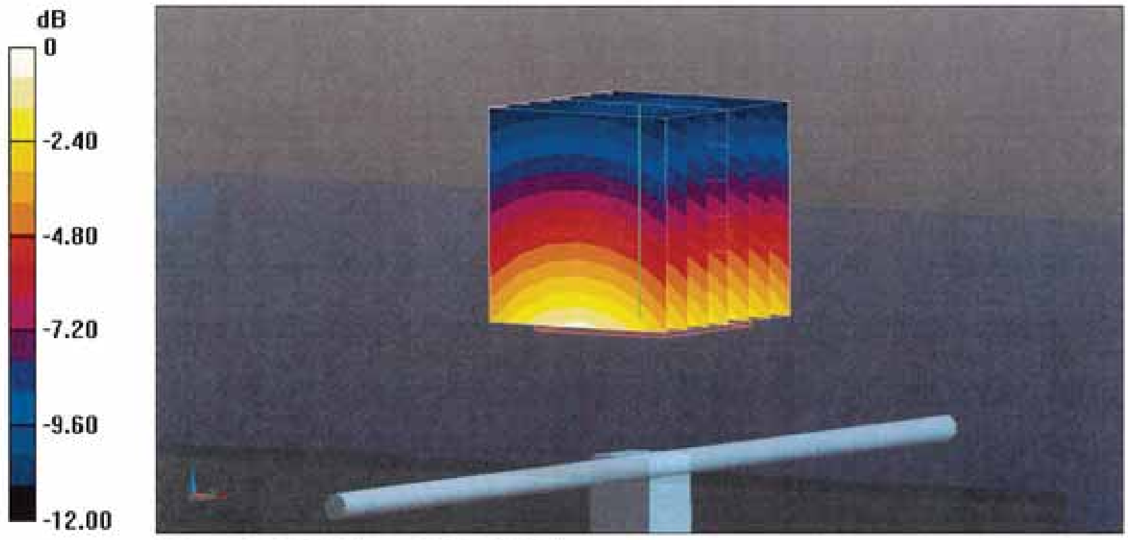
Communication System: UID 0 - CW; Frequency: 900 MHz
Medium parameters used: f = 900 MHz; $\sigma$ = 0.96 S/m; $\varepsilon_r$ = 41.6; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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)

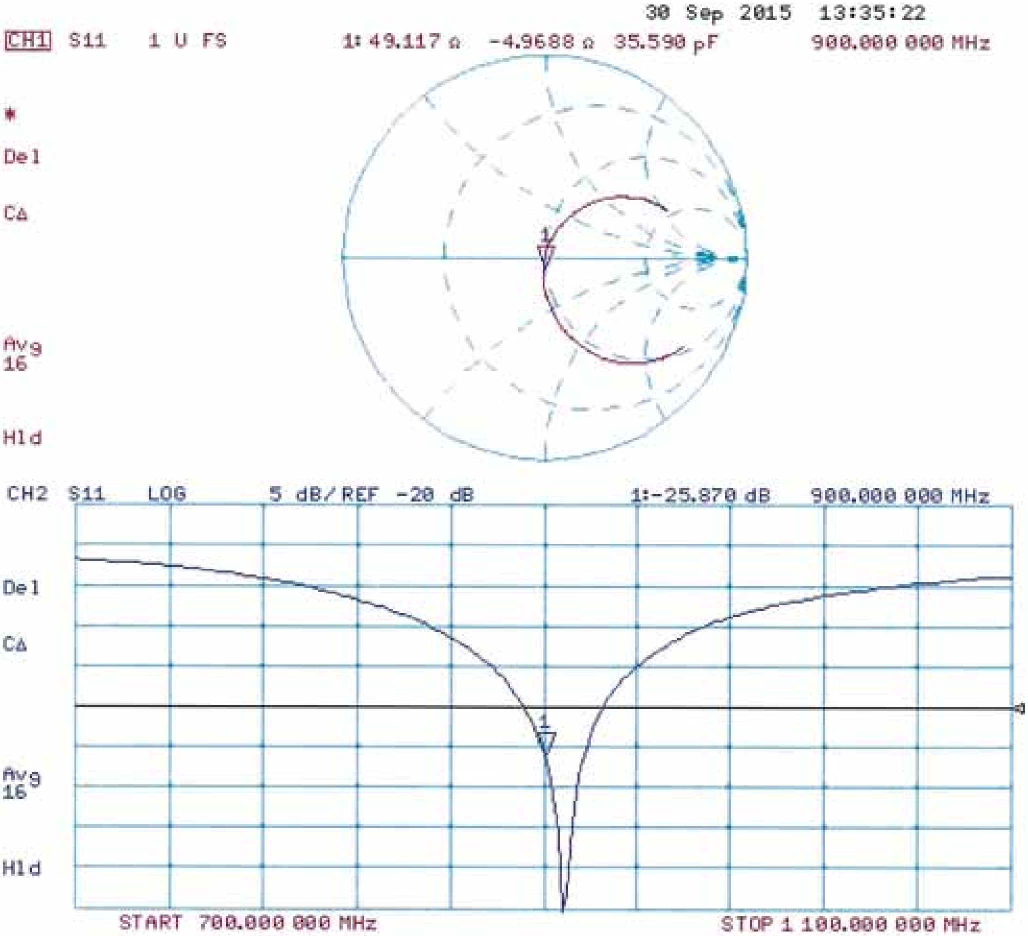
### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

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




0 dB = 3.73 W/kg = 5.72 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 30.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

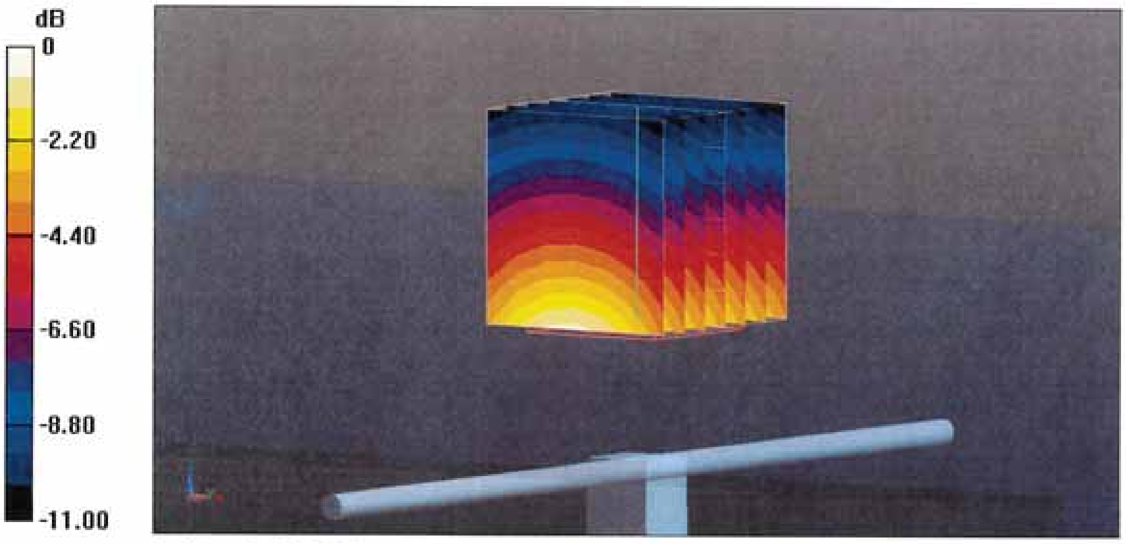
**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN:164**

Communication System: UID 0 - CW; Frequency: 900 MHz
Medium parameters used: f = 900 MHz; $\sigma$ = 1.03 S/m; $\varepsilon_r$ = 53.6; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

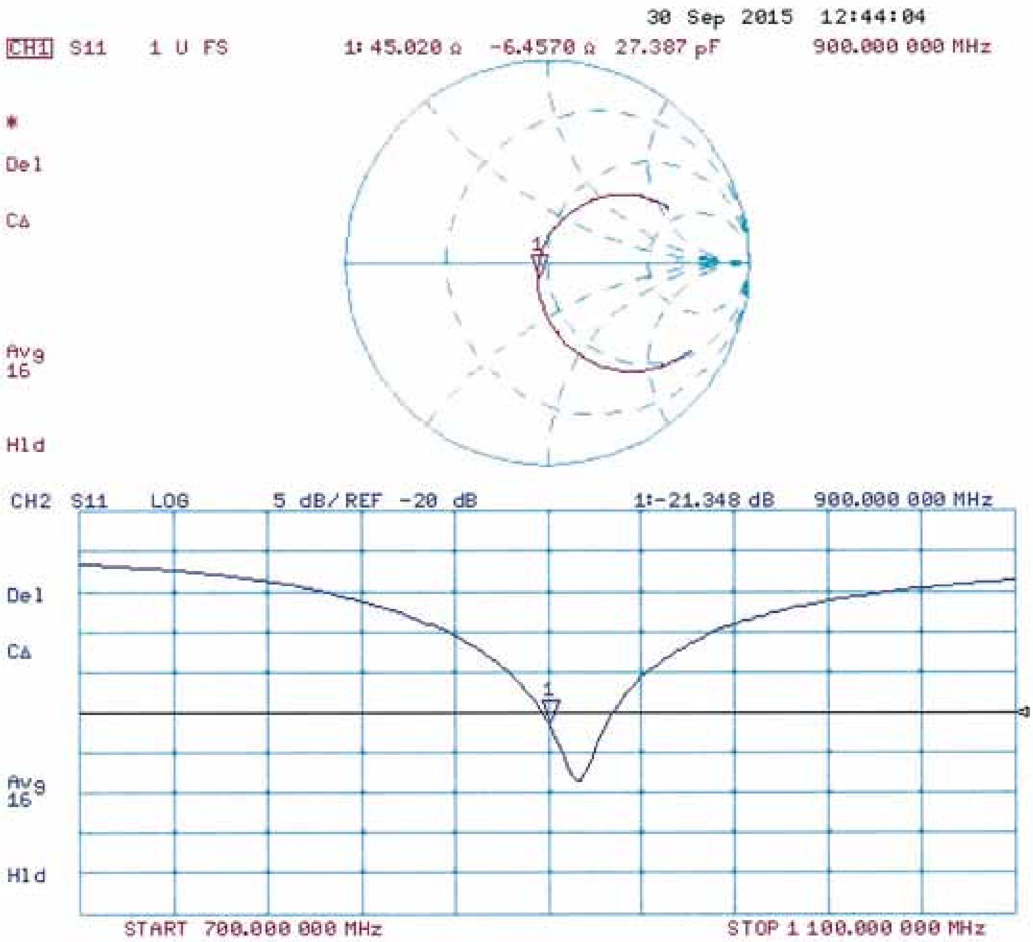
- Probe: EX3DV4 - SN7349; ConvF(9.39, 9.39, 9.39); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**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




0 dB = 3.72 W/kg = 5.71 dBW/kg

## Impedance Measurement Plot for Body TSL



**Client** **Eurofins**

**Certificate No: D1900V2-5d025_Sep15**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN:5d025 |
| Calibration procedure(s) | QA CAL-05.v9<br>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 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Leif Klysner | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: September 30, 2015

**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

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 |
| 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) 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"

## Additional Documentation:

e) 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 ± 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 ± 0.2) °C | 39.3 ± 6 % | 1.38 mho/m ± 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 ± 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 ± 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 ± 0.2) °C | 52.6 ± 6 % | 1.52 mho/m ± 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 ± 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 ± 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 jΩ |
| Return Loss | - 25.9 dB |

## Antenna Parameters with Body TSL

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

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.199 ns |

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 |

Date: 29.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

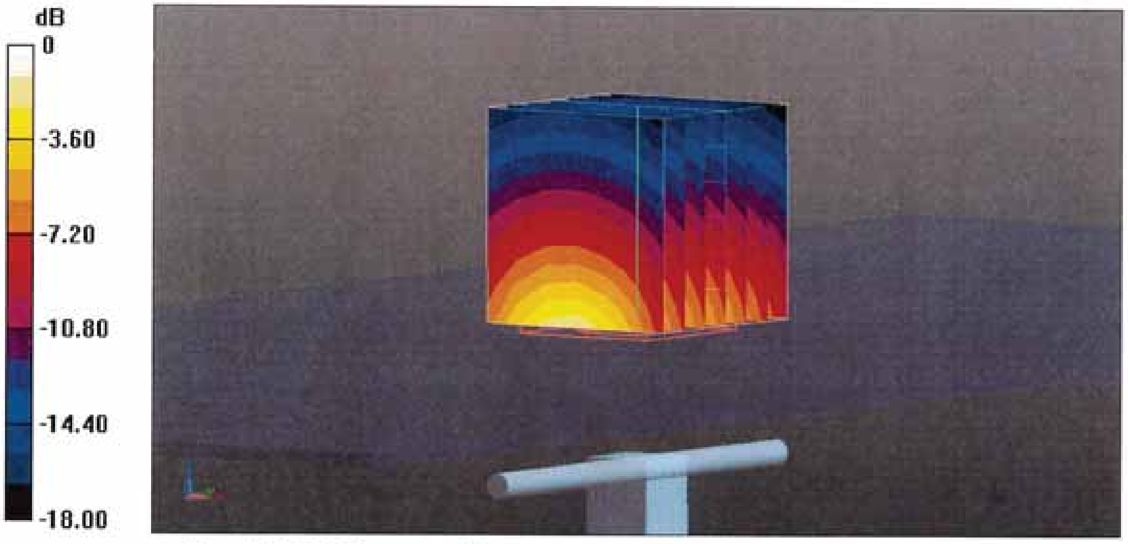
**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d025**

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.38 S/m; $\varepsilon_r$ = 39.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

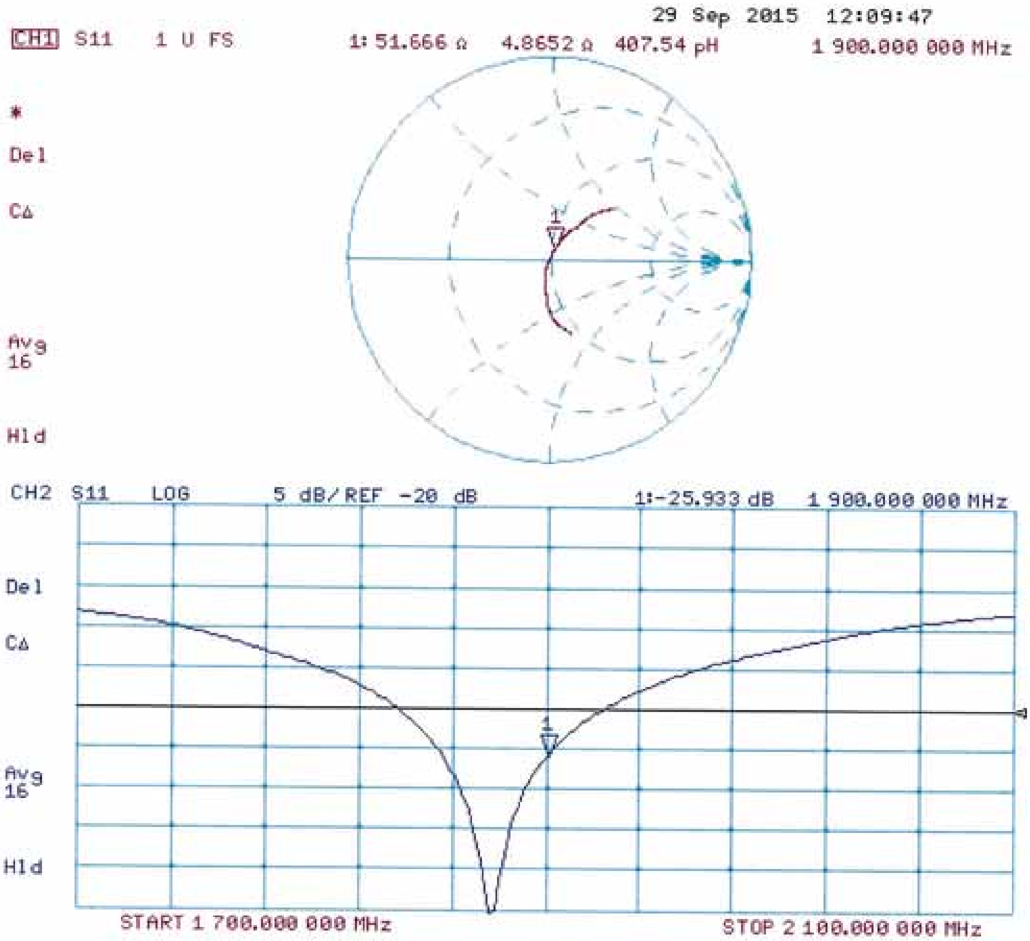
- Probe: EX3DV4 - SN7349; ConvF(8.14, 8.14, 8.14); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**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




0 dB = 15.6 W/kg = 11.93 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 29.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

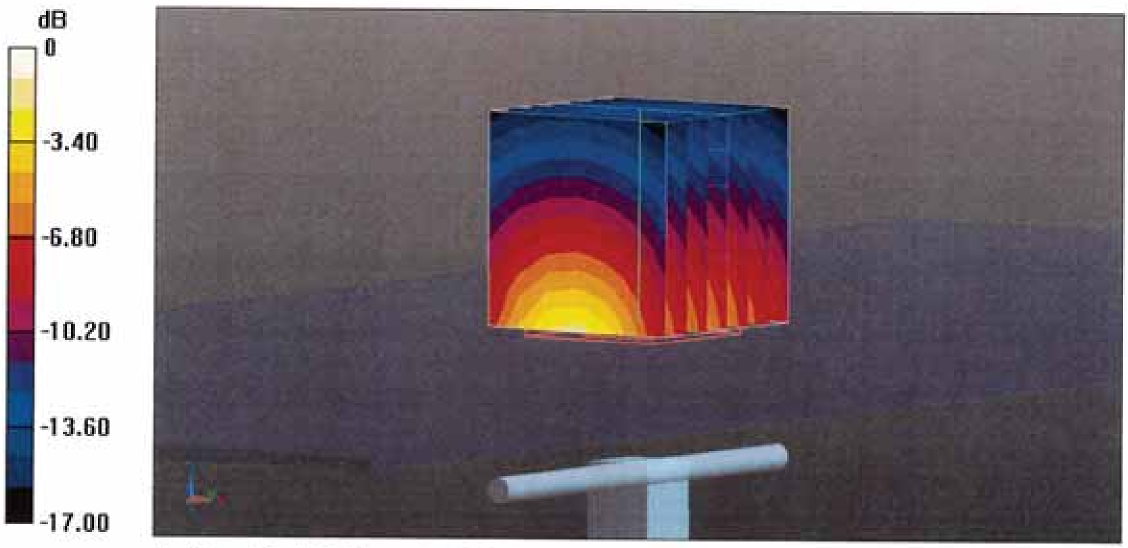
**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d025**

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma = 1.52$ S/m; $\varepsilon_r = 52.6$; $\rho = 1000$ kg/m$^3$
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