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# SAR Test Report

# Dosimetric Assessment of the Cordless DECT Headset D 10 HS from Sennheiser Communications

**(FCC ID: DMOCDHDGG)**
**(IC: 2099A-D10HS)**

# According to the FCC Requirements

February 18, 2015


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## Executive Summary

The device D 10 HS is a new cordless headset (Portable Device) from Sennheiser Communications operating in the 1920 MHz frequency range. The device has two integrated antennas and works in US DECT standard.

The objective of the measurements done by IMST was the dosimetric assessment of one device in a worst case setup below the flat part of the SAM phantom, according FCC inquiry 924777.

Since there was a special test software available, SAR tests in US DECT standard were conducted with a specific channel and maximum output power during the measurement. The examinations have been carried out with the dosimetric assessment system „DASY4“.

The measurements were made according to the 47 CFR § 2.1093 [47CFR] for evaluating compliance of mobile and portable devices with FCC limits for human exposure (general population) to radiofrequency emissions.

Additional information and guidelines given by the following FCC documents were used:

- SAR Measurement Requirements for 100 MHz to 6 GHz [KDB 865664 D01 v01r03]
- Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies [KDB 447498 D01 v05r02]

All measurements have been performed in accordance to the recommendations given by the System Manufacturer SPEAG AG, Switzerland.

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## Compliance Statement

The D 10 HS cordless headset from Sennheiser Communications (FCC ID: DMOCDHDGG, IC: 2099A-D10HS) is in compliance with the following standards for uncontrolled exposure:

- 47 CFR § 2.1093 [47CFR]
- ANSI / IEEE C95.1-1999 [IEEE C95.1-1999]

According to reply of FCC inquiry 924777, SAR assessment was conducted with the device positioned below the flat part of the SAM phantom using head tissue simulating liquid.

According to the declaration of identity from Sennheiser Communications, DW 10 HS, SD 10 HS, OR 10 HS and OR 10 Blue-HS are technically identical with the assessed D 10 HS. The same PCB and RF circuits are used in all headsets. The only one different between these products is their names. Therefore, a compliance with the FCC requirements for those devices could be granted, accordingly.

All measured SAR results are shown in Table 5, the maximum results of SAR for the D 10 HS from Sennheiser Communications are as follows:

| Highest Measured $SAR_{1g}$ [W/kg] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Position** | **Device Config.** | | **Freq. [MHz]** | **CH** | **Figure No.** | **Plot No.** | **Highest Reported $SAR_{1g}$ [W/kg]** | **SAR Limit [W/kg]** | |
| Flat Part | Ant. 1 | Ear Hook | 1924.99 | 2 | 14 | 1 | 0.048 | 1.6 | PASS |
| | | Headband | 1924.99 | 2 | 15 | 2 | 0.048 | 1.6 | PASS |

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## Subject of Investigation

The device D 10 HS is a new cordless headset (Portable Device) from Sennheiser Communications operating in the 1920 MHz frequency range. The device has two integrated antennas and works in US DECT standard.

*Fig. 1: Pictures of the device under test.*

The objective of the measurements done by IMST was the dosimetric assessment of one device in a worst case setup below the flat part of the SAM phantom, according FCC inquiry 924777. Since there was a special test software available, SAR tests in US DECT standard were conducted with a specific channel and maximum output power during the measurement. The examinations have been carried out with the dosimetric assessment system „DASY4“.

## 1 FCC Exposure Criteria

In the USA the FCC exposure criteria are based on the IEEE Standard C95.1-1999 [IEEE C95.1-1999].

In this report the comparison between the FCC exposure limits and the measured data is made using the spatial peak SAR; the power level of the device under test guarantees that the whole body averaged SAR is not exceeded.

Having in mind a worst case consideration, the SAR limit is valid for uncontrolled environment and mobile respectively portable transmitters. According to Table 1 the SAR values have to be averaged over a mass of 1 g ($SAR_{1g}$) with the shape of a cube.

| Rule | SAR Limit [W/kg] |
|---|---|
| 47 CFR § 2.1093 (d)(2) | 1.6 |

*Table 1: Relevant spatial peak SAR limit averaged over a mass of 1 g.*

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## 1.1 Distinction Between Exposed Population, Duration of Exposure and Frequencies

The American Standard [IEEE C95.1-1999] distinguishes between controlled and uncontrolled environment. Controlled environments are locations where there is exposure that may be incurred by persons who are aware of the potential for exposure as a concomitant of employment or by other cognizant persons. Uncontrolled environments are locations where there is the exposure of individuals who have no knowledge or control of their exposure. The exposures may occur in living quarters or workplaces. For exposure in controlled environments higher field strengths are admissible. In addition the duration of exposure is considered.

Due to the influence of frequency on important parameters, as the penetration depth of the electromagnetic fields into the human body and the absorption capability of different tissues, the limits in general vary with frequency.

## 1.2 Distinction between Maximum Permissible Exposure and SAR Limits

The biological relevant parameter describing the effects of electromagnetic fields in the frequency range of interest is the specific absorption rate SAR (dimension: power/mass). It is a measure of the power absorbed per unit mass. The SAR may be spatially averaged over the total mass of an exposed body or its parts. The SAR is calculated from the r.m.s. electric field strength *E* inside the human body, the conductivity $\sigma$ and the mass density $\rho$ of the biological tissue:

$$SAR = \sigma \frac{E^2}{\rho} = c \left. \frac{\partial T}{\partial t} \right|_{t \to 0+} \quad . \tag{1}$$

The specific absorption rate describes the initial rate of temperature rise $\partial T / \partial t$ as a function of the specific heat capacity *c* of the tissue. A limitation of the specific absorption rate prevents an excessive heating of the human body by electromagnetic energy.

As it is sometimes difficult to determine the SAR directly by measurement (e.g. whole body averaged SAR), the standard specifies more readily measurable maximum permissible exposures in terms of external electric *E* and magnetic field strength *H* and power density *S*, derived from the SAR limits. The limits for *E*, *H* and *S* have been fixed so that even under worst case conditions, the limits for the specific absorption rate SAR are not exceeded.

For the relevant frequency range the maximum permissible exposure may be exceeded if the exposure can be shown by appropriate techniques to produce SAR values below the corresponding limits.

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# 2 The FCC Measurement Procedure

## 2.1 General Requirements

The test shall be performed in a laboratory with an environment which avoids influence on SAR measurements by ambient EM sources and any reflection from the environment itself. The ambient temperature shall be in the range of 20°C to 26°C and 30-70% humidity. All tests have been conducted according the latest version of all relevant KDBs.

## 2.2 Device Operating Next to a Person's Ear

### 2.2.1 Phantom Requirements

The phantom is a simplified representation of the human anatomy and comprised of material with electrical properties similar to the corresponding tissues. The physical characteristics of the phantom model shall resemble the head and the neck of a user since the shape is a dominant parameter for exposure.

### 2.2.2 Test Positions

As it cannot be expected that the user will hold the mobile phone exactly in one well defined position, different operational conditions shall be tested. The IEEE 1528 [IEEE 1528] requires two test positions. For an exact description helpful geometrical definitions are introduced and shown in Fig. 2 - 3.

There are two imaginary lines on the mobile, the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width $w_t$ of the handset at the level of the acoustic output (point A on Fig. 2), and the midpoint of the width $w_b$ of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Fig. 2). The two lines intersect at point A.

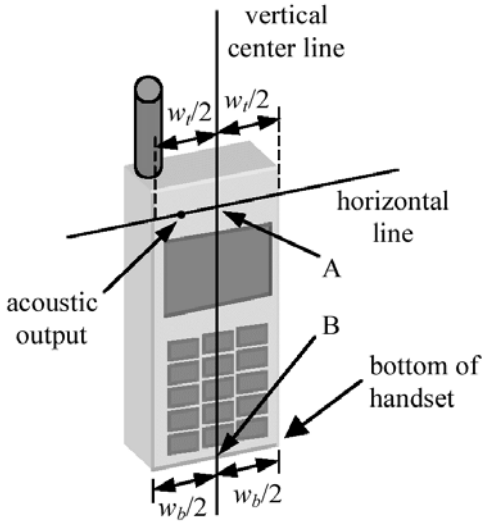


*Fig. 2: Handset vertical and horizontal reference lines.*

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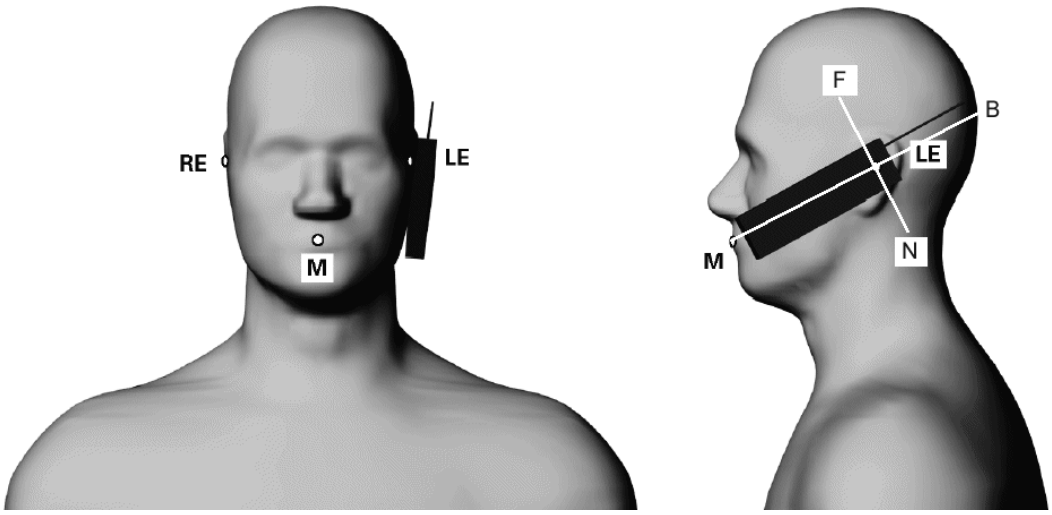


*Fig. 3: Phantom reference points.*

According to Fig. 3 the human head position is given by means of the following three reference points: auditory canal opening of both ears (RE and LE) and the center of the closed mouth (M). The ear reference points are 15 - 17 mm above the entrance to the ear canal along the BM line (back-mouth), as shown in Fig. 3. The plane passing through the two ear canals and M is defined as the reference plane. The line NF (Neck-Front) perpendicular to the reference plane and passing through the RE (or LE) is called the reference pivoting line. Line BM is perpendicular to the NF line. With this definitions the test positions are given by

- **Cheek Position (see Fig. 4):**

Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Fig. 3), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom. Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear. While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to MB-NF including the line MB (called the reference plane). Rotate the phone around the vertical centerline until the phone (horizontal line) is symmetrical with respect to the line NF. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the ear.

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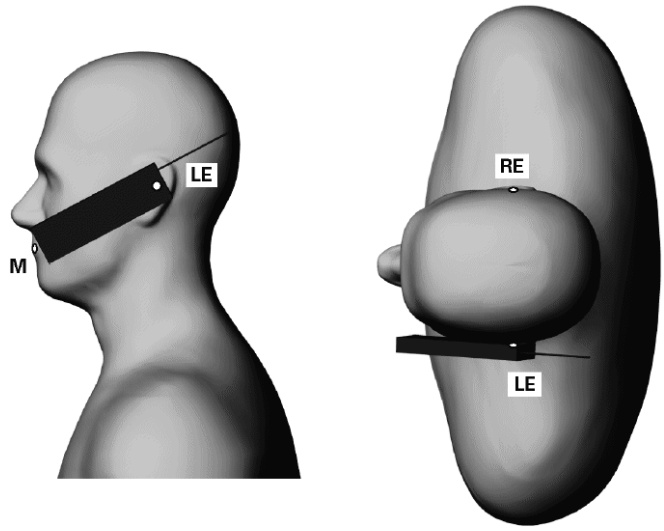


*Fig. 4: The cheek position.*

- **Tilted Position (see Fig. 5):**

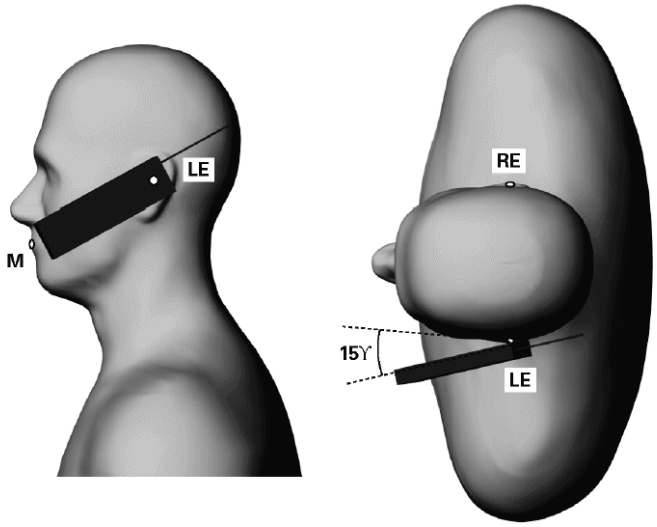


*Fig. 5: The tilted position.*

While maintaining the orientation of the phone retract the phone parallel to the reference plane far enough to enable a rotation of the phone by 15°. Rotate the phone around the horizontal line by 15°. While maintaining the orientation of the phone, move the phone parallel to the reference plane until any part of the phone touches the head. In this position, point A will be located on the line RE-LE.

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### 2.2.3 Test to be Performed

The SAR test shall be performed with both phone positions described above, on the left and right side of the phantom. The device shall be measured for all modes operating when the device is next to the ear, even if the different modes operate in the same frequency band.

For devices with retractable antenna the SAR test shall be performed with the antenna fully extended and fully retracted. Other factors that may affect the exposure shall also be tested. For example, optional antennas or optional battery packs which may significantly change the volume, lengths, flip open/closed, etc. of the device, or any other accessories which might have the potential to considerably increase the peak spatial-average SAR value.

The SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at the middle channel for each test configuration is at least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional.

### 2.2.4 Measurement Variability

According KDB 865664 repeated measurements are required only when the measured SAR is ≥ 0.80 W/kg. If the measured SAR value of the initial repeated measurement is < 1.45 W/kg with ≤ 20% variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. A second repeated measurement is required only if the measured result for the initial repeated measurement is within 10% of the SAR limit and vary by more than 20%, which are often related to device and measurement setup difficulties. The following procedures are applied to determine if repeated measurements are required.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

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# 3 The Measurement System

DASY is an abbreviation of „Dosimetric Assessment System“ and describes a system that is able to determine the SAR distribution inside a phantom of a human being according to different standards. The DASY4 system consists of the following items as shown in Fig: 6. Additional Fig: 7 show the equipment, similar to the installations in other laboratories.

- Fully compliant with all current measurement standards as stated in Fig. 9
- High precision robot with controller
- Measurement server (for surveillance of the robot operation and signal filtering)
- Data acquisition electronics DAE (for signal amplification and filtering)
- Field probes calibrated for use in liquids
- Electro-optical converter EOC (conversion from the optical into a digital signal)
- Light beam (improving of the absolute probe positioning accuracy)
- Two SAM phantoms filled with tissue simulating liquid
- DASY4 software
- SEMCAD

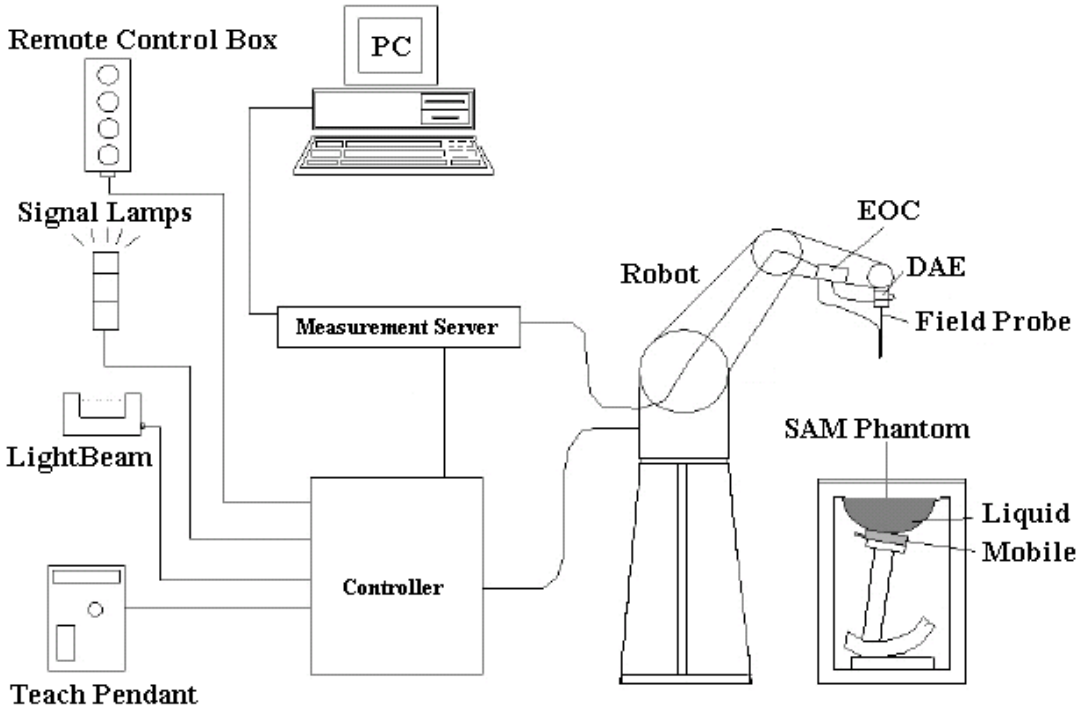


*Fig. 6: The DASY4 measurement system.*

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*Fig. 7: The measurement set-up with two SAM phantoms containing tissue simulating liquid.*

The mobile phone operating at the maximum power level is placed by a non metallic device holder (delivered from Schmid & Partner) in the above described positions at a shell phantom of a human being. The distribution of the electric field strength *E* is measured in the tissue simulating liquid within the shell phantom. For this miniaturised field probes with high sensitivity and low field disturbance are used. Afterwards the corresponding SAR values are calculated with the known electrical conductivity $\sigma$ and the mass density $\rho$ of the tissue in the SEMCAD FDTD software. The software is able to determine the averaged SAR values (averaging region 1 g or 10 g) for compliance testing.

The measurements are done by two scans: first a coarse scan determines the region of the maximum SAR, afterwards the averaged SAR is measured in a second scan within the shape of a cube. The measurement time takes about 20 minutes.

## 3.1 Phantoms

| TWIN SAM PHANTOM V4.0 | |
|---|---|
| | Specific Anthropomorphic Mannequin defined in IEEE 1528 and IEC 62209-1 and delivered by Schmid & Partner Engineering AG. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region.<br>The details and the Certificate of conformity can be found in Fig. 10. |
| **Shell Thickness** | 2 ± 0.2 mm (6 ± 0.2 mm at ear point) |
| **Dimensions** | Length: 1000 mm; Width: 500 mm<br>Height: adjustable feet |
| **Filling Volume** | approx. 25 liters |

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## 3.2 E-Field-Probes

For the measurements the Dosimetric E-Field Probes ET3DV6R or EX3DV4 with following specifications are used. They are manufactured and calibrated in accordance with FCC [KDB 865664] recommendations annually by Schmid & Partner Engineering AG.

| ET3DV6R | |
|---|---|
| **Construction** | Symmetrical design with triangular core<br>Built-in optical fiber for surface detection system (ET3DV6 only)<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| **Dimensions** | Overall length: 337 mm (Tip: 16 mm)<br>Tip diameter: 6.8 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.7 mm |
| **Frequency** | 10 MHz to 2.3 GHz<br>Linearity: ± 0.2 dB (30 MHz to 2.3 GHz) |
| **Directivity** | Axial isotropy: ± 0.2 dB in TSL (rotation around probe axis)<br>Spherical isotropy: ± 0.4 dB in TSL (rotation normal to probe axis) |
| **Dynamic Range** | 5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB |
| **Calibration Range** | 450 MHz / 750 MHz / 900 MHz / 1750 MHz / 1900 MHz / 1950 MHz<br>for head and body simulating liquid |

| EX3DV4 | |
|---|---|
| **Construction** | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| **Dimensions** | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm |
| **Frequency** | 10 MHz to > 6 GHz<br>Linearity: ± 0.2 dB (30 MHz to 6 GHz) |
| **Directivity** | Axial isotropy: ± 0.3 dB in TSL (rotation around probe axis)<br>Spherical isotropy: ± 0.5 dB in TSL (rotation normal to probe axis) |
| **Dynamic Range** | 10 µW/g to > 100 mW/g<br>Linearity: ± 0.2 dB (noise: typically < 1 µW/g) |
| **Calibration Range** | 1950 MHz / 2450 MHz / 2600 MHz / 3500 MHz / 5200 MHz / 5300 MHz /<br>5600 MHz / 5800 MHz for head and body simulating liquid |

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## 3.3 Measurement Procedure

The following steps are used for each test position:

- Establish a call with the maximum output power with a base station simulator. The connection between the mobile phone and the base station simulator is established via air interface.
- Measurement of the local E-field value at a fixed location (P1). This value serves as a reference value for calculating a possible power drift.
- Measurement of the SAR distribution with resolution settings for area scan and zoom scan according KDB 865664 D01 as shown in Table *2*.
- The used extrapolation and interpolation routines are all based on the modified Quadratic Shepard´s method [DASY4].
- Repetition of the E-field measurement at the fixed location (P1) and repetition of the whole procedure if the two results differ by more than ± 0.21dB.

| | | | ≤ 3 GHz | ≥ 3 GHz |
|---|---|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | | | 5 ± 1 mm | ½·δ·ln(2) ± 0.5 mm |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location | | | 30° ± 1° | 20° ± 1° |
| Maximum area scan spatial resolution: $\Delta x_{Area}$, $\Delta y_{Area}$ | | | ≤ 2 GHz: ≤ 15 mm<br>2 - 3 GHz: ≤ 12 mm | 3 - 4 GHz: ≤ 12 mm<br>4 - 6 GHz: ≤ 10 mm |
| | | | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. | |
| Maximum zoom scan spatial resolution: $\Delta X_{Zoom}$, $\Delta Y_{Zoom}$ | | | ≤ 2 GHz: ≤ 8 mm<br>2 - 3 GHz: ≤ 5 mm* | 3 - 4 GHz: ≤ 5 mm*<br>4 - 6 GHz: ≤ 4 mm* |
| Maximum zoom scan spatial resolution, normal to phantom surface | Uniform grid: $\Delta Z_{Zoom}(n)$ | | ≤ 5 mm | 3 - 4 GHz: ≤ 4 mm<br>4 - 5 GHz: ≤ 3 mm<br>5 - 6 GHz: ≤ 2 mm |
| | graded grid | $\Delta Z_{Zoom}(1)$: between 1st two points closest to phantom surface | ≤ 4 mm | 3 - 4 GHz: ≤ 3 mm<br>4 - 5 GHz: ≤ 2.5 mm<br>5 - 6 GHz: ≤ 2 mm |
| | | $\Delta Z_{Zoom}(n>1)$: between subsequent points | ≤ 1.5· $\Delta Z_{Zoom}(n-1)$ | |
| Minimum zoom scan volume | x, y, z | | ≥ 30 mm | 3 - 4 GHz: ≥ 28 mm<br>4 - 5 GHz: ≥ 25 mm<br>5 - 6 GHz: ≥ 22 mm |
| Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium: see draft standard IEEE P1528-2011 for details.<br>* When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz | | | | |

*Table 2: Parameters for SAR scan procedures.*

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## 3.4 Uncertainty Assessment

Table 3 includes the worst case uncertainty budget suggested by KDB 865664 and determined by Schmid & Partner Engineering AG. The expanded uncertainty (K=2) is assessed to be ± 21.7% and is valid up to 3.0 GHz.

| Uncertainty Budget of DASY4 up to 3 GHz | | | | | | |
|---|---|---|---|---|---|---|
| **Error Sources** | **Uncertainty Value** | **Probability Distribution** | **Divisor** | **$c_i$** | **Standard Uncertainty** | **$v_i^2$ or $v_{eff}$** |
| **Measurement System** | | | | | | |
| Probe calibration | ± 5.9 % | Normal | 1 | 1 | ± 5.9 % | ∞ |
| Axial isotropy | ± 4.7 % | Rectangular | √3 | 0.7 | ± 1.9 % | ∞ |
| Hemispherical isotropy | ± 9.6 % | Rectangular | √3 | 0.7 | ± 3.9 % | ∞ |
| Boundary effects | ± 1.0 % | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| Linearity | ± 4.7 % | Rectangular | √3 | 1 | ± 2.7 % | ∞ |
| System detection limit | ± 1.0 % | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| Readout electronics | ± 1.0 % | Normal | 1 | 1 | ± 1.0 % | ∞ |
| Response time | ± 0.8 % | Rectangular | √3 | 1 | ± 0.5 % | ∞ |
| Integration time | ± 2.6% | Rectangular | √3 | 1 | ± 1.5 % | ∞ |
| RF ambient conditions | ± 3.0 % | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| Probe positioner | ± 0.4 % | Rectangular | √3 | 1 | ± 0.2 % | ∞ |
| Probe positioning | ± 2.9 % | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| Algorithm for max SAR eval. | ± 1.0 % | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| **Test Sample Related** | | | | | | |
| Device positioning | ± 2.9 % | Normal | 1 | 1 | ± 2.9 % | 145 |
| Device holder | ± 3.6 % | Normal | 1 | 1 | ± 3.6 % | 5 |
| Power drift | ± 5.0 % | Rectangular | √3 | 1 | ± 2.9 % | ∞ |
| **Phantom and Set-up** | | | | | | |
| Phantom uncertainty | ± 4.0 % | Rectangular | √3 | 1 | ± 2.3 % | ∞ |
| Liquid conductivity (target) | ± 5.0 % | Rectangular | √3 | 0.64 | ± 1.8 % | ∞ |
| Liquid conductivity (meas.) | ± 2.5 % | Normal | 1 | 0.64 | ± 1.6 % | ∞ |
| Liquid permittivity (target) | ± 5.0 % | Rectangular | √3 | 0.6 | ± 1.7 % | ∞ |
| Liquid permittivity (meas.) | ± 2.5 % | Normal | 1 | 0.6 | ± 1.5 % | ∞ |
| **Combined Uncertainty** | | | | | **± 10.8 %** | |

*Table 3: Uncertainty budget of DASY4.*

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# 4 Output Power Values and Tune-Up Information

| Measured and Maximum Transmit Output Power [dBm] | | | | |
|---|---|---|---|---|
| **Mode** | **Freq. [MHz]** | **CH** | **Measured Output Power** | **Tune-Up Limit** |
| **DECT** | 1921.536 | 00 | 18.4 | 20.4 |
| | 1924.992 | 02 | 18.4 | 20.4 |
| | 1928.448 | 04 | 18.4 | 20.4 |

*Table 4: Conducted output power and tune-up limit values for Sennheiser Communications D 10 HS.*

# 5 SAR Results

The tables below contain the measured SAR values averaged over a mass of 1 g. SAR assessment was conducted in the worst case configuration with output power values according Table 4.

According KDB 447498 D01 V05, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.

- Scaling Factor = tune-up limit power (mW) / RF power (mW)
- Reported SAR = measured SAR * scaling factor

Furthermore, testing of other required channels within the operating mode of frequency band is not required when the reported SAR for the mid-band or highest output power channel is ≤ 0.4 W/kg for transmission band ≥ 200 MHz.

| SAR Measurement Results | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Freq. [MHz]** | **CH** | **Device Config.** | | **Fig No.** | **Measured $SAR_{1g}$ [W/kg]** | **Power Drift [dB]** | **Output Power [dBm]** | **Tune Up Limit [dBm]** | **Scaling Factor** | **Reported $SAR_{1g}$ [W/kg]** | **Plot No.** |
| **DECT** 1924.99 | 02 | Antenna 1 | Ear Hook | 14 | 0.030 | -0.179 | 18.4 | 20.4 | 1.585 | 0.048 | 1 |
| | | | Head-band | 15 | 0.030 | 0.130 | | | | 0.048 | 2 |
| | | Antenna 2 | Ear Hook | 14 | 0.002 | 0.046 | | | | 0.003 | 3 |
| | | | Head-band | 15 | 0.001 | 0.173 | | | | 0.002 | 4 |

*Table 5: Measurement results for D 10 HS from Sennheiser Communications.*

To control the output power stability during the SAR test the used DASY4 system calculates the power drift by measuring the e-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in the above tables labeled as: (Drift[dB]). This ensures that the power drift during one measurement is within 5%.

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# 6 Appendix

## 6.1 Administrative Data

Date of Validation: August 22, 2014
Date of Measurement: August 22, 2014
Data Stored: Secom_60320_6140275
Contact: IMST GmbH
Carl-Friedrich-Gauß-Str. 2
D-47475 Kamp-Lintfort, Germany
Tel.: +49- 2842-981 378
Fax: +49- 2842-981 399
email: vandenBosch@imst.de

## 6.2 Device under Test and Test Conditions

MTE: Sennheiser Communications D 10 HS
Date of Receipt: July 31, 2014
SN: 506421
FCC ID: DMOCDHDGG
IC: 2099A-D10HS
Equipment Class: Portable device
RF Exposure Environment: General Population/ Uncontrolled
Power Supply: Internal battery
Antenna: Two integrated
Used accessory: Headband and Cheek Spacer
Method to Establish a Call: Test mode
Used Accessory: N.A.

| Test Conditions | | | | | |
|---|---|---|---|---|---|
| **Sennheiser Communications D 10 HS** | **TX Range [MHz]** | **RX Range [MHz]** | **Used Channels** | **Used Crest Factor** | **Phantom** |
| US DECT | 1921.536 - 1928.448 | 1921.536 - 1928.448 | 02 | 15 | SAM Twin Phantom V4.0 |

*Table 6: Used phantom, channels and crest factors during the test.*

## 6.3 Tissue Recipes

The following recipes are provided in percentage by weight.

| | | |
|---|---|---|
| 1900 MHz, Head: | 45.65% | Diethylenglykol-monobutylether |
| | 54.00% | De-Ionized Water |
| | 0.35% | Salt |

SAR_Report_FCC_DECT_Head_1.0/13.06.2014/AR

## 6.4 Material Parameters

For the measurement of the following parameters the HP 85070B dielectric probe kit is used, representing the open-ended coaxial probe measurement procedure. The measured values should be within ± 5% of the recommended values given by the FCC.

| Tissue Simulating Liquids | | | | | |
|---|---|---|---|---|---|
| Frequency | | $\varepsilon_r$ | σ [S/m] | Temperature | |
| | | | | Ambient [°C] | Liquid [°C] |
| 1900 MHz Head | Recommended Value | 40.00 ± 2.00 | 1.40 ± 0.07 | 20.0 - 26.0 | - |
| | Measured Value (Validation) | 41.40 | 1.44 | 21.7 | 20.8 |
| | Measured Value (CH 2) | 41.40 | 1.47 | 21.7 | 20.8 |

*Table 7: Parameters of the tissue simulating liquids.*

## 6.5 Simplified Performance Checking

The simplified performance check was realized using the dipole validation kits. The input power of the dipole antennas were 250 mW (cw signal) and they were placed under the flat part of the SAM phantom. The target and measured results are listed in the table 8 - 9 and shown in figure 8. The target values were adopted from the calibration certificates which are attached in the appendix. Table 10 includes the uncertainty assessment for the system performance checking which was suggested by the KDB 865664 and determined by Schmid & Partner Engineering AG. The expanded uncertainty (K=2) is assessed to be ± 16.8%. To justify the two year calibration interval of the used validation dipoles, IMST consider the requirements in 3.2.2 of KDB 865664. The result of the annual SAR target, impedance and return loss assessment, conducted by IMST, show no significant deviation to dipole calibration results.

| Dipole Target Results | | | | | |
|---|---|---|---|---|---|
| Band | Available Dipoles | | $SAR_{1g}$ [W/kg] | $\varepsilon_r$ | σ [S/m] |
| DECT | D1900V2, SN #5d051 | Target Values Head | 9.80 | 41.40 | 1.43 |

*Table 8: Dipole target results as given by the calibration certificates.*

| Dipole Validation Results | | | | | |
|---|---|---|---|---|---|
| Band | Used Dipoles | | $SAR_{1g}$ [W/kg] | $\varepsilon_r$ | σ [S/m] |
| DECT | D1900V2, SN #5d051 | Measured Values Head | 10.10 | 41.40 | 1.44 |

*Table 9: Dipole measured validation results.*

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**Test Laboratory: Imst GmbH, DASY Yellow (II); File Name: 220814_y_1579.da4**

**DUT: Dipole 1900 MHz SN: 5d051; Type: D1900V2; Serial: D1900V2 - SN5d051**
**Program Name: System Performance Check at 1900 MHz**

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.44 mho/m; $\varepsilon_r$ = 41.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6R - SN1579; ConvF(5.19, 5.19, 5.19); Calibrated: 28.01.2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 23.07.2014
- Phantom: SAM Glycol 1340; Type: QD 000 P40 CB; Serial: TP-1340
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**d=10mm, Pin=250mW/Area Scan (7x7x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 11.4 mW/g
**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.0 V/m; Power Drift = -0.023 dB
Peak SAR (extrapolated) = 17.9 W/kg
**SAR(1 g) = 10.1 mW/g; SAR(10 g) = 5.22 mW/g**
Maximum value of SAR (measured) = 11.5 mW/g

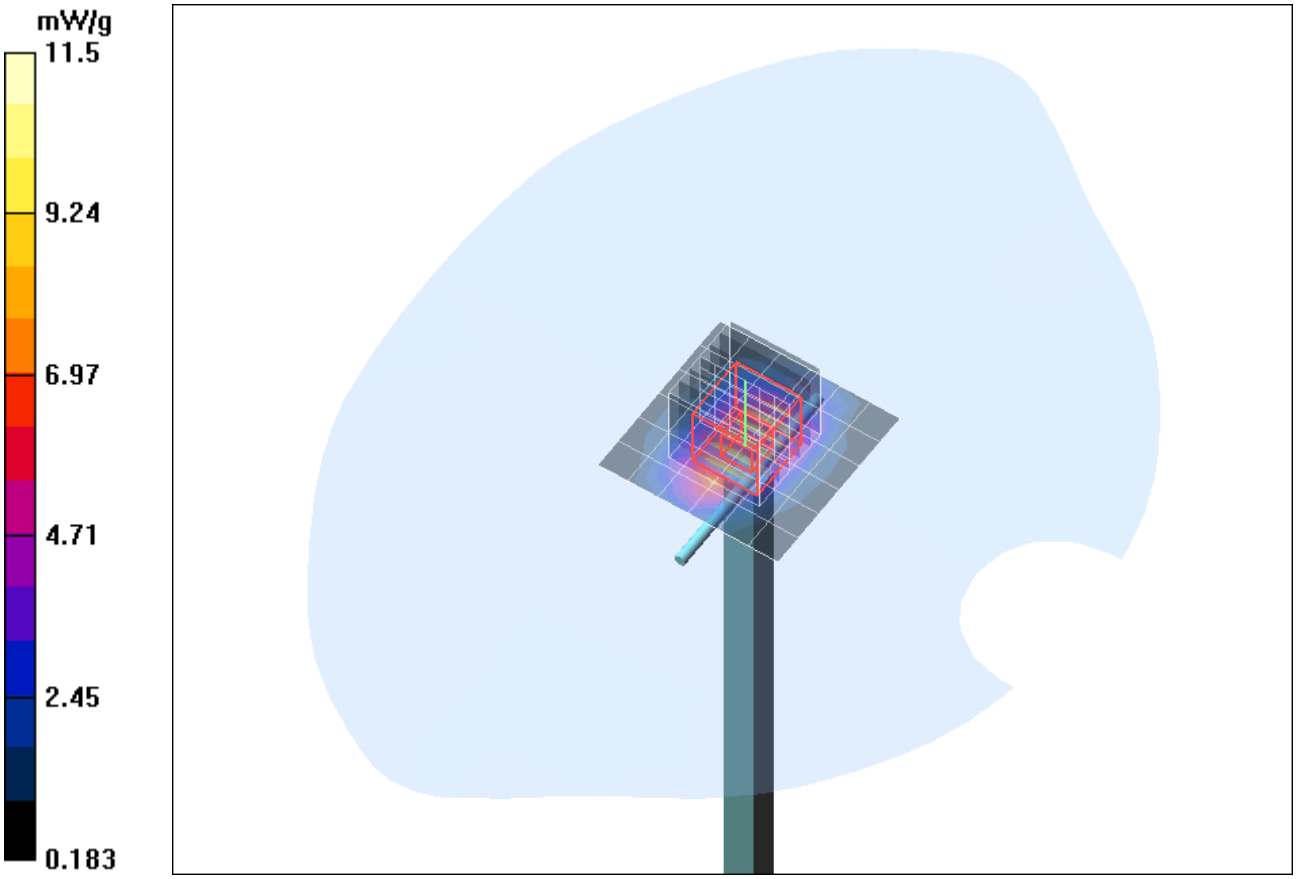


*Fig. 8: Validation measurement 1900 MHz Head (August 22, 2014), coarse grid.*

| Uncertainty Budget up to 3 GHz | | | | | | |
|---|---|---|---|---|---|---|
| **Error Sources** | **Uncertainty Value** | **Probability Distribution** | **Divisor** | **$c_i$** | **Standard Uncertainty** | **$v_i^2$ or $v_{eff}$** |
| **Measurement System** | | | | | | |
| Probe calibration | ± 5.9 % | Normal | 1 | 1 | ± 5.9 % | ∞ |
| Axial isotropy | ± 4.7 % | Rectangular | √3 | 1 | ± 2.7 % | ∞ |
| Hemispherical isotropy | ± 0 % | Rectangular | √3 | 1 | ± 0 % | ∞ |
| Boundary effects | ± 1.0 % | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| Linearity | ± 4.7 % | Rectangular | √3 | 1 | ± 2.7 % | ∞ |
| System detection limit | ± 1.0 % | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| Readout electronics | ± 0.3 % | Normal | 1 | 1 | ± 0.3 % | ∞ |
| Response time | ± 0 % | Rectangular | √3 | 1 | ± 0 % | ∞ |
| Integration time | ± 0% | Rectangular | √3 | 1 | ± 0 % | ∞ |
| RF ambient conditions | ± 3.0 % | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| Probe positioner | ± 0.4 % | Rectangular | √3 | 1 | ± 0.2 % | ∞ |
| Probe positioning | ± 2.9 % | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| Algorithms for max SAR eval. | ± 1.0 % | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| **Dipole** | | | | | | |
| Dipole Axis to Liquid Distance | ± 2.0 % | Rectangular | 1 | 1 | ± 1.2 % | ∞ |
| Input power and SAR drift mea. | ± 4.7 % | Rectangular | √3 | 1 | ± 2.7 % | ∞ |
| **Phantom and Set-up** | | | | | | |
| Phantom uncertainty | ± 4.0 % | Rectangular | √3 | 1 | ± 2.3 % | ∞ |
| Liquid conductivity (target) | ± 5.0 % | Rectangular | √3 | 0.64 | ± 1.8 % | ∞ |
| Liquid conductivity (meas.) | ± 2.5 % | Normal | 1 | 0.64 | ± 1.6 % | ∞ |
| Liquid permittivity (target) | ± 5.0 % | Rectangular | √3 | 0.6 | ± 1.7 % | ∞ |
| Liquid permittivity (meas.) | ± 2.5 % | Normal | 1 | 0.6 | ± 1.5 % | ∞ |
| **Combined Uncertainty** | | | | | ± 9.2 % | |

*Table 10: Uncertainty budget for the system performance check.*

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## 6.6 Environment

To comply with the required noise level (less than 12 mW/kg) periodically measurements without a DUT were conducted.

Humidity: 40% ± 5 %

## 6.7 Test Equipment

| SAR Equipment | | | | |
|---|---|---|---|---|
| **Test Equipment** | **Model** | **Serial Number** | **Last Calibration** | **Next Calibration** |
| **DASY4 Systems** | | | | |
| Software Versions DASY4 | V4.7 | N/A | N/A | N/A |
| Software Versions SEMCAD | V1.8 | N/A | N/A | N/A |
| Dosimetric E-Field Probe | ET3DV6R | 1579 | 01/2014 | 01/2015 |
| Data Acquisition Electronics | DAE 4 | 631 | 07/2014 | 07/2015 |
| Phantom | SAM | 1059 | N/A | N/A |
| Phantom | SAM | 1176 | N/A | N/A |
| Phantom | SAM | 1340 | N/A | N/A |
| Phantom | SAM | 1341 | N/A | N/A |
| **Dipoles** | | | | |
| Validation Dipole | D1900V2 | 5d051 | 09/2013 | 09/2015 |
| **Material Measurement** | | | | |
| Network Analyzer | E5071C | MY46103220 | 07/2013 | 07/2015 |
| Dielectric Probe Kit | HP85070B | US33020263 | N/A | N/A |

*Table 11: SAR equipment.*

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| Test Equipment | | | | |
|---|---|---|---|---|
| **Test Equipment** | **Model** | **Serial Number** | **Last Calibration** | **Next Calibration** |
| **Power Meters** | | | | |
| Power Meter. Agilent | E4416A | GB41050414 | 12/2012 | 12/2014 |
| Power Meter. Agilent | E4417A | GB41050441 | 12/2012 | 12/2014 |
| Power Meter. Anritsu | ML2487A | 6K00002319 | 02/2014 | 02/2016 |
| Power Meter. Anritsu | ML2488A | 6K00002078 | 02/2014 | 02/2016 |
| **Power Sensors** | | | | |
| Power Sensor. Agilent | E9301H | US40010212 | 12/2012 | 12/2014 |
| Power Sensor. Agilent | E9301A | MY41495584 | 12/2012 | 12/2014 |
| Power Sensor. Anritsu | MA2481B | 031600 | 02/2014 | 02/2016 |
| Power Sensor. Anritsu | MA2490A | 031565 | 02/2014 | 02/2016 |
| **RF Sources** | | | | |
| Network Analyzer | E5071C | MY46103220 | 07/2013 | 07/2015 |
| Rohde & Schwarz | SME300 | 100142 | N/A | N/A |
| **Amplifiers** | | | | |
| Mini Circuits | ZHL-42 | D012296 | N/A | N/A |
| Mini Circuits | ZHL-42 | D031104#01 | N/A | N/A |
| Mini Circuits | ZVE-8G | D031004 | N/A | N/A |
| **Radio Tester** | | | | |
| Rohde & Schwarz | CMU200 | 835305/050 | N/A | N/A |

*Table 12: Test equipment, General.*

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## 6.8 Certificates of Conformity

Schmid & Partner Engineering AG

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

### Certificate of conformity

| | |
|---|---|
| Item | Dosimetric Assessment System DASY4 |
| Type No | SD 000 401A, SD 000 402A |
| Software Version No | DASY 4.7 |
| Manufacturer / Origin | Schmid & Partner Engineering AG<br>Zeughausstrasse 43, CH-8004 Zürich, Switzerland |

**References**

[1] IEEE 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, December 2003
[2] EN 50361:2001, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz – 3 GHz)", July 2001
[3] IEC 62209 – 1, "Specific Absorption Rate (SAR) in the frequency range of 300 MHz to 3 GHz – Measurement Procedure, Part 1: Hand-held mobile wireless communication devices", February 2005
[4] IEC 62209 – 2, Draft Version 0.9, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation and Procedures
Part 2: Procedure to determine the Specific Absorption Rate (SAR) for ... including accessories and multiple transmitters", December 2004
[5] OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 01-01
[6] ANSI-C63.19-2006, "American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids", June 2006
[7] ANSI-C63.19-2007, "American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids", June 2007

**Conformity**

We certify that this **system is designed to be fully compliant** with the standards [1 – 7] for RF emission tests of wireless devices.

**Uncertainty**

The uncertainty of the measurements with this system was evaluated according to the above standards and is documented in the applicable chapters of the DASY4 system handbook.
The uncertainty values represent current state of methodology and are subject to changes. They are applicable to all laboratories using DASY4 provided the following requirements are met (responsibility of the system end user):

1) the system is used by an experienced engineer who follows the manual and the guidelines taught during the training provided by SPEAG,
2) the probe and validation dipoles have been calibrated for the relevant frequency bands and media within the requested period,
3) the DAE has been calibrated within the requested period,
4) the "minimum distance" between probe sensor and inner phantom shell and the radiation source is selected properly,
5) the system performance check has been successful,
6) the operational mode of the DUT is CW, CDMA, FDMA or TDMA (GSM, DCS, PCS, IS136, PDC) and the measurement/integration time per point is ≥ 500 ms,
7) if applicable, the probe modulation factor is evaluated and applied according to field level, modulation and frequency,
8) the dielectric parameters of the liquid are conformant with the standard requirement,
9) the DUT has been positioned as described in the manual.
10) the uncertainty values from the calibration certificates, and the laboratory and measurement equipment dependent uncertainties, are updated by end user accordingly.

**Date** 24.4.2008 **Signature / Stamp**

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*Fig. 9: Certificate of conformity for the used DASY4 system:*

SAR_Report_FCC_DECT_Head_1.0/13.06.2014/AR

**Schmid & Partner Engineering AG**

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

## Certificate of conformity / First Article Inspection

| | |
|---|---|
| Item | SAM Twin Phantom V4.0 |
| Type No | QD 000 P40 BA |
| Series No | TP-1002 and higher |
| Manufacturer / Origin | Untersee Composites<br>Hauptstr. 69<br>CH-8559 Fruthwilen<br>Switzerland |

### Tests

The series production process used allows the limitation to test of first articles.
Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

| Test | Requirement | Details | Units tested |
|---|---|---|---|
| Shape | Compliance with the geometry according to the CAD model. | IT'IS CAD File (*) | First article, Samples |
| Material thickness | Compliant with the requirements according to the standards | 2mm +/- 0.2mm in specific areas | First article, Samples |
| Material parameters | Dielectric parameters for required frequencies | 200 MHz – 3 GHz<br>Relative permittivity < 5<br>Loss tangent < 0.05. | Material sample TP 104-5 |
| Material resistivity | The material has been tested to be compatible with the liquids defined in the standards | Liquid type HSL 1800 and others according to the standard. | Pre-series, First article |

### Standards

[1] CENELEC EN 50361
[2] IEEE P1528-200x draft 6.5
[3] IEC PT 62209 draft 0.9
(*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

### Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

**Date** 18.11.2001

**Signature / Stamp** Schmid & Partner Engineering AG
Zeughausstrasse 43, CH-8004 Zurich
Tel. +41 1 245 97 00, Fax +41 1 245 97 79

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*Fig. 10: Certificate of conformity for the used SAM phantom.*

## 6.9 Pictures of the Device under Test

Figure 11 - 13 show the device under test.

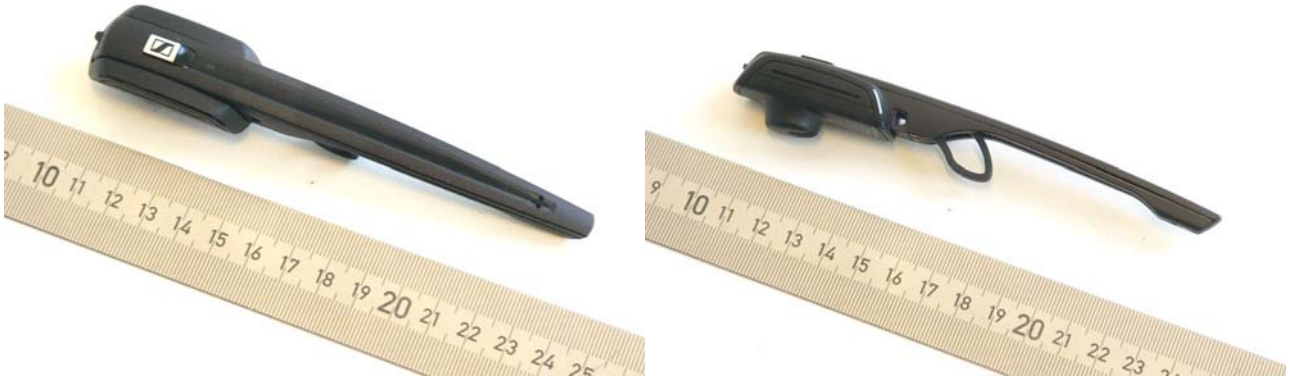

*Fig. 11: Pictures of the D 10 HS under test (ear hook style).*

*Fig. 12: Pictures of the D 10 HS under test with attached headband without rubber ear buds.*

*Fig. 13: Pictures of the D 10 HS with attached headband and rubber ear buds.*

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## 6.10 Test Positions for the Device under Test

Figure 14 - 15 show the test positions for the SAR measurements.

According to reply of FCC inquiry 924777, SAR assessment with attached headband was conducted with removed rubber ear buds during testing.

*Fig. 14: Ear hook wearing style, test position 1 for the D 10 HS from* Sennheiser Communications.

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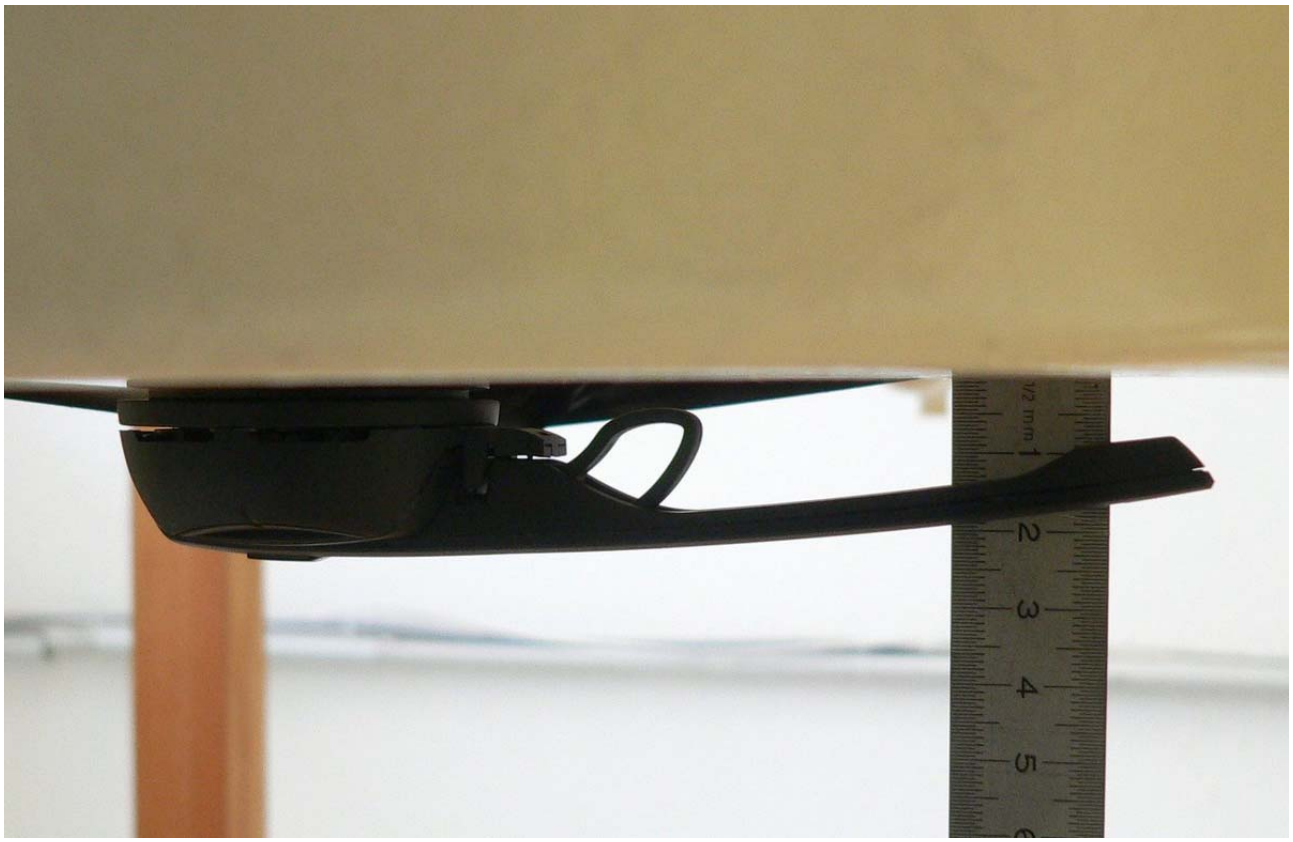

*Fig. 15: Headband wearing style, test position 2 for the D 10 HS f*rom Sennheiser Communications.

SAR_Report_FCC_DECT_Head_1.0/13.06.2014/AR

## 6.11 Pictures to Demonstrate the Required Liquid Depth

Figure 16 shows the liquid depth in the used SAM phantom.

*Fig. 16: Head liquid depth for 1900 MHz in flat part of the phantom.*

SAR_Report_FCC_DECT_Head_1.0/13.06.2014/AR

# 7 Revision History

| Revision History of Test Report | | | | |
|---|---|---|---|---|
| **Revision** | **Name of Test Report** | **Date** | **Revised Page** | **Comments** |
| Original | _FCC_DECT_D10HS | Nov. 10, 2014 | - | - |
| 1 | _FCC_DECT_D10HS_Rev1 | Feb. 17, 2015 | 3 | Declaration of identity added |
| 2 | _FCC_DECT_D10HS_Rev2 | Feb. 18, 2015 | 3 | Product name OR Blue-HS changed to OR 10 Blue-HS |

# 8 References


[IEEE C95.1-1999] IEEE Std C95.1-1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, Inst. of Electrical and Electronics Engineers, Inc., 1999.

[IEEE C95.1-2005] IEEE Std C95.1-2005: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, Inst. of Electrical and Electronics Engineers, Inc., 2005.

[ICNIRP 1998] ICNIRP: Guidelines for Limiting Exposure to Time-varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz), In: Health Physics, Vol. 74, No. 4, 494-522, 1998.

[DASY4] Schmid & Partner Engineering AG: DASY4 Manual. April 2008

[KDB 447498] 447498 D01 v05r02 General RF Exposure Guidance v05, February 07, 2014

[KDB 865664] 865664 D01 v01r03 SAR measurement 100 MHz to 6 GHz, February 07, 2014

[47 CFR] Code of Federal Regulations; Title 47, Telecommunications


SAR_Report_FCC_DECT_Head_1.0/13.06.2014/AR