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SAR Test Report

Dosimetric Assessment of the Portable Device Hasselblad H5D-50C

(Contains FCC ID: 2AEFAODINW160)

According to the FCC Requirements

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Executive Summary

The H5D-50C is a new digital camera (portable device) from Hasselblad operating in the 2.4 GHz frequency range. The camera has an integrated antenna and works in the IEEE 802.11 b/g/n standards.

The objective of the measurements done by IMST was the dosimetric assessment of one device in a worst case setup in body supported and head exposure configuration. Since there was a special test software available, SAR tests in IEEE 802.11 b/g/n are conducted with a specific channel, data rate and maximum output power. 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 and IEEE 1528-2013 [IEEE1528-2013].

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]
- SAR Measurement Procedures for 802.11 a/b/g Transmitters [KDB 248227 v01r02]

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

Compliance Statement

The Hasselblad H5D-50C digital camera (FCC ID: 2AEFAODINW160) is in compliance with the following standards for uncontrolled exposure:

- 47 CFR § 2.1093 [47CFR],
- IEEE Std. C95.1 - 1999 [C95.1-1999],
- IEEE 1528-2013 [IEEE1528-2013]
- The latest version of all relevant FCC OET KDB Procedures

SAR assessment in body supported configuration was conducted with a closest distance of 0 mm between the flat part of the phantom and the housing of the camera in standard configuration with attached view finder. Additionally, the configuration with detached view finder has been tested with a distance of 5 mm distance between the phantom and the top side of the camera.

In addition to the body supported configuration, the camera has been tested in the following head exposure configuration using head tissue simulating liquid:

- Back side of the camera with attached view finder, distance 0 mm
- Top side of the camera with detached view finder, distance 5 mm

All measured SAR results are shown in Table 6 – 7, the highest results of SAR for the H5D-50C are as follows:

Worst Case SAR Results									
Mode	**Freq. [MHz]**	**CH**	**Device Config.**	**Gap [mm]**	**Fig No.**	**Measured SAR_{1g} [W/kg]**	**Reported SAR_{1g} [W/kg]**	**SAR Limit [W/kg]**	
IEEE 802.11g (9 Mbit/s)	**Body Exposure**								
	2437	6	Top Side	5	15	0.221	0.278	1.6	PASS
	Head Exposure								
	2437	6	Top Side	5	15	0.268	0.337	1.6	PASS

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Subject of Investigation

The H5D-50C is a new digital camera (portable device) from Hasselblad operating in the 2.4 GHz frequency range. The camera has an integrated antenna and works in the IEEE 802.11 b/g/n standards.

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 in body supported and head exposure configuration. Since there was a special test software available, SAR tests in IEEE 802.11 b/g/n are conducted with a specific channel, data rate and maximum output power. The examinations have been carried out with the dosimetric assessment system „DASY4".

1 FCC Exposure Criteria

In the USA the FCC exposure criteria [KDB 865664] are based on the withdrawn 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.

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 σ and the mass density ρ of the biological tissue:

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

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.

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.

3 Body-Worn Configurations

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. Per FCC KDB 648474 [KDB 648474], Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in KDB 447498 [KDB 447498] should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for body worn accessory, measured without headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body worn accessory with a headset attached to the handset.

For purpose of determining test requirements, accessories may be divided into two categories: those that do not contain metallic components and those that do. For multiple accessories that do not contain metallic components, the device may be tested only with that accessory which provides the closest spacing to the body.

For multiple accessories that contain metallic components, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component, only the accessory that provides the closest spacing to the body must be tested.

Devices that are designed to operate on the body of users using lanyards and straps, or without requiring additional body worn accessories, must be tested for SAR compliance using a conservative minimum test separation distance ≤ 5 mm to support compliance. Nevertheless, all accessories that contain metallic components must be tested for compliance additionally.

Other separation distances may be used, but they shall not exceed 2.5 cm.

3.1 Phantom Requirements

For body-worn and other configurations a flat phantom shall be used which is comprised of material with electrical properties similar to the corresponding tissues.

3.2 Test to be Performed

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 resp. that channel with the highest output power for each test configuration is < 0.4 W/kg, testing at the high and low channels is optional.

3.3 Additional Information for 802.11 a/b/g Transmitters

In May 2007 the FCC published the revised issue of the SAR Measurement Procedures for 802 a/b/g transmitters to support the SAR measurements for demonstrating compliance with the FCC RF exposure guidelines. Additional information were required to establish specific device operating configurations to use during the measurements since the specific signal modulations, data rates, network conditions and other parameters were not considered within the current SAR measurement procedures (FCC, IEEE-1528).

Following the most important differences compared to the common SAR measurements of e.g. mobile phones working in the GSM or PCS standards were listed:

- Using of chipset based test mode software to ensure consistent and reliable results
- If the device supports switched diversity, the SAR should be measured with only one antenna transmitting (with fixed modulation and data rate) at a time
- The SAR is measured for the “default test channels” listed below as given by the FCC
- SAR measurements for 802.11 g channels when the maximum avg output power is less than ≥ 0.25 dB higher than the values for the corresponding 802.11b channels
- The avg. output power for 802.11a should be measured on all channels in each frequency band
- If the channel with the maximum avg. output power is not included in the default test channels, this channel should be tested instead of an adjacent default test channel
- For multiple channel bandwidth configurations, the configuration with the highest output power limit should be tested.
- Each channel should be tested at the lowest data rate in each a/b/g mode

- When the extrapolated maximum peak SAR for the maximum output channel is ≤ 1.6 W/kg and the 1g avg SAR is ≤ 0.8 W/kg, testing of other channels in the default test channel configuration is optional.
- If the device supports MIMO capability and the antennas are in close proximity to each other (within 3 cm – 5 cm), it is necessary to summarize the SAR_{1g} values of the antennas.
- If the peak SAR locations from different antennas are more than 5 cm apart, spatial summing is optional.
- Each channel should be tested at the lowest data rate in each a-b/g mode.

Mode 802.11	Frequency [MHz]	Channel	Turbo Channel	Default Test Channels			
				§ 15.247		UNII	
				b	g		
b / g	2412	1°		x	^		
	2437	6	6	x	^		
	2462	11°		x	^		

Table 2: Default Test channels given by the FCC.

X: default test channels

*: possible 802.11a channels with maximum avg output > the default test channels

^: possible 802.11g channels with maximum avg output ¼ dB ≥ the default test channels

°: when output power is reduced for channel 1 and / or 11 to meet restricted band requirements the highest output channels closet to each of these channels should be tested

3.3.1 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.

4 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. 2. Additional Fig. 3 shows the equipment, similar to the installations in other laboratories.

- Fully compliant with all current measurement standards as stated in Fig. 6
- 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

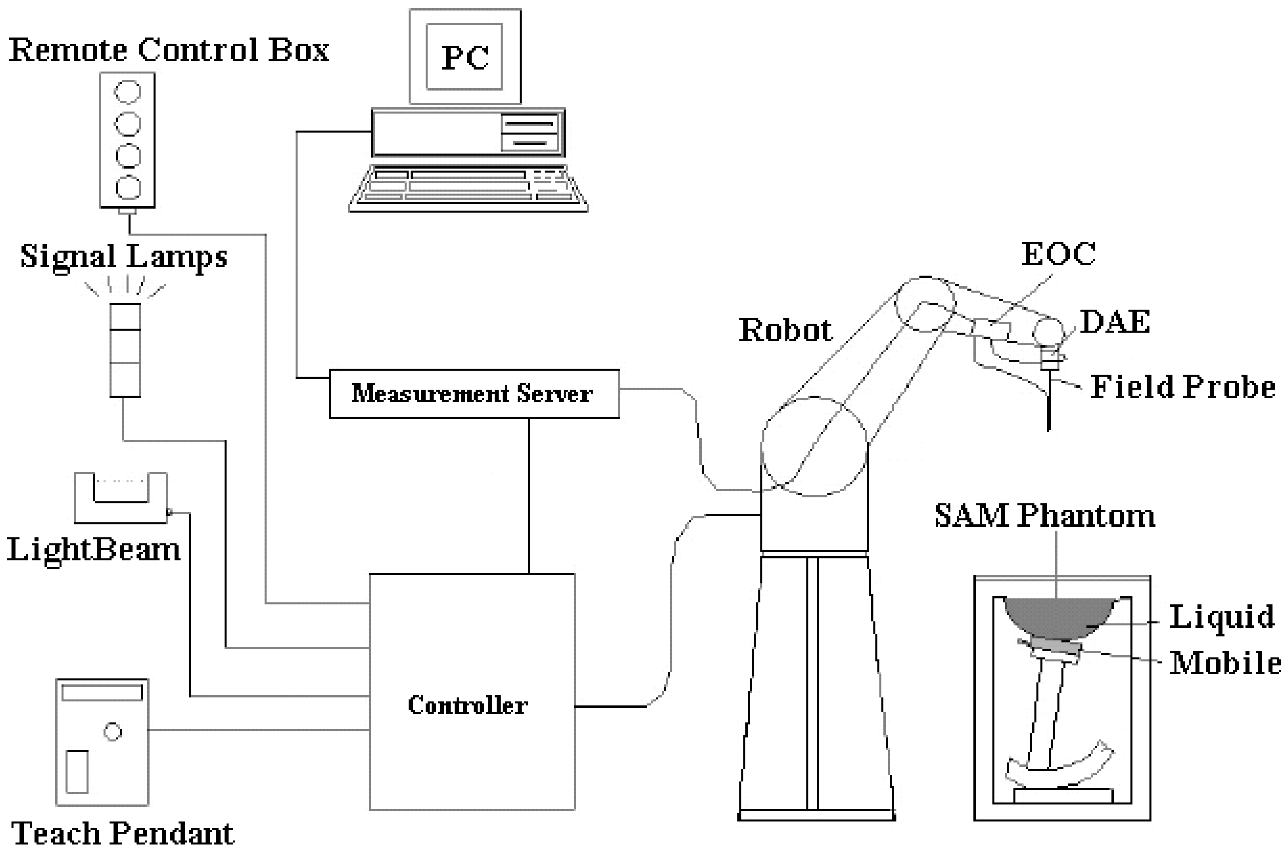

Fig. 2: The DASY4 measurement system.

Fig. 3: 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 σ and the mass density ρ 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.

4.1 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. The details and the Certificate of conformity can be found in Fig. 7.
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)
Dimensions	Length: 1000 mm; Width: 500 mm Height: adjustable feet
Filling Volume	approx. 25 liters

4.2 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 KDB 865664 and IEEE 1528 recommendations annually by Schmid & Partner Engineering AG.

ET3DV6R	
Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system (ET3DV6 only) Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Dimensions	Overall length: 337 mm (Tip: 16 mm) Tip diameter: 6.8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.7 mm
Frequency	10 MHz to 2.3 GHz Linearity: ± 0.2 dB (30 MHz to 2.3 GHz)
Directivity	Axial isotropy: ± 0.2 dB in TSL (rotation around probe axis) 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 for head and body simulating liquid

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

4.3 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 3.
- 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: Δx_{Area}, Δy_{Area}			≤ 2 GHz: ≤ 15 mm 2 - 3 GHz: ≤ 12 mm	3 - 4 GHz: ≤ 12 mm 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: ΔX_{Zoom}, ΔY_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 - 3 GHz: ≤ 5 mm*	3 - 4 GHz: ≤ 5 mm* 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 4 - 5 GHz: ≤ 3 mm 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 4 - 5 GHz: ≤ 2.5 mm 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 4 - 5 GHz: ≥ 25 mm 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. * 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 3: Parameters for SAR scan procedures.

4.4 Uncertainty Assessment

Table 4 includes the worst case uncertainty budget suggested by the KDB 865664 and IEEE 1528 determined by Schmid & Partner Engineering AG. The expanded uncertainty (K=2) is assessed to be ± 21.6%.

Uncertainty Budget of DASY4						
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 4: Uncertainty budget of DASY4.

5 Output Power Values and Tune-Up Information

Average Measured and Maximum Transmit Output Power Values [dBm]											
Mode	**Freq. [MHz]**	**CH**	**Measured Output Power for Data Rate [Mbit/s]**								**Tune-Up Limit**
			1		**2**		**5.5**		**11**		
IEEE 802.11b	2412	1	13.2		13.4		13.4		13.4		14.5
	2437	6	14.3		14.1		13.9		14.0		15.5
	2462	11	14.4		14.2		14.1		14.2		15.5
Mode	**Freq. [MHz]**	**CH**	**Measured Output Power for Data Rate [Mbit/s]**								**Tune-Up Limit**
			6	**9**	**12**	**18**	**24**	**36**	**48**	**54**	
IEEE 802.11g	2412	1	14.5	14.4	14.3	14.4	14.5	14.4	14.6	14.4	15.5
	2437	6	15.6	16.0	16.0	16.0	16.1	15.9	15.9	16.0	17.0
	2462	11	15.0	15.4	15.4	15.5	15.3	15.5	15.4	15.5	16.5
Mode	**Freq. [MHz]**	**CH**	**Measured Output Power for Data Rate [Mbit/s]**								**Tune-Up Limit**
			MCS0	**MCS1**	**MCS2**	**MCS3**	**MCS4**	**MCS5**	**MCS6**	**MCS7**	
IEEE 802.11n 20 MHz	2412	1	14.3	14.2	14.2	14.3	14.4	14.4	14.3	14.2	15.5
	2437	6	15.8	15.9	15.9	15.8	15.9	16.0	15.8	15.4	17.0
	2462	11	15.3	15.3	15.3	15.3	15.2	15.2	15.4	15.3	16.5

Table 5: Conducted output power and maximum transmit power values for Hasselblad H5D-50C for IEEE 802.11 b/g/n.

6 SAR Results

The table below contains 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 5.

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 for IEEE 802.11 b/g											
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.
IEEE 802.11 b (1 Mbit/s)	2437	6	**Standard camera configuration with attached view finder, distance = 0 mm**								
			Back	10	0.005	-0.026	14.3	15.5	1.318	0.007	1
			Left	11	0.004	0.099				0.005	2
			Right	12	Below system detection limit	/				/	3
			Bottom	13		/				/	4
			Top	14	0.005	-0.125				0.007	5
			Camera configuration with detached view finder, distance = 5 mm								
			Top	**15**	0.136	-0.077	14.3	15.5	1.318	0.179	6
IEEE 802.11 g (9 Mbit/s)	2437	6	**Standard camera configuration with attached view finder, distance = 0 mm**								
			Back	10	0.012	-0.100	16.0	17.0	1.259	0.015	7
			Left	11	0.006	0.111				0.008	8
			Right	12	Below system detection limit	/				/	9
			Bottom	13		/				/	10
			Top	14	0.008	-0.054				0.010	11
			Camera configuration with detached view finder, distance = 5 mm								
			Top	15	0.221	0.011	16.0	17.0	1.259	**0.278**	12
	2412	1	Top	15	0.095	0.130	14.4	15.5	1.288	0.122	13
	2462	11	Top	15	0.177	-0.145	15.4	16.5	1.288	0.228	14

Table 6: SAR measurement results in body supported configuration for Hasselblad H5D-50C.

According to KDB 248227, SAR is not required for 802.11n mode when the maximum average output power is less than ¼ dB higher than in IEEE 802.11b/g modes, so SAR assessment in 802.11n mode is not necessary.

In addition to the body supported configuration, the camera has been tested in the following head exposure configuration using head tissue simulating liquid.

SAR Measurement Results for IEEE 802.11 g											
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.
IEEE 802.11 g (9 Mbit/s)	2437	6	Standard camera configuration with attached view finder, distance = 0 mm								
			Back	10	0.010	0.106	16.0	17.0	1.259	0.013	15
			Camera configuration with detached view finder, distance = 5 mm								
			Top	15	0.268	0.099	16.0	17.0	1.259	**0.337**	16
	2412	1	Top	15	0.096	0.078	14.4	15.5	1.288	0.124	17
	2462	11	Top	15	0.198	-0.025	15.4	16.5	1.288	0.255	18

Table 7: SAR measurement results for head exposure configuration for Hasselblad H5D-50C.

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%.

6.1 Standalone SAR Test Exclusion

Standalone SAR Test Exclusion Consideration						
Communication System	Freq. [MHz]	Distance [mm]	Pavg [dBm]	Pavg [mW]	Threshold 1g Comparison Values	SAR Test Exclusion (Yes/No)
WiFi	2437	5	17.0	50.12	15.6	No

Table 8: Standalone SAR consideration.

Standalone SAR test exclusion according to KDB 447498 D01 v05 with 1g SAR exclusion thresholds for 100 MHz to 6GHz at test separation distances ≤ 50 mm determined by:

[(*max. power of channel, incuding tune-up tolerance, mW*) / (*min. test separation distance, mm*)] [√f(GHz)]

≤ 3.0 for 1-g SAR and
≤ 7.5 for 10-g extremity SAR where

- f (GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Appendix

6.2 Administrative Data

Date of Validation:	2450 MHz Body:	February 25, 2015
	2450 MHz Head:	March 18, 2015
Date of Measurement:	February 25, 2015 - March 18, 2015	
Data Stored:	Nemko_60320_6140533	
Contact:	IMST GmbH	
	Carl-Friedrich-Gauß-Str. 2 - 4	
	D-47475 Kamp-Lintfort, Germany	
	Tel.: +49- 2842-981 384	
	Fax: +49- 2842-981 399	
	email: ridder@imst.de	

6.3 Device under Test and Test Conditions

MTE:	Hasselblad H5D-50C
Date of Receipt:	December 11, 2014
SN:	SQ34000448
FCC ID:	2AEFAODINW160
Equipment Class:	Portable device
RF Exposure Environment:	General Population/ Uncontrolled
Power Supply:	Internal Battery
Antenna:	integrated
Measured Standards:	IEEE 802.11 b/g/n
Method to establish a Call:	Test software

Hasselblad H5D-50C	TX Range [MHz]	RX Range [MHz]	Used Channels	Used Crest Factor	Phantom
IEEE 802.11 b/g/n	2412.0 – 2462.0	2412.0 – 2462.0	1, 6, 11	1	SAM Twin Phantom V4.0

Table 9: Used channels and crest factors during the test.

6.4 Tissue Recipes

The following recipes are provided in percentage by weight.

2450 MHz, Body:	31.40%	Diethylenglykol-monobutylether
	68.60%	De-Ionized Water
2450 MHz, Head:	45.65%	Diethylenglykol-monobutylether
	54.00%	De-Ionized Water

6.5 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.

Frequency		ε_r	σ [S/m]	Temperature	
				Ambient [C]	Liquid [° C]
2450 MHz Body Exposure Conditions	Recommended Value	52.70 ± 2.63	1.95 ± 0.09	20.0 - 26.0	-
	Measured Value (Validation)	52.60	2.00	21.9	21.7
	Measured Value (CH 1)	52.80	1.94		
	Measured Value (CH 6)	52.70	1.98		
	Measured Value (CH 11)	52.80	2.01		
2450 MHz Head Exposure Conditions	Recommended Value	39.20 ± 2.00	1.80 ± 0.09	20.0 - 26.0	-
	Measured Value (Validation)	38.90	1.83	22.4	22.1
	Measured Value (CH 1)	39.10	1.78		
	Measured Value (CH 6)	39.00	1.82		
	Measured Value (CH 11)	38.90	1.84		

Table 10: Parameters of the tissue simulating liquids.

6.6 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 11 and shown in figure 4 - 5. The target values were adopted from the calibration certificates which are attached in the appendix. Table 12 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%.

Available Dipoles		SAR_{1g} [W/kg]	ε_r	σ [S/m]
D2450V2, SN: 709	Target Values Body	14.33	53.80	1.96
	Target Values Head	14.25	40.40	1.84
Used Dipoles		**SAR_{1g} [W/kg]**	**ε_r**	**σ [S/m]**
D2450V2, SN: 709	Measured Values Body	14.10	52.60	2.00
	Measured Values Head	14.00	38.90	1.83

Table 11: Dipole validation results.

Test Laboratory: IMST GmbH, DASY Blue (I); File Name: 250215_b_3536_631.da4

DUT: Dipole 2450 MHz SN: 709; Type: D2450V2; Serial: D2450V2 - SN:709
Program Name: System Performance Check at 2450 MHz

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 2 mho/m; ε_r = 52.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3536; ConvF(7.34, 7.34, 7.34); Calibrated: 24.07.2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 23.07.2014
- Phantom: SAM Glycol 1176; Type: Speag; Serial: 1176
- 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) = 15.8 mW/g
d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 88.9 V/m; Power Drift = 0.063 dB
Peak SAR (extrapolated) = 28.9 W/kg
SAR(1 g) = 14.1 mW/g; SAR(10 g) = 6.46 mW/g
Maximum value of SAR (measured) = 16.0 mW/g

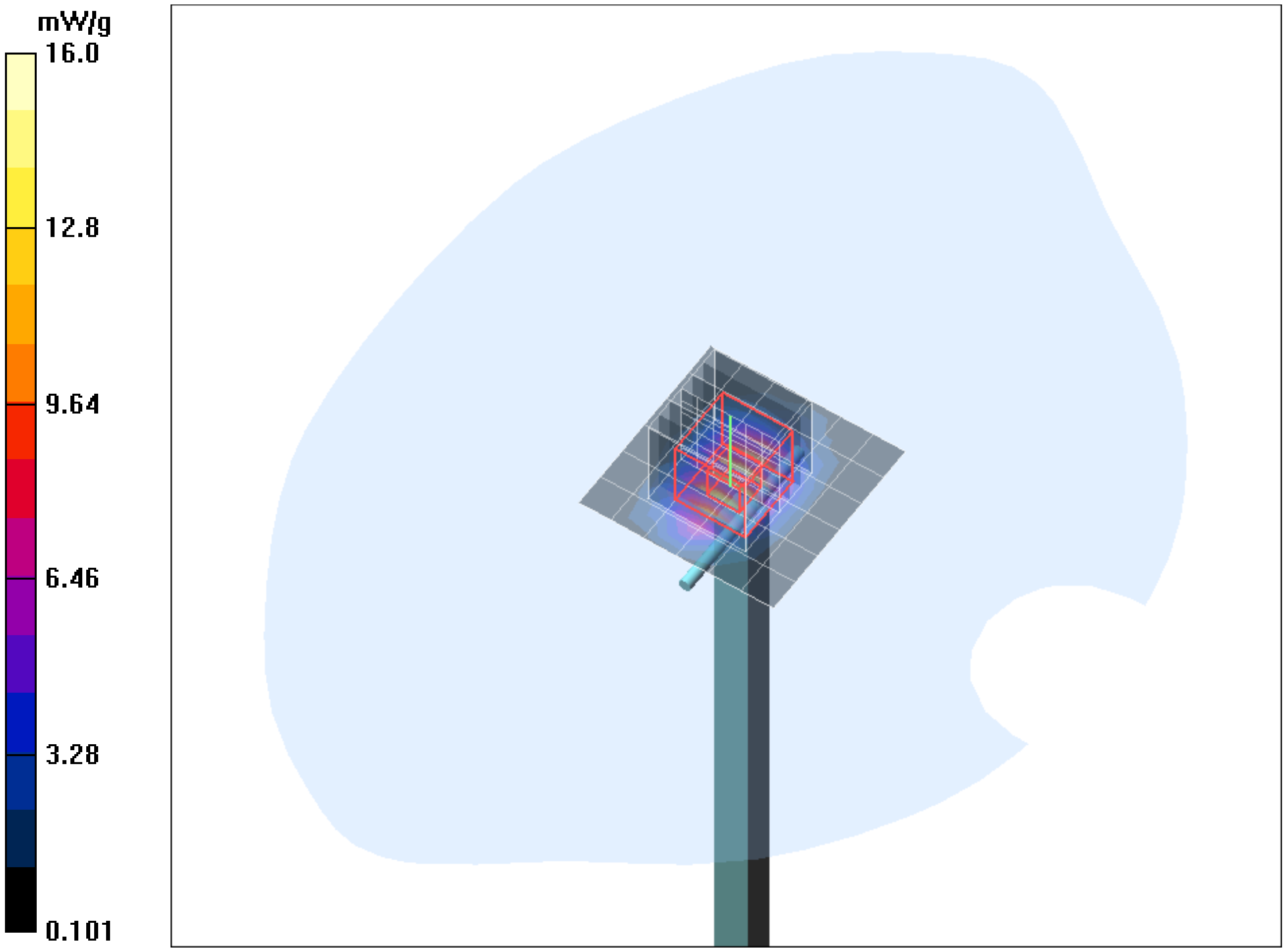

Fig. 4: Validation measurement 2450 MHz Body (February 25, 2015), coarse grid.

Test Laboratory: IMST GmbH, DASY Blue (I); File Name: 180315_b_3536_631.da4

DUT: Dipole 2450 MHz SN: 709; Type: D2450V2; Serial: D2450V2 - SN:709
Program Name: System Performance Check at 2450 MHz

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.83 mho/m; ε_r = 38.9; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3536; ConvF(7.52, 7.52, 7.52); Calibrated: 24.07.2014
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 23.07.2014
- Phantom: SAM Glycol 1176; Type: Speag; Serial: 1176
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=10mm, Pin=250mW/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 15.1 mW/g
d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 93.9 V/m; Power Drift = 0.000 dB
Peak SAR (extrapolated) = 31.1 W/kg
SAR(1 g) = 14 mW/g; SAR(10 g) = 6.32 mW/g
Maximum value of SAR (measured) = 16.0 mW/g

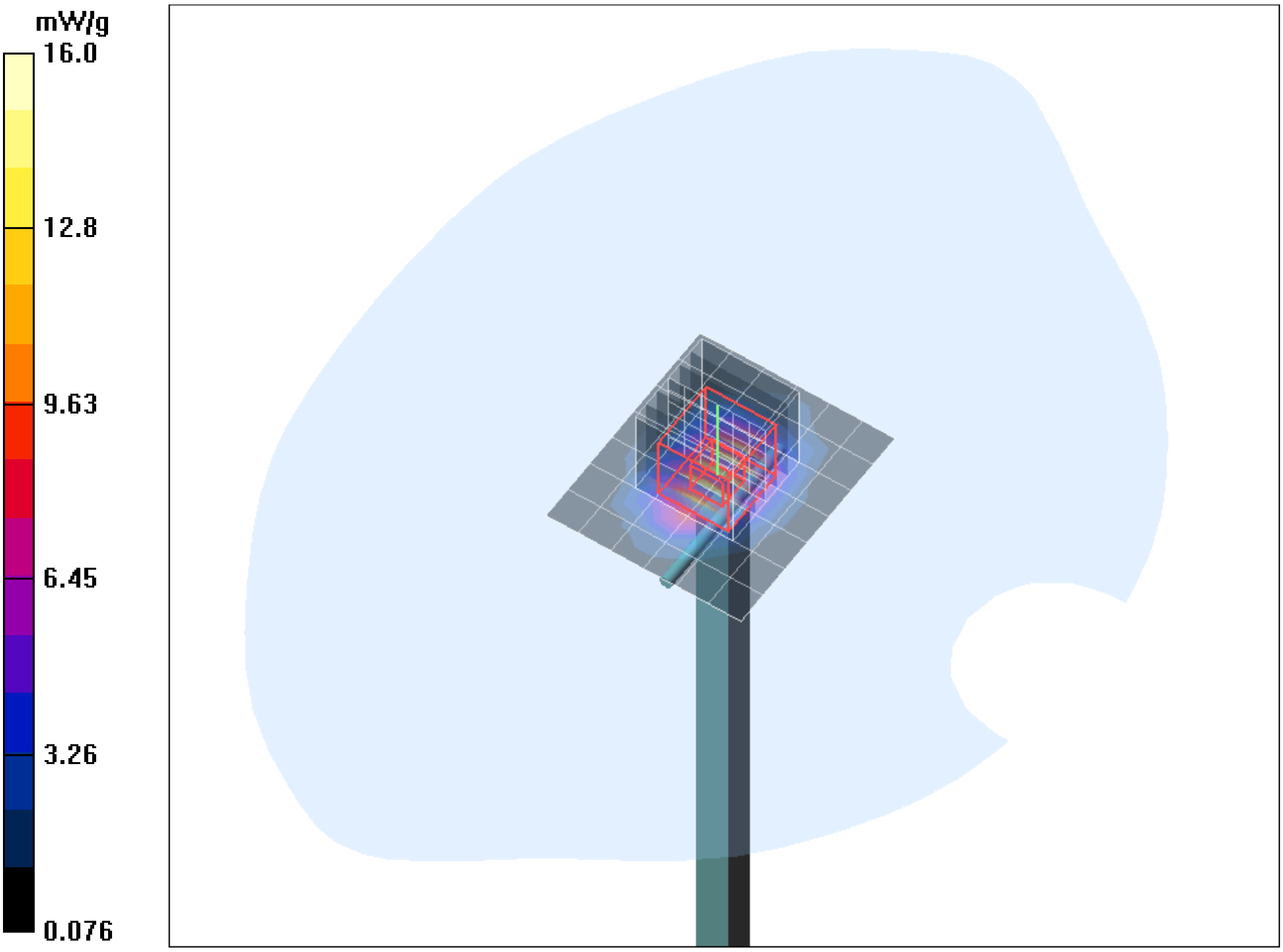

Fig. 5: Validation measurement 2450 MHz Head (March 18, 2015), coarse grid.

Uncertainty Budget						
Error Sources	**Uncertainty Value**	**Probability Distribution**	**Divisor**	**c_i**	**Standard Uncertainty**	**v_i^2 or v_{eff}**
Measurement System						
Probe calibration	± 4.8 %	Normal	1	1	± 4.8 %	∞
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	± 1.0 %	Normal	1	1	± 1.0 %	∞
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					± 8.4 %	

Table 12: Uncertainty budget for the system performance check.

6.7 Environment

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

Humidity: 40% ± 5 %

6.8 Test 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	EX3DV4	3536	07/2014	07/2015
Data Acquisition Electronics	DAE 4	631	07/2014	07/2015
Phantom	SAM	1176	N/A	N/A
Dipoles				
Validation Dipole	D2450V2	709	07/2014	07/2016
Material Measurement				
Network Analyzer	E5071C	MY46103220	07/2013	07/2015
Dielectric Probe Kit	HP85070B	US33020263	N/A	N/A

Table 13: SAR equipment.

Test Equipment	Model	Serial Number	Last Calibration	Next Calibration
Power Meters				
Power Meter, Anritsu	ML2487A	6K00002319	02/2014	02/2016
Power Meter, Anritsu	ML2488A	6K00002078	02/2014	02/2016
Power Sensors				
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 14: Test equipment, General.

6.9 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 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. 6: Certificate of conformity for the used DASY4 system:

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 Hauptstr. 69 CH-8559 Fruthwilen 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 Relative permittivity < 5 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. 7: Certificate of conformity for the used SAM phantom.

6.10 Pictures of the Device under Test

Figure 8 - 9 show the device under test.

Fig. 8: Hasselblad H5D-50C in standard configuration with attached view finder.

Fig. 9: Hasselblad H5D-50C with detached view finder.

6.11 Test Positions for the Device under Test

Fig. 10 – 15 show the test positions for the SAR measurements.

Fig. 10: Back side towards the phantom.

Fig. 11: Left side towards the phantom.

Fig. 12: Right side towards the phantom.

Fig. 13: Bottom side towards the phantom.

Fig. 14: Top side towards the phantom.

Fig. 15: Top side towards the phantom, view finder detached, 5 mm distance.

6.12 Pictures to Demonstrate the Required Liquid Depth

Figure 16 - 17 show the liquid depth in the used SAM phantom.

Fig. 16: Liquid depth for 2450 MHz body exposure measurements.

Fig. 17: Liquid depth for 2450 MHz head exposure measurements.

7 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.

[IEEE 1528-2013] IEEE Std 1528-2013: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques. 1528-2013, June 14, 2013, The Institute of Electrical and Electronics Engineers.

[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 7, 2014

[KDB 865664] 865664 D01 v01r03 SAR measurement 100 MHz to 6 GHz, February 7, 2014

[[KDB 248227] 248227 D01 SAR meas for 802.11 a b g v01r02; SAR Measurement Procedures for 802.11 a/b/g Transmitters, May 2007

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