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IMST

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Report

Dosimetric Assessment of the SDP660TU FM Analogue PMR and Digital DMR (TDMA) Two-Way Radio from Simoco (FCC ID: STZSDP600TU) (IC: 7068A-SDP600TU)

According to the FCC Requirements

July 19, 2013

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Executive Summary

The device SDP660TU is a multiple mode FM Analogue PMR and Digital DMR (TDMA) two way portable radio from Simoco operating in the 400 MHz – 480 MHz frequency range. The device has a whip antenna.

The objective of the measurements done by IMST was the dosimetric assessment of one test device in the 400 MHz – 480 MHz frequency range in the highest output mode (FM Analogue PMR).The examinations have been carried out with the dosimetric assessment system „DASY4“.

The measurements were made according to the Supplement C to OET Bulletin 65 of the Federal Communications Commission (FCC) Guidelines [OET 65] for evaluating compliance of mobile and portable devices with FCC limits for human exposure (Occupational Exposure) to radiofrequency emissions and IC RSS 102 Issue 4.

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

- SAR Measurement Requirements for 100 MHz to 6 GHz [KDB 865664 D01 v01r01]
- Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies [KDB 447498 D01 v05r01]
- SAR Test Reduction Considerations for Occupational PTT Radios [KDB 643646]

All measurements have been performed in accordance to the recommendations given by SPEAG.

Compliance Statement

The device SDP660TU from Simoco (FCC ID: STZSDP600TU, IC: 7068A-SDP600TU) is in compliance with the following standards for controlled exposure:

- **IC RSS 102 Issue 4 [RSS 102],**
- **OET Bulletin 65 Supplement C [OET 65],**
- **IEEE Std. C95.1 - 1999 [C95.1-1999],**
- **IEEE Std. C95.3 - 2002 [C95.3-2002],**
- **IEEE 1528-2003 [IEEE 1528-2003],**
- **The latest version of all relevant FCC OET KDB Procedures**

SAR assessment in body worn was conducted with a distance of 0 mm, in PTT configuration with 25 mm between the housing of the device and the flat phantom.

The maximum results of SAR for the SDP660TU are as follows:

Test Position	Frequency	Position	Highest Reported SAR_{1g} [W/kg]
Body Worn	400.125 MHz	1 (Fig. 14)	2.957
PTT	400.125 MHz	2 (Fig. 15)	2.935

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1 Subject of Investigation

The device SDP660TU is a multiple mode FM Analogue PMR and Digital DMR (TDMA) two way portable radio from Simoco operating in the 400 MHz – 480 MHz frequency range. The device has a whip antenna.

Fig. 1: Pictures of the device under test.

The objective of the measurements done by IMST was the dosimetric assessment of one test device in the 400 MHz – 480 MHz frequency range in the highest output mode (FM Analogue PMR).The examinations have been carried out with the dosimetric assessment system „DASY4“.

2 The IEEE Standard C95.1 and the FCC Exposure Criteria

In the USA the FCC exposure criteria [OET 65, KDB 865664] are based on the withdrawn IEEE Standard C95.1-1999 [IEEE C95.1-1999]. This version was replaced by the IEEE Standard C95.1-2005 [IEEE C95.1-2005] in October, 2005.

Both IEEE standards set limits for human exposure to radio frequency electromagnetic fields in the frequency range 3 kHz to 300 GHz. One of the major differences in the newly revised C95.1-2005 is the change in the basic restrictions for localized exposure, from e.g. 1.6 W/kg averaged over 1 g tissue to 2.0 W/kg averaged over 10 g tissue, which is now identical to the ICNIRP guidelines [ICNIRP 1998].

2.1 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.

2.2 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:

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

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.

2.3 General SAR Limit

In this report the comparison between the American 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 occupational/controlled 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.

Standard	Status	SAR [W/kg] limit for controlled exposure
IEEE C95.1-1999	Replaced	8.0

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

3 The FCC Measurement Procedure

The Federal Communications Commission (FCC) has published a report and order on the 1st of August 1996 [FCC 96-326], which requires routine dosimetric assessment of mobile telecommunications devices, either by laboratory measurement techniques or by computational modeling, prior to equipment authorization or use. In 2001 the Commission's Office of Engineering and Technology has released Edition 01-01 of Supplement C to OET Bulletin 65. This revised edition, which replaces Edition 97-01, provides additional guidance and information for evaluating compliance of mobile and portable devices with FCC limits for human exposure to radiofrequency emissions [OET 65]. In 2013 the FCC has published a Notice of Proposed Rule Making [FCC 03-137] that discontinued the Supplement C to OET Bulletin 65 and reference will be made to KDB publications in 2.1093 (d)(3).

3.1 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.

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.

- 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

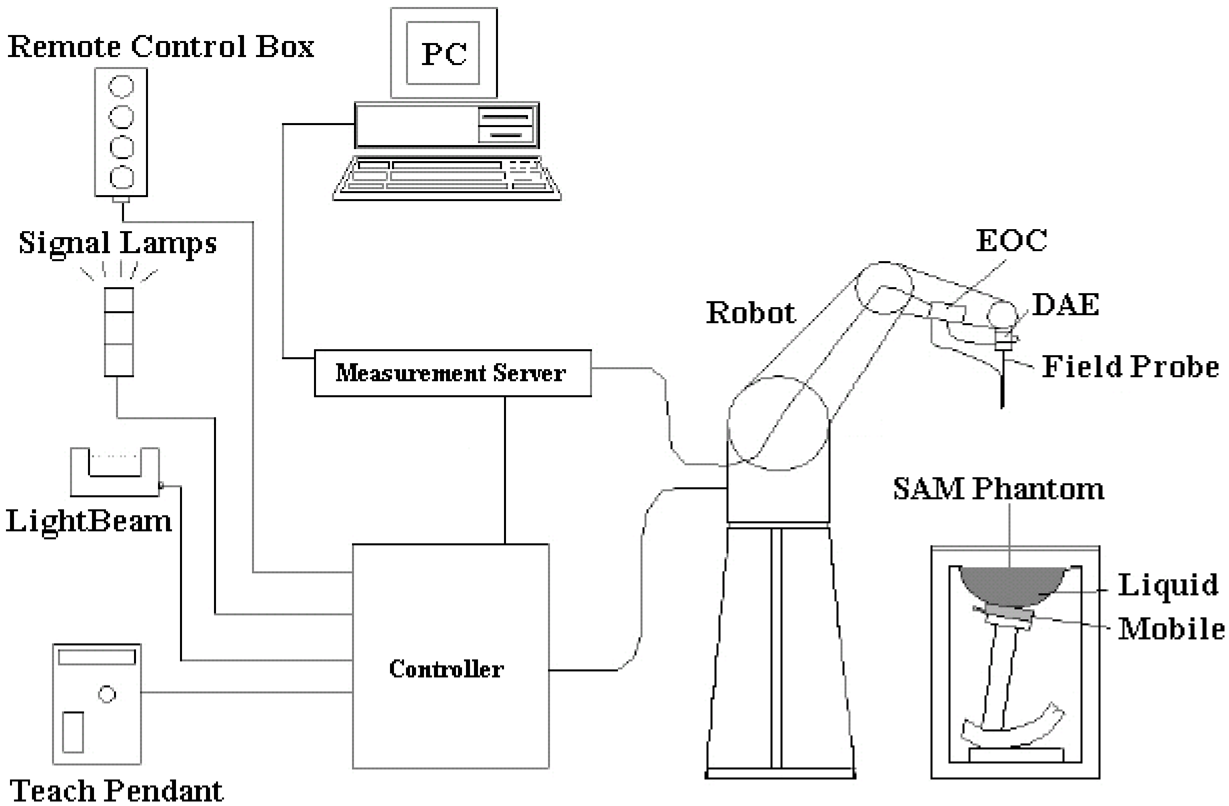

Fig. 2: The DASY4 measurement system.

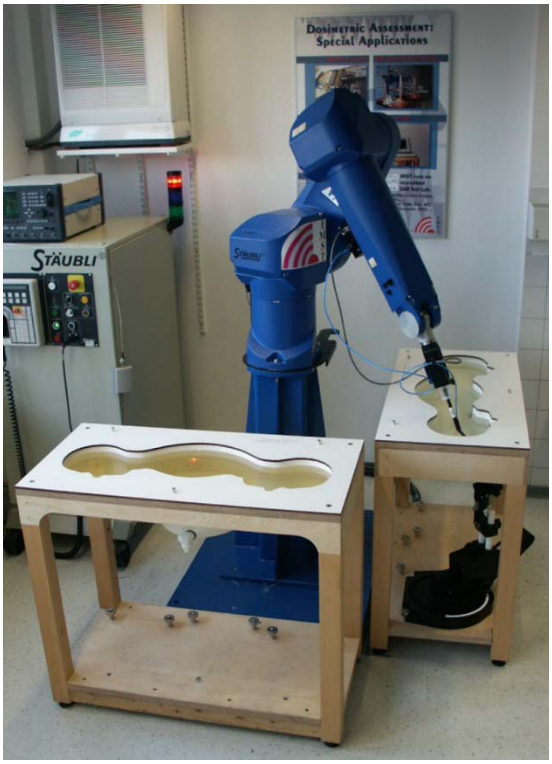

Fig. 3: The measurement set-up with two SAM phantoms containing tissue simulating liquid.

The device 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.

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. 9.
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

ELI4 Phantom	
	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. The details and the Certificate of conformity can be found in Fig. 10.
Shell Thickness	2.0 ± 0.2 mm (bottom plate)
Dimensions	Major axis: 600 mm Minor axis: 400 mm
Filling Volume	approx. 30 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 FCC [OET 65] and IEEE [IEEE 1528-2003] 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 via test mode.
- 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	$\frac{1}{2}\cdot\delta\cdot\ln(2) \pm 0.5$ 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	$\leq 1.5\cdot \Delta Z_{Zoom}(n-1)$	
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 2: Parameters for SAR scan procedures.

4.4 Uncertainty Assessment

Table 3 includes the worst case uncertainty budget suggested by the [IEEE 1528-2003] 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.

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.

5 Output Power Values and Tune-Up Information

The Simoco SDP660TU can be used with different output power configurations, high and low power mode, shown in table below.

Frequency	Measured Output Power [dBm]		Maximum Transmit Output Power [dBm]	
	High Power Mode	Low Power Mode	High Power Mode	Low Power Mode
400.125 MHz	36.70	26.90	37.16	No Information
412.950 MHz	36.80	26.60	37.16	No Information
459.075 MHz	36.70	26.80	37.16	No Information
479.925 MHz	36.80	26.90	37.16	No Information

Table 4: Measured output power and tune-up information for the Simoco SDP660TU.

6 SAR Test 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.

Since the output power in high power mode is higher than in low power mode, SAR assessement was conducted in high power mode only.

Mode	Spacing [kHz]	Frequency [MHz]	Channel	Test Position	Measured SAR_{1g} [W/kg]		Power Drift [dBm]	Plot No.
					Duty Cycle 100%	Duty Cycle 50%		
PMR (High Power)	25	400.125	low	Body Worn (Fig. 14)	5.320	2.660	-0.080	1
		412.950	middle		4.850	2.425	-0.158	2
		459.075	middle		3.760	1.880	-0.074	3
		479.925	high		3.560	1.780	-0.105	4
		400.125	low	PTT (Fig. 15)	5.280	2.640	-0.131	5
		412.950	middle		5.080	2.540	0.148	6
		459.075	middle		3.180	1.590	0.083	7
		479.925	high		2.720	1.360	-0.103	8

Table 5: Measured SAR results for the Simoco SDP660TU.

Freq. [MHz]	CH	Test Position	Measured SAR$_{1g}$ [W/kg]		Power Drift [dBm]	Output Power [dBm]	Tune Up Limit [dBm]	Scaling Factor	Reported SAR$_{1g}$ [W/kg]	
			Duty Cycle 100%	Duty Cycle 50%					Duty Cycle 100%	Duty Cycle 50%
400.125	low	Body Worn (Fig. 14)	5.320	2.660	-0.080	36.70	37.16	1.112	5.914	2.957
412.950	middle		4.850	2.425	-0.158	36.80	37.16	1.086	5.269	2.635
459.075	middle		3.760	1.880	-0.074	36.70	37.16	1.112	4.180	2.090
479.925	high		3.560	1.780	-0.105	36.80	37.16	1.086	3.868	1.934
400.125	low	PTT (Fig. 15)	5.280	2.640	-0.131	36.70	37.16	1.112	5.870	2.935
412.950	middle		5.080	2.540	0.148	36.80	37.16	1.086	5.519	2.760
459.075	middle		3.180	1.590	0.083	36.70	37.16	1.112	3.535	1.768
479.925	high		2.720	1.360	-0.103	36.80	37.16	1.086	2.955	1.478

Table 6: Reported SAR results for worst case position including scaling factor for the Simoco SDP660TU.

7 Evaluation

In Figure 4 - 5 the flat phantom SAR results given in Table 5 - 6 are summarized and compared to the limit.

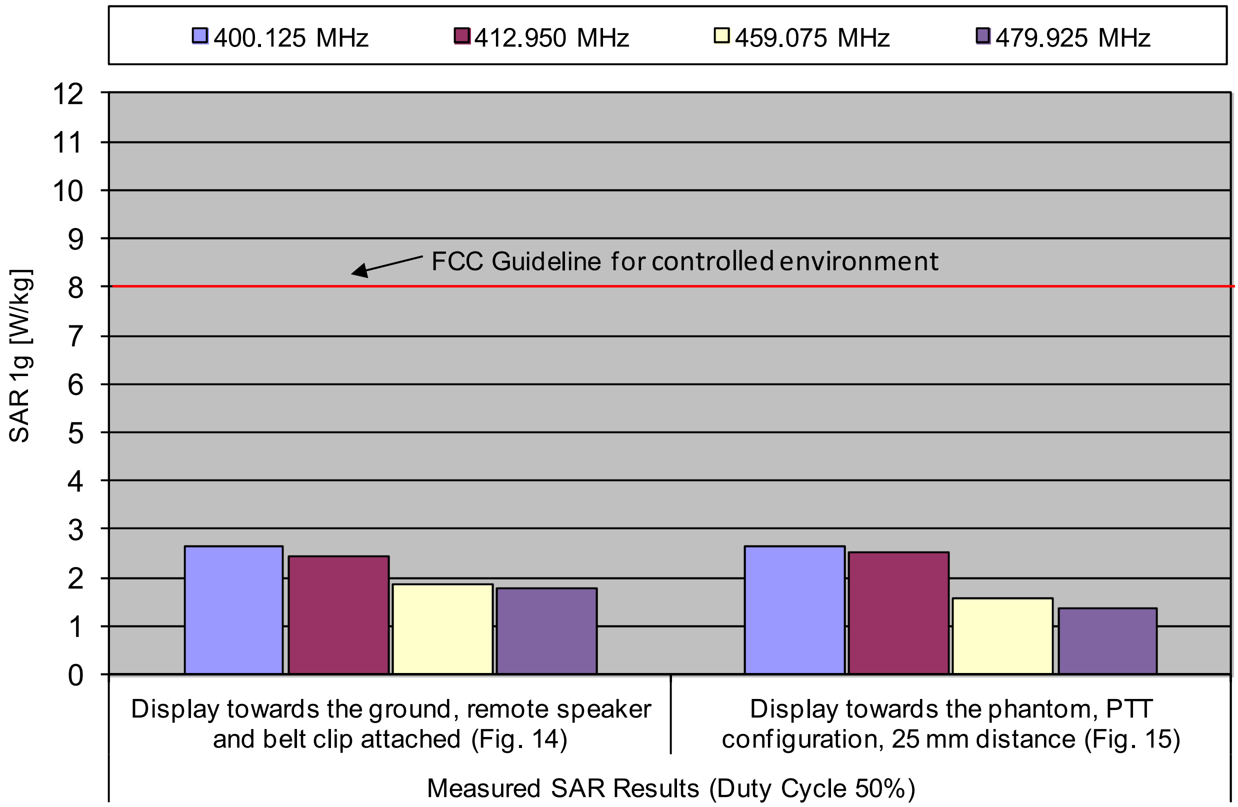

Fig. 4: The measured SAR values for the Simoco SDP660TU in comparison to the FCC exposure limit.

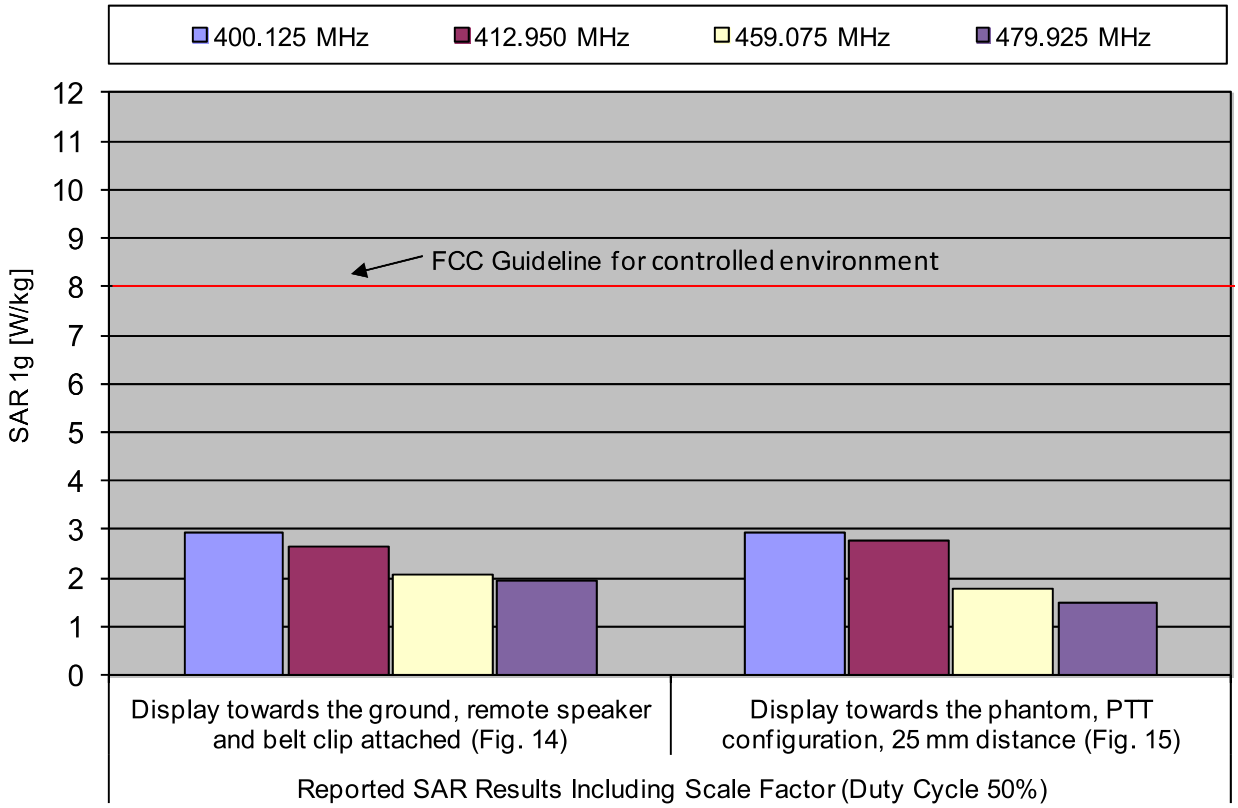

Fig. 5: The reported SAR values for the Simoco SDP660TU in comparison to the FCC exposure limit.

8 Appendix

8.1 Administrative Data

Date of Validation:	450 MHz Body: May 08, 2013 450 MHz Head: May 02, 2013
Date of Measurement:	May 02, 2013 – May 08, 2013
Data Stored:	TRaC_60320_6130147
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

8.2 Device under Test and Test Conditions

MTE:	Simoco SDP660TU, identical prototype
Date of Receipt:	May 02, 2013
SN:	56KTU123800FZ
FCC ID:	STZSDP600TU
IC:	7068A-SDP600TU
Equipment Class:	Portable device
Power Class:	max output power
RF Exposure Environment:	occupational/controlled environment
Power Supply:	Internal battery
Antenna Type:	whip
Measured Standards:	FM Analogue PMR and Digital DMR (TDMA) (25 kHz channel spacing)
Used TX Frequencies:	400 MHz, 412 MHz, 459 MHz, 479 MHz
Used Phantom:	Oval Flat Phantom ELI 4.0 delivered by Schmid & Partner Engineering AG

Simoco SDP660TU	TX Range [MHz]	RX Range [MHz]	Used Channels [low. middle. high]	Used Crest Factor
PMR	400 MHz – 480 MHz	400 MHz – 480	400, 412, 459, 479	1

Table 7: Used channels and crest factors during the test.

8.3 Tissue Recipes

The following recipes are provided in percentage by weight.

450 MHz, Body:	51.17%	Sugar
	46.21%	De-Ionized Water
	2.34%	Salt
	0.18%	Hydroxyetyl-cellulose
	0.08%	Preventol D7
450 MHz Head:	56.93%	Sugar
	38.91%	De-Ionized Water
	3.79%	Salt
	0.25%	Hydroxyetyl-cellulose
	0.12%	Preventol D7

8.4 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.

Frequency		ε_r	σ [S/m]
450 MHz Body	Recommended Value	52.70 ± 2.63	1.95 ± 0.09
	Measured Value (Validation)	55.60	0.95
	Measured Value (400 MHz)	56.30	0.91
	Measured Value (412 MHz)	56.00	0.92
	Measured Value (459 MHz)	55.60	0.95
	Measured Value (479 MHz)	55.50	0.97
450 MHz Head (PTT)	Recommended Value	43.50 ± 2.20	0.87 ± 0.04
	Measured Value (Validation)	41.80	0.86
	Measured Value (400 MHz)	43.00	0.83
	Measured Value (412 MHz)	42.70	0.83
	Measured Value (459 MHz)	41.60	0.87
	Measured Value (479 MHz)	41.40	0.89

Table 8: Parameters of the tissue simulating liquid.

8.5 Simplified Performance Checking

The simplified performance check was realized using the dipole validation kits. The input power of the dipole antennas were 250 mW and they were placed under the flat part of the SAM phantoms. The target and measured results are listed in the Table 9 - 10 and shown in Fig. 7. The target values were adopted from the calibration certificates.

Available Dipoles		SAR_{1g} [W/kg]	ε_r	σ [S/m]
D450V2, SN #1014	Target Values Body	1.31	56.00	0.95
D450V2, SN #1014	Target Values Head	1.28	43.30	0.85

Table 9: Dipole target results.

Used Dipoles		SAR_{1g} [W/kg]	ε_r	σ [S/m]
D450V2, SN #1014	Measured Values Body	1.34	55.6	0.94
D450V2, SN #1014	Measured Values Head	1.31	41.80	0.86

Table 10: Measured dipole validation results.

Test Laboratory: Imst GmbH, DASY Yellow (II); File Name: 080513_y_1669_ELI4.da4

DUT: Dipole 450 MHz SN1014; Type: D450V2; Serial: D450V2 - SN:1014
Program Name: System Performance Check at 450 MHz

Communication System: CW; Frequency: 450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 450 MHz; σ = 0.95 mho/m; ε_r = 55.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6R - SN1669; ConvF(7.62, 7.62, 7.62); Calibrated: 19.02.2013
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 20.09.2012
- Phantom: ELI 4; Type: ELI 4;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=10mm, Pin=250mW/Area Scan (7x7x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 1.36 mW/g
d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 38.4 V/m; Power Drift = 0.046 dB
Peak SAR (extrapolated) = 2.08 W/kg
SAR(1 g) = 1.34 mW/g; SAR(10 g) = 0.914 mW/g
Maximum value of SAR (measured) = 1.43 mW/g

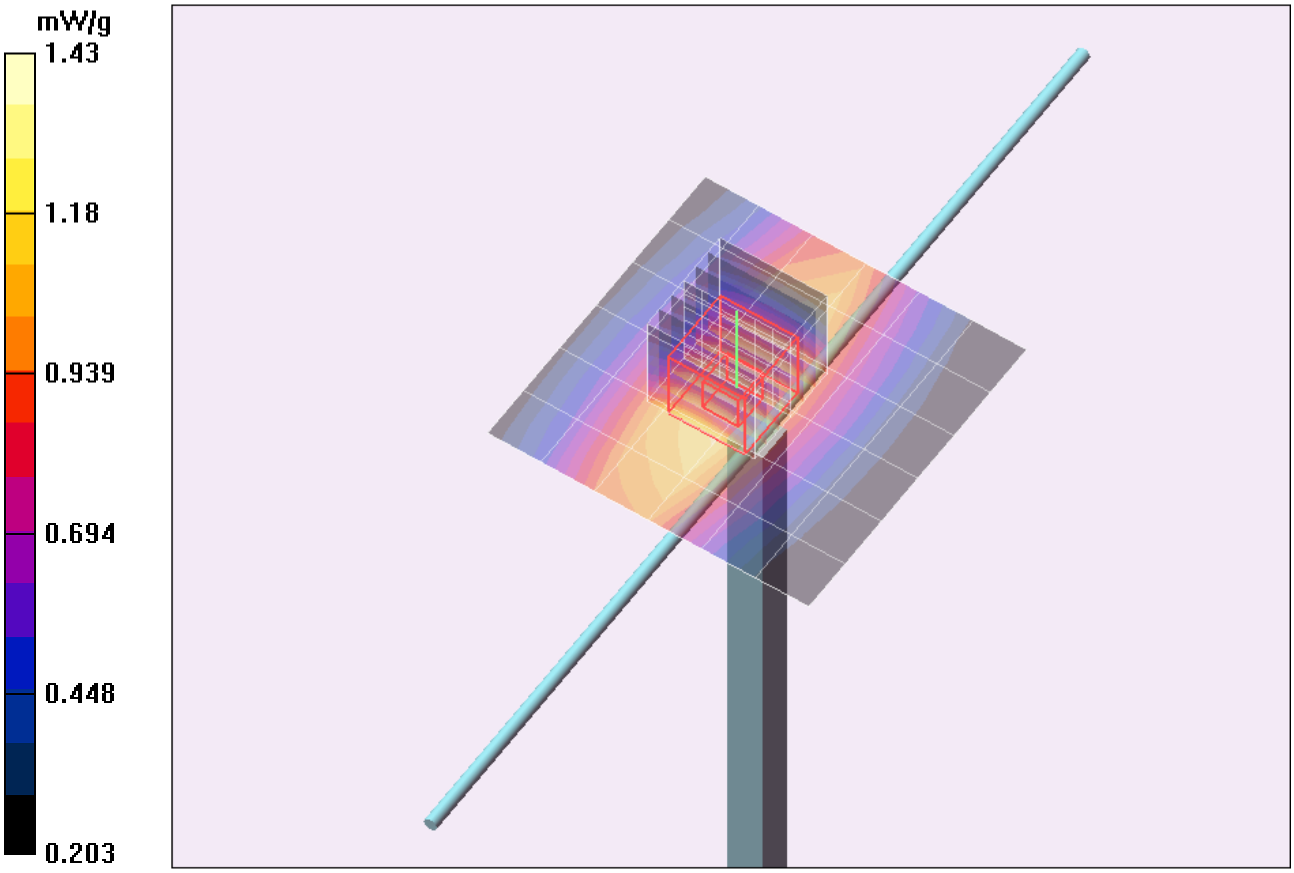

Fig. 6: Validation measurement 450 MHz Body (May 08, 2013).

Test Laboratory: IMST GmbH, DASY Blue (I); File Name: 020513_b_1669_ELI4.da4

DUT: Dipole 450 MHz SN1014; Type: D450V2; Serial: D450V2 - SN:1014
Program Name: System Performance Check at 450 MHz

Communication System: CW; Frequency: 450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 450 MHz; σ = 0.86 mho/m; ε_r = 41.8; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6R - SN1669; ConvF(7.35, 7.35, 7.35); Calibrated: 19.02.2013
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 20.09.2012
- Phantom: ELI 4; Type: ELI 4;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=10mm, Pin=250mW/Area Scan (7x7x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 1.38 mW/g
d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 41.3 V/m; Power Drift = -0.007 dB
Peak SAR (extrapolated) = 1.93 W/kg
SAR(1 g) = 1.31 mW/g; SAR(10 g) = 0.910 mW/g
Maximum value of SAR (measured) = 1.40 mW/g

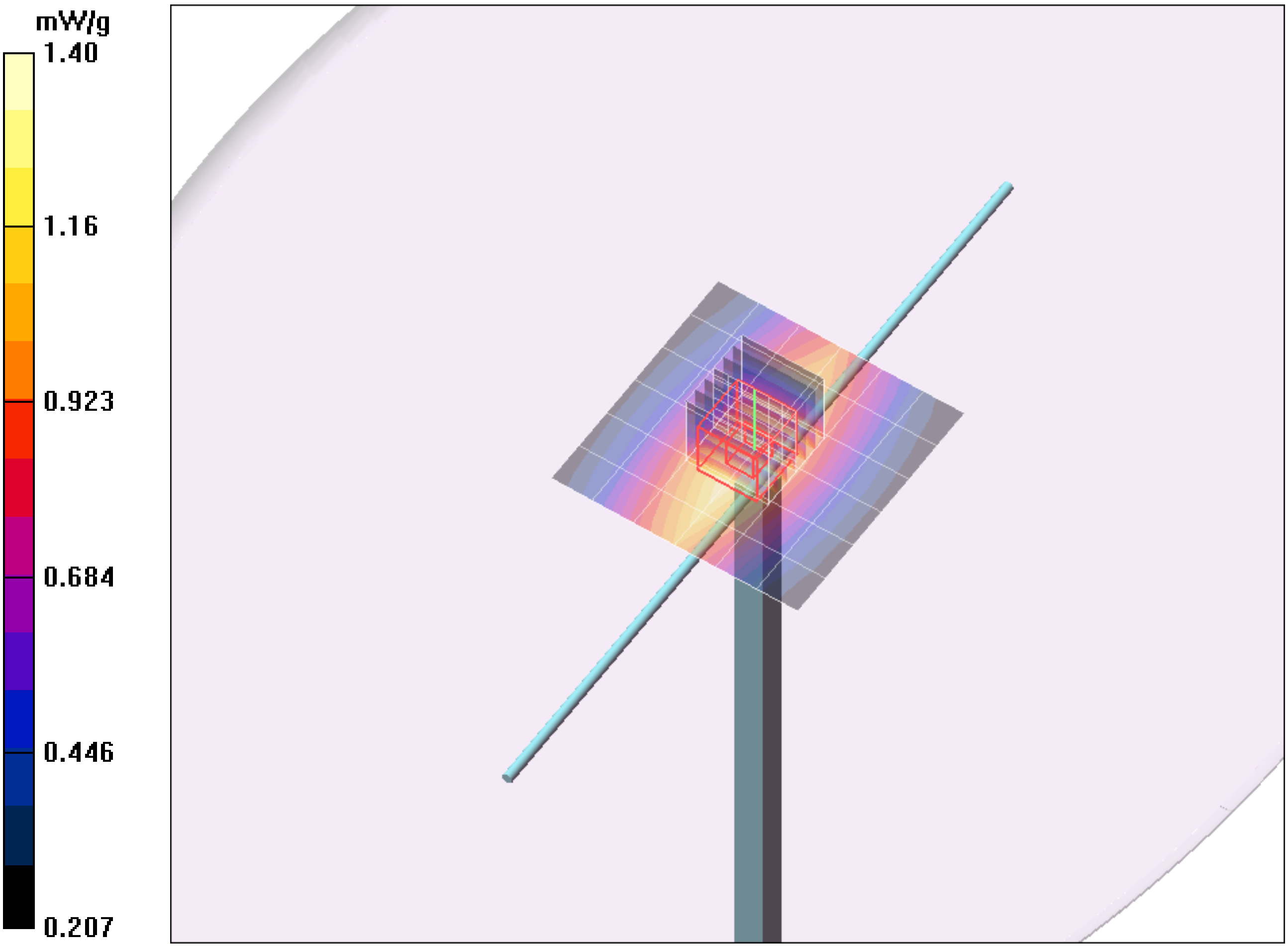

Fig. 7: Validation measurement 450 MHz Head (May 02, 2013).

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 meas.	± 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 11: Uncertainty budget for the system performance check.

8.6 Environment

To comply with the required noise level (less than 12 mW/kg) periodically measurements without a DUT were conducted. Humidity: 37% ± 5 %

8.7 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	09/2012	09/2013
Data Acquisition Electronics	DAE 4	631	09/2012	09/2013
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	D2450V2	709	12/2011	12/2013
Material Measurement				
Network Analyzer	E5071C	MY46103220	08/2011	08/2013
Dielectric Probe Kit	HP85070B	US33020263	N/A	N/A

Table 12: SAR 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	12/2011	12/2013
Power Meter. Anritsu	ML2488A	6K00002078	12/2011	12/2013
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	12/2011	12/2013
Power Sensor. Anritsu	MA2490A	031565	12/2011	12/2013
RF Sources				
Network Analyzer	E5071C	MY46103220	08/2011	08/2013
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				
Anritsu	MT8815B	6200586536	N/A	N/A

Table 13: Test equipment. General.

8.8 Certificates of Conformity

Schmid & Partner Engineering AG **s p e a g**

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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. 8: Certificate of conformity for the used DASY4 system

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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

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Fig. 9: Certificate of conformity for Twin SAM phantom.

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Certificate of Conformity / First Article Inspection

Item	Oval Flat Phantom ELI 4.0
Type No	QD OVA 001 B
Series No	1003 and higher
Manufacturer	SPEAG Zeughausstrasse 43 CH-8004 Zürich Switzerland

Tests
Complete tests were made on the prototype units QD OVA 001 AA 1001, QD OVA 001 AB 1002, pre-series units QD OVA 001 BA 1003-1005 as well as on the series units QD OVA 001 BB, 1006 ff.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the standard IEC 62209 – 2 [1] requirements	Dimensions of bottom for 300 MHz – 6 GHz: longitudinal = 600 mm (max. dimension) width= 400 mm (min dimension) depth= 190 mm Shape: ellipse	Prototypes, Samples
Material thickness	Compliant with the standard IEC 62209 – 2 [1] requirements	Bottom plate: 2.0mm +/- 0.2mm	Prototypes, All items
Material parameters	Dielectric parameters for required frequencies	300 MHz – 6 GHz Rel. permittivity = 4 +/-1, Loss tangent ≤ 0.05	Material sample
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions. Observe Technical Note for material compatibility.	DEGMBE based simulating liquids	Equivalent phantoms, Material sample
Sagging	Compliant with the requirements according to the standard. Sagging of the flat section when filled with tissue simulating liquid	< 1% typical < 0.8% if filled with 155mm of HSL900 and without DUT below	Prototypes, Sample testing

Standards

[1] 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

Conformity
Based on the sample tests above, we certify that this item is in compliance with the standard [1].

Date 07.07.2005

Signature / Stamp

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Fig. 10: Certificate of conformity for ELI4 phantom.

8.9 Pictures of the Device under Test

Fig. 11 - 13 show the device under test and the used accessory.

Fig. 11: Front view of the Simoco SDP660TU.

Fig. 12: Back view of the Simoco SDP660TU.

Fig. 13: Pictures of the used PAR-600LMS4 remote speaker.

8.10 Test Positions for the Device under Test

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

Fig. 14: Body worn configuration for the Simoco SDP660TU, PAR-600LMS4 remote speaker and belt clip attached, display towards the ground.

Fig. 15: Body worn configuration for the Simoco SDP660TU, PTT configuration with 25 mm distance, display towards the phantom.

9 References

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[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.

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[KDB 865664] 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r01: SAR Measurement Requirements for 100 MHz to 6 GHz. 05/11/2013

[KDB 447498] 447498 D01 Mobile Portable RF Exposure v05r01: Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies. 05/28/2013

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