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SAR Test Report

Dosimetric Assessment of the ADTS TOUCH Hand Terminal from GE Druck

**(FCC ID: 2AAVWADTSTOUCH-01)
(IC: 12097A-ADTSTOUCH01)**

According to the FCC Requirements

November 20, 2014

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Executive Summary

The ADTS TOUCH is a new hand terminal (Portable Device) from GE Druck operating in the 2402 MHz – 2480 MHz frequency range. The device has an integrated antenna and works in Bluetooth standard.

The objective of the measurements done by IMST was the dosimetric assessment of one device according the applicable KDB. For SAR assessment, a special test software was used to set the device to a specific frequency and maximum output power with a specific data rate. 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.

Compliance Statement

The assessed SAR values for ADTS TOUCH hand terminal from GE Druck (FCC ID: 2AAVWADTSTOUCH-01; IC: 12097A-ADTSTOUCH01) are in compliance with the following standards for uncontrolled exposure:

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

The device was tested in body supported configuration with a closest distance of 0 mm between test device and phantom. All measured SAR results are shown in Table 6, the highest results of SAR for the ADTS TOUCH are as follows:

WORST CASE SAR RESULTS							
Mode	Freq. [MHz]	CH	Phantom Configuration		Fig. No	Reported SAR _{1g} [W/kg]	SAR Limit [W/kg]
Bluetooth	2441	39	Body	Top Side	11	0.223	1.6 PASS

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Table of Contents

SUBJECT OF INVESTIGATION	5
1 FCC EXPOSURE CRITERIA.....	5
1.1 <i>DISTINCTION BETWEEN EXPOSED POPULATION, DURATION OF EXPOSURE AND FREQUENCIES.....</i>	6
1.2 <i>DISTINCTION BETWEEN MAXIMUM PERMISSIBLE EXPOSURE AND SAR LIMITS</i>	6
2 THE FCC MEASUREMENT PROCEDURE	7
2.1 <i>GENERAL REQUIREMENTS</i>	7
2.2 <i>PHANTOM REQUIREMENTS.....</i>	7
2.3 <i>TEST TO BE PERFORMED</i>	7
2.3.1 <i>MEASUREMENT VARIABILITY</i>	8
3 THE MEASUREMENT SYSTEM.....	9
3.1 <i>PHANTOMS.....</i>	10
3.2 <i>E-FIELD-PROBES.....</i>	11
3.3 <i>MEASUREMENT PROCEDURE.....</i>	12
3.4 <i>UNCERTAINTY ASSESSMENT</i>	13
4 OUTPUT POWER VALUES	14
5 SAR TEST EXCLUSION CONSIDERATION ACCORDING KDB 447498.....	14
6 SAR RESULTS.....	15
7 APPENDIX.....	16
7.1 <i>ADMINISTRATIVE DATA.....</i>	16
7.2 <i>DEVICE UNDER TEST AND TEST CONDITIONS</i>	16
7.3 <i>TISSUE RECIPES.....</i>	16
7.4 <i>MATERIAL PARAMETERS</i>	17
7.5 <i>SIMPLIFIED PERFORMANCE CHECKING.....</i>	17
7.6 <i>ENVIRONMENT.....</i>	20
7.7 <i>TEST EQUIPMENT</i>	20
7.8 <i>CERTIFICATES OF CONFORMITY</i>	22
7.9 <i>PICTURES OF THE DEVICE UNDER TEST</i>	24
7.10 <i>TEST POSITIONS FOR THE DEVICE UNDER TEST</i>	25
7.11 <i>PICTURES TO DEMONSTRATE THE REQUIRED LIQUID DEPTH.....</i>	27
8 REFERENCES.....	27

Subject of Investigation

The ADTS TOUCH is a new hand terminal (Portable Device) from GE Druck operating in the 2402 MHz – 2480 MHz frequency range. The device has an integrated antenna and works in Bluetooth standard.



Fig. 1: Picture of the device under test.

The objective of the measurements done by IMST was the dosimetric assessment of one device according the applicable KDB. For SAR assessment, a special test software was used to set the device to a specific frequency and maximum output power with a specific data rate. 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:

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

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 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 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.

2.3 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. For phablet computers additionally the configurations according applicable KDBs needs to be considered.

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 $< 0.4 \text{ W/kg}$, testing at the high and low channels is optional.

2.3.1 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 $\leq 20\%$ 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 ($\sim 10\%$ 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 .

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: 2. Additional Fig: 3 show the equipment, similar to the installations in other laboratories.

- Fully compliant with all current measurement standards as stated in Fig. 5
- 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

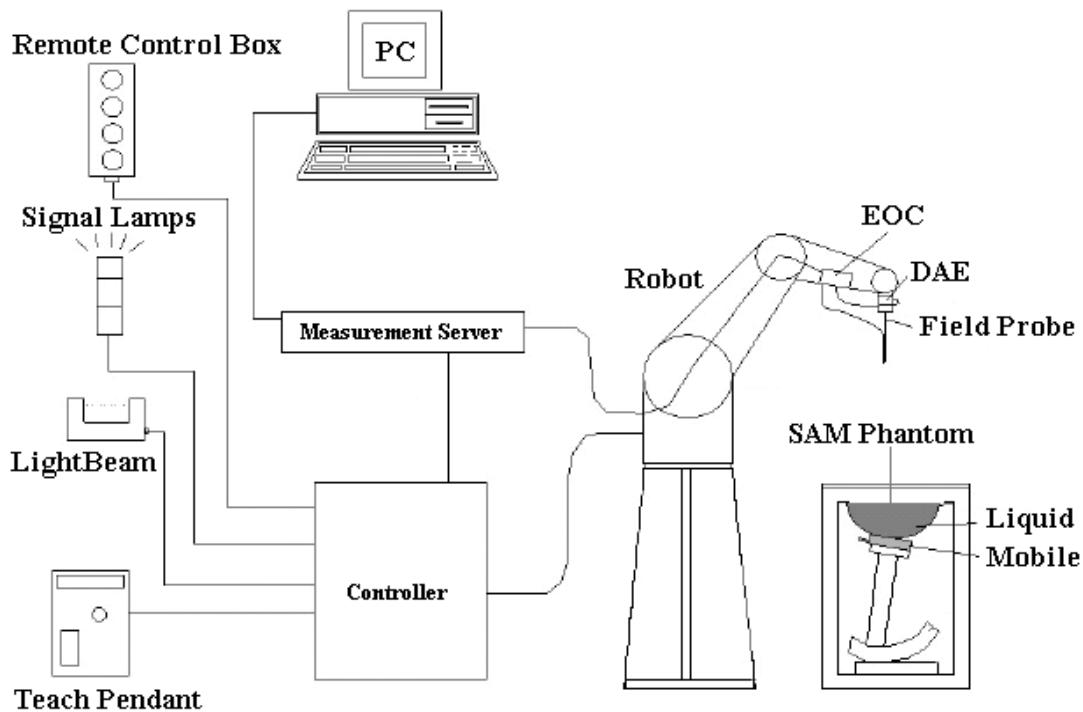


Fig. 2: The DASY4 measurement system.



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.

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

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 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 μ W/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 μ W/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 μ W/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

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 or by software. 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 $\pm 0.21\text{dB}$.

		$\leq 3 \text{ GHz}$	$\geq 3 \text{ GHz}$
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface		$5 \pm 1 \text{ mm}$	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5 \text{ mm}$
Maximum probe angle from probe axis to phantom surface normal at the measurement location		$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
		$\leq 2 \text{ GHz}: \leq 15 \text{ mm}$ $2 - 3 \text{ GHz}: \leq 12 \text{ mm}$	$3 - 4 \text{ GHz}: \leq 12 \text{ mm}$ $4 - 6 \text{ GHz}: \leq 10 \text{ mm}$
Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$		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 \leq 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: $\Delta X_{\text{Zoom}}, \Delta Y_{\text{Zoom}}$		$\leq 2 \text{ GHz}: \leq 8 \text{ mm}$ $2 - 3 \text{ GHz}: \leq 5 \text{ mm}^*$	$3 - 4 \text{ GHz}: \leq 5 \text{ mm}^*$ $4 - 6 \text{ GHz}: \leq 4 \text{ mm}^*$
Maximum zoom scan spatial resolution, normal to phantom surface	Uniform grid: $\Delta Z_{\text{Zoom}}(n)$	$\leq 5 \text{ mm}$	$3 - 4 \text{ GHz}: \leq 4 \text{ mm}$ $4 - 5 \text{ GHz}: \leq 3 \text{ mm}$ $5 - 6 \text{ GHz}: \leq 2 \text{ mm}$
	graded grid	$\Delta Z_{\text{Zoom}}(1): \text{between 1}^{\text{st}} \text{ two points closest to phantom surface}$	$\leq 4 \text{ mm}$
Minimum zoom scan volume	x, y, z	$\geq 30 \text{ mm}$	$3 - 4 \text{ GHz}: \geq 28 \text{ mm}$ $4 - 5 \text{ GHz}: \geq 25 \text{ mm}$ $5 - 6 \text{ GHz}: \geq 22 \text{ mm}$

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 $\leq 1.4 \text{ W/kg}$, $\leq 8 \text{ mm}$, $\leq 7 \text{ mm}$ and $\leq 5 \text{ mm}$ 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.

3.4 Uncertainty Assessment

Table 3 includes the worst case uncertainty budget suggested by the KDB 865664 and determined by Schmid & Partner Engineering AG. The expanded uncertainty (K=2) is assessed to be $\pm 21.6\%$.

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	$\pm 5.9\%$	Normal	1	1	$\pm 5.9\%$	∞
Axial isotropy	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	0.7	$\pm 1.9\%$	∞
Hemispherical isotropy	$\pm 9.6\%$	Rectangular	$\sqrt{3}$	0.7	$\pm 3.9\%$	∞
Boundary effects	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	$\pm 0.6\%$	∞
Linearity	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	1	$\pm 2.7\%$	∞
System detection limit	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	$\pm 0.6\%$	∞
Readout electronics	$\pm 1.0\%$	Normal	1	1	$\pm 1.0\%$	∞
Response time	$\pm 0.8\%$	Rectangular	$\sqrt{3}$	1	$\pm 0.5\%$	∞
Integration time	$\pm 2.6\%$	Rectangular	$\sqrt{3}$	1	$\pm 1.5\%$	∞
RF ambient conditions	$\pm 3.0\%$	Rectangular	$\sqrt{3}$	1	$\pm 1.7\%$	∞
Probe positioner	$\pm 0.4\%$	Rectangular	$\sqrt{3}$	1	$\pm 0.2\%$	∞
Probe positioning	$\pm 2.9\%$	Rectangular	$\sqrt{3}$	1	$\pm 1.7\%$	∞
Algorithm for max SAR eval.	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	$\pm 0.6\%$	∞
Test Sample Related						
Device positioning	$\pm 2.9\%$	Normal	1	1	$\pm 2.9\%$	145
Device holder	$\pm 3.6\%$	Normal	1	1	$\pm 3.6\%$	5
Power drift	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	1	$\pm 2.9\%$	∞
Phantom and Set-up						
Phantom uncertainty	$\pm 4.0\%$	Rectangular	$\sqrt{3}$	1	$\pm 2.3\%$	∞
Liquid conductivity (target)	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.64	$\pm 1.8\%$	∞
Liquid conductivity (meas.)	$\pm 2.5\%$	Normal	1	0.64	$\pm 1.6\%$	∞
Liquid permittivity (target)	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.6	$\pm 1.7\%$	∞
Liquid permittivity (meas.)	$\pm 2.5\%$	Normal	1	0.6	$\pm 1.5\%$	∞
Combined Uncertainty					$\pm 10.8\%$	

Table 3: Uncertainty budget of DASY4 up to 3 GHz.

4 Output Power Values

Averaged Output Power for Bluetooth [dBm]					
Bluetooth	Modulation	Mode	2402 [MHz] CH 0	2441 [MHz] CH 39	2480 [MHz] CH 78
BDR	GFSK	DH1	12.4	13.2	12.8
		DH3	15.8	16.6	16.2
		DH5	16.3	17.0	16.8
EDR	$\pi/4$ -DQPSK	2-DH1	13.5	13.6	12.7
		2-DH3	15.8	16.0	15.0
		2-DH5	16.1	16.4	15.4
	8-DPSK	3-DH1	13.4	13.6	12.5
		3-DH3	15.7	15.9	15.0
		3-DH5	16.1	16.3	15.4

Table 4: Measured output power for Bluetooth for ADTS TOUCH from GE Druck.

5 SAR Test Exclusion Consideration according KDB 447498

Standalone SAR Test Exclusion Considerations for Body Worn Configuration						
Communication System	Freq. [MHz]	Distance [mm]	Pavg [dBm]	Pavg [mW]	Threshold 1g Comparison Values	SAR Test Exclusion (Yes/No)
Bluetooth	2441	5	17.9	61.66	30.1	No

Table 5: SAR test exclusion for body worn configuration.

The above table shows the SAR test exclusion consideration for the applicable modes against the different device edges with the relevant distances.

The 1g and 10g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances \leq 50mm are determined by:

$$[(\text{max power of channel, incl. tune-up tolerance, mW}) / (\text{min test separation distance, mm})]^* [\text{f(GHz)}]$$

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

When the minimum test separation distance is $< 5\text{mm}$. a distance of 5mm is applied to determine SAR test exclusion.

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 4. The device does not support any power reduction mode.

Following KDB 447498 D01 V05r02, 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 Results for Bluetooth												
Band	Freq. [MHz]	Channel	Test Position	Spacing [mm]	Figure No.	Tune-Up Limit [dBm]	Output Power [dBm]	Measured SAR _{1g} [W/kg]	Power Drift [dBm]	Scaling Factor	Reported SAR _{1g} [W/kg]	Plot No.
Bluetooth GFSK / DH5	2441	39	Front	0	9	17.9	17.0	0.075	-0.195	1.230	0.092	1
		39	Back	0	10		17.0	0.139	0.158	1.230	0.171	2
		39	Top	0	11		17.0	0.181	-0.124	1.230	0.223	3
		39	Left	0	12		17.0	0.047	0.096	1.230	0.058	4
	2402	0	Top	0	11		16.3	0.117	0.060	1.445	0.169	5
		2480	78	Top	0		16.8	0.171	-0.038	1.288	0.220	6

Table 6: SAR results for body exposure for ADTS TOUCH from GE Druck.

The measured SAR values are scaled according to the tune-up information given by the manufacturer, shown above.

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%.

7 Appendix

7.1 Administrative Data

Date of Validation: October 30, 2014
 Date of Measurement: October 30, 2014
 Data Stored: TRaC_60320_6140365
 Contact: IMST GmbH
 Carl-Friedrich-Gauß-Str. 2 - 4
 D-47475 Kamp-Lintfort, Germany
 Tel.: +49- 2842-981 378
 Fax: +49- 2842-981 399
 email: vandenBosch@imst.de

7.2 Device under Test and Test Conditions

MTE: ADTS TOUCH from GE Druck
 Date of Receipt: October 22, 2014
 IMEI: 4294899
 FCC ID: 2AAVWADTSTOUCH-01
 IC: 12097A-ADTSTOUCH01
 Equipment Class: Portable device
 RF Exposure Environment: General Population/ Uncontrolled
 Power Supply: Internal Battery
 Antenna: integrated
 Used Accessory: N.A.

Standard	TX Range [MHz]	RX Range [MHz]	Used Channels	Crest Factor	Phantom
Bluetooth	2402.0 – 2480.0	2402.0 – 2480.0	0, 39, 78	1.3	SAM Twin Phantom V4.0

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

7.3 Tissue Recipes

The following recipes are provided in percentage by weight.

2450 MHz Body: 31.40 % Diethylenglykol-monobutylether
 68.60 % De-IonizedWater

7.4 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 $\pm 5\%$ of the recommended values given by the FCC.

Tissue Simulating Liquids			
Frequency		ϵ_r	σ [S/m]
2450 MHz Body	Recommended Value	52.70 ± 2.65	1.95 ± 0.09
	Measured Value (Ch. 0)	51.90	1.88
	Measured Value (Ch. 39)	51.70	1.94
	Measured Value (Ch. 78)	51.60	2.01

Table 8: Parameters of the tissue simulating liquids.

7.5 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 9 - 10 and shown in figure 4. The target values were adopted from the calibration certificates which are attached in the appendix. Table 11 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 $\pm 16.8\%$. 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]	ϵ_r	σ [S/m]
Bluetooth	D2450V2, SN #709	Target Values Body	14.33	53.80	1.96

Table 9: Dipole target results as given by the calibration certificates.

Dipole Validation Results					
Band	Used Dipoles		SAR_{1g} [W/kg]	ϵ_r	σ [S/m]
Bluetooth	2450 MHz, SN:709	Measured Values Body	13.90	51.60	1.95

Table 10: Measured dipole validation results.

Test Laboratory: IMST GmbH, DASY Blue (I); File Name: [301014_b_3536.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; $\sigma = 1.95$ mho/m; $\epsilon_r = 51.6$; $\rho = 1000$ kg/m³

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) = 15.6 mW/g

d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 89.7 V/m; Power Drift = 0.055 dB

Peak SAR (extrapolated) = 30.9 W/kg

SAR(1 g) = 13.9 mW/g; SAR(10 g) = 6.15 mW/g

Maximum value of SAR (measured) = 15.8 mW/g

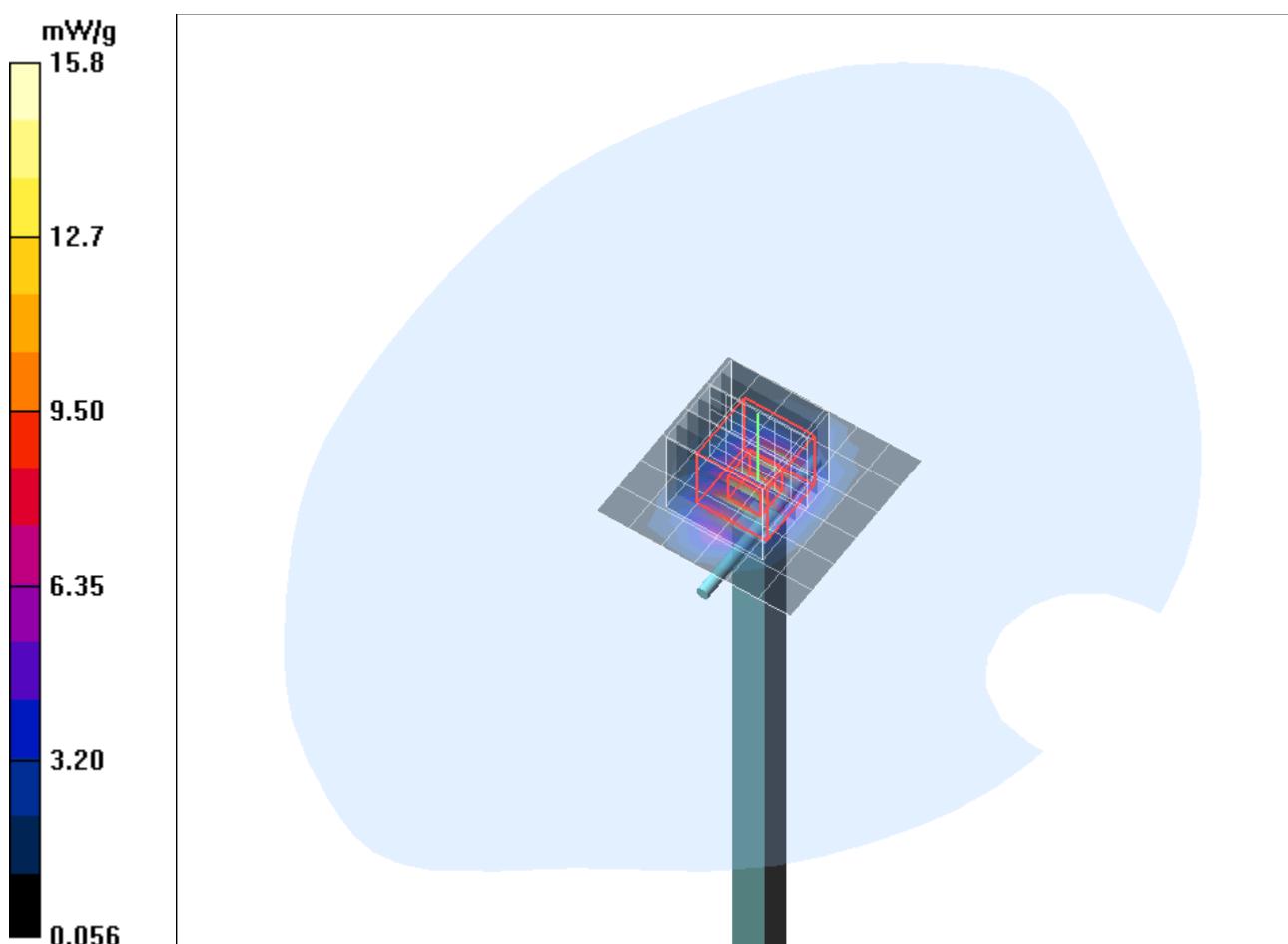


Fig. 4: Validation measurement 2450 MHz Body (October 30, 2014), coarse grid.

Uncertainty Budget						
Error Sources	Uncertainty Value	Probability Distribution	Divisor	c_i	Standard Uncertainty	v_i^2 or v_{eff}
Measurement System						
Probe calibration	$\pm 4.8 \%$	Normal	1	1	$\pm 4.8 \%$	∞
Axial isotropy	$\pm 4.7 \%$	Rectangular	$\sqrt{3}$	1	$\pm 2.7 \%$	∞
Hemispherical isotropy	$\pm 0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0 \%$	∞
Boundary effects	$\pm 1.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0.6 \%$	∞
Linearity	$\pm 4.7 \%$	Rectangular	$\sqrt{3}$	1	$\pm 2.7 \%$	∞
System detection limit	$\pm 1.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0.6 \%$	∞
Readout electronics	$\pm 1.0 \%$	Normal	1	1	$\pm 1.0 \%$	∞
Response time	$\pm 0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0 \%$	∞
Integration time	$\pm 0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0 \%$	∞
RF ambient conditions	$\pm 3.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 1.7 \%$	∞
Probe positioner	$\pm 0.4 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0.2 \%$	∞
Probe positioning	$\pm 2.9 \%$	Rectangular	$\sqrt{3}$	1	$\pm 1.7 \%$	∞
Algorithms for max SAR eval.	$\pm 1.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0.6 \%$	∞
Dipole						
Dipole Axis to Liquid Distance	$\pm 2.0 \%$	Rectangular	1	1	$\pm 1.2 \%$	∞
Input power and SAR drift mea.	$\pm 4.7 \%$	Rectangular	$\sqrt{3}$	1	$\pm 2.7 \%$	∞
Phantom and Set-up						
Phantom uncertainty	$\pm 4.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 2.3 \%$	∞
Liquid conductivity (target)	$\pm 5.0 \%$	Rectangular	$\sqrt{3}$	0.64	$\pm 1.8 \%$	∞
Liquid conductivity (meas.)	$\pm 2.5 \%$	Normal	1	0.64	$\pm 1.6 \%$	∞
Liquid permittivity (target)	$\pm 5.0 \%$	Rectangular	$\sqrt{3}$	0.6	$\pm 1.7 \%$	∞
Liquid permittivity (meas.)	$\pm 2.5 \%$	Normal	1	0.6	$\pm 1.5 \%$	∞
Combined Uncertainty					$\pm 8.4 \%$	

Table 11: Uncertainty budget for the system performance check up to 3 GHz.

7.6 Environment

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

Humidity: 40% \pm 5 %

7.7 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	EX3DV4	3536	07/2014	07/2015
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	D2450V2	709	09/2013	09/2015
Material Measurement				
Network Analyzer	E5071C	MY46103220	07/2013	07/2015
Dielectric Probe Kit	HP85070B	US33020263	N/A	N/A

Table 12: SAR equipment.

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 13: Test equipment.

7.8 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 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



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
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Fig. 6: Certificate of conformity for the used SAM phantom.

7.9 Pictures of the Device under Test

Fig. 7 - 8 show the device under test.



Fig. 7: Front and back view of ADTS TOUCH from GE Druck.

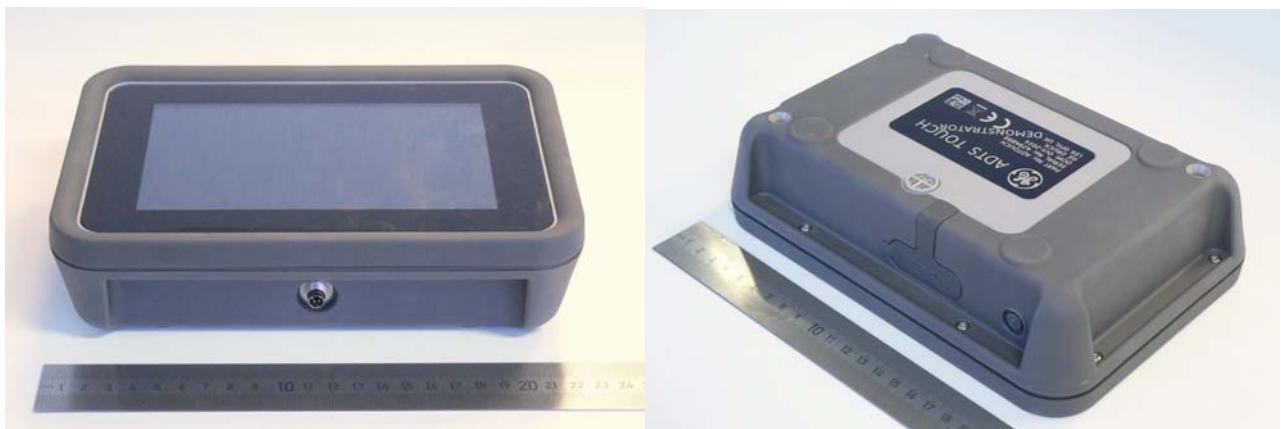


Fig. 8: Side view of ADTS TOUCH from GE Druck.

7.10 Test Positions for the Device under Test

Fig. 9 – 12 show the test positions for the SAR measurements.



Fig. 9: Body supported configuration, position 1, front side toward the phantom, gap = 0 mm.



Fig. 10: Body supported configuration, position 2, back side toward the phantom, gap = 0 mm.



Fig. 11: *Body supported configuration, position 3, top edge toward the phantom, gap = 0 mm.*



Fig. 12: *Body supported configuration, position 4, right edge toward the phantom, gap = 0 mm.*

7.11 Pictures to Demonstrate the Required Liquid Depth

Figure 13 shows the liquid depth in the used SAM phantom.



Fig. 13: Liquid depth for Bluetooth body measurements.

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. 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