Accredited testing laboratory

DAR registration number: TTI-P-G 166/98

Federal Motor Transport Authority (KBA)
DAR registration number: KBA-P 00070-97

Test report no. : 2-2859_1_2/02
Type identification : Netpad 5510
Test specification : Draft IEEE Std 1528-200X
FCC-ID : GM3GSMA

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1 General Information

1.1 Notes

The test results of this test report relate exclusively to the test item specified in 1.5. The CETECOM ICT Services GmbH does not assume responsibility for any conclusions and generalisations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of the CETECOM ICT Services GmbH.

1.2 Statement of Compliance

The SAR values found for the Netpad 5510 are below the maximum recommended levels of 1.6 W/Kg as averaged over any 1 g tissue according the FCC rule §2.1093, the ANSI/IEEE C 95.1:1992 and the NCRP Report Number 86 for uncontrolled environment.

Test laboratory manager:

September 20, 2002	**Bernd Rebmann**	
Date	Name	Signature

Technical responsibility for area of testing:

September 20, 2002	**Ralf Hoehn**	
Date	Name	Signature

1.3 Testing laboratory

CETECOM ICT Services GmbH
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Fax: + 49 681 598 - 8475

e-mail: info@ict.cetecom.de
Internet: http://www.cetecom-ict.de

State of accreditation: The Test laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025. DAR registration number: TTI-P-G-166/98

Test location, if different from CETECOM ICT Services GmbH

Name:
Street:
Town:
Country:
Phone:
Fax:

1.4 Details of applicant

Name: Psion Digital Ltd

Street: 12 Park Crescent
Town: London W1B 1PH
Country: United Kingdom

Contact: Mr. Steve Lucas
Telephone: +44-207-317-4296

1.5 Application details

Date of receipt of application: September 10, 2002
Date of receipt of test item: September 17, 2002
Start/Date of test: September 17, 2002
End of test: September 17, 2002

Person(s) present during the test: Mr. Steve Lucas

1.6 Test item

Description of the test item: **GSM Netpad**

The Wireless NetPad is an EPOC Based, or WinCE based, ½ VGA touch-sensitive tablet. It is designed for use in applications such as: field service; field data collection; mobile sales; track, trace and delivery; installation and repair; meter reading; route or van sales and asset tracking. The NetPad can be used in both landscape or portrait mode. The Wireless NetPad can store data into its internal memory (Flash and SDRAM). An MMC/SD interface is available to allow additional memory expansion via plug-in MMC and MMCSD memory cards. Other interfaces such as RS232 and IrDA are provided for communicating and downloading data to a PC.

The Netpad is a data-only product. Consequently, voice calls cannot be made from this device.

GPRS:
The transceiver unit is sealed inside the Option Globetrotter Pccard. This card is installed in the Netpad, during manufacture, and connects to Psion's own dedicated external antenna via the antenna matching circuit. The Globetrotter radio is triple band (GSM900, DCS1800 and PCS1900) GPRS/GSM (Class B, Type 1 mode, GSM Phase 2+, GPRS phase 1, with multi-slot class 10 capability) The RF output power specification corresponds to class 4 (Nominal output power 2 W) in the GSM-900 band and class 1 (Nominal output power 1 W) in the GSM-1800 (1900) band. RF performance meets GSM 05.05. The Globetrotter meets JTD-STD007 for PCS1900.

Type identification: **Netpad 5510**

Serial number: **1000-8C70-15B2-002C**

IMEI No: **01009000057290**

Manufacturer:

Name:	Psion Digital Ltd
Street:	12 Park Crescent
Town:	London W1B 1PH
Country:	United Kingdom

Additional information :

Battery type :

The battery consists of two rechargeable Lithium Ion cells (nominal diameter of 10mm) connected in series, giving 1400 mAH. The battery is fitted with a Dallas 2438 smart electronics for the purpose of fuel gauging. The main battery has sensing circuits to monitor charge capacity. A power isolation switch removes battery power from the netpad when docked. A power-on/off switch is routed via the auxiliary microcontroller circuit to toggle the system between 'sleep' and 'run' modes. A soft-reset switch resets the SA1110 microprocessor but retains the SDRAM memory contents. A hard reset can be achieved by simultaneously pressing the on/off switch and reset switch. Protection circuits for over-charge, over-discharge and short circuit are also included, as are fuse type components for over temperature and short circuit.

The battery cells are housed inside an injection-moulded case that is injected with a potting compound to prevent ingress of moisture.

Antenna type:

The antenna port of the Option Globetrotter Pccard is connected, via a matching circuit, to a dedicted tri band antenna, custom designed for the Netpad by Centurion International. The antenna has two elements: one a helix for GSM band and the other a monopole covering both the DCS and PCS bands

Frequency band :

Transmitter frequency range :	1850 MHz ~ 1910 MHz
Receiver frequency range :	1930.2 MHz ~ 1989.8 MHz

Auxiliary equipment:

Body Holster	Part Number:1202 0023 0001

1.7 Test specification(s)

Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01)

Draft IEEE Std 1528-200X: Version 6.4:July 2001

1.7.1 RF exposure limits

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Spatial Peak SAR* (Brain)	**1.60 mW/g**	8.00 mW/g
Spatial Average SAR** (Whole Body)	0.08 mW/g	0.40 mW/g
Spatial Peak SAR*** (Hands/Feet/Ankle/Wrist)	4.00 mW/g	20.00 mW/g

Table 1: RF exposure limits

Notes:

* The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time

** The Spatial Average value of the SAR averaged over the whole body.

*** The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

2 Technical test

2.1 Summary of test results

No deviations from the technical specification(s) were ascertained in the course of the tests performed.	☒
The deviations as specified in 2.5 were ascertained in the course of the tests performed.	☐

2.2 Test environment

Ambient temperature: 22°C – 24°C
Tissue simulating liquid: 22°C – 24°C
Humidity: 40% – 50%

2.3 Measurement and test set-up

Body worn measurement:
The Netpad 5510 was tested in the following Body-Worn configurations:

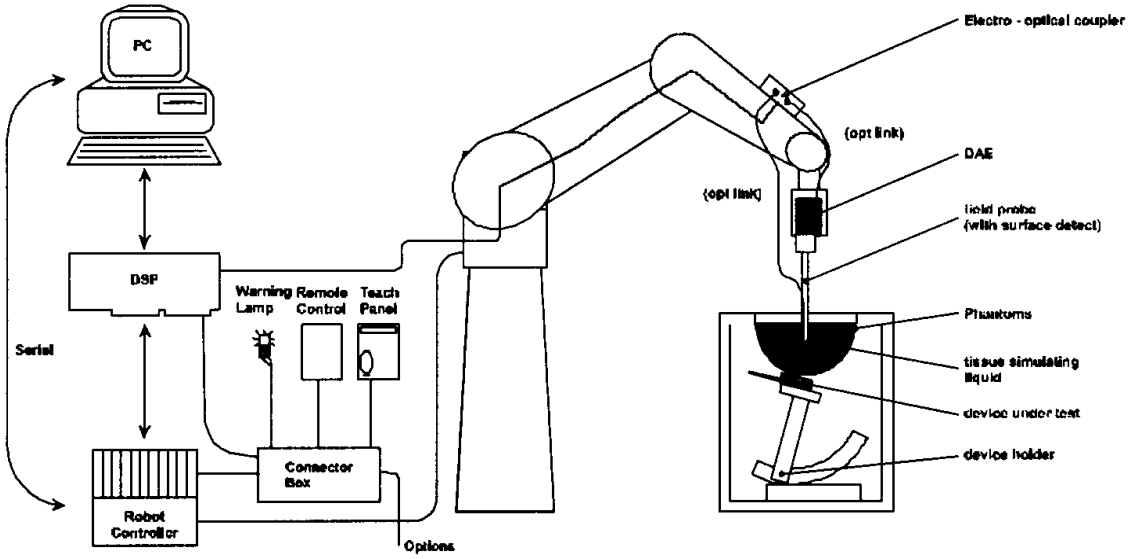
Measurement with the accessory "holster"
The EUT operating at the maximum output power is placed at the Specific Anthropomorphic Mannequin (SAM) by a non metallic device holder. The "holster" can only be used in the configuration with "display of the EUT towards the phantom".

Measurement without accessories:
Normally, if the manufacturer does not provide any body-worn accessories (belt-clips, holster etc.) a separation of 1.5 cm between the back of the device and the flat phantom is recommended. To simulate the case without holster, the EUT without holster was placed with a distance of 1.5 mm between EUT (front and rear side) and phantom.

Test signal establishment:
The test signal is created by setting up a connection with the CMU 200 Communications Tester at the tested frequency bands. Test channels and output power can be controlled by the CMU 200 to obtain the relevant test conditions.

2.4 Measurement system

2.4.1 System Description



The DASY3 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).

- A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

- A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

- A unit to operate the optical surface detector which is connected to the EOC.
- The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the PC plug-in card.
- The function of the PC plug-in card based on a DSP is to perform the time critical task such as signal filtering, surveillance of the robot operation fast movement interrupts.
- A computer operating Windows 95 or higher
- DASY3 software
- Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
- The generic twin phantom enabling the testing of left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to given recipes.
- System validation dipoles allowing to validate the proper functioning of the system.

2.4.2 Probe description

Isotropic E-Field Probe ET3DV6 for Dosimetric Measurements

Technical data according to manufacturer information	
Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycolether)
Calibration (more details see additional calibration document)	In air from 10 MHz to 2.5 GHz In head tissue simulating liquid (HSL) at 900 (800-1000) MHz and 1.8 GHz (1700-1910 MHz) (accuracy ± 9.5%; k=2) Calibration for other liquids and frequencies upon request
Frequency	10 MHz to 3 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.4 dB in HSL (rotation normal to probe axis)
Dynamic range	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
Optical Surface Detection	± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces (ET3DV6 only)
Dimensions	Overall length: 330 mm Tip length: 16 mm Body diameter: 12 mm Tip diameter: 6.8 mm Distance from probe tip to dipole centers: 2.7 mm
Application	General dosimetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms (ET3DV6)

2.4.3 Phantom description

The used SAM Phantom meets the requirements specified in Edition 01-01 of Supplement C to OET Bulletin 65 for Specific Absorption Rate (SAR) measurements.

The phantom consists of a fibreglass shell integrated in a wooden table. It allows left-hand and right-hand head as well as body-worn measurements with a maximum liquid depth of 18 mm for head and 22 mm for body measurements. The thickness of the Phantom shell is 2mm +/- 0.1 mm. Further information can be found in the additional calibration data report delivered together with this test report. Picture 1 of the photo documentation shows a complete view of the SAM Phantom.

2.4.4 Scanning procedure

The DASY3 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

- The „reference“ and „drift“ measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max. +/- 5 %.

- The „surface check“ measurement tests the optical surface detection system of the DASY3 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ± 0.1mm). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within ± 30°.)

  The „coarse scan“ measures the SAR above the dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strenth is measured by the probe. The standard scan uses large grid spacing for faster measurement. Standard grid spacing for head measurements is 15 mm in x- and y- dimension. If a finer graphic is needed, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation.
  Results of this coarse scan are shown in annex 1.

- A „cube 5x5x7 scan” measures the field in a volume around the 2D peak SAR value acquired in the previous „coarse“ scan. This is a fine 5x5 grid where the robot additionally moves the probe in 7 steps along the z-axis away from the bottom of the Phantom. Grid spacing for the cube measurement is 8 mm in x and y-direction and 5 mm in z-direction. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in annex 1. Test results relevant for the specified standard (see chapter 1.7.) are shown in table form in chapter 2.5.

2.4.5 Spatial Peak SAR Evaluation

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of 5 x 5 x 7 points. If any parameter is changed afterwards with ‘File Modify’ (for example crest factor or medium factors) a re-evaluation of the measurement is needed. This evaluation can be repeated by selecting ‘Job Evaluation’ on the selected scans. The algorithm that finds the maximal averaged volume is separated into three different stages.

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting ‘Graph Evaluated’.

- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.

- All neighboring volumes are evaluated until no neighboring volume with a higher average value is found.

Extrapolation

The extrapolation is based on a least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 3 cm along the z-axis, polynomials of order four are calculated. These polynomials are then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from each other.

Interpolation

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot"-condition [W. Gander, Computermathematik, p.141-150] (x, y and z -direction) [Numerical Recipes in C, Second Edition, p.123ff].

2.4.5.1 Volume Averaging

At First the size of the cube is calculated. Then the volume is integrated with the trapezoidal algorithm. 8000 points (20x20x20) are interpolated to calculate the average.

Advanced Extrapolation

The BIOEMC group of the ETH Zurich is currently investigating the boundary effects on E-field probes. As soon as the research is finished DASY3 will allow to compensate for these boundary effects. But until then we do not encourage to use the ‘Advanced Extrapolation’ option.

2.4.6 Data Storage and Evaluation

2.4.6.1 Data Storage

The DASY3 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension ".DA3". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated. To avoid unintentional parameter changes or data manipulations, the parameters in measured files are locked. In the administrator access mode of the software, the parameters can be unlocked by selecting the "modify"-switch in the "file"-pull down menu. After changing the parameters, the measured scans must be re-evaluated by selecting them and using the "evaluate"-option in the "scan"-pull down menu.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

2.4.6.2 Data Evaluation

The DASY3 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion factor	$ConvF_i$
	- Diode compression point	Dcpi
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY3 components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics.

If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot cf/dcp_i$$

with	V_i	= compensated signal of channel i	(i = x, y, z)
	U_i	= input signal of channel i	(i = x, y, z)
	cf	= crest factor of exciting field	(DASY parameter)
	dcp_i	= diode compression point	(DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes: $E_i = (V_i / Norm_i \bullet ConvF)^{1/2}$

H-field probes: $H_i = (V_i)^{1/2} \bullet (a_{i0} + a_{i1}f + a_{i2}f^2)/f$

with	V_i	= compensated signal of channel i	(i = x, y, z)
	$Norm_i$	= sensor sensitivity of channel i [mV/(V/m)^2] for E-field Probes	(i = x, y, z)
	ConvF	= sensitivity enhancement in solution	
	a_{ij}	= sensor sensitivity factors for H-field probes	
	f	= carrier frequency [GHz]	
	E_i	= electric field strength of channel i in V/m	
	H_i	= magnetic field strength of channel i in A/m	

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = (E_x^2 + E_Y^2 + E_z^2)^{1/2}$$

The primary field data are used to calculate the derived field units.

$$SAR = (E_{tot}^2 \bullet \sigma) / (\rho \bullet 1000)$$

with	SAR	= local specific absorption rate in mW/g
	E_{tot}	= total field strength in V/m
	σ	= conductivity in [mho/m] or [Siemens/m]
	ρ	= equivalent tissue density in g/cm^3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.The power flow density is calculated assuming the excitation field to be a free space field.

$P_{pwe} = E_{tot}^2 / 3770$ or $P_{pwe} = H_{tot}^2 \bullet 37.7$

with	P_{pwe}	= equivalent power density of a plane wave in mW/cm^2
	E_{tot}	= total electric field strength in V/m
	H_{tot}	= total magnetic field strength in A/m

2.5 Test equipment utilized

Manufacturer	Device	Type	Serial number	Date of last calibration
Schmid & Partner Engineering AG	Dosimetric E-Field Probe	ET3DV6	1558	March 22, 2002
Schmid & Partner Engineering AG	Dosimetric E-Field Probe	ET3DV6	1559	February 20, 2001
Schmid & Partner Engineering AG	900 MHz System Validation Dipole	D900V2	102	February 13, 2001
Schmid & Partner Engineering AG	1800 MHz System Validation Dipol	D1800V2	287	February 13, 2001
Schmid & Partner Engineering AG	1900 MHz System Validation Dipole	D1900V2	5d009	June 13, 2002
Schmid & Partner Engineering AG	2450 MHz System Validation Dipol	D2450V2	710	July 15, 2002
Schmid & Partner Engineering AG	Data acquisition electronics	DAE3V1	413	January 15, 2001
Schmid & Partner Engineering AG	Software	DASY 3 V3.1c	---	Calibration not necessary
Schmid & Partner Engineering AG	Phantom	SAM	---	Calibration not necessary
Rohde & Schwarz	Universal Radio Communication Tester	CMU 200	U-972406/000	August 30, 2001
Agilent	Network Analyser 300 kHz to 3 GHz	8753C	2936A00872	February 26, 2002
Agilent	Dielectric Probe Kit	85070C	US99360146	March 8, 2001

2.5.1 Tissue dielectric properties

The following materials are used for producing the tissue-equivalent materials:

Ingredients (% of weight)	**Frequency (MHz)**											
frequency band	☐ 450		☐ 835		☐ 900		☐ 1800		☒ 1900		☐ 2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	52.64	69.91	52.64	69.91	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.40	1.35	0.76	0.36	0.13	0.36	0.13	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	0.0	0.0	0.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	0.0	0.0	0.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.0	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	47.0	29.96	47.0	29.96	0.0	26.7

Table 2: Tissue dielectric properties

Salt: 99+% Pure Sodium Chloride
Sugar: 98+% Pure Sucrose
Water: De-ionized, 16MΩ+ resistivity
HEC: Hydroxyethyl Cellulose
DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
Triton X-100(ultra pure): Polyethylene glycol mono [4-(1,1,3,3-tetramethylbutyl)phenyl]ether

2.5.2 Tissue parameters

Used Target Frequency	**Target Head Tissue**		**Target Body Tissue**		**Measured Head Tissue**		**Measured Body Tissue**		**Measured Date**
[GHz]	Permit-tivity	Conduc-tivity [S/m]	Permit-tivity	Conduc-tivity [S/m]	Permit-tivity	Conduc-tivity [S/m]	Permit-tivity	Conduc-tivity [S/m]	
☐ 450	44.0	0.88	56.7	0.94	---	---	60.6	0.84	2002-02-25
☐ 835	41.5	0.90	55.2	0.97	---	---	---	---	---
☐ 900	41.5	0.97	55.0	1.05	44.5	0.95	55.4	0.98	2002-08-22
☐ 915	41.5	0.98	55.0	1.06	---	---	---	---	---
☐ 1800	40.0	1.38	53.3	1.52	38.7	1.40	54.6	1.31	2002-08-22
☒ 1900	40.0	1.40	53.3	1.52	40.5	1.45	52.9	1.45	2002-09-16
☐ 2450	39.2	1.80	52.7	1.95	42.1	1.88	56.1	2.01	2002-08-22

Table 3: Parameter of the tissue simulating liquid

Note: The dielectric properties have been measured using the contact probe method at 22°C.

2.5.3 Measurement uncertainties

The overall combined measurement uncertainty of the measurement system is ± 13,6% (K=1).
The breakdown of the individual uncertainties is as follows:

Error Sources	Uncertainty Value	Probability Distribution	Divisor	c_i	Standard Uncertainty	v_i^2 or v_{eff}
Measurement System						
Probe calibration	± 4.4%	Normal	1	1	± 4.4%	∞
Axial isotropy	± 4.7%	Rectangular	√3	$(1-cp)^{1/2}$	± 1.9%	∞
Spherical isotropy	± 9.6%	Rectangular	√3	$(cp)^{1/2}$	± 3.9%	∞
Spatial resolution	± 0.0%	Rectangular	√3	1	± 0.0%	∞
Boundary effects	± 5.5%	Rectangular	√3	1	± 3.2%	∞
Probe linearity	± 4.7%	Rectangular	√3	1	± 2.7%	∞
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	± 1.4%	Rectangular	√3	1	± 0.8%	∞
RF ambient conditions	± 3.0%	Rectangular	√3	1	± 1.7%	∞
Mech. robot constructions	± 0.4%	Rectangular	√3	1	± 0.2%	∞
Probe positioning	± 2.9%	Rectangular	√3	1	± 1.7%	∞
Extrapolation & integration	± 3.9%	Rectangular	√3	1	± 2.3%	∞
Test Sample Related						
Device holder	± 6.0%	Normal	0.89	1	± 6.7%	12
Device holder uncertainty	± 5.0%	Normal	0.84	1	± 5.9%	8
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	0.6	± 1.7%	∞
Liquid conductivity (meas.)	± 10.0%	Rectangular	√3	0.6	± 3.5%	∞
Liquid permittivity (target)	± 5.0%	Rectangular	√3	0.6	± 1.7%	∞
Liquid permittivity (meas.)	± 5.0%	Rectangular	√3	0.6	± 1.7%	∞
Combined Uncertainty					± 13.6%	

Table 4: Measurement uncertainties

The measurement uncertainty budget suggested by IEEE Std 1528-200X and determined by Schmid & Partner Engineering AG. The expanded uncertainty (k=2) is assessed to be ± 27.2%

2.5.4 System validation

The system validation is used for verifying the accuracy of the complete measurement system and performance of the software. The system validation is performed with 1900 MHz head tissue equivalent material according IEEE Std 1528-200X: 2001. (graphic plot attached).

Validation Kit	Frequency	Target SAR_{1g} (1 W)	Target SAR_{10g} (1 W)	Measured SAR_{1g}	Measured SAR_{10g}	Measured date
DV2 900, S/N:102	900 MHz head	11.0 mW/g	6.92 mW/g	10.5 mW/g	7.06 mW/g	2002-09-04
DV2 1800, S/N:287	1800 MHz head	39.9 mW/g	20.6 mW/g	37.4 mW/g note 1	21.1 mW/g note 1	2002-09-04
DV2 1900, S/N:5d009	**1900 MHz head**	**43.6 mW/g**	**22.5 mW/g**	**40.5 mW/g**	**23.1 mW/g**	**2002-08-30**
DV2 2450, S/N:710	2450 MHz head	52.4 mW/g	24.0 mW/g	54.4 mW/g	25.6 mW/g	2002-07-19

2.5.5 Note 1: Normalized to a forward power of 1000 mW

Table 5: Results system validation

2.6 Test results (SAR body-worn measurement)

2.6.1 (Netpad 5510 with holster)

The table contains the measured SAR values averaged over a mass of 1 g				
Channel / frequency	Position	Body worn	Limit	Liquid temperature
661 / 1880.0 MHz	Netpad 5510 with holster -Display towards the phantom- (see pictures 2 to 4)	0.0354 W/kg	1.6 W/kg	23.4°C

Table 6: Test results (Netpad 5510 with holster)

2.6.2 (Netpad 5510 without holster)

The table contains the measured SAR values averaged over a mass of 1 g				
Channel / frequency	Position	Body worn	Limit	Liquid temperature
661 / 1880.0 MHz	Front side. -Display towards the phantom- (see pictures 5 to 7)	0.0985 W/kg	1.6 W/kg	23.4°C
661 / 1880.0 MHz	Rear side. -Display towards the ground- (see pictures 6 to 10)	0.0223 W/kg	1.6 W/kg	23.4°C

Table 7: Test results (Netpad 5510 without holster)

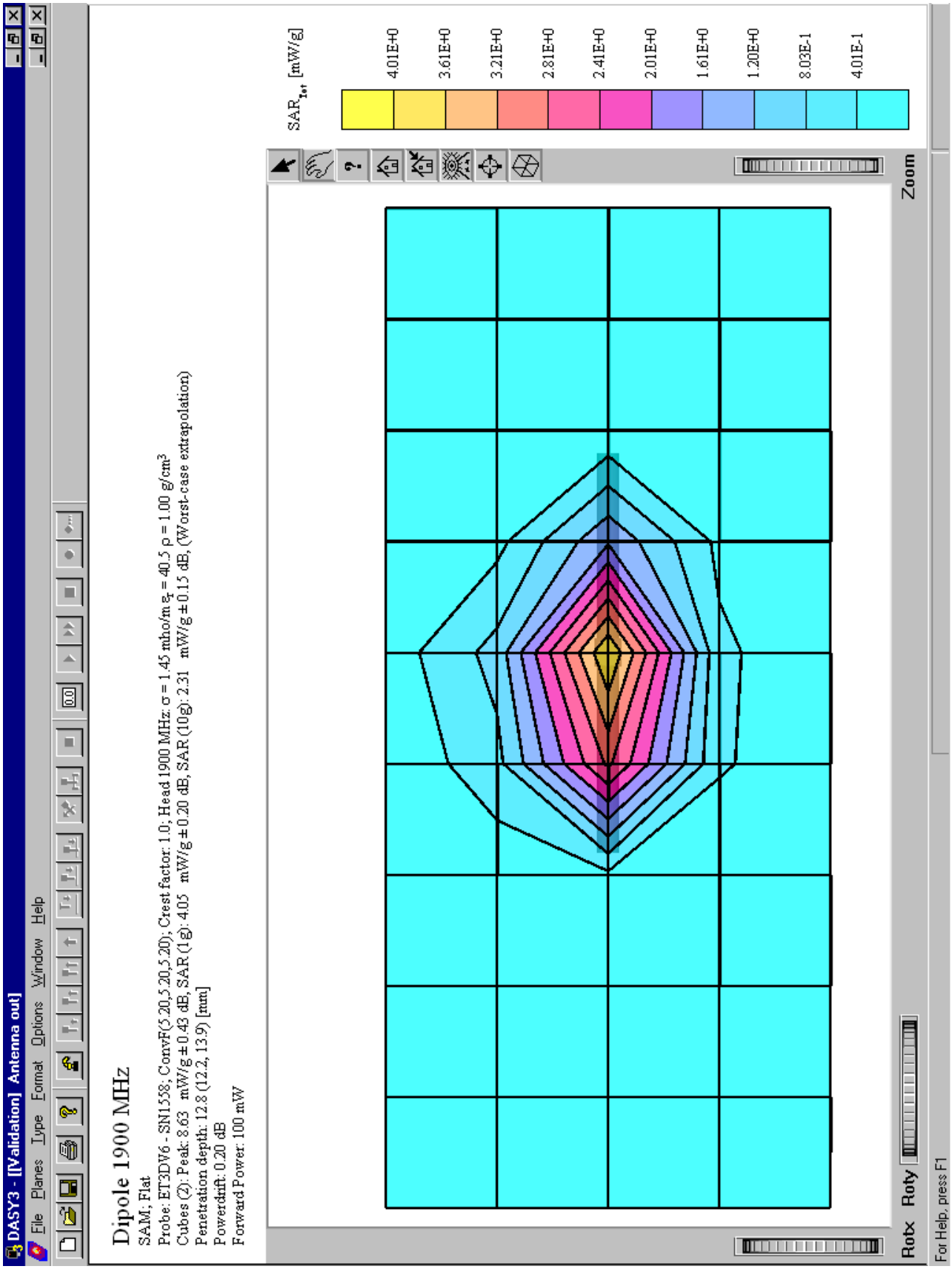
2.7 Test results (effective radiated power measurement)

The measurement were performed in a fully-anechoic chamber with the dimensions 8m x 5m x 5m. To find the maximum output power, a special positioner prepared for this field of application will be fitted on a conventional turning table. The turning table is performing the azimuth-turn and the position-installation the elevation-level. The distance between the EUT and the receive antenna was 5 m.

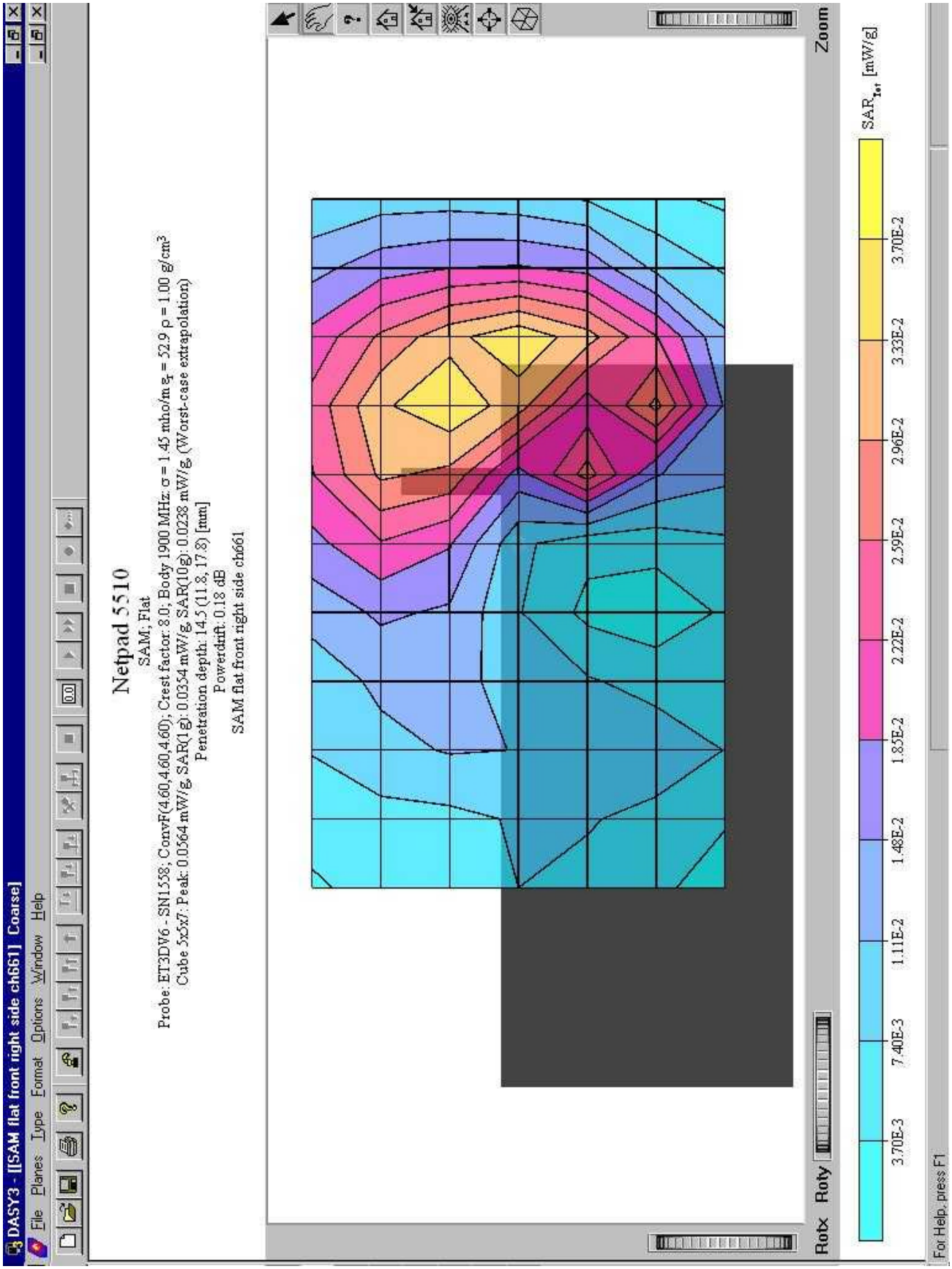
GSM 1900	
Channel	peak power (ERP)
512	26.01 dBm
661	25.90 dBm
810	25.88 dBm

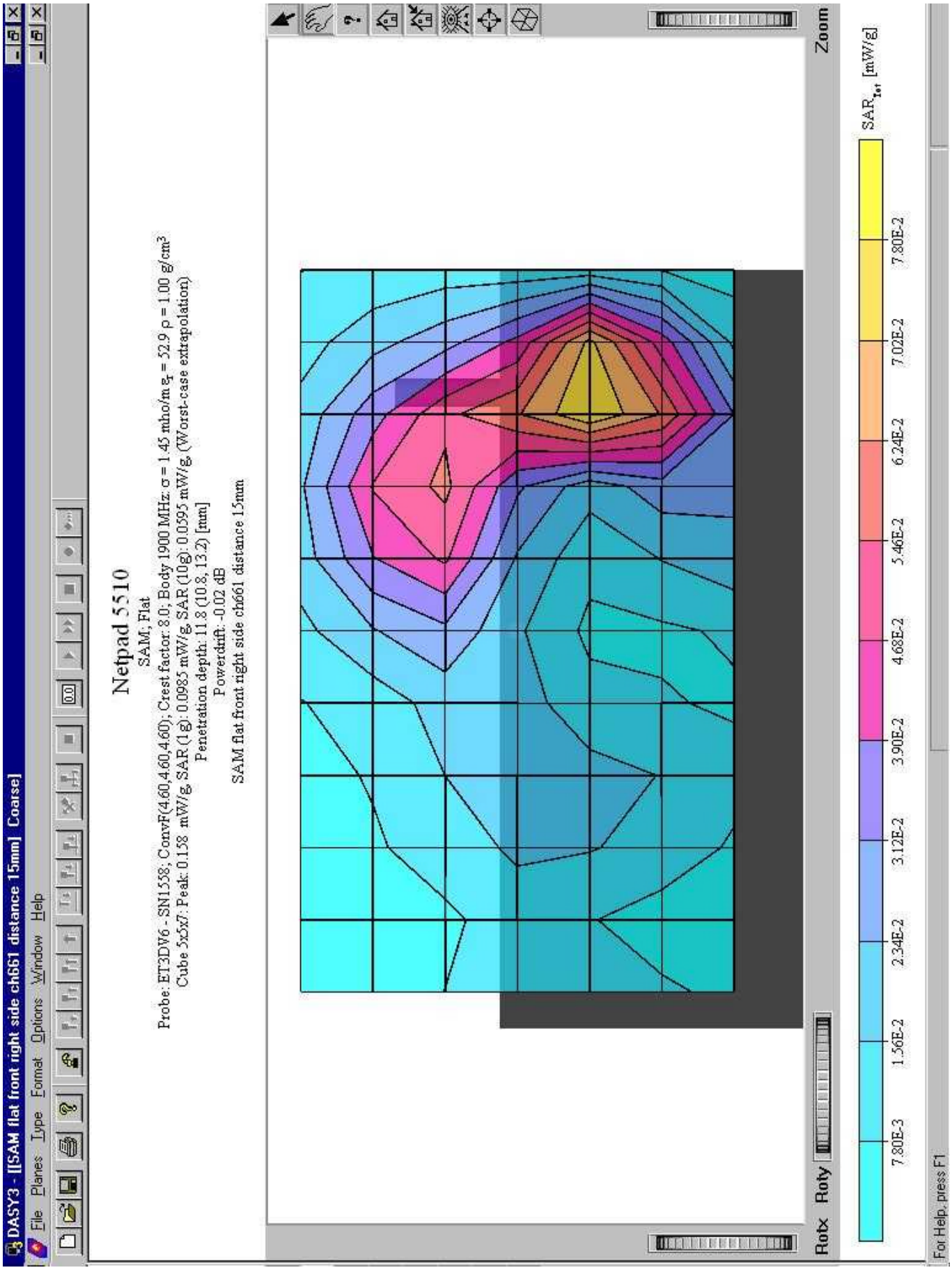
Table 8: Test results radiated peak power measurement

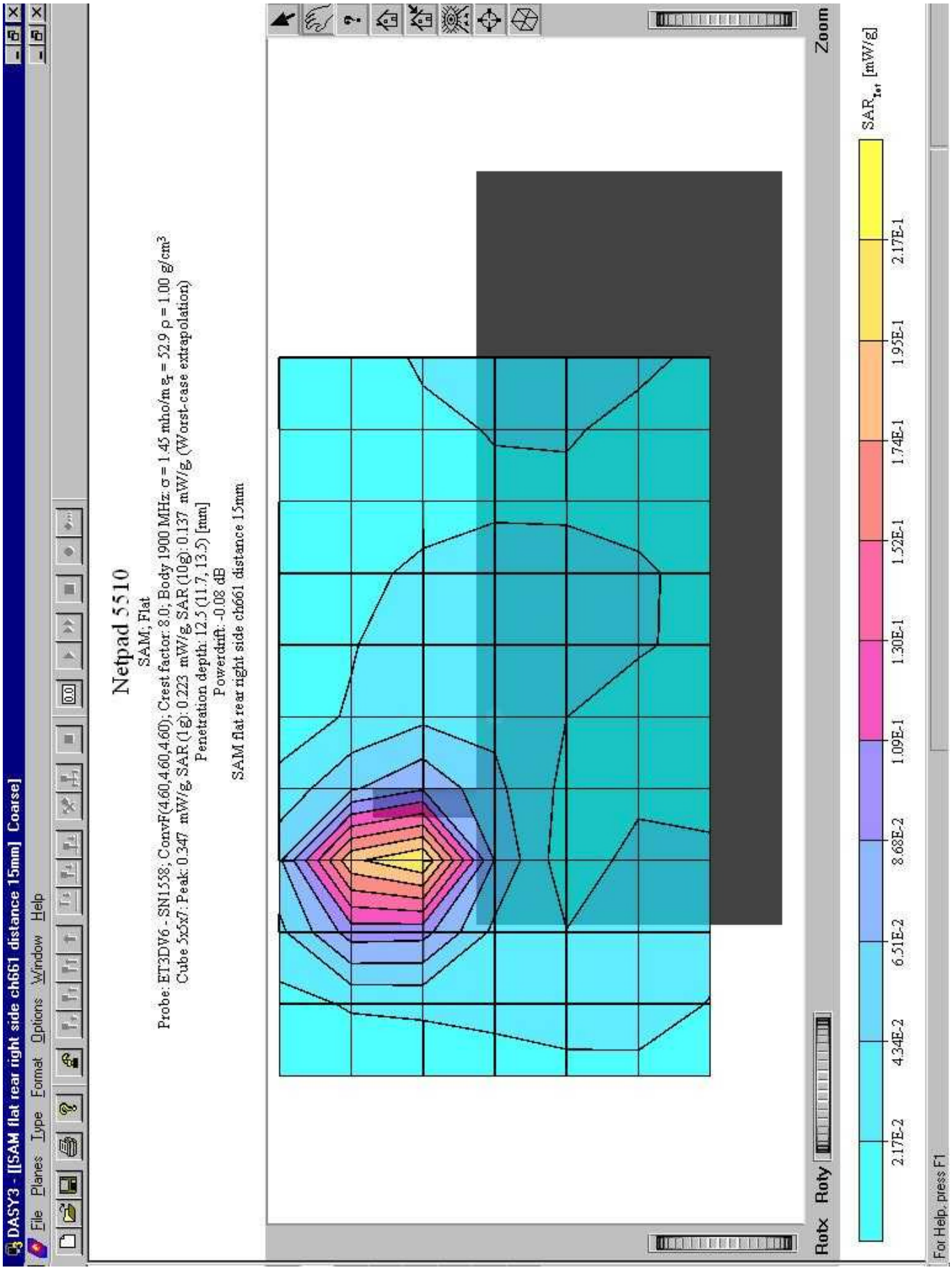
System performance verification



Annex 1 Measurement results (printout from DASY TM)




DASY3 - [[SAM flat front right side ch661 distance 15mm] Coarse]
File Planes Type Format Options Window Help
Netpad 5510
SAM, Flat
Probe: ET3DV6 - SN1558; ConvF(4.60,4.60,4.60); Crest factor: 8.0; Body 1900 MHz: σ = 1.45 mho/m ε_r = 52.9 ρ = 1.00 g/cm³
Cube 5x5x7: Peak: 0.158 mW/g, SAR (1g): 0.0985 mW/g, SAR (10g): 0.0595 mW/g, (Worst-case extrapolation)
Penetration depth: 11.8 (10.8, 13.2) [mm]
Powerdrift: -0.02 dB
SAM flat front right side ch661 distance 15mm
Zoom
Rotx
Roty
SAR_Test [mW/g]
7.80E-3
1.56E-2
2.34E-2
3.12E-2
3.90E-2
4.68E-2
5.46E-2
6.24E-2
7.02E-2
7.80E-2
For Help, press F1


DASY3 - [[SAM flat rear right side ch661 distance 15mm] Coarse]
File Planes Type Format Options Window Help
Netpad 5510
SAM, Flat
Probe: ET3DV6 - SN1558; ConvF(4.60,4.60,4.60); Crest factor: 8.0; Body 1900 MHz: σ = 1.45 mho/m ε_r = 52.9 ρ = 1.00 g/cm³
Cube 5x5x7: Peak: 0.347 mW/g, SAR (1g): 0.223 mW/g, SAR (10g): 0.137 mW/g (Worst-case extrapolation)
Penetration depth: 12.5 (11.7, 13.5) [mm]
Powerdrift: -0.08 dB
SAM flat rear right side ch661 distance 15mm
Zoom
Rotx
Roty
SAR_Test [mW/g]
2.17E-2
4.34E-2
6.51E-2
8.68E-2
1.09E-1
1.30E-1
1.52E-1
1.74E-1
1.95E-1
2.17E-1
For Help, press F1

Annex 2 Photo documentation

Picture no. 1: Measurement System DASY 3

Picture no. 2: Netpad 5510 flat front

Picture no. 3: Netpad 5510 flat front

Picture no. 4: Netpad 5510 flat front

Picture no. 5 Netpad 5510 flat front, distance 15mm

Picture no. 6: Netpad 5510 flat front, distance 15mm

Picture no. 7: Netpad 5510 flat front, distance 15mm