

SAR EVALUATION REPORT

For

Chi Mei Communication Systems, Inc.

11F, No. 39, Chung Hua Road Sec. 1
Taipei 100, Taiwan, R.O.C.

FCC ID: QDJ-0302AMD01

March 18, 2003

This Report Concerns: ☒ Original Report	Equipment Type: PCS Wireless Phone
Test Engineer:	Eric Hong
Report No.:	R0302191S
Test Date:	March 17, 2003
Reviewed By:	Hans Mellberg
Prepared By:	Bay Area Compliance Laboratory Corporation 230 Commercial Street Sunnyvale, CA 94085 Tel: (408) 732-9162 Fax: (408) 732 9164

Note: This test report is specially limited to the above client company and the product model only. It may not be duplicated without prior written consent of Bay Area Compliance Laboratory Corporation. This report **must not** be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.

TABLE OF CONTENTS

SUMMARY.....	3
1 - REFERENCE.....	4
2 - TESTING EQUIPMENT.....	5
2.1 EQUIPMENTS LIST & CALIBRATION INFO.....	5
2.2 EQUIPMENT CALIBRATION CERTIFICATE.....	5
3 - EUT DESCRIPTION.....	10
4 - CONDUCTED OUTPUT POWER MEASUREMENT.....	11
4.1 MEASUREMENT PROCEDURE	11
4.2 TEST RESULTS.....	12
4.3 MEASUREMENT PLOTS.....	12
5 - DOSIMETRIC ASSESSMENT SETUP.....	15
5.1 MEASUREMENT SYSTEM DIAGRAM.....	16
5.2. SYSTEM COMPONENTS.....	17
5.3 MEASUREMENT UNCERTAINTY	21
6 - EVALUATION PROCEDURE.....	22
6.1 SAR EVALUATION PROCEDURE.....	22
6.2 EXPOSURE LIMITS.....	23
6.3 SIMULATED TISSUE LIQUID PARAMETER CONFIRMATION.....	23
6.4 SAR MEASUREMENT	23
6.5 SYSTEM ACCURACY VERIFICATION	24
6.6 LIQUID MEASUREMENT RESULT	25
7 - SAR TEST RESULTS	30
7.1 SAR BODY-WORN WORST -CASE TEST DATA	30
7.2 PLOTS OF TEST RESULT	31
EXHIBIT A - SAR SETUP PHOTOGRAPHS	54
BOTTOM TOUCHING PHANTOM – SIDE VIEW	54
BOTTOM TOUCHING PHANTOM WITH EARPHONE – SIDE VIEW.....	54
BOTTOM 1.5 SEPARATION TO PHANTOM – SIDE VIEW	55
BOTTOM 1.5 SEPARATION TO PHANTOM WITH EARPHONE – SIDE VIEW	55
FACE TOUCHING PHANTOM – SIDE VIEW	56
FACE TOUCHING PHANTOM – FRONT VIEW.....	56
FACE TOUCHING PHANTOM – REAR VIEW.....	57
FACE TOUCHING PHANTOM WITH EARPHONE – SIDE VIEW.....	57
FACE TOUCHING PHANTOM WITH EARPHONE – FRONT VIEW	58
FACE 1.5CM SEPARATION TO PHANTOM WITH EARPHONE – SIDE VIEW	58
FACE 1.5CM SEPARATION TO PHANTOM WITH EARPHONE – FRONT VIEW	59
FACE 1.5CM SEPARATION TO PHANTOM – SIDE VIEW.....	59
FACE 1.5CM SEPARATION TO PHANTOM – FRONT VIEW	60
CHEEK POSITION LEFT SIDE.....	60
CHEEK POSITION WITH EARPHONE LEFT SIDE	61
CHEEK POSITION RIGHT SIDE.....	61
CHEEK POSITION WITH EARPHONE RIGHT SIDE	62
TILTED POSITION LEFT SIDE.....	62
TILTED POSITION WITH EARPHONE LEFT SIDE	63
TILTED POSITION RIGHT SIDE	63
TILTED POSITION WITH EARPHONE RIGHT SIDE.....	64
EXHIBIT C – Z-AXIS	65
EXHIBIT D – ACCESSORIES.....	66

SUMMARY

The US Federal Communications Commission has released the report and order “Guidelines for Evaluating the Environmental Effects of RF Radiation”, ET Docket No. 93-62 in August 1996 [1].

The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 mW/g as recommended by the ANSI/IEEE standard C95.1-1992 [6] for an uncontrolled environment (Paragraph 65). According to the Supplement C of OET Bulletin 65 “Evaluating Compliance with FCC Guide-lines for Human Exposure to Radio frequency Electromagnetic Fields”, released on Jun 29, 2001 by the FCC, the device should be evaluated at maximum output power (radiated from the antenna) under “worst-case” conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation and if radiation is found, what is the extent of radiation with respect to safety limits. SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in North America is 1.6 mW/g average over 1 gram of tissue mass.

The test configurations were laid out on a specially designed test fixture to ensure the reproducibility of measurements. Each configuration was scanned for SAR. Analysis of each scan was carried out to characterize the above effects in the device.

There was no SAR of any concern measured on the device for any of the investigated configurations.

1 - REFERENCE

- [1] Federal Communications Commission, "Report and order: Guidelines for evaluating the environmental effects of radiofrequency radiation", Tech. Rep. FCC 96-326, FCC, Washington, D.C. 20554, 1996.
- [2] David L. Means Kwok Chan, Robert F. Cleveland, "Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commission, Office of Engineering & Technology, Washington, DC, 1997.
- [3] Thomas Schmid, Oliver Egger, and Niels Kuster, "Automated E-field scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp. 105-113, Jan. 1996.
- [4] Niels Kuster, Ralph Kastle, and Thomas Schmid, "Dosimetric evaluation of mobile communications equipment with known precision", IEEE Transactions on Communications, vol. E80-B, no. 5, pp. 645-652, May 1997.
- [5] CENELEC, "Considerations for evaluating of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz - 6GHz", Tech. Rep., CENELEC, European Committee for Electrotechnical Standardization, Brussels, 1997.
- [6] ANSI, ANSI/IEEE C95.1-1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.
- [7] Katja Pokovic, Thomas Schmid, and Niels Kuster, "Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies", in ICECOM '97, Dubrovnik, October 15-17, 1997, pp. 120-24.
- [8] Katja Pokovic, Thomas Schmid, and Niels Kuster, "E-field probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23-25 June, 1996, pp. 172-175.
- [9] Volker Hombach, Klaus Meier, Michael Burkhardt, Eberhard Kuhn, and Niels Kuster, "The dependence of EM energy absorption upon human head modeling at 900 MHz", IEEE Transactions on Microwave Theory and Techniques, vol. 44, no. 10, pp. 1865-1873, Oct. 1996.
- [10] Klaus Meier, Ralf Kastle, Volker Hombach, Roger Tay, and Niels Kuster, "The dependence of EM energy absorption upon human head modeling at 1800 MHz", IEEE Transactions on Microwave Theory and Techniques, Oct. 1997, in press.
- [11] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.
- [12] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992. Dosimetric Evaluation of Sample device, month 1998 9
- [13] NIS81 NAMAS, "The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.
- [14] Barry N. Taylor and Christ E. Kuyatt, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10

2 - TESTING EQUIPMENT

2.1 Equipments List & Calibration Info

Type / Model	Cal. Date	S/N:
DASY3 Professional Dosimetric System	N/A	N/A
Robot RX60L	N/A	F00/5H31A1/A/01
Robot Controller	N/A	F01/5J72A1/A/01
Dell Computer Optiplex GX110	N/A	N/A
Pentium III, Windows NT	N/A	N/A
SPEAG EDC3	N/A	N/A
SPEAG DAE3	08/26/02	456
SPEAG E-Field Probe ET3DV6	08/26/02	1604
SPEAG Dummy Probe	N/A	N/A
SPEAG Generic Twin Phantom	N/A	N/A
SPEAG Light Alignment Sensor	N/A	278
SPEAG Validation Dipole D-1800-S-2	11/6/01	BCL-049
SPEAG Validation Dipole D900V2	9/3/02	122
Brain Equivalent Matter (800MHz)	Daily	N/A
Brain Equivalent Matter (1900MHz)	Daily	N/A
Muscle Equivalent Matter (800MHz)	Daily	N/A
Muscle Equivalent Matter (1900MHz)	Daily	N/A
Robot Table	N/A	N/A
Phone Holder	N/A	N/A
Phantom Cover	N/A	N/A
HP Spectrum Analyzer HP8593GM	6/20/02	3009A00791
Microwave Amp. 8349B	N/A	2644A02662
Power Meter HP436A	4/2/02	2709A29209
Power Sensor HP8482A	4/2/02	2349A08568
Signal Generator RS SMIQ O3	2/10/02	1084800403
Network Analyzer HP-8753ES	7/30/02	820079
Dielectric Probe Kit HP85070A	N/A	N/A
Hewlett Packard HP8566B Spectrum Analyzer	7/23/02	None
Hewlett Packard HP 7470A Plotter	7/23/02	None
A.H. System SAS0200 Horn Antenna	7/23/02	None
Com-Power AB-100 Dipole Antenna	7/23/02	None
Agilent E4419b	4/8/02	GB40202891
Agilent E4412a	4/8/02	US38486529

2.2 Equipment Calibration Certificate

Please see the attached file for detailed information.

Schmid & Partner Engineering AG

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

Calibration Certificate

Dosimetric E-Field Probe

Type:

ET3DV6

Serial Number:

1604

Place of Calibration:

Zurich

Date of Calibration:

August 26, 2002

Calibration Interval

12 months

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

Calibrated by

N. Vetter

Approved by:

Christoph Kaya

ET3DV6 SN:1604

August 26, 2002

DASY3 - Parameters of Probe: ET3DV6 SN:1604**Sensitivity in Free Space**

NormX	$1.73 \mu\text{V}/(\text{V}/\text{m})^2$
NormY	$1.68 \mu\text{V}/(\text{V}/\text{m})^2$
NormZ	$1.72 \mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression

DCP X	93	mV
DCP Y	93	mV
DCP Z	93	mV

Sensitivity in Tissue Simulating Liquid

Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\%$ mho/m
	ConvF X	$6.5 \pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	$6.5 \pm 9.5\%$ (k=2)	Alpha 0.36
	ConvF Z	$6.5 \pm 9.5\%$ (k=2)	Depth 2.82
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
Head	1900 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
	ConvF X	$5.5 \pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	$5.5 \pm 9.5\%$ (k=2)	Alpha 0.50
	ConvF Z	$5.5 \pm 9.5\%$ (k=2)	Depth 2.46

Boundary Effect

Head	900 MHz	Typical SAR gradient: 5 % per mm	
Probe Tip to Boundary		1 mm	2 mm
SAR _{be} [%] Without Correction Algorithm		11.1	6.6
SAR _{be} [%] With Correction Algorithm		0.4	
Head	1800 MHz	Typical SAR gradient: 10 % per mm	
Probe Tip to Boundary		1 mm	2 mm
SAR _{be} [%] Without Correction Algorithm		12.3	8.1
SAR _{be} [%] With Correction Algorithm		0.1	0.1

Sensor Offset

Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.3 ± 0.2	mm

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

Additional Conversion Factors

for Dosimetric E-Field Probe

Type**ET3DV6****Serial Number:****1604****Place of Assessment****Zurich****Date of Assessment:****October 4, 2002****Probe Calibration Date****August 26, 2002**

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. Since the evaluation is coupled with measured conversion factors, it has to be recalculated yearly, i.e., following the re-calibration schedule of the probe. The uncertainty of the numerical assessment is based on the extrapolation from measured value at 900 MHz or at 1800 MHz.

Assessed by

Conversion factor ($\pm$ standard deviation)**835 MHz** **ConvF** **$6.4 \pm 8\%$** $\epsilon_r = 55.2 \pm 5\%$
 $\sigma = 0.97 \pm 5\%$ mho/m
(body tissue)**1900 MHz** **ConvF** **$4.9 \pm 8\%$** $\epsilon_r = 53.3 \pm 5\%$
 $\sigma = 1.52 \pm 5\%$ mho/m
(body tissue)

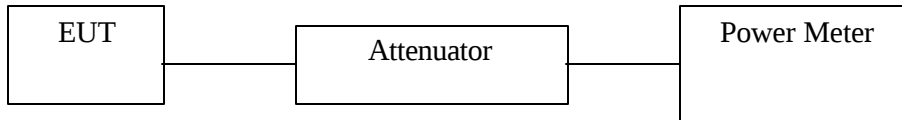
3 - EUT DESCRIPTION

Applicant:	Chi Mei Communication Systems, Inc.
Product Description:	PCS Wireless Phone
Product Name:	AMADEUS
FCC ID:	QDJ-0302AMD01
Serial Number:	None
Maximum RF Output Power:	(EIRP) 25.3dBm
Dimension:	3.8" L x 1.6"W x 0.65"H approximately
RF Exposure environment:	General Population/Uncontrolled
Applicable Standard	FCC CFR 47, Part 24
Application Type:	Certification

4 - CONDUCTED OUTPUT POWER MEASUREMENT

4.1 Measurement Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to a spectrum analyzer.
3. Add a correction factor to the display.



General Procedure for Conducted Output Power measurements not employing a connector for SAR Measurements:

Description of measurement method of the conductive output power for connector-less portable telephones:

Conducted output power measured before or after each SAR test to verify if the output power levels are within the tolerance specified for the device. The detail to measured conductive power before or after each SAR test is as following:

On the device, search for the final PCB trace for the antenna. This may be a pad or feed-through hole or a spring finger landing area. Unsolder or remove the connection to the antenna and replace the antenna connection with the non-radiating coaxial cable (Picture attached) was soldered on the PCB trace or pad or feedthrough. On the other end of the cable, it was connected to the input of the spectrum analyzer. Then, the measurement was read off the Spectrum Analyzer.

The cable loss of the cable connected between the device and the spectrum analyzer was added to the conducted output power measurement.

Prior to each SAR measurement scan, measure the output power level and record or plot the levels. Attach those to the SAR report

4.2 Test Results

3/18/03:

Frequency (MHz)	Output Power (dBm)	Correction Factor (dBm)	Corrected Output Power (dBm)	Corrected Output Power (mW)	Standard (W)	Result
1850.0	27.00	1.19	28.19	659.17	< 1W	Compliant
1880.0	25.83	1.19	27.02	503.50	≤ 1W	Compliant
1909.8	24.83	1.19	26.02	399.94	< 1W	Compliant

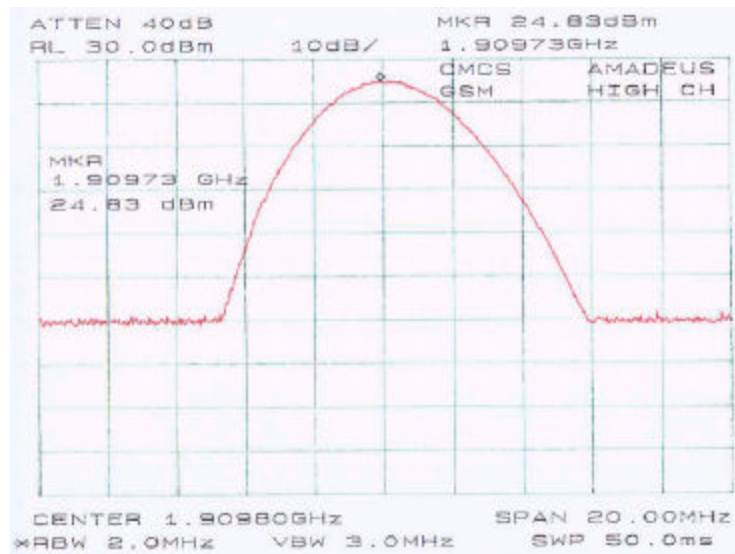
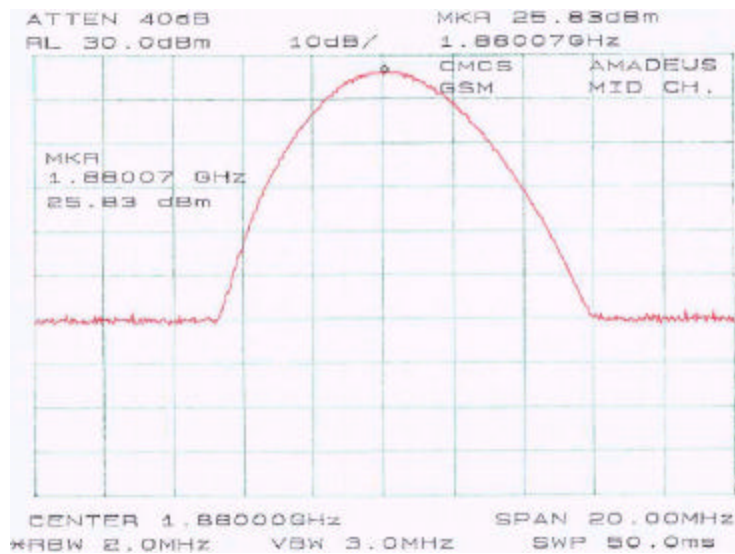
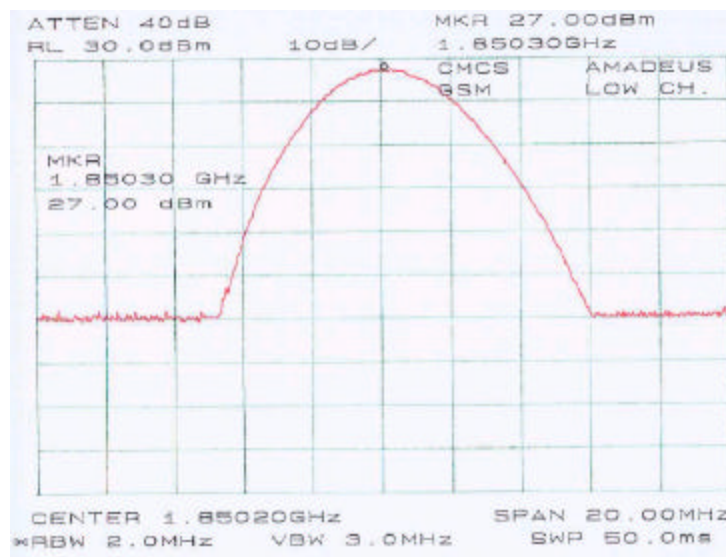
7/16/03

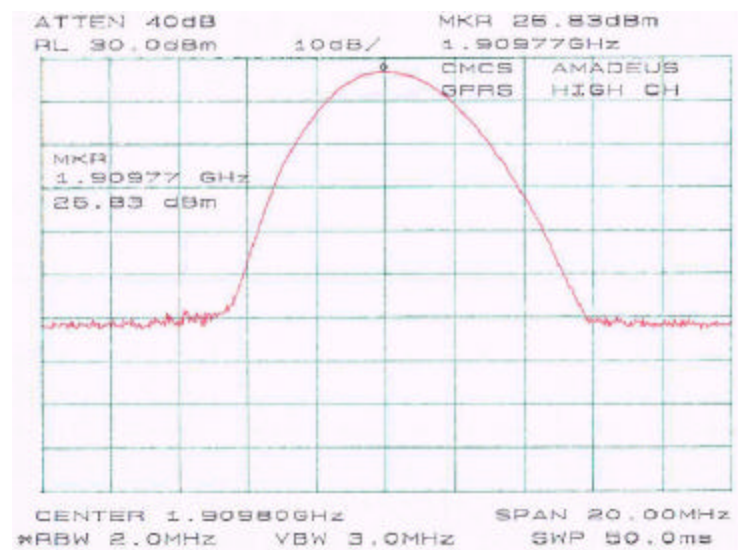
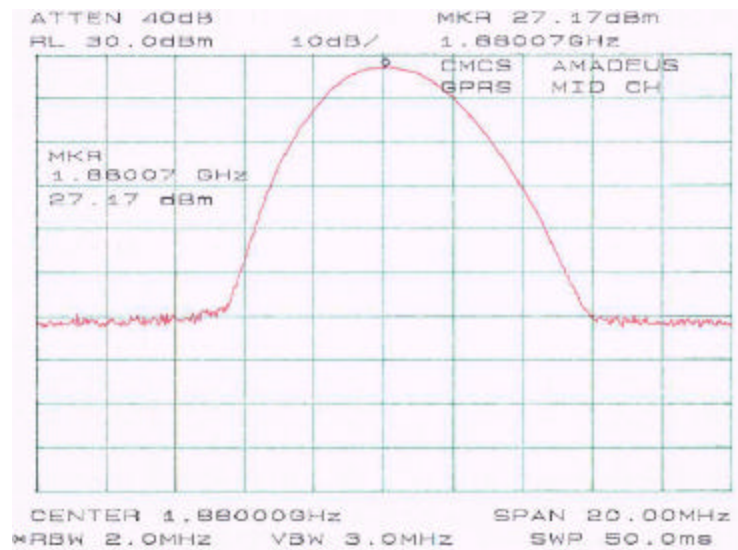
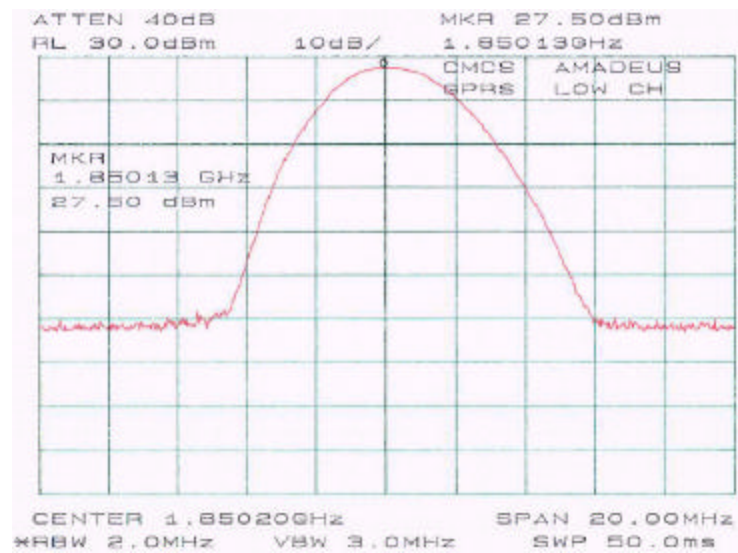
Frequency (MHz)	Output Power (dBm)	Correction Factor (dBm)	Corrected Output Power (dBm)	Corrected Output Power (mW)	Standard (W)	Result
1850.0	27.50	1.19	28.69	739.60	< 1W	Compliant
1880.0	27.17	1.19	28.36	685.49	≤ 1W	Compliant
1909.8	26.83	1.19	28.02	633.87	< 1W	Compliant

Note: The power output may depend on the intended use of the EUT. For all tests, the EUT was set to maximum conditions.

4.3 Measurement Plots

Please refer to the plots hereinafter.





5 - DOSIMETRIC ASSESSMENT SETUP

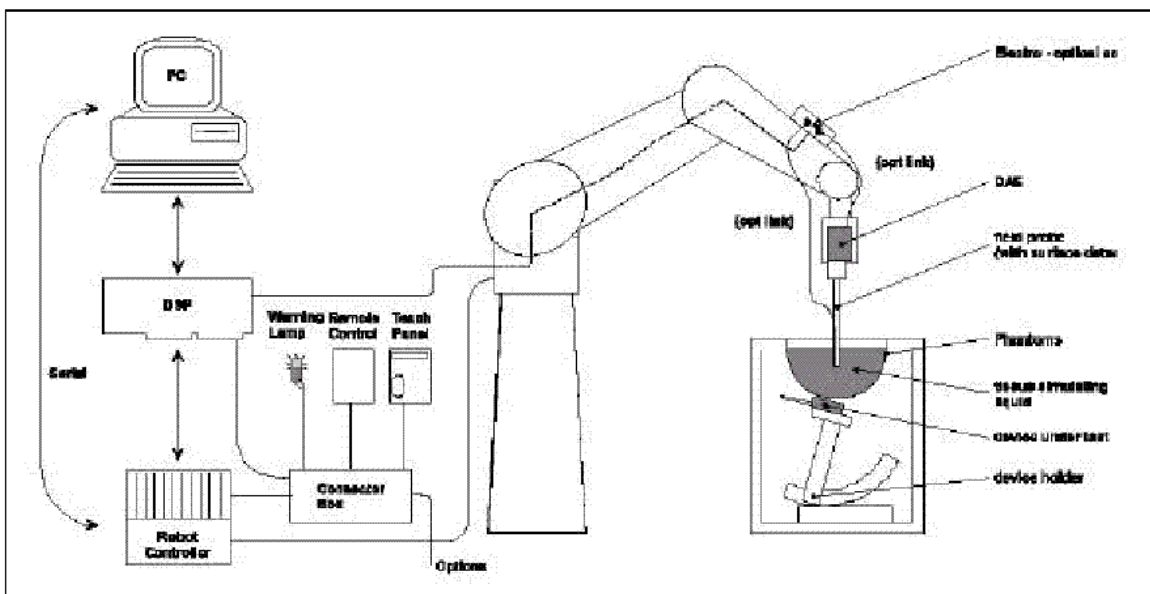
These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than $\pm 0.02\text{mm}$. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The system is described in detail in [3].

The SAR measurements were conducted with the dosimetric probe ET3DV6 SN: 1577 (manufactured by SPEAG), designed in the classical triangular configuration [3] and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in [7] with accuracy of better than $\pm 10\%$. The spherical isotropy was evaluated with the procedure described in [8] and found to be better than $\pm 0.25\text{dB}$.

The phantom used was the "Generic Twin Phantom" described in [4]. The ear was simulated as a spacer of 4 mm thickness between the earpiece of the phone and the tissue simulating liquid. The Tissue simulation liquid used for each test is in according with the FCC OET65 supplement C as listed below.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (Nacl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton x-100	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	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (s/m)	0.85	0.83	0.91	0.91	1.0	1.07	1.42	1.45	1.88	1.78

5.1 Measurement System Diagram



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

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
2. An arm extension for accommodating the data acquisition electronics (DAE).
3. 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.
4. 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.
5. 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 functions 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.
6. A computer operating Windows 95 or larger
7. DASY3 software
8. Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling testing left-hand and right-hand usage.
10. The device holder for handheld EUT.
11. Tissue simulating liquid mixed according to the given recipes (see Application Note).
12. System validation dipoles to validate the proper functioning of the system.

5.2. System Components

ET3DV6 Probe Specification

Construction Symmetrical design with triangular core

Built-in optical fiber for surface detection System

Built-in shielding against static charges

Calibration In air from 10 MHz to 2.5 GHz

In brain and muscle simulating tissue at

Frequencies of 450 MHz, 900 MHz and

1.8 GHz (accuracy $\pm 8\%$)

Frequency 10 MHz to > 6 GHz; Linearity: ± 0.2 dB

(30 MHz to 3 GHz)

Directivity ± 0.2 dB in brain tissue (rotation around probe axis)

± 0.4 dB in brain tissue (rotation normal probe axis)

Dynamic 5 mW/g to > 100 mW/g;

Range Linearity: ± 0.2 dB

Surface ± 0.2 mm repeatability in air and clear liquids

Detection over diffuse reflecting surfaces.

Dimensions Overall length: 330 mm

Tip length: 16 mm

Body diameter: 12 mm

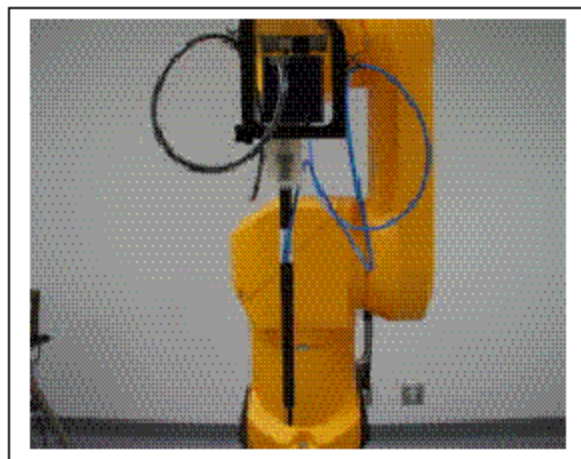
Tip diameter: 6.8 mm

Distance from probe tip to dipole centers: 2.7 mm

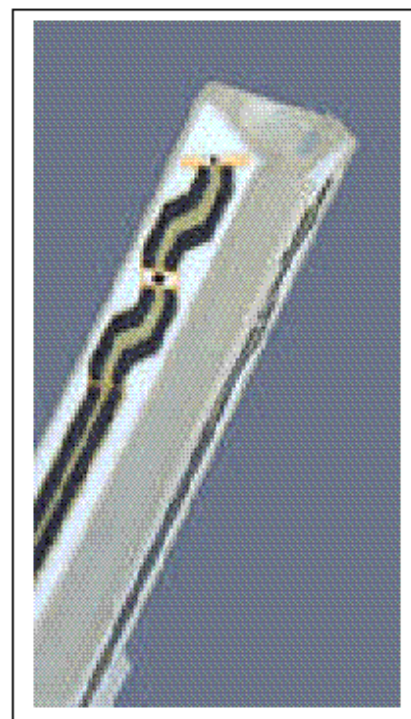
Application General dosimetric up to 3 GHz

Compliance tests of mobile phones

Fast automatic scanning in arbitrary phantoms



Photograph of the probe



Inside view of
ET3DV6 E-field Probe

The SAR measurements were conducted with the dosimetric probe ET3DV6 designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY3 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped when reaching the maximum.

E-Field Probe Calibration Process

Each probe is calibrated according to a dosimetric assessment procedure described in [6] with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in [7] and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

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 Parameter:	-Sensitivity	Norm _i , a _{i0} , a _{i1} , a _{i2}
	-Conversion Factor	ConvFi
	-Diode compression point	Dcp _i
Device parameter:	-Frequency	f
	-Crest Factor	cf
Media parameter:	-Conductivity	ó
	-Density	ñ

These parameters must be set correctly in the software. They can either be found in the component documents or be imported into the software from the configuration files issued for the DASY3 components. In the direct measuring mode of the multi-meter 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:

$$V_i = U_i + (U_i)^2 \text{ cf} / \text{dcp}_i$$

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:

$$\begin{aligned} \text{E-field probes:} \quad E_i &= \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConvF}}} \\ \text{H-field probes:} \quad H_i &= \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f} \end{aligned}$$

With V_i = compensated signal of channel i (i = x, y, z)
 Norm_i = sensor sensitivity of channel i (i = x, y, z)
 $\text{V}/(\text{V}/\text{m})^2$ for E-field probes
 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 = diode compression point (DASY parameter)

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

$$E_{\text{tot}} = \text{Square Root} [(E_x)^2 + (E_y)^2 + (E_z)^2]$$

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

$$\text{SAR} = (E_{\text{tot}})^2 \cdot \sigma / (\tilde{n} \cdot 1000)$$

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]
 $\tilde{n}$ = 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 as a free space field.

$$P_{\text{pwe}} = (E_{\text{tot}})^2 / 3770 \text{ or } P_{\text{pwe}} = (H_{\text{tot}})^2 \cdot 37.7$$

With P_{pwe} = equivalent power density of a plane wave in mW/cm^3
 E_{tot} = total electric field strength in V/m
 H_{tot} = total magnetic field strength in V/m

Generic Twin Phantom

The Generic Twin Phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users [9][10]. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allows the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

Shell Thickness 2 ± 0.1 mm

Filling Volume Approx. 20 liters

Dimensions 810 x 1000 x 500 mm (H x L x W)

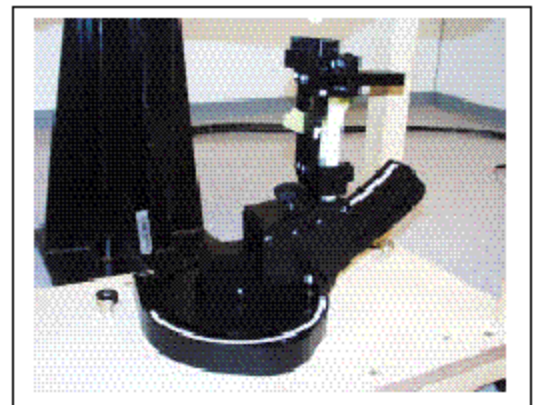


Generic Twin Phantom

Device Holder

In combination with the Generic Twin Phantom V3.0, the Mounting Device enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatedly positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

* Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produced infinite number of configurations [10]. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.



Device Holder

5.3 Measurement Uncertainty

The uncertainty budget has been determined for the DASY3 measurement system according to the NIS81 [13] and the NIST1297 [14] documents and is given in the following Table.

Uncertainty Description	Error	Distribution	Weight	Std. Dev.	Offset
Probe Uncertainty					
Axial isotropy	± 0.2 dB	U-shape	0.5	± 2.4 %	/
Spherical isotropy	± 0.4 dB	U-shape	0.5	± 4.8 %	/
Isotropy from gradient	± 0.5 dB	U-shape	0	/	/
Spatial resolution	± 0.5 %	Normal	1	± 0.5 %	/
Linearity error	± 0.2 dB	Rectangle	1	± 2.7 %	/
Calibration error	± 3.3 %	Normal	1	± 3.3 %	/
SAR Evaluation Uncertainty					
Data acquisition error	± 1 %	Rectangle	1	± 0.6 %	/
ELF and RF disturbances	± 0.25 %	Normal	1	± 0.25 %	/
Conductivity assessment	± 10 %	Rectangle	1	± 5.8 %	/
Spatial Peak SAR Evaluation Uncertainty					
Extrapol boundary effect	± 3 %	Normal	1	± 3 %	± 5 %
Probe positioning error	± 0.1 mm	Normal	1	± 1 %	/
Integrat. and cube orient	± 3 %	Normal	1	± 3 %	/
Cube shape inaccuracies	± 2 %	Rectangle	1	± 1.2 %	/
Device positioning	± 6 %	Normal	1	± 6 %	/
Combined Uncertainties	/	/	1	± 11.7 %	± 5 %
Extended uncertainty (K = 2)	/	/	/	± 23.5 %.	/

6 - EVALUATION PROCEDURE

6.1 SAR Evaluation Procedure

The evaluation was performed with the following procedure:

Step 1: Measurement of the SAR value at a fixed location above the ear point or central position was used as a reference value for assessing the power drop.

Step 2: The SAR distribution at the exposed side of the head was measured at a distance of 3.9 mm from the inner surface of the shell. The area covered the entire dimension of the head or EUT and the horizontal grid spacing was 20 mm x 20 mm. Based on these data, the area of the maximum absorption was determined by spline interpolation.

Step 3: Around this point, a volume of 32 mm x 32 mm x 34 mm was assessed by measuring 5 x 5 x 7 points. On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

1. The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation was based on a least square algorithm [11]. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
2. The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three onedimensional splines with the "Not a knot"-condition (in x, y and z-directions) [11], [12]. The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.
3. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

Step 4: Re-measurement of the SAR value at the same location as in Step 1. If the value changed by more than 5%, the evaluation was repeated.

6.2 Exposure Limits

Table 1: Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

Table 2: Limits for General Population/Uncontrolled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

Note: Whole-body SAR is averaged over the entire body, partial-body SAR is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

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

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

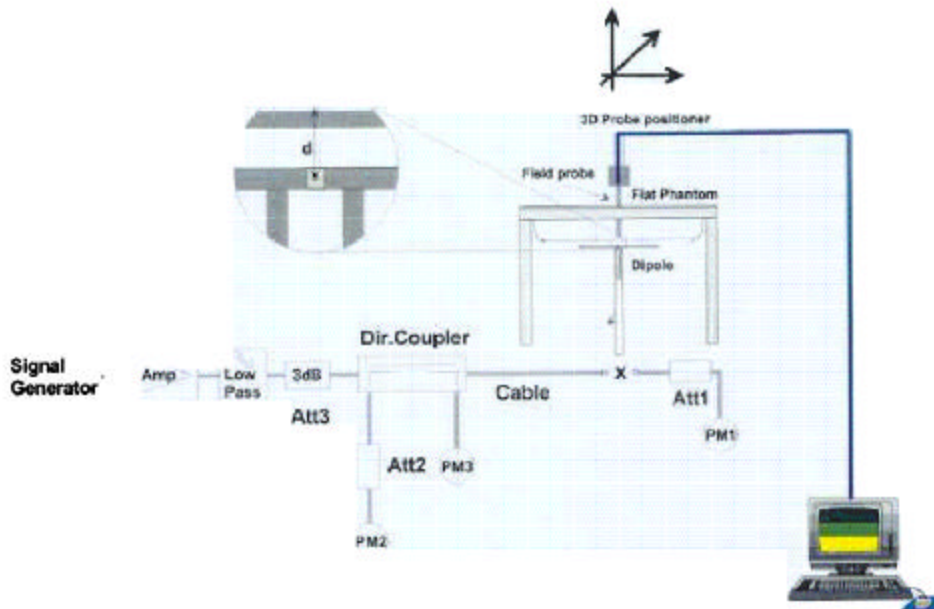
Population/uncontrolled environments Partial-body limit 1.6W/kg applied to the EUT.

6.3 Simulated Tissue Liquid Parameter Confirmation

The dielectric parameters were checked prior to assessment using the HP85070A dielectric probe kit. The dielectric parameters measured are reported in each correspondent section:

6.4 SAR Measurement

The SAR measurement was performed with the E-field probe in mechanical detection mode only. The setup and determination of the forward power into the dipole was performed using the following procedures.



First, the power meter PM1 (including attenuator Att1) is connected to the cable to measure the forward power at the location of the dipole connector (X). The signal generator is adjusted for the desired forward power at the dipole connector (taking into account the attenuation of Att1) as read by power meter PM2. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2. If the signal generator does not allow adjustment in 0.01dB steps, the remaining difference at PM 2 must be taken into consideration. PM3 records the reflected power from the dipole to ensure that the value is not changed from the previous value. The reflected power should be 20dB below the forward power.

The SAR measurements were performed in order to achieve repeatability and to establish an average target value.

6.5 System Accuracy Verification

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of $\pm 10\%$. The validation results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

IEEE P1528 recommended reference value for head

Frequency (MHz)	1 g SAR	10 g SAR	Local SAR at surface (above feed point)	Local SAR at surface (v=2cm offset from feed point)
300	3.0	2.0	4.4	2.1
450	4.9	3.3	7.2	3.2
835	9.5	6.2	14.1	4.9
900	10.8	6.9	16.4	5.4
1450	29.0	16.0	50.2	6.5
1800	38.1	19.8	69.5	6.8
1900	39.7	20.5	72.1	6.6
2000	41.1	21.1	74.6	6.5
2450	52.4	24.0	104.2	7.7
3000	63.8	25.7	140.2	9.5

Validation Dipole SAR Reference Test Result for Body (1900 MHz)

Validation Measurement	SAR @ 0.126W Input averaged over 1g	SAR @ 1W Input averaged over 1g	SAR @ 0.126W Input averaged over 10g	SAR @ 1W Input averaged over 10g
Test 1	3.1	24.61	1.42	11.27
Test 2	3.1	24.61	1.41	11.20
Test 3	3.2	25.41	1.43	11.35
Test 4	3.2	25.41	1.42	11.27
Test 5	3.1	24.61	1.42	11.27
Test 6	3.2	25.61	1.41	11.20
Test 7	3.2	25.61	1.43	11.35
Test 8	3.1	24.61	1.42	11.27
Test 9	3.1	24.61	1.42	11.27
Test 10	3.1	24.61	1.43	11.35
Average	3.14	24.97	1.421	11.28

6.6 Liquid Measurement Result

3/18/03:

Simulant	Freq [MHz]	Parameters	Liquid Temp [°C]	Target Value	Measured Value	Deviation	Limits [%]
Body	1900	ϵ_r	21.0	53.3	55.5	4.1	±5
		σ	21.0	1.52	1.53	0.66	±5
		1g SAR	21.0	24.97	27.0	8.1	±10
Head	1900	ϵ_r	21.0	40.0	41.9	4.8	±5
		σ	21.0	1.4	1.46	4.3	±5
		1g SAR	21.0	39.7	37.16	6.4	±10

Forward power (body) = 15.6 dBm = 36.3 mW

Forward power (head) = 14.1 dBm = 25.7 mW

7/16/03:

Simulant	Freq [MHz]	Parameters	Liquid Temp [°C]	Target Value	Measured Value	Deviation	Limits [%]
Body	1900	ϵ_r	21.0	53.3	52.4	-1.69	±5
		σ	21.0	1.52	1.46	-3.95	±5
		1g SAR	21.0	24.97	26.73	7.05	±10
Head	1900	ϵ_r	22.0	40.0	39.7	0.75	±5
		σ	22.0	1.4	1.40	0	±5
		1g SAR	22.0	39.7	39.24	-1.16	±10

Forward power (body) = 150 mW

Forward power (head) = 105 mW

 ϵ_r = relative permittivity, σ = conductivity and $\rho=1000\text{kg/m}^3$

System Validation 1900 MHz (Body liquid, Forward Power = 15.6 dBm, liquid Temp = 21 Deg C, Ambient Temp = 23 Deg C, 3/18/2003)

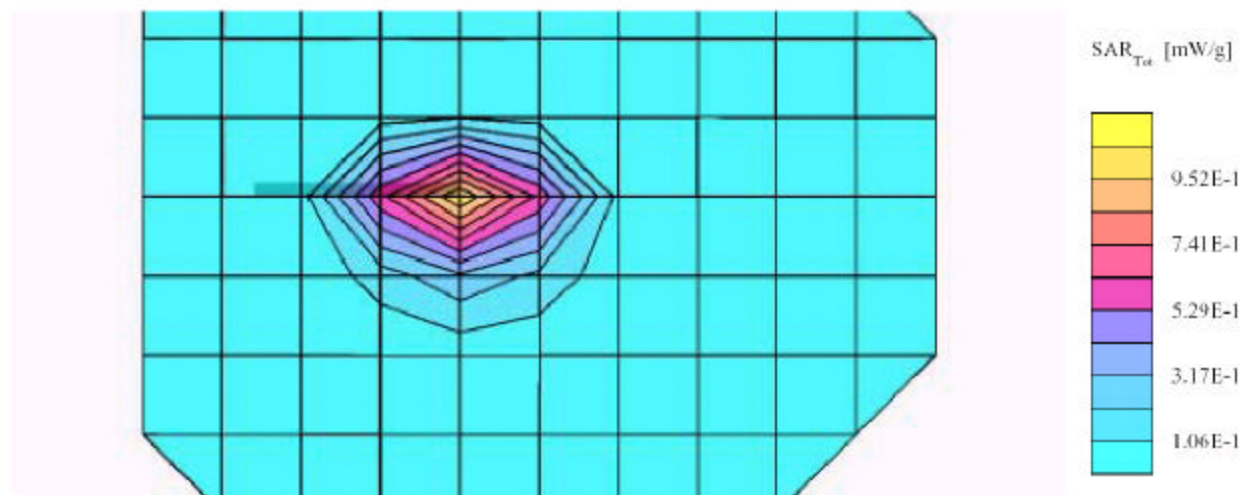
SAM Phantom: Flat Section; Position: (90°, 90°); Frequency: 1900 MHz

Probe: ET3DV6 - SN1604; ConvF(4.90,4.90,4.90); Crest factor: 8.0; Head 1900 MHz: $\sigma = 1.53 \text{ mho/m}$, $\epsilon_r = 55.5$, $\rho = 1.00 \text{ g/cm}^3$

Cube 5x5x7; SAR (1g): 0.980 mW/g, SAR (10g): 0.540 mW/g, (Worst-case extrapolation)

Coarse: Dx = 20.0, Dy = 20.0, Dz = 14.0

Powerdrift: -0.03 dB



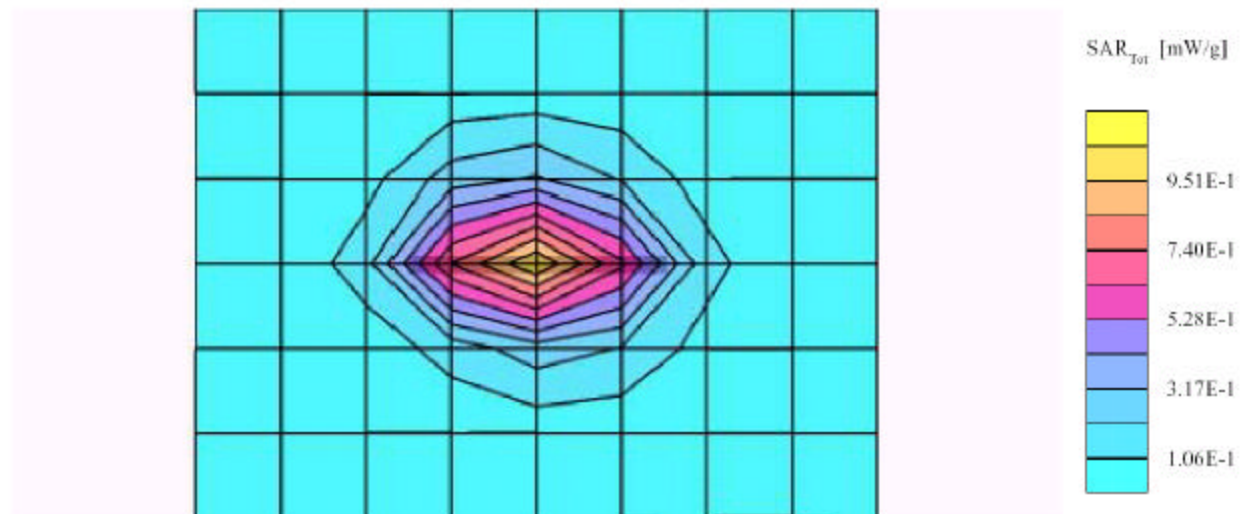
System Validation 1900 MHz (Head liquid, Forward Power = 14.1 dBm, liquid Temp = 21 Deg C, Ambient Temp = 23 Deg C, 3/18/2003)

Probe: ET3DV6 - SN1604; ConvF(5.50,5.50,5.50); Crest factor: 8.0; Head 1900 MHz: $\sigma = 1.46$ mho/m $\epsilon_r = 41.9$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 0.929 mW/g, SAR (10g): 0.494 mW/g, (Worst-case extrapolation)

Coarse: Dx = 17.0, Dy = 17.0, Dz = 14.0

Powerdrift: -0.02 dB



System Validation 1900 MHz (Body Liquid, Ambient Temp = 22 Deg C, Liquid Temp = 22 Deg C, 7/16/03)

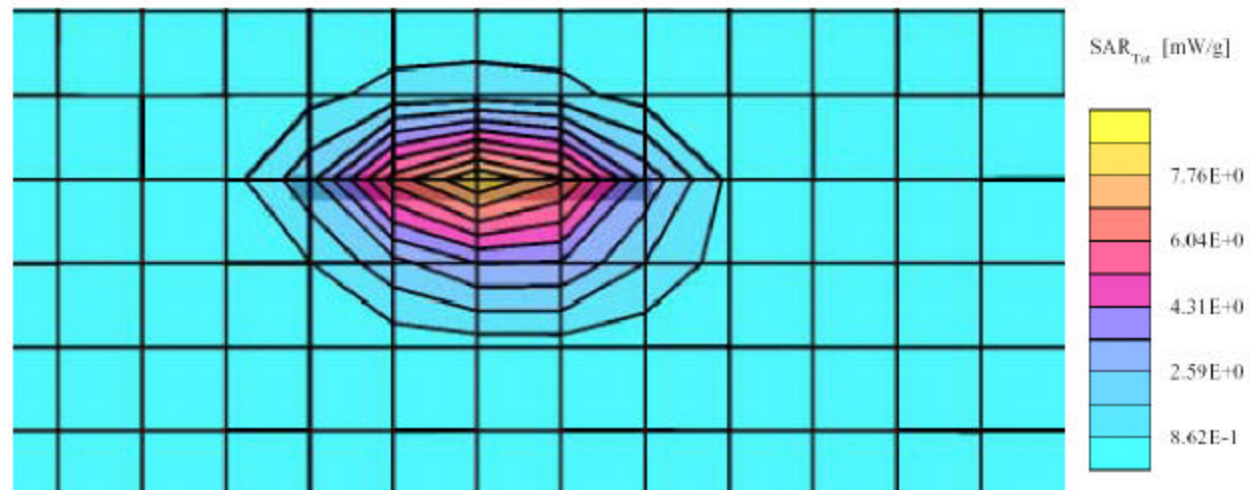
SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 1900 MHz

Probe: ET3DV6 - SN1604; ConvF(4.90,4.90,4.90); Crest factor: 4.0; Body 1900 MHz: $\sigma = 1.46 \text{ mho/m}$, $\epsilon_r = 52.4$, $\rho = 1.00 \text{ g/cm}^3$

Cube 5x5x7; SAR (1g): 4.01 mW/g, SAR (10g): 2.18 mW/g, (Worst-case extrapolation)

Coarse: Dx = 12.0, Dy = 12.0, Dz = 10.0

Powerdrift: -0.00 dB



System Validation 1900 MHz (Head Liquid, Ambient Temp = 22 Deg C, Liquid Temp = 22 Deg C, 7/16/2003)

SAM Phantom: Flat Section; Position: (90°,90°); Frequency: 1900 MHz

Probe: ET3DV6 - SN1604; ConvF(5.50,5.50,5.50); Crest factor: 4.0; Head 1900 MHz: $\sigma = 1.40 \text{ mho/m}$, $\epsilon_r = 39.7$, $\rho = 1.00 \text{ g/cm}^3$

Cube 5x5x7; SAR (1g): 4.12 mW/g, SAR (10g): 2.17 mW/g, (Worst-case extrapolation)

Coarse: Dx = 12.0, Dy = 12.0, Dz = 10.0

Powerdrift: -0.02 dB

