

SAR EVALUATION REPORT

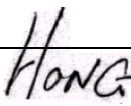

For

High Tech Computer, Corp.

23, Hsin-Hua Rd.,
Taoyuan, 330, Taiwan

FCC ID: NM8HIMALAYAS

2003-09-11

This Report Concerns: <input checked="" type="checkbox"/> Original Report	Equipment Type: Wireless PDA Phone
Test Engineer: Eric Hong / 	
Report No.: R0308083S	
Test Date: 2003-08-19 / 2003-08-22	
Reviewed By: Ling Zhang / 	
Prepared By: Bay Area Compliance Laboratory Corporation 230 Commercial Street Sunnyvale, CA 94085 Tel: (408) 732-9162 Fax: (408) 732 9164	

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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.

Summary of the Worst Case SAR values for head and body:

Ambient Temperature (°C): 23.0

Relative Humidity (%): 53

Model	Position	Frequency (MHz)	Output Power (dBm)	Test Type	Liquid	Phantom	Notes / Accessories	Measured (mW/g)	Limit (mW/g)	Plot #
PH10B – GPRS Modulation	Body Back Touching	1880	29.93	Body worn	Body	Flat	Backpack & Serial Cble	0.726	1.6	5
		1880	29.93	Body worn	Body	Flat	Backpack	0.726	1.6	6
PH10B	Left Head, Tilted	1880	29.93	Face-held	Head	Head	Backpack	0.362	1.6	12

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.
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- [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	2003-08-26	456
SPEAG E-Field Probe ET3DV6	2003-08-26	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	2003-11-06	BCL-049
SPEAG Validation Dipole D900V2	2003-09-02	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	2004-06-20	3009A00791
Microwave Amp. 8349B	N/A	2644A02662
Power Meter HP436A	2004-04-02	2709A29209
Power Sensor HP8482A	2004-04-02	2349A08568
Signal Generator RS SMIQ O3	2004-02-10	1084800403
Network Analyzer HP-8753ES	2004-07-30	820079
Dielectric Probe Kit HP85070A	N/A	N/A
Hewlett Packard HP8566B Spectrum Analyzer	2004-07-23	None
Hewlett Packard HP 7470A Plotter	2004-07-23	None
A.H. System SAS0200 Horn Antenna	2004-07-23	None
Com-Power AB-100 Dipole Antenna	2004-07-23	None
Agilent E4419b	2004-04-08	GB40202891
Agilent E4412a	2004-04-08	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:

Hans Klay

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

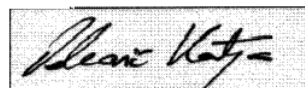
Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

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)

1900 MHz Head Liquid Validation. 2003-08-19

1900 MHz Head Liquid Validation.txt

frequency	ϵ'	ϵ''
1850000000.0000	39.3503	12.8420
1852000000.0000	39.3842	12.8324
1854000000.0000	39.3942	12.8960
1856000000.0000	39.4190	12.9443
1858000000.0000	39.4096	12.9601
1860000000.0000	39.3979	12.9829
1862000000.0000	39.4186	12.9712
1864000000.0000	39.4100	12.9902
1866000000.0000	39.4232	12.9845
1868000000.0000	39.4134	12.9935
1870000000.0000	39.4292	12.9689
1872000000.0000	39.4326	12.9761
1874000000.0000	39.3976	12.9334
1876000000.0000	39.4099	12.9676
1878000000.0000	39.4444	12.9571
1880000000.0000	39.4611	12.9623
1882000000.0000	39.4844	12.9898
1884000000.0000	39.4928	12.9593
1886000000.0000	39.4724	13.0062
1888000000.0000	39.5293	13.0587
1890000000.0000	39.5229	13.0403
1892000000.0000	39.5232	13.0441
1894000000.0000	39.4713	13.0088
1896000000.0000	39.5052	13.0142
1898000000.0000	39.5121	13.0054
1900000000.0000	39.5005	13.0059
1902000000.0000	39.4934	12.9807
1904000000.0000	39.4693	12.9747
1906000000.0000	39.4804	12.9484
1908000000.0000	39.4350	12.9324
1910000000.0000	39.4459	12.9260
1912000000.0000	39.4633	12.9303
1914000000.0000	39.4319	12.9072
1916000000.0000	39.4207	12.9075
1918000000.0000	39.4308	12.9061
1920000000.0000	39.3863	12.8934
1920000000.0000	39.3619	12.8610
1924000000.0000	39.3678	12.8735
1926000000.0000	39.3590	12.8981
1928000000.0000	39.3283	12.9295
1930000000.0000	39.3424	12.9307
1932000000.0000	39.3400	12.9312
1934000000.0000	39.3061	12.9201
1936000000.0000	39.3011	12.9242
1938000000.0000	39.2583	12.9180
1940000000.0000	39.2379	12.9278
1942000000.0000	39.2117	12.9221
1944000000.0000	39.2407	12.9108
1946000000.0000	39.1922	12.9286
1948000000.0000	39.1907	12.9518
1950000000.0000	39.1637	12.9792

8/19/2003
Hong

$$\sigma = \omega \epsilon_0 \epsilon'' = 2 \pi f \epsilon_0 \epsilon'' = 1.37$$

where $f = 1900 \times 10^6$
 $\epsilon_0 = 8.854 \times 10^{-12}$
 $\epsilon'' = 13.0059$

1900 MHz Body Liquid Validation, 2003-08-22

frequency	e'	e''
1850000000.0000	53.4409	13.8883
1852000000.0000	53.4208	13.8620
1854000000.0000	53.4186	13.8400
1856000000.0000	53.4223	13.8738
1858000000.0000	53.4060	13.8743
1860000000.0000	53.3804	13.8556
1862000000.0000	53.4142	13.8456
1864000000.0000	53.3790	13.8796
1866000000.0000	53.4089	13.8786
1868000000.0000	53.3906	13.8981
1870000000.0000	53.4077	13.8784
1872000000.0000	53.4221	13.8863
1874000000.0000	53.3931	13.9005
1876000000.0000	53.4071	13.9288
1878000000.0000	53.4071	13.8842
1880000000.0000	53.4027	13.8896
1882000000.0000	53.4353	13.8809
1884000000.0000	53.4400	13.8781
1886000000.0000	53.3894	13.8818
1888000000.0000	53.4198	13.8801
1890000000.0000	53.4038	13.8855
1892000000.0000	53.4340	13.9041
1894000000.0000	53.4060	13.8976
1896000000.0000	53.4149	13.8650
1898000000.0000	53.3674	13.8411
1900000000.0000	53.3743	13.8716
1902000000.0000	53.4000	13.8601
1904000000.0000	53.3756	13.8413
1906000000.0000	53.3811	13.8295
1908000000.0000	53.3398	13.8217
1910000000.0000	53.3334	13.7982
1912000000.0000	53.3474	13.8070
1914000000.0000	53.3218	13.7901
1916000000.0000	53.3398	13.7812
1918000000.0000	53.3166	13.7369
1920000000.0000	53.2468	13.7170
1922000000.0000	53.2701	13.7291
1924000000.0000	53.2527	13.7818
1926000000.0000	53.1968	13.7024
1928000000.0000	53.1685	13.7062
1930000000.0000	53.1679	13.6953
1932000000.0000	53.1663	13.7182
1934000000.0000	53.1450	13.7040
1936000000.0000	53.1456	13.6593
1938000000.0000	53.0805	13.6425
1940000000.0000	53.0323	13.6261
1942000000.0000	52.9913	13.5919
1944000000.0000	52.9829	13.5923
1946000000.0000	52.9307	13.5903
1948000000.0000	52.9426	13.6107
1950000000.0000	52.9209	13.6303

8/22/2003
HONG

$$\sigma = \omega \epsilon_0 \epsilon'' = 2 \pi f \epsilon_0 \epsilon'' = 1.47$$

where $f = 1900 \times 10^6$
 $\epsilon_0 = 8.854 \times 10^{-12}$
 $\epsilon'' = 13.8716$

1900 MHz Head Liquid Validation, 2003-08-22

1900 MHz Head Liquid Validation - M1.txt

frequency	ϵ'	ϵ''
1850000000.0000	39.1501	13.8521
1852000000.0000	39.1843	13.8425
1854000000.0000	39.1941	13.8861
1856000000.0000	39.2191	13.9344
1858000000.0000	39.2095	13.9502
1860000000.0000	39.1978	13.9728
1862000000.0000	39.2187	13.9611
1864000000.0000	39.2101	13.9803
1866000000.0000	39.2233	13.9744
1868000000.0000	39.2133	13.9836
1870000000.0000	39.2294	13.9588
1872000000.0000	39.2325	13.9662
1874000000.0000	39.1975	13.9435
1876000000.0000	39.2098	13.9574
1878000000.0000	39.2445	13.9472
1880000000.0000	39.2612	13.9524
1882000000.0000	39.2843	13.9799
1884000000.0000	39.2927	13.9497
1886000000.0000	39.2725	14.0163
1888000000.0000	39.3294	14.0488
1890000000.0000	39.3228	14.0304
1892000000.0000	39.3233	14.0342
1894000000.0000	39.3714	14.0289
1896000000.0000	39.3053	14.0153
1898000000.0000	39.3122	14.0163
1900000000.0000	39.3004	13.9011
1902000000.0000	39.2933	13.9708
1904000000.0000	39.2692	13.9648
1906000000.0000	39.2803	13.9385
1908000000.0000	39.2352	13.9223
1910000000.0000	39.2458	13.9162
1912000000.0000	39.2632	13.9202
1914000000.0000	39.2318	13.8073
1916000000.0000	39.2204	13.8074
1918000000.0000	39.2307	13.8062
1920000000.0000	39.2863	13.8933
1920000000.0000	39.2619	13.8612
1924000000.0000	39.1677	13.7733
1926000000.0000	39.1591	13.7982
1928000000.0000	39.1286	13.7291
1930000000.0000	39.1423	13.3064
1932000000.0000	39.1401	13.9312
1934000000.0000	39.1062	13.9201
1936000000.0000	39.1015	13.9244
1938000000.0000	39.0586	13.9172
1940000000.0000	39.0378	13.9269
1942000000.0000	39.0116	13.9222
1944000000.0000	39.0407	13.9117
1946000000.0000	38.9822	13.9277
1948000000.0000	38.9807	13.9526
1950000000.0000	38.9832	13.9783

8/22/2003
HONG

$$\sigma = \omega \epsilon_0 \epsilon'' = 2 \pi f \epsilon_0 \epsilon'' = 1.47$$

where $f = 1900 \times 10^6$
 $\epsilon_0 = 8.854 \times 10^{-12}$
 $\epsilon'' = 13.9011$

3 - EUT DESCRIPTION

3.1 EUT Description

Applicant: High Tech Computer, Corp.
Product Description: Wireless PDA Phone
Product Model Number: PH10A/PH10B
FCC ID: NM8HIMALAYAS
Serial Number: None
Maximum RF Output Power: 29.93 dBm
RF Exposure environment: General Population/Uncontrolled
Applicable Standard: FCC CFR 47, Part 24
Application Type: Certification

3.2 Accessories Information

Manufacturer	Description	Model
HTC	USB/Serial Cradle with Cable	PH15A PH15B
MEC	USB/Serial Cable	60-3897-200A/ 60-3897-100A
HTC	Backpack	PH16
MEC	VGA Cable	N/A
MEC	DC Connector	60-3897-300A
Stereo Headset	Eacotech	TS168-45- 03206N-VM-02
Mono Headset	Eacotech	N/A
Pouch	Newtch	HTC-055B-6

4 - SYSTEM TEST CONFIGURATION

4.1 Justification

The system was configured for testing in a typical fashion (as normally used by a typical user).

4.2 EUT Exercise Procedure

The EUT exercising program used during SAR testing was designed to exercise the various system components in a manner similar to a typical use.

4.3 Equipment Modifications

No modification(s) were made by BACL to ensure that the EUT complies with the applicable limits.

5 – CONDUCTED OUTPUT POWER MEASUREMENTS

5.1 Provision Applicable

According to FCC §22.913 (a), the ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 watts.

5.2 Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

5.3 Test equipment

Hewlett Packard HP8564E Spectrum Analyzer, Calibration Due Date: 2004-08-01.

Hewlett Packard HP 7470A Plotter, Calibration not required.

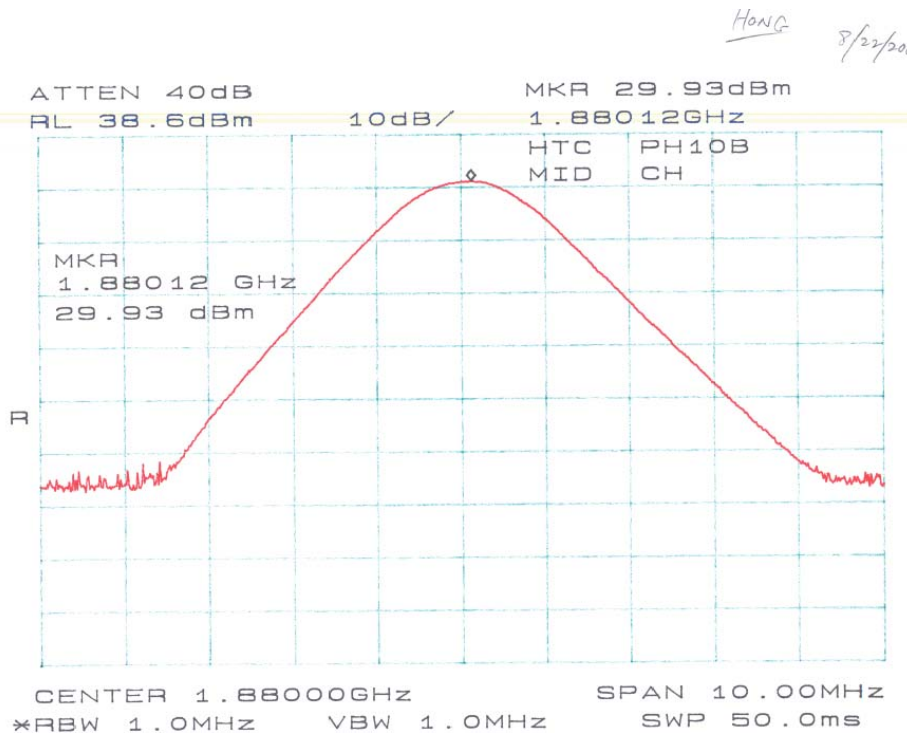
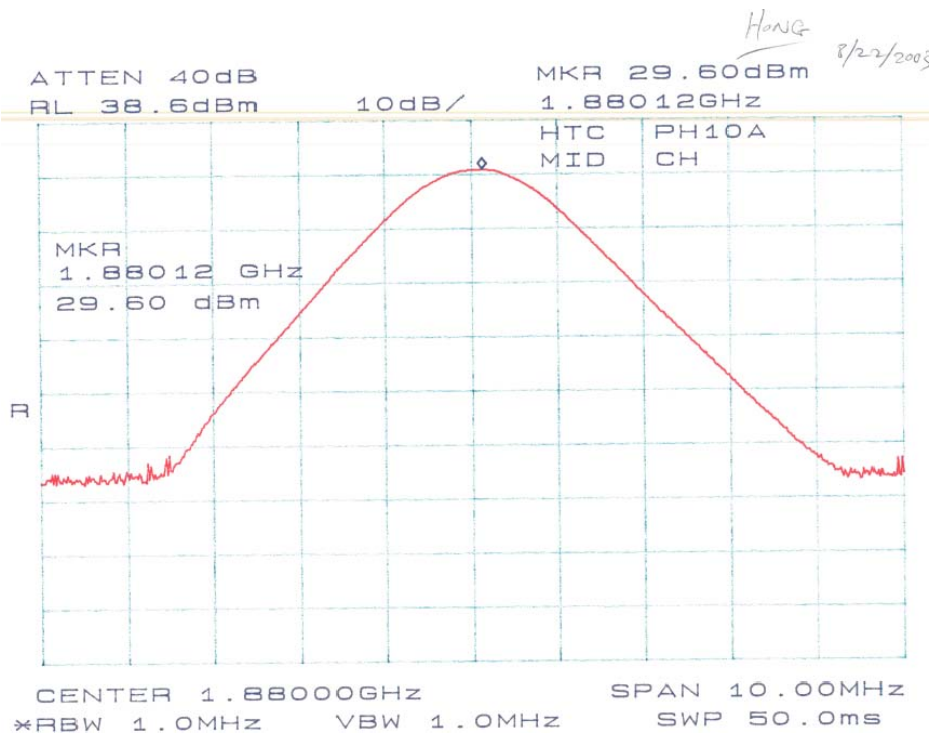
A.H. Systems SAS200 Horn Antenna, Calibration Due Date: 2004-05-31

Com-Power AB-100 Dipole Antenna, Calibration Due Date: 2003-09-05

5.4 Test Results

Model No.	Channel	Frequency (MHz)	Output Power in dBm	Output Power in W	Limit (W)
PH10A	Middle	1880	29.60	0.912	7
PH10B	Middle	1880	29.93	0.984	7

Please refer to the following plots.



6 - DOSIMETRIC ASSESSMENT SETUP

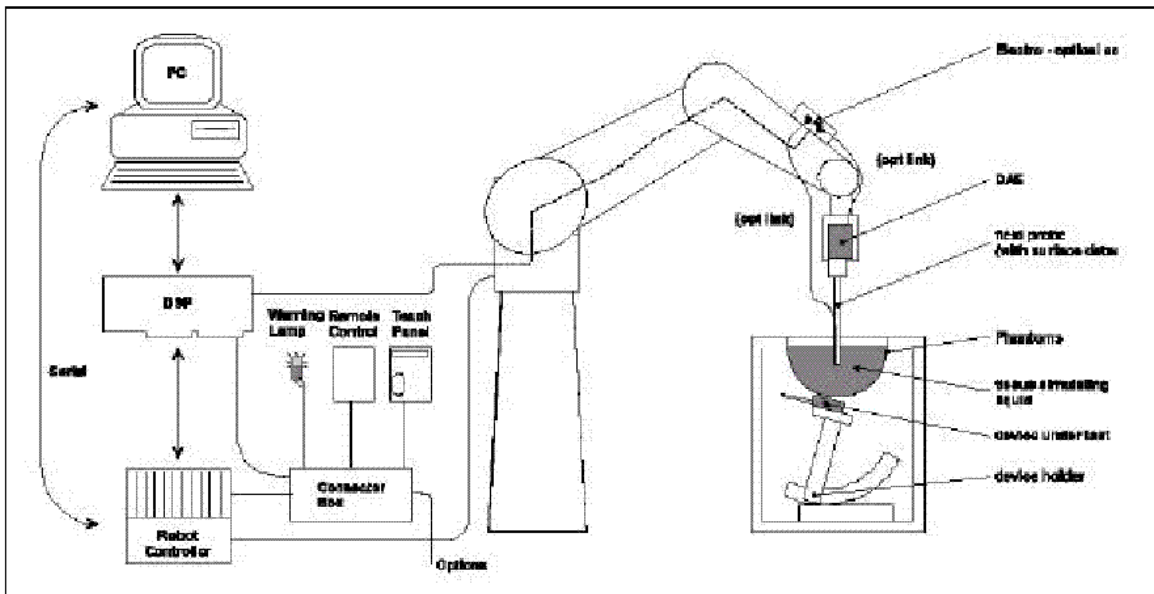
These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than $\pm 0.02\text{mm}$. 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	0.95	1.0	1.07	1.42	1.45	1.88	1.78

6.1 Measurement System Diagram



The DAS3 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. DAS3 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.

6.2. 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

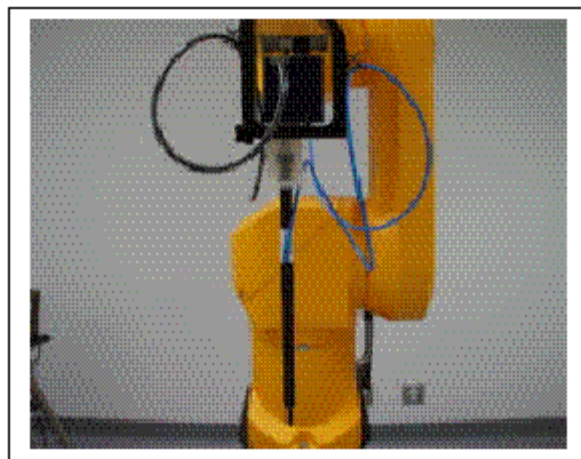
Tip diameter: 6.8 mm

Distance from probe tip to dipole centers: 2.7 mm

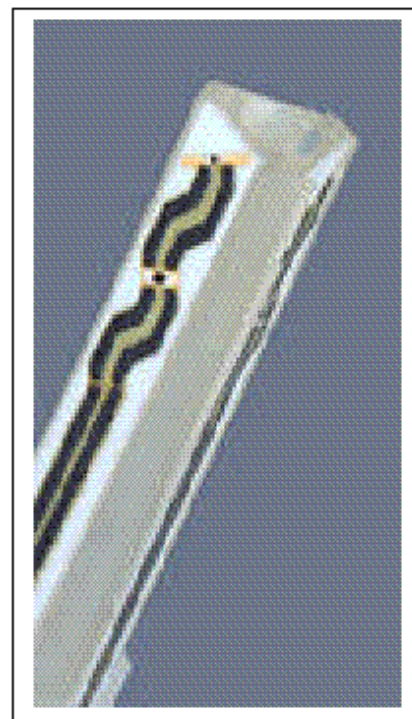
Application General dosimetric up to 3 GHz

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	σ
	-Density	ρ

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)
 $\mu\text{V}/(\text{V/m})^2$ 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.

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

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]
 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 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/cm³
 E_{tot} = total electric field strength in V/m
 H_{tot} = total magnetic field strength in V/m

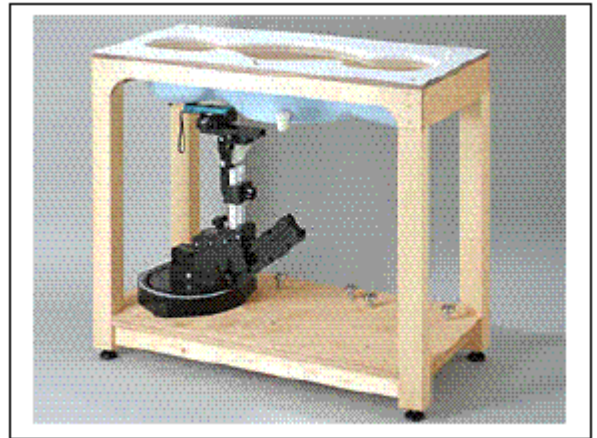
Generic Twin Phantom

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)

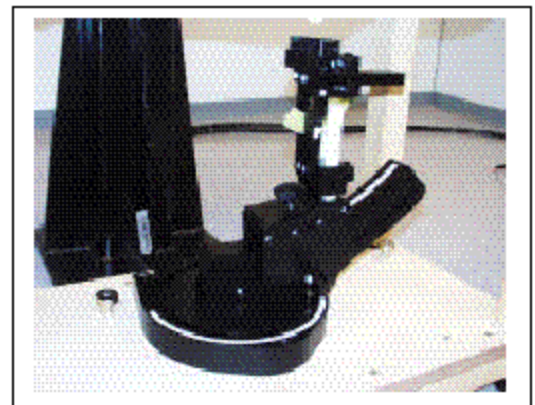


Generic Twin Phantom

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

6.3 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.

Measurement Uncertainty Analysis per IEEE P1528-2002

Description	Section	Reported Variance (%)	Probability Distribution type	Divisor	CI (1g)	Ui (1g)	Vi	welc/satt series term
Probe Calibration	E.2.1	4.80	N	1	1	4.80	1.00E+09	5.30842E-07
Axial isotropy	E.2.2	4.70	R	1.732	0.707107	1.92	1.00E+09	1.35563E-08
Hemispherical isotropy	E.2.2	9.60	R	1.732	0.707107	3.92	1.00E+09	2.35957E-07
Boundary effects	E.2.3	8.30	R	1.732	1	4.79	1.00E+09	5.27377E-07
Linearity	E.2.4	4.70	R	1.732	1	2.71	1.00E+09	5.4225E-08
System Detection Limit	E.2.5	1.00	R	1.732	1	0.58	1.00E+09	1.11124E-10
Readout Electronics	E.2.6	0.00	N	1	1	0.00	1.00E+09	0
Response time	E.2.7	0.00	R	1.732	1	0.00	1.00E+09	0
Integration time	E.2.8	0.00	R	1.732	1	0.00	1.00E+09	0
RF Ambient conditions	E.6.1	3.00	R	1.732	1	1.73	1.00E+09	9.00106E-09
Probe positioning mechanical tolerance	E.6.2	0.40	R	1.732	1	0.23	1.00E+09	2.84478E-12
Probe positioning wrt phantom shell	E.6.3	2.90	R	1.732	1	1.67	1.00E+09	7.8596E-09
Extra/inter-polation & integration algorithmsfor max								
SAR evaluation	E.5.2	3.90	R	1.732	1	2.25	1.00E+09	2.57079E-08
Test sample positioning	8, E.4.2	6.00	R	1.732	1	3.46	1.00E+09	1.44017E-07
Device holder distance tolerance	E.4.1	5.00	N	1	1	5.00	1.00E+09	0.000000625
Output power and SAR drift measurement	8, E.6.6.2	5.00	R	1.732	1	2.89	1.00E+09	6.94526E-08
Phantom uncertainty, shell thickness tolerance	E.3.1	4.00	R	1.732	1	2.31	1.00E+09	2.84478E-08
Liquid conductivity, deviation from target values	E.3.2	5.00	R	1.732	0.64	1.85	1.00E+09	1.16522E-08
Liquid conductivity, measurement uncertainty	E.3.3	5.00	N	1	0.64	3.20	5	20.97152
Liquid permittivity, deviation from target values	E.3.2	5.00	R	1.732	0.6	1.73	1.00E+09	9.00106E-09
Liquid permittivity, measurement uncertainty	E.3.3	5.00	N	1	0.6	3.00	5	16.2
								689
Probe isotropy sensitivity coefficient	0.5							
Combined Standard Uncertainty					12.65 %			
Expanded Uncertainty, 95%	k= 2.0036				25.34 %			

7 - EVALUATION PROCEDURE

7.1 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.

7.2 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).

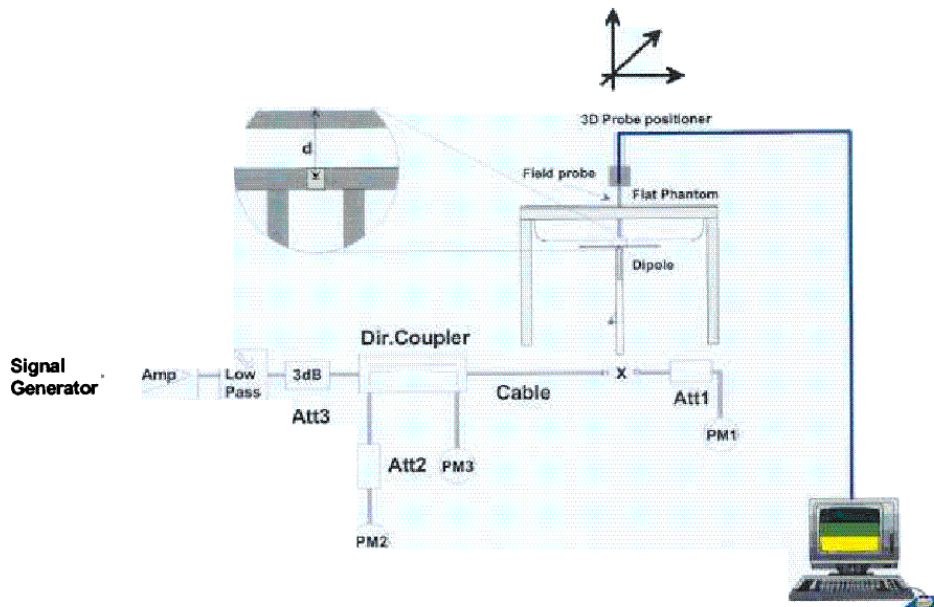
Population/uncontrolled environments Partial-body limit 1.6W/kg applied to the EUT.

7.3 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:

7.4 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.

7.5 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

7.6 Liquid Measurement Result

Simulant	Freq [MHz]	Parameters	Liquid Temp [°C]	Target Value	Measured Value	Deviation	Limits [%]
Head	1900	ϵ_r	21.0	40.0	39.5	-1.25	± 5
		σ	21.0	1.40	1.37	-2.14	± 5
		1g SAR	21.0	39.7	35.93	-9.50	± 10
Body	1900	ϵ_r	22.0	53.3	53.4	0.19	± 5
		σ	22.0	1.52	1.47	-3.29	± 5
		1g SAR	22.0	24.97	25.85	3.52	± 10
Head	1900	ϵ_r	21.0	40.0	39.3	-1.75	± 5
		σ	21.0	1.40	1.47	5.00	± 5
		1g SAR	21.0	39.7	38.84	-2.17	± 10

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

1900 MHz Head Liquid (2003-08-19) Forward Power = 20.4 dBm = 109.65 mW

1900 MHz Body Liquid (2003-08-22) Forward Power = 21.65 dBm = 146.22 mW

1900 MHz Head Liquid (2003-08-22) Forward Power = 20.16 dBm = 103.75 mW

1900 MHz Head Liquid System Validation (Ambient Temp = 23 Deg C, Liquid Temp = 21 Deg C, Forwar Power = 20.4 dBm, 8/19/03)

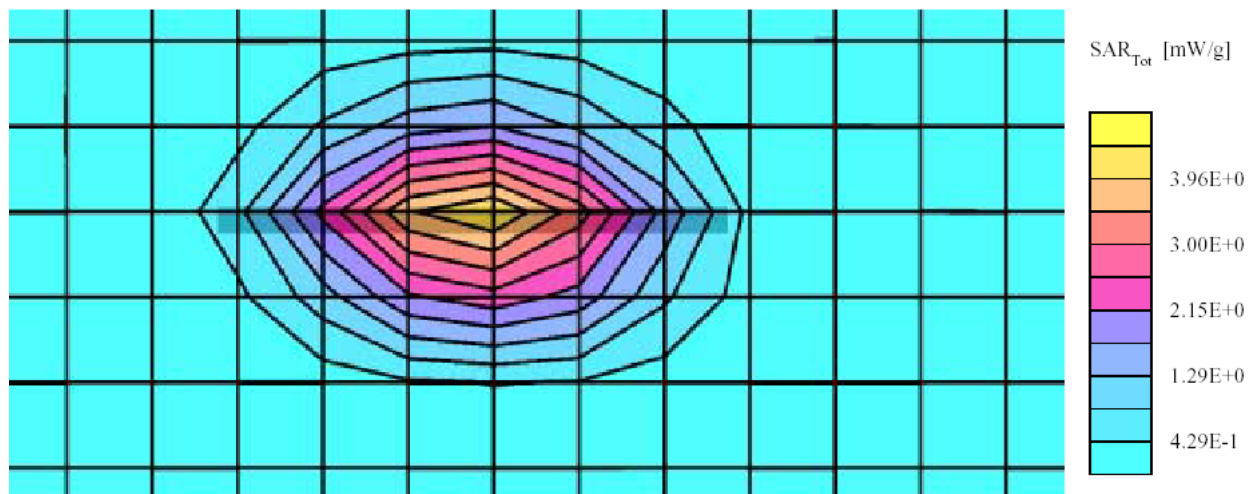
SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 1900 MHz

Probe: ET3DV6 - SN1604; ConvF(5.50,5.50,5.50); Crest factor: 1.0; Head 1900 MHz: $\sigma = 1.37$ mho/m $\epsilon_r = 39.5$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 3.94 mW/g, SAR (10g): 1.99 mW/g, (Worst-case extrapolation)

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

Powerdrift: -0.01 dB



1900 MHz Body Liquid System Validation (Ambient Temp = 23 Deg C, Liquid Temp = 22 Deg C, Forward Power = 21.65 dBm, 8/22/2003)

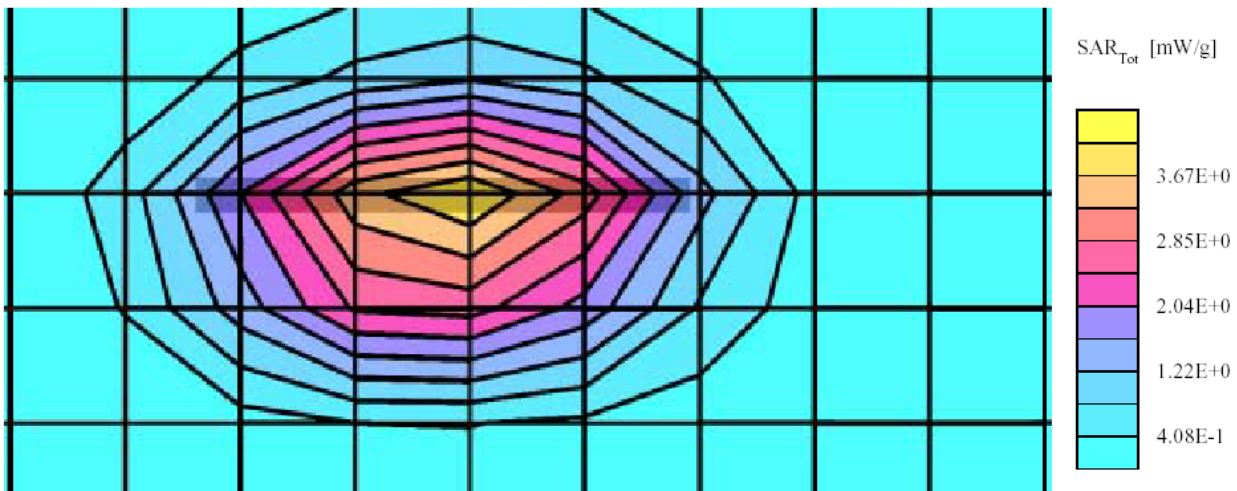
SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 1900 MHz

Probe: ET3DV6 - SN1604; ConvF(4.90,4.90,4.90); Crest factor: 1.0; Body 1900 MHz: $\sigma = 1.47$ mho/m $\epsilon_r = 53.4$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 3.78 mW/g, SAR (10g): 2.01 mW/g, (Worst-case extrapolation)

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

Powerdrift: -0.00 dB



1900 MHz Head Liquid System Validation (Ambient Temp = 23 Deg C, Liquid Temp = 21 Deg C, Forwar Power = 20.16 dBm, 8/22/03)

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

Probe: ET3DV6 - SN1604; ConvF(5.50,5.50,5.50); Crest factor: 1.0; Head 1900 MHz: $\sigma = 1.47$ mho/m $\epsilon_r = 39.3$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 4.03 mW/g, SAR (10g): 2.02 mW/g, (Worst-case extrapolation)

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

Powerdrift: -0.02 dB

