



SAR EVALUATION REPORT

Report No. : 24EE0060-HO-1

Applicant : YAMAHA CORPORATION
Type of Equipment : Wireless LAN Card
Model No. : WD05740
FCC ID : A6RDKV137138
Test standard : FCC47CFR 2.1093
FCC OET Bulletin 65, Supplement C
Test Result : Complied
Max SAR Measured : 0.563W/kg(Body, 2412MHz)

1. This test report shall not be reproduced except full or partial, without the written approval of UL Apex Co., Ltd.
2. The results in this report apply only to the sample tested.
3. This equipment is in compliance with above regulation. We hereby certify that the data contain a true representation of the SAR profile.
4. The test results in this test report are traceable to the national or international standards.

Date of test : January 06, 2004

Tested by :

Miyo Ikuta
Head Office EMC Lab.

Approved by :

Tetsuo Maeno
Site Manager of Head Office EMC Lab.

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SECTION 1 : Client information

Company Name : YAMAHA CORPORATION
Brand Name : YAMAHA
Address : 10-1 Nakazawa-Cho, Hamamatsu-City, Shizuoka-Pref 430-8650 , Japan
Telephone Number : +81 53 460 2376
Facsimile Number : +81 53 460 2379
Contact Person : Kenji Fujisawa

SECTION 2 : Equipment under test (Wireless LAN Card)

2.1 Identification of Wireless LAN Card

Applicant : YAMAHA CORPORATION
Type of Equipment : Wireless LAN Card
Model No. : WD05740
Serial No. : D2.3A.E4
Country of Manufacture : Japan
Receipt Date of Sample : January 06,2003
Condition of EUT : Production prototype
(Not for sale: This sample is equivalent to mass-produced items.)
Category Identified : Portable device

2.2 Product description of Wireless LAN Card

Tx Frequency : 2412MHz~2462MHz
Modulation : DSSS: Direct sequence spread spectrum (IEEE802.11b)
Rating : DC 3.3V
Max.Output Power Tested : 16.10 dBm Peak Conducted
Antenna Type : Monopole



SECTION 3 : Requirements for compliance testing defined by the FCC

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. 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 for an uncontrolled environment and 8.0 mW/g for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992. 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.

1 Specific Absorption Rate (SAR) is a measure of the rate of energy absorption due to exposure to an RF transmitting source (wireless portable device).

2 IEEE/ANSI Std. C95.1-1992 limits are used to determine compliance with FCC ET Docket 93-62.

SECTION 4 : Dosimetry assessment setup

These measurements were performed with the automated near-field scanning system DASY4 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9 m), which positions the probes with a positional repeatability of better than +/- 0.02 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 SAR measurements were conducted with the dosimetry probe ET3DV6, SN: 1685 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in [2] with accuracy of better than +/-10%. The spherical isotropy was evaluated with the procedure described in [3] and found to be better than +/-0.25 dB. The phantom used was the SAM Twin Phantom as described in FCC supplement C, IEEE P1528 and CENELEC EN50361.

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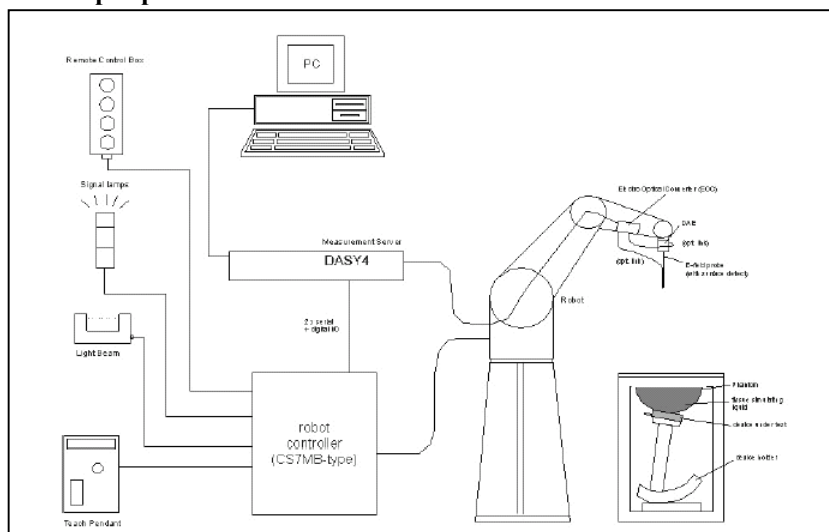
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4.1 Configuration and peripherals



The DASY4 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.
An arm extension for accommodating the data acquisition electronics (DAE).
2. 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.
3. 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.
4. The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
5. The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
6. A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
7. A computer operating Windows 2000.
8. DASY4 software.
9. Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
10. The SAM twin phantom enabling testing left-hand and right-hand usage.
11. The device holder for handheld mobile phones.
12. Tissue simulating liquid mixed according to the given recipes.
13. Validation dipole kits allowing to validate the proper functioning of the system.

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4.2 System components

4.2.1 ET3DV6 Probe Specification

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., glycol ether)

Calibration:

Basic Broad Band calibration in air from 10 MHz to 2.5 GHz
In brain and muscle simulating tissue at
Frequencies of 450 MHz, 900 MHz, 1.8 GHz and 2.45GHz (accuracy +/-8%)

Frequency:

10 MHz to 3GHz; 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 Range:

5 mW/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.

Dimensions:

Overall length: 330 mm (Tip: 16 mm)
Tip length: 16 mm
Body diameter: 12 mm (Body: 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



**Inside view of
ET3DV6 E-field Probe**

4.2.2 SAM Phantom

Construction:

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X, CENELEC EN 50361 and IEC 62209. 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 evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.

Shell Thickness:

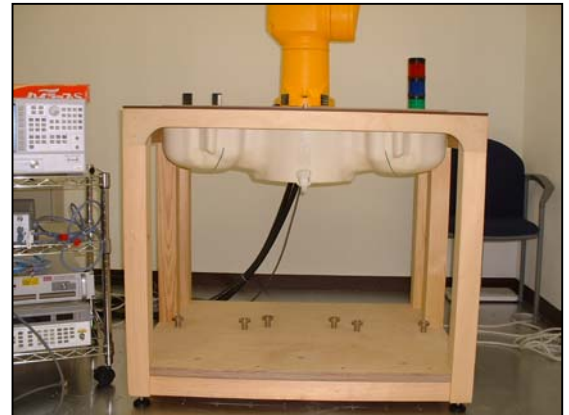
2 +/-0.2 mm

Filling Volume:

Approx. 25 liters

Dimensions:

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



SAM Phantom

4.2.3 Device Holder for Transmitters

In combination with the SAM Twin Phantom V4.0, 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. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.



Device Holder

Device holder couldn't be used at this SAR measurement.

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SECTION 5 : Test system specifications

Robot RX60L

Number of Axes	:	6
Payload	:	1.6 kg
Reach	:	800mm
Repeatability	:	+/-0.025mm
Control Unit	:	CS7M
Programming Language	:	V+
Manuafacture	:	Stäubli Unimation Corp. Robot Model: RX60

DASY4 Measurement sever

Features	:	166MHz low power Pentium MMX 32MB chipdisk and 64MB RAM Serial link to DAE (with watchdog supervision) 16 Bit A/D converter for surface detection system Two serial links to robot (one for real-time communication which is supervised by watchdog) Ethernet link to PC (with watchdog supervision) Emergency stop relay for robot safety chainTwo expansion slots for future applications
Manufacture	:	Schimid & Partner Engineering AG

Data Acquisition Electronic (DAE)

Features	:	Signal amplifier, multiplexer, A/D converter and control logic Serial optical link for communication with DASY4 embedded system (fully remote controlled) 2 step probe touch detector for mechanical surface detection and emergency robot stop (not in -R version)
Measurement Range	:	1 μ V to > 200 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset voltage	:	< 1 μ V (with auto zero)
Input Resistance	:	200 M Ω
Battery Power	:	> 10 h of operation (with two 9 V battery)
Dimension	:	60 x 60 x 68 mm
Manufacture	:	Schimid & Partner Engineering AG

Software

Item	:	Dosimetric Assesment System DASY4
Type No.	:	SD 000 401A, SD 000 402A
Software version No.	:	4.1
Manufacture / Origin	:	Schimid & Partner Engineering AG

E-Field Probe

Model	:	ET3DV6
Serial No.	:	1685
Construction	:	Triangular core fiber optic detection system
Frequency	:	10 MHz to 6 GHz
Linearity	:	+/-0.2 dB (30 MHz to 3 GHz)
Manufacture	:	Schimid & Partner Engineering AG

Phantom

Type	:	SAM Twin Phantom V4.0
Shell Material	:	Fiberglass
Thickness	:	2.0 +/-0.2 mm
Volume	:	Approx. 25 liters
Manufacture	:	Schimid & Partner Engineering AG

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SECTION 6 : Measurement outline

This EUT (Wireless LAN card) can be inserted into only PCMCIA slot of PDA.
We tested 1-host of PDA, because the power of this EUT was less than 100mW.
The detail of host device that we used for SAR testing is shown in the following.

6.1 Information of PDA

Manufacture : FUJITSU
Model No. : FLX2H
Serial No. : YN2703803
Slot : Single slot



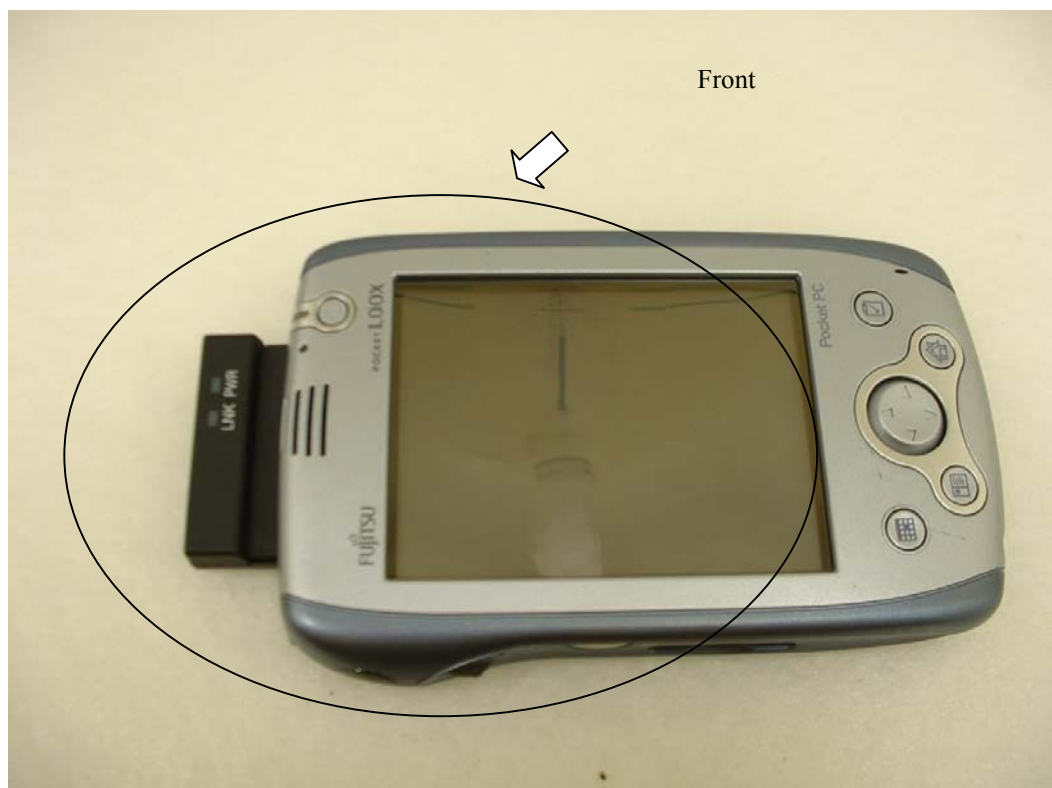
SECTION 7 : Test setup of EUT

7.1 Photographs of test setup

When users operate PDA with this EUT (Wireless LAN card) inserted in, it could be considered to touch or get close to their bodies. In order to assume this situation, we performed the test at the following positions. Please refer to "APPENDIX 1" for more details.

- 1.Front : The test was performed in touch with front surface of PDA to the flat phantom. Wireless LAN card was distanced 7mm from the flat phantom
- 2.Back : The test was performed in touch with back surface of PDA to the flat phantom. Wireless LAN card was distanced 3mm from the flat phantom
- 3.Right Side : The test was performed in touch with right side of PDA Terminal to the flat phantom. Wireless LAN card was distanced 17mm from the flat phantom
- 4.Left Side : The test was performed in touch with left side of PDA to the flat phantom. Wireless LAN card was distanced 20mm from the flat phantom
- 5.Top : The test was performed in touch with top of Wireless LAN card to the flat phantom.

1. Front



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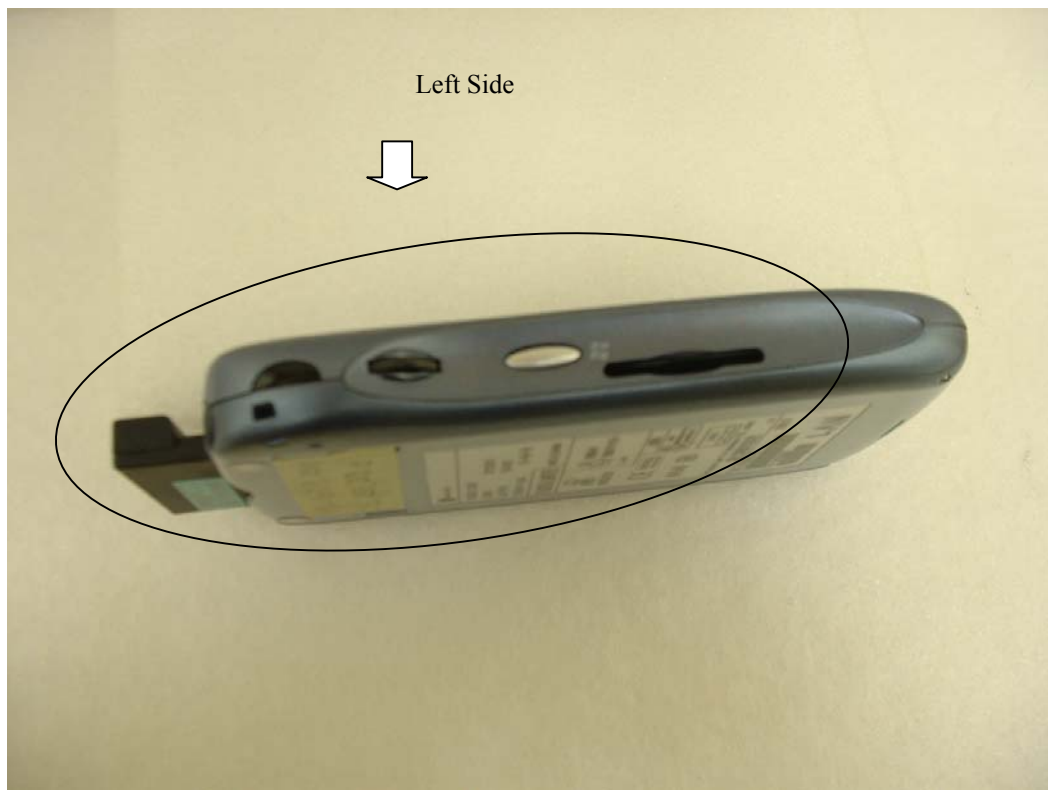
2. Back



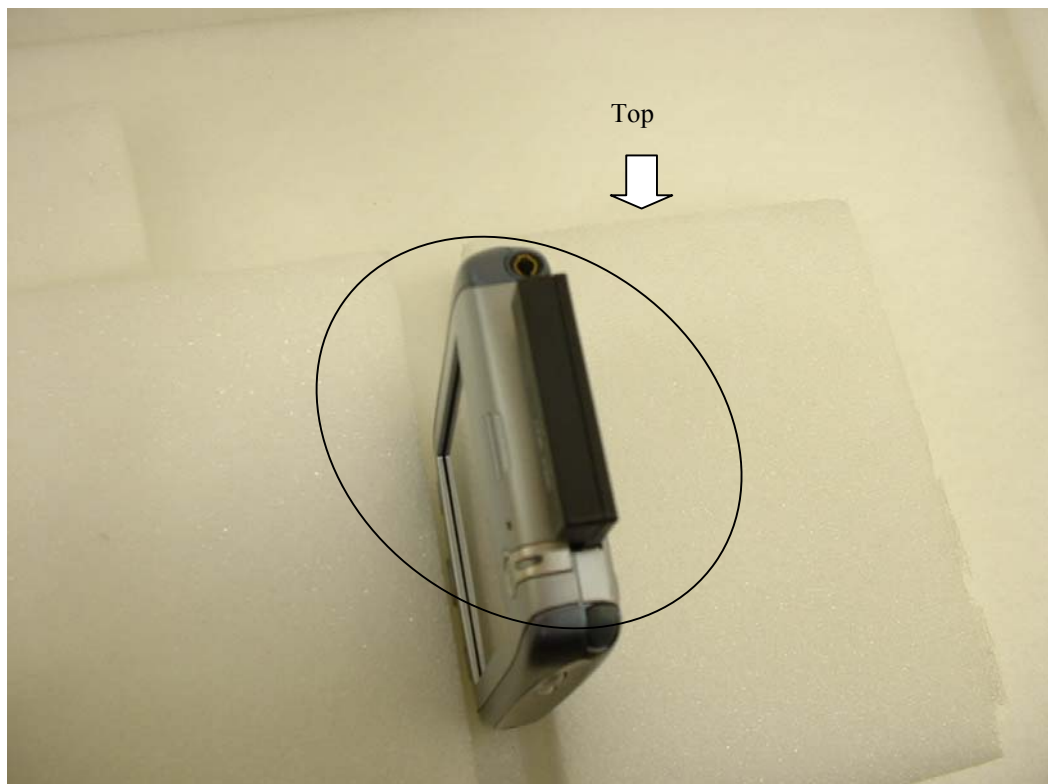
3. Right Side



4. Left Side



5. Top



7.2 EUT Tune-up procedure

We determined following conditions ;

Transmitter was continuous mode.

Crest Factor = 1

Frequency conditions were low , middle and high channels (2412MHz ,2437MHz and 2462MHz)

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SECTION 8 : Measurement uncertainty

The uncertainty budget has been determined for the DASY4 measurement system according to the NIS81 [13] and the NIST1297 [6] documents and is given in the following Table. The result of some test showed that the power drift has exceeded 5%. Therefore, the uncertainty of power drift expanded to 10%. However, the extended uncertainty ($k=2$) of a test is less than 30%.

Error Description	Uncertainty value \pm %	Probability distribution	divisor	(ci)1 lg	Standard Uncertainty (1g)	vi or v _{eff}
Measurement System						
Probe calibration	± 4.8	Normal	1	1	± 4.8	∞
Axial isotropy of the probe	± 4.7	Rectangular	$\sqrt{3}$	$(1-c_p)^{1/2}$	± 1.9	∞
Spherical isotropy of the probe	± 9.6	Rectangular	$\sqrt{3}$	$(c_p)^{1/2}$	± 3.9	∞
Boundary effects	± 1.0	Rectangular	$\sqrt{3}$	1	± 0.6	∞
Probe linearity	± 4.7	Rectangular	$\sqrt{3}$	1	± 2.7	∞
Detection limit	± 1.0	Rectangular	$\sqrt{3}$	1	± 0.6	∞
Readout electronics	± 1.0	Normal	1	1	± 1.0	∞
Response time	± 0.8	Rectangular	$\sqrt{3}$	1	± 0.5	∞
Integration time	± 2.6	Rectangular	$\sqrt{3}$	1	± 1.5	∞
RF ambient conditions	± 3.0	Rectangular	$\sqrt{3}$	1	± 1.7	∞
Mech. constraints of robot	± 0.4	Rectangular	$\sqrt{3}$	1	± 0.2	∞
Probe positioning	± 2.9	Rectangular	$\sqrt{3}$	1	± 1.7	∞
Extrap. and integration	± 1.0	Rectangular	$\sqrt{3}$	1	± 0.6	∞
Test Sample Related						
Device positioning	± 2.9	Rectangular	$\sqrt{3}$	1	± 2.9	6
Device holder uncertainty	± 3.6	Rectangular	$\sqrt{3}$	1	± 3.6	4
Power drift	± 10.0	Rectangular	$\sqrt{3}$	1	± 5.8	∞
Phantom and Setup						
Phantom uncertainty	± 4.0	Rectangular	$\sqrt{3}$	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	Rectangular	$\sqrt{3}$	0.64	± 1.8	∞
Liquid conductivity (meas.)	± 5.0	Rectangular	$\sqrt{3}$	0.64	± 1.8	∞
Liquid permittivity (target)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (meas.)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Combined Standard Uncertainty					± 11.51	
Expanded Uncertainty ($k=2$)					± 23.0	

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SECTION 9 : Simulated tissue liquid parameter

9.1 Simulated Tissue Liquid Parameter confirmation

The dielectric parameters were checked prior to assessment using the HP85070D dielectric probe kit.
The dielectric parameters measurement are reported in each correspondent section.

9.1.1 Head 2450MHz

Type of liquid : Head 2450 MHz
Ambient temperature (deg.c.) : 24.8
Relative Humidity (%) : 45
Liquid depth (cm) : 15.3

Date : January 06, 2004
Measured By : Miyo Ikuta

DIELECTRIC PARAMETERS MEASUREMENT RESULTS						
Liquid Temp [deg.c]		Parameters	Target Value	Measured	Deviation [%]	Limit [%]
Before	After					
23.6	23.6	Relative Permittivity ϵ_r	39.2	38.5	-1.8	+/-5
		Coductivity σ [mho/m]	1.80	1.84	2.2	+/-5

9.1.2 Muscle 2450MHz

Type of liquid : Muscle 2450 MHz
Ambient temperature (deg.c.) : 24.8
Relative Humidity (%) : 45
Liquid depth (cm) : 15.6

Date : January 06, 2004
Measured By : Miyo Ikuta

DIELECTRIC PARAMETERS MEASUREMENT RESULTS						
Liquid Temp [deg.c]		Parameters	Target Value	Measured	Deviation [%]	Limit [%]
Before	After					
21.8	21.8	Relative Permittivity ϵ_r	52.7	50.1	-4.9	+/-5
		Coductivity σ [mho/m]	1.95	1.98	1.5	+/-5

9.2 Simulated Tissues

Ingredient	MiXTURE(%)	
	Head 2450MHz	Muscle 2450MHz
Water	45.0	69.83
DGMBE	55.0	30.17

Note:DGMBE(Diethylenglycol-monobuthyl ether)

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SECTION 10 : System validation data

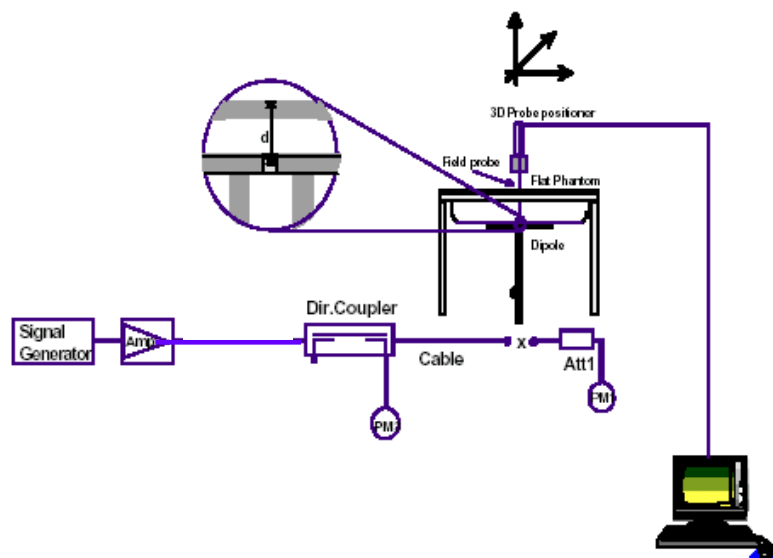
Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of +/-10%. The validation results are tabulated below. Please refer to APPENDIX 3.

Type of liquid	:	HEAD 2450MHz
Frequency	:	2450MHz
Liquid depth (cm)	:	15.3
Ambient temperature (deg.c.)	:	24.8
Relative Humidity (%)	:	45
Dipole	:	D2450V2 SN:713
Power	:	250mW

Date : January 06, 2004
Measured By : Miyo Ikuta

SYSTEM PERFORMANCE CHECK									
Liquid (HEAD 2450MHz)						System dipole validation target & measured			
Liquid Temp [deg.c.]		Relative Permittivity ϵ_r		Conductivity σ [mho/m]		SAR 1g [W/kg]		Deviation [%]	Limit [%]
Before	After	Target	Measured	Target	Measured	Target	Measured		
23.0	23.0	39.2	38.5	1.80	1.84	13.1	14.2	8.4	+/-10

Note: Please refer to Attachment for the result representation in plot format



2450MHz System performance check setup

Test system for the system performance check setup diagram

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SECTION 11 : Evaluation procedure

The evaluation was performed with the following procedure:

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

Step 2: The SAR distribution at the exposed side of head or body position was measured at a distance of each device from the inner surface of the shell. The area covered the entire dimension of the EUT(180 x 260) 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 found in the Step 2 (area scan) , a volume of 32 mm x 32 mm x 30 mm was assessed by measuring 5 x 5 x 7 points. And for any secondary peaks found in the Step2 which are within 2dB of maximum peak and not with this Step3 (Zoom scan) is repeated. 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 1.3 mm. The extrapolation was based on a least square algorithm [4]. 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 one-dimensional splines with the "Not a knot"-condition (in x, y and z-directions) [4], [5]. 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 E-field at the same location as in Step 1. It is measured power drift (the difference between the E-field measured in Step 4 and Step 1)

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SECTION 12 : Exposure limit

(A) Limits for Occupational/Controlled Exposure (W/kg)

Spatial Average (averaged over the whole body)	Spatial Peak (averaged over any 1g of tissue)	Spatial Peak (hands/wrists/feet/ankles averaged over 10g)
0.4	8.0	20.0

(B) Limits for General population/Uncontrolled Exposure (W/kg)

Spatial Average (averaged over the whole body)	Spatial Peak (averaged over any 1g of tissue)	Spatial Peak (hands/wrists/feet/ankles averaged over 10g)
0.08	1.6	4.0

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).

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

<p align="center">NOTE:GENERAL POPULATION/UNCONTROLLED EXPOSURE SPATIAL PEAK(averaged over any 1g of tissue) LIMIT 1.6 W/kg</p>
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SECTION 13 : SAR Measurement results

13.1 Conducted power measurement results

Date : January 06,2004

Measured By : Miyo Ikuta

CONDUCTED POWER MEASUREMENT RESULTS												
Frequency [MHz]	Before					After					Deviation [%]	Limit [%]
	Reading [dBm]	Att. [dB]	Cable loss [dB]	Result [dBm]	Convert [mW]	Reading [dBm]	Att. [dB]	Cable loss [dB]	Result [dBm]	Convert [mW]		
2412	4.8	10	1.3	16.10	40.7	4.6	10	1.3	15.90	38.9	-4.5	+/-5
2437	4.6	10	1.3	15.90	38.9	4.4	10	1.3	15.70	37.2	-4.5	+/-5
2462	4.2	10	1.3	15.50	35.5	4.1	10	1.3	15.40	34.7	-2.3	+/-5

13.2 Body 2450MHz SAR

Liquid Depth (cm) : 15.6
Parameters : $\epsilon_r = 50.1$, $\sigma = 1.98$
Ambient Temperature[deg.c.] : 24.8
Relative Humidity (%) : 45

Model : WD05740
Serial No. : D2.3A.E4
Modulation : DSSS
Crest factor : 1

Date : January 06 ,2004

Measured By : Miyo Ikuta

BODY SAR MEASUREMENT RESULTS								
Frequency		Phantom Section	EUT Set-up Conditions			Liquid Temp.[deg.c]		SAR(1g) [W/kg]
Channel	[MHz]		Antenna	Position	Separation [mm]	Before	After	Maximum value of multi-peak)
Mid	2437	Flat	Fixed	Front	0	21.8	21.8	0.0813
Mid	2437	Flat	Fixed	Back	0	21.8	21.9	0.274
Mid	2437	Flat	Fixed	Right Side	0	21.8	21.9	0.0248
Mid	2437	Flat	Fixed	Left Side	0	22.0	22.0	0.0243
Mid	2437	Flat	Fixed	Top	0	21.9	21.8	0.496
Low	2412	Flat	Fixed	Top	0	22.0	22.1	0.563
High	2462	Flat	Fixed	Top	0	22.0	22.0	0.503
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						Body SAR: 1.6 W/kg (averaged over 1 gram)		

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SECTION 14 : Equipment & calibration information

Name of Equipment	Manufacture	Model number	Serial number	Calibration	
				Last Cal	due date
Power Meter	Agilent	E4417A	GB41290639	2003/11/12	2004/11/11
Power Sensor	Agilent	E9300B	US40010300	2003/11/17	2004/11/16
Power Sensor	Agilent	E9327A	US40440576	2003/11/13	2004/11/12
S-Parameter Network Analyzer	Agilent	E8358A	US41080381	2003/08/13	2004/08/12
Signal Generator	Rohde&Schwarz	SML03	100332	2003/08/26	2004/08/25
RF Amplifier	OPHIR	5056F	1005	2003/02/06	2004/02/05
Dosimetric E-Field Probe	Schmid&Partner Engineering AG	ET3DV6	1685	2003/10/10	2004/10/09
Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE3 V1	509	2003/04/10	2004/04/09
Robot,SAM Phantom	Schmid&Partner Engineering AG	DASY4	I021834	N/A	N/A
Attenuator	HIROSE ELECTRIC CO.,LTD.	AT-110	-	2003/02/04	2004/02/03
Attenuator	Agilent	US40010300	08498-60012	2003/12/16	2004/12/15
2450MHz System Validation Dipole	Schmid&Partner Engineering AG	D2450V2	713	2002/11/15	2004/11/14
Dual Directional Coupler	N/A	Narda	03702	N/A	N/A
Head 2450MHz	N/A	N/A	N/A	N/A	N/A
Body 2450MHz	N/A	N/A	N/A	N/A	N/A

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SECTION 15 : References

- [1]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.
- [2] 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. 120-124.
- [3] 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.
- [4] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.
- [5] 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.
- [6] 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.

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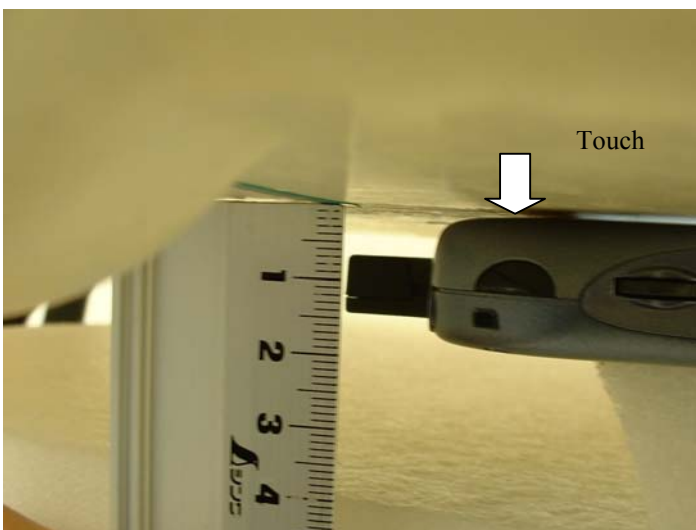
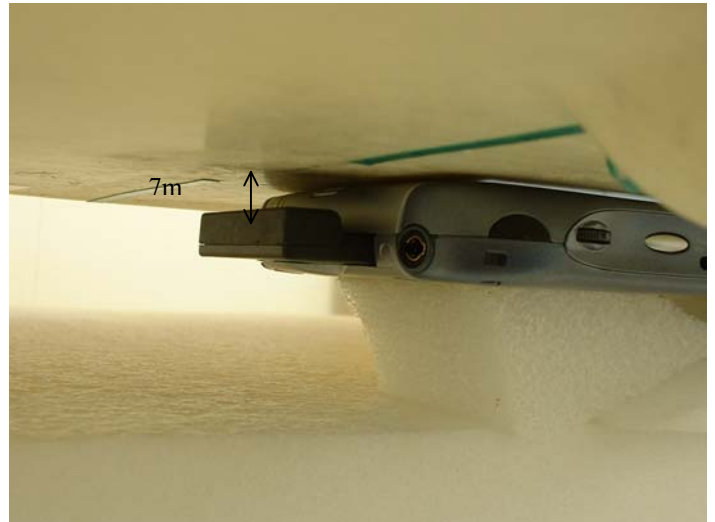
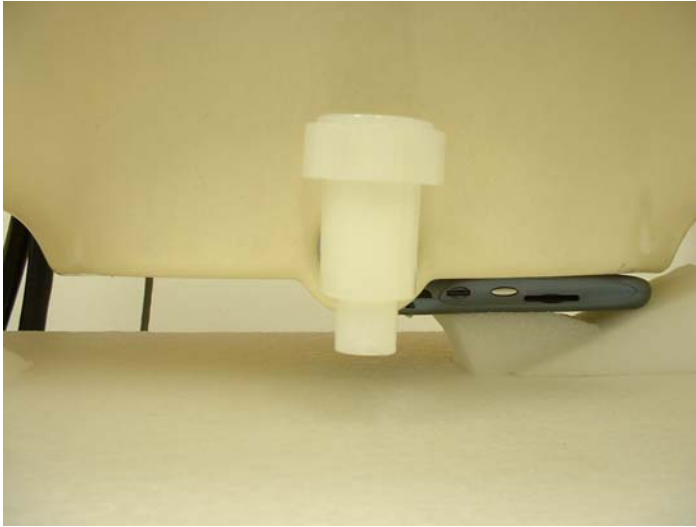
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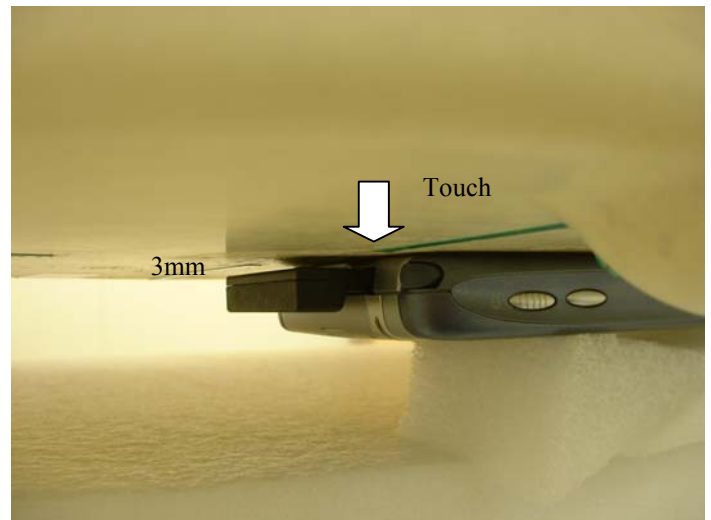
Facsimile: +81 596 24 8124

APPENDIX 1 : Photographs of test setup

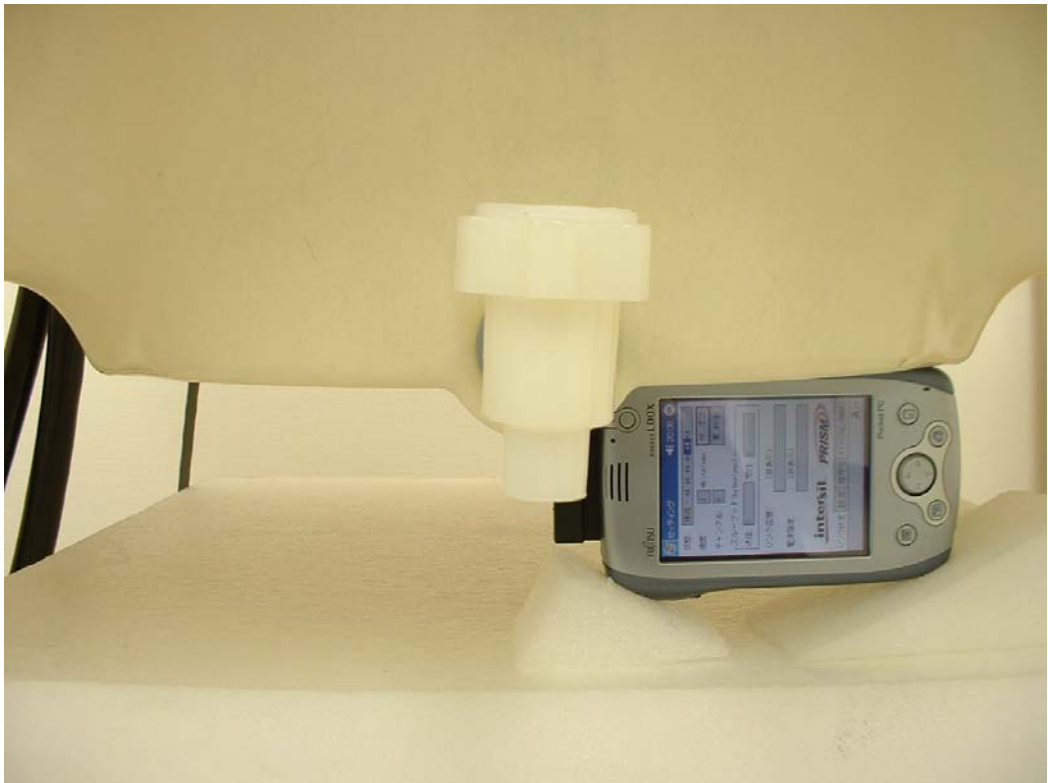
Front



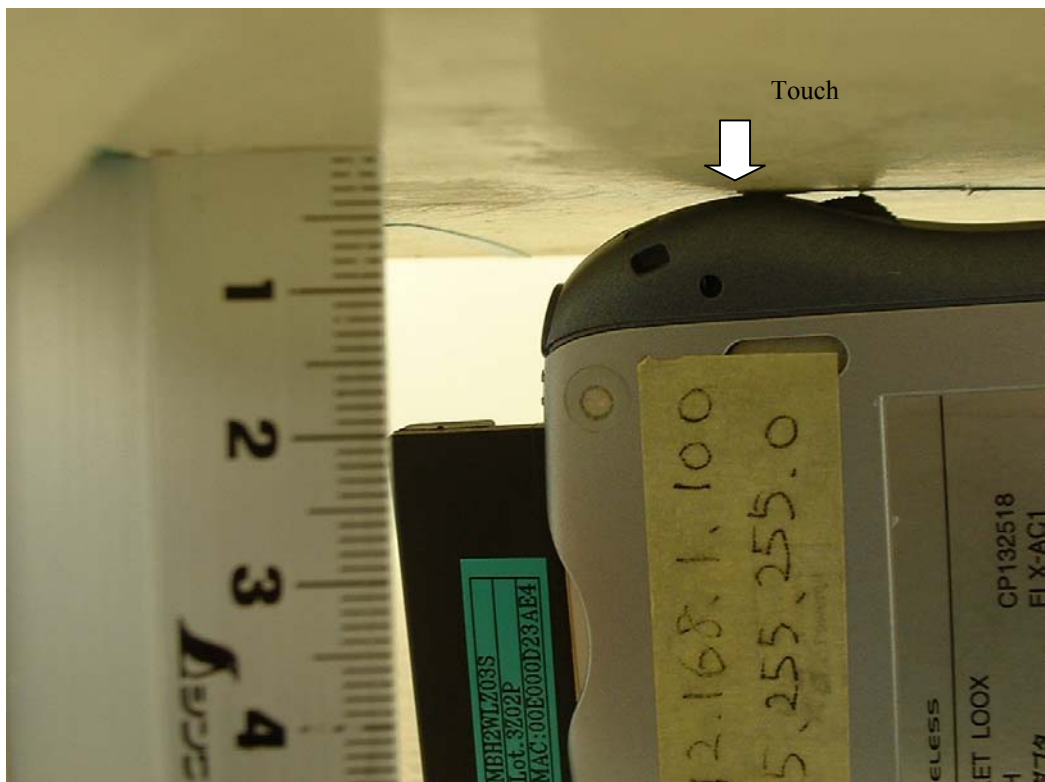
Back



Right Side



Left Side



Top



APPENDIX 2 : SAR Measurement data

WD05740 / Body / Front / 2437MHz

Crest factor: 1

Medium: M2450 ($\sigma = 1.98$ mho/m, $\epsilon_r = 50.1$, $\rho = 1000$ kg/m³)

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1685; ConvF(4.3, 4.3, 4.3); Calibrated: 2003/10/10
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Phantom: SAM 1196
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

Area Scan (91x111x1): Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR = 0.0963 mW/g

Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Peak SAR (extrapolated) = 0.197 W/kg

SAR(1 g) = 0.0813 mW/g; SAR(10 g) = 0.0445 mW/g

Maximum value of SAR = 0.077 mW/g

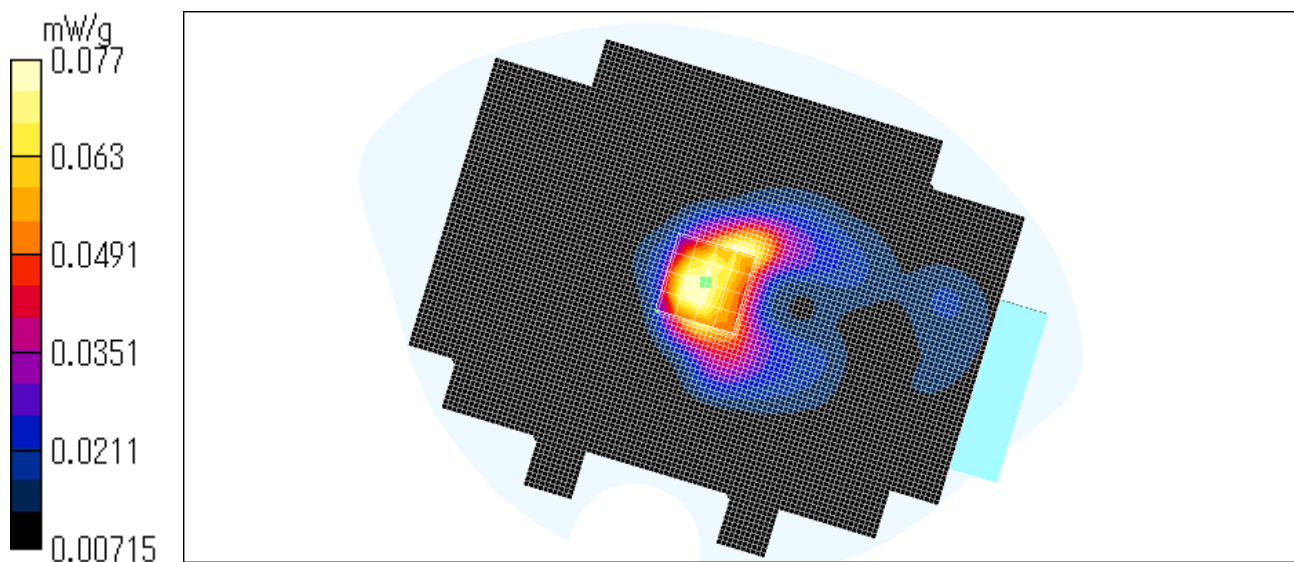
Test date = 01 / 06 / 04

Reference Value = 6.51 V/m

Power Drift = -0.4 dB

Ambient Temperature : 24.8 degree.c

Liquid Temperature : Before 21.8 degree.C , After 21.8 degree.C



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WD05740 / Body / Back / 2437MHz

Crest factor: 1

Medium: M2450 ($\sigma = 1.98$ mho/m, $\epsilon_r = 50.1$, $\rho = 1000$ kg/m³)

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1685; ConvF(4.3, 4.3, 4.3); Calibrated: 2003/10/10
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Phantom: SAM 1196
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

Area Scan (91x111x1): Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR = 0.353 mW/g

Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Peak SAR (extrapolated) = 0.682 W/kg

SAR(1 g) = 0.274 mW/g; SAR(10 g) = 0.122 mW/g

Maximum value of SAR = 0.303 mW/g

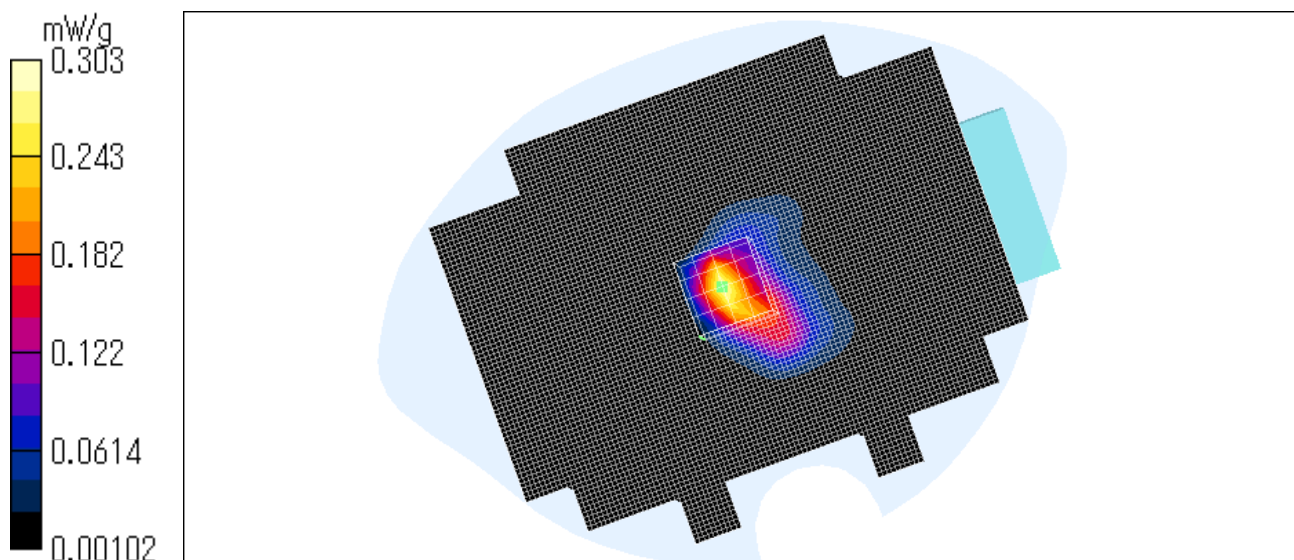
Test date = 01 / 06 / 04

Reference Value = 11.2 V/m

Power Drift = 0.4 dB

Ambient Temperature : 24.8 degree.c

Liquid Temperature : Before 21.8 degree.C , After 21.9 degree.C



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WD05740 / Body / Right side / 2437MHz

Crest factor: 1

Medium: M2450 ($\sigma = 1.98$ mho/m, $\epsilon_r = 50.1$, $\rho = 1000$ kg/m³)

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1685; ConvF(4.3, 4.3, 4.3); Calibrated: 2003/10/10
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Phantom: SAM 1196
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

Area Scan (91x111x1): Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR = 0.0188 mW/g

Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Peak SAR (extrapolated) = 0.0488 W/kg

SAR(1 g) = 0.0248 mW/g; SAR(10 g) = 0.0117 mW/g

Maximum value of SAR = 0.0268 mW/g

Zoom Scan (5x5x7)/Cube 1: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Peak SAR (extrapolated) = 0.0446 W/kg

SAR(1 g) = 0.0203 mW/g; SAR(10 g) = 0.0104 mW/g

Maximum value of SAR = 0.021 mW/g

Zoom Scan (5x5x7)/Cube 2: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Peak SAR (extrapolated) = 0.0428 W/kg

SAR(1 g) = 0.0185 mW/g; SAR(10 g) = 0.0092 mW/g

Maximum value of SAR = 0.0187 mW/g

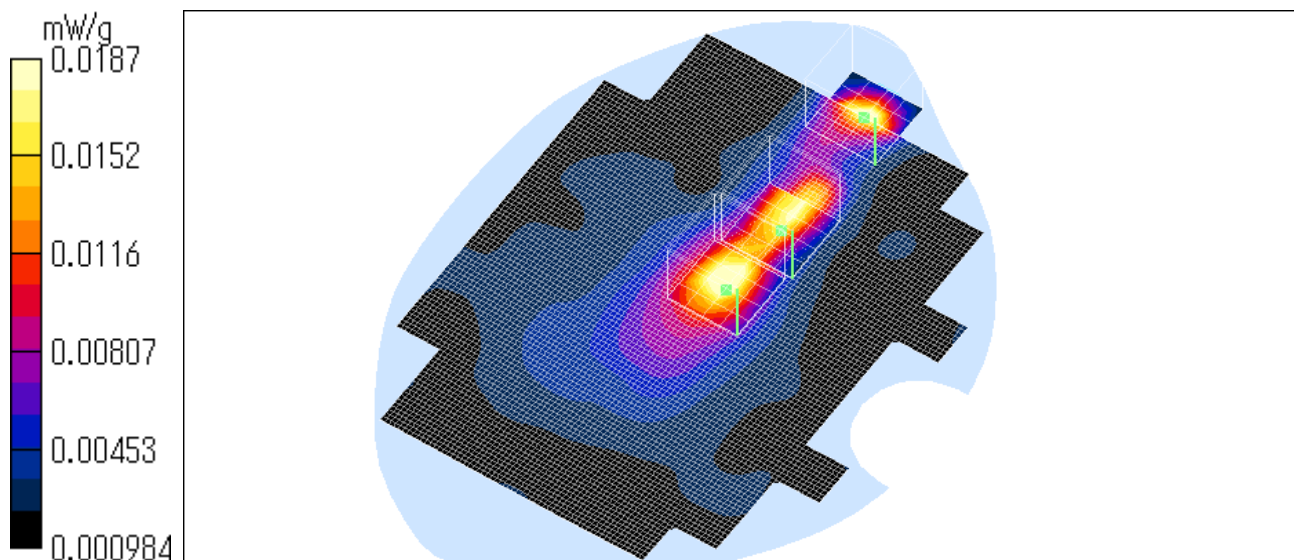
Test date = 01 / 06 / 04

Reference Value = 2.77 V/m

Power Drift = -0.4 dB

Ambient Temperature : 24.8 degree.c

Liquid Temperature : Before 21.8 degree.C , After 21.9 degree.C



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WD05740 / Body / Left side / 2437MHz

Crest factor: 1
Medium: M2450 ($\sigma = 1.98$ mho/m, $\epsilon_r = 50.1$, $\rho = 1000$ kg/m³)
Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1685; ConvF(4.3, 4.3, 4.3); Calibrated: 2003/10/10
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Phantom: SAM 1196
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

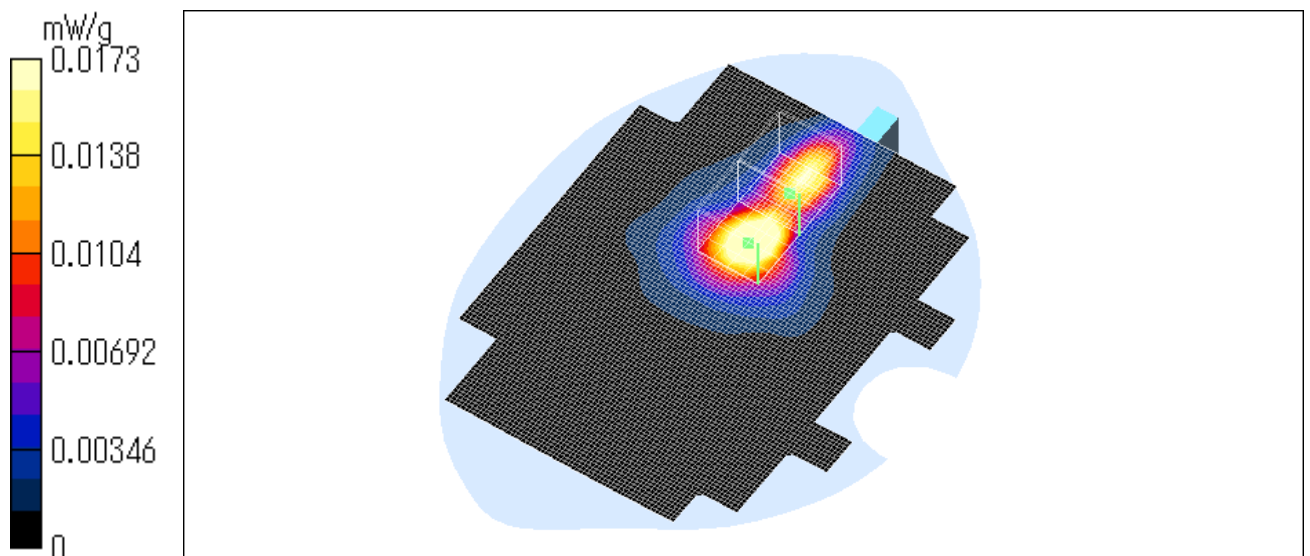
Area Scan (91x111x1): Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR = 0.0227 mW/g

Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 0.0504 W/kg
SAR(1 g) = 0.0243 mW/g; SAR(10 g) = 0.0116 mW/g
Maximum value of SAR = 0.0261 mW/g

Zoom Scan (5x5x7)/Cube 1: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Peak SAR (extrapolated) = 0.0484 W/kg
SAR(1 g) = 0.0166 mW/g; SAR(10 g) = 0.00799 mW/g
Maximum value of SAR = 0.0173 mW/g

Test date = 01 / 06 / 04
Reference Value = 1.31 V/m
Power Drift = -0.07 dB

Ambient Temperature : 24.8 degree.c
Liquid Temperature : Before 22.0 degree.C , After 22.0 degree.C



WD05740 / Body / Top / 2437MHz

Crest factor: 1

Medium: M2450 ($\sigma = 1.98$ mho/m, $\epsilon_r = 50.1$, $\rho = 1000$ kg/m³)

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1685; ConvF(4.3, 4.3, 4.3); Calibrated: 2003/10/10
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Phantom: SAM 1196
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

Area Scan (91x111x1): Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR = 0.338 mW/g

Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Peak SAR (extrapolated) = 1.45 W/kg

SAR(1 g) = 0.496 mW/g; SAR(10 g) = 0.183 mW/g

Maximum value of SAR = 0.52 mW/g

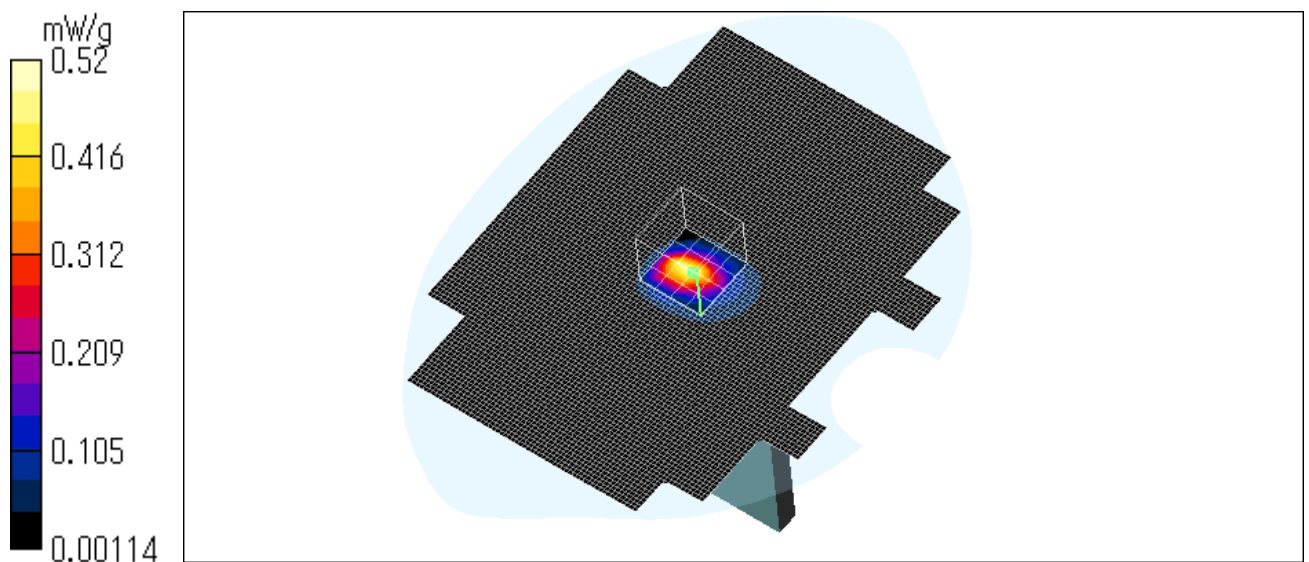
Test date = 01 / 06 / 04

Reference Value = 17.3 V/m

Power Drift = -0.1 dB

Ambient Temperature : 24.8 degree.c

Liquid Temperature : Before 21.9 degree.C , After 21.8 degree.C



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WD05740 / Body / Top / 2412MHz

Crest factor: 1

Medium: M2450 ($\sigma = 1.98$ mho/m, $\epsilon_r = 50.1$, $\rho = 1000$ kg/m³)

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1685; ConvF(4.3, 4.3, 4.3); Calibrated: 2003/10/10
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Phantom: SAM 1196
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

Area Scan (91x111x1): Measurement grid: dx=20mm, dy=20mm

Reference Value = 15.5 V/m

Power Drift = -0.1 dB

Maximum value of SAR = 0.388 mW/g

Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Peak SAR (extrapolated) = 1.62 W/kg

SAR(1 g) = 0.563 mW/g; SAR(10 g) = 0.208 mW/g

Maximum value of SAR = 0.579 mW/g

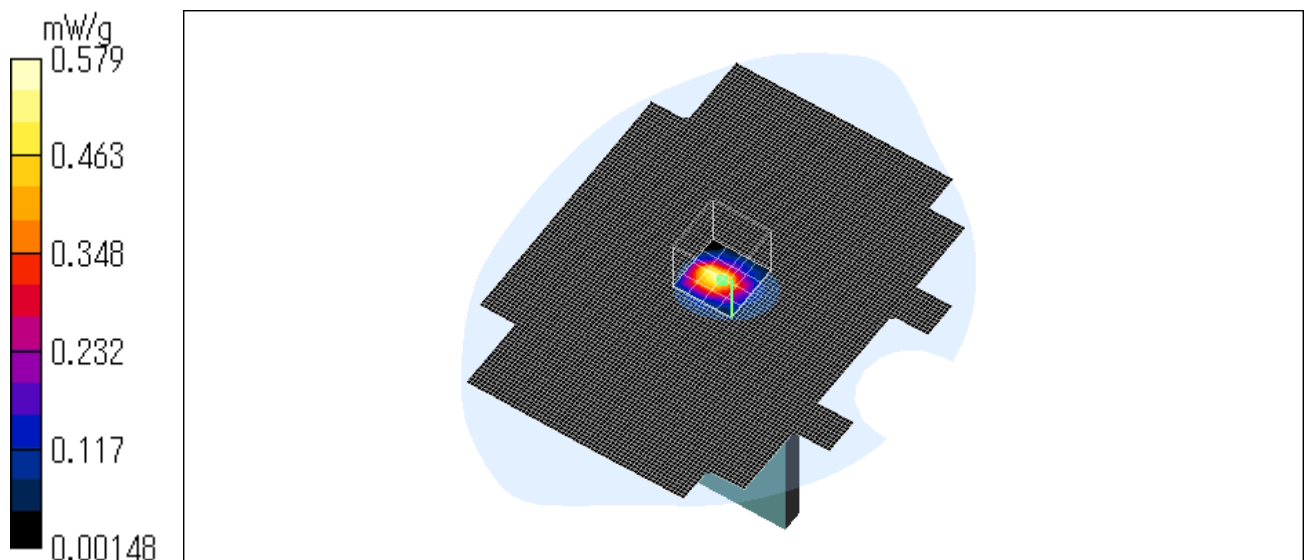
Test date = 01 / 06 / 04

Reference Value = 15.5 V/m

Power Drift = -0.1 dB

Ambient Temperature : 24.8 degree.c

Liquid Temperature : Before 22.0 degree.C , After 22.1 degree.C



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Z-axis scan at max SAR location

WD05740 / Body / Top / 2412MHz

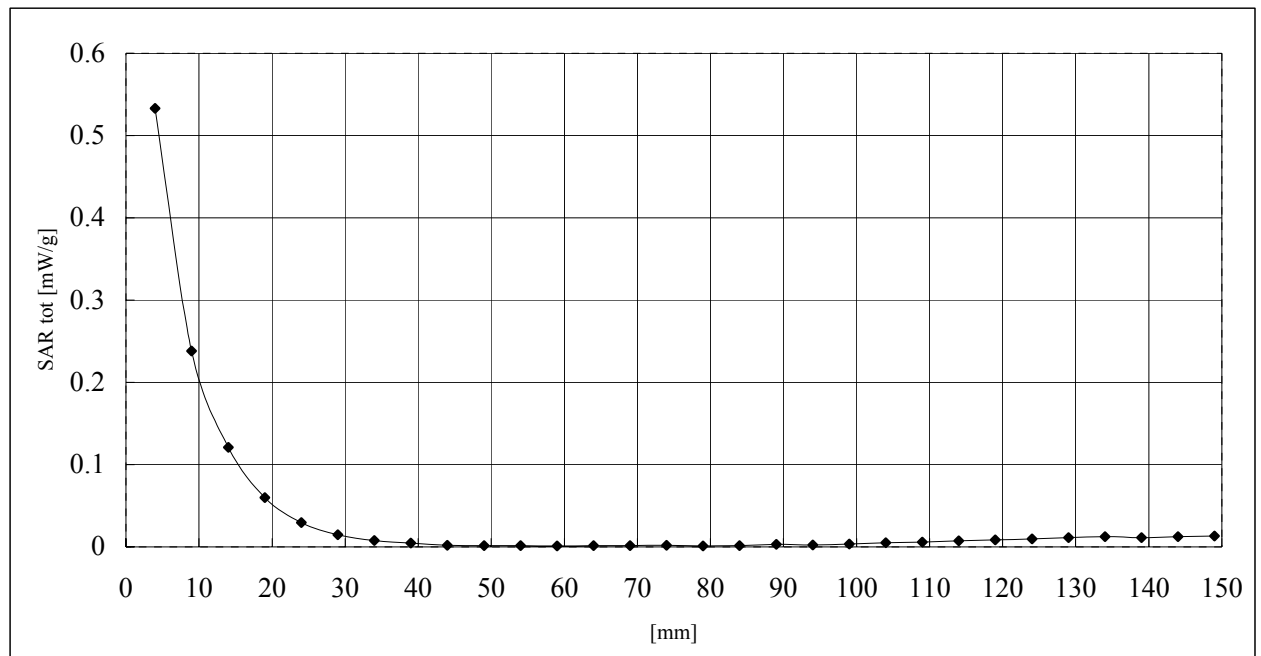
Crest factor: 1

Medium: M2450 ($\sigma = 1.98$ mho/m, $\epsilon_r = 50.1$, $\rho = 1000$ kg/m³)

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1685; ConvF(4.3, 4.3, 4.3); Calibrated: 2003/10/10
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Phantom: SAM 1196
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115



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WD05740 / Body / Top / 2462MHz

Crest factor: 1

Medium: M2450 ($\sigma = 1.98$ mho/m, $\epsilon_r = 50.1$, $\rho = 1000$ kg/m³)

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1685; ConvF(4.3, 4.3, 4.3); Calibrated: 2003/10/10
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Phantom: SAM 1196
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

Area Scan (91x111x1): Measurement grid: dx=20mm, dy=20mm

Reference Value = 12.2 V/m

Power Drift = -0.2 dB

Maximum value of SAR = 0.371 mW/g

Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Peak SAR (extrapolated) = 1.42 W/kg

SAR(1 g) = 0.503 mW/g; SAR(10 g) = 0.185 mW/g

Maximum value of SAR = 0.5 mW/g

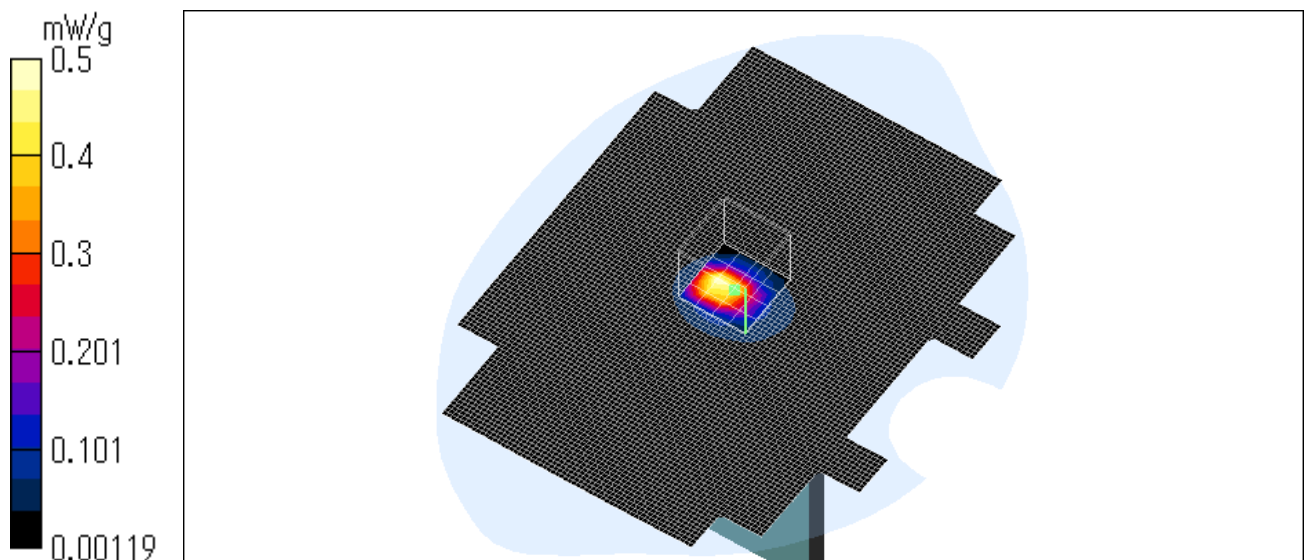
Test date = 01 / 06 / 04

Reference Value = 12.2 V/m

Power Drift = -0.2 dB

Ambient Temperature : 24.8degree.c

Liquid Temperature : Before 22.0 degree.C , After 22.0 degree.C



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APPENDIX 3 : Validation Measurement data

System Validation / Dipole 2450 MHz / Forward Conducted Power : 250mW

Crest factor: 1

Medium: HSL2450 ($\sigma = 1.84$ mho/m, $\epsilon_r = 38.5$, $\rho = 1000$ kg/m³)

Phantom section: Flat Section

Dipole 2450 MHz;

- Type: D2450V2; Serial: SN:713

DASY4 Configuration:

- Probe: ET3DV6 - SN1685; ConvF(4.7, 4.7, 4.7); Calibrated: 2003/10/10

- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)

- Phantom: SAM 1196

- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

Area Scan (51x51x1): Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR = 17.1 mW/g

Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Peak SAR (extrapolated) = 29.8 W/kg

SAR(1 g) = 14.2 mW/g; SAR(10 g) = 6.44 mW/g

Maximum value of SAR = 15.6 mW/g

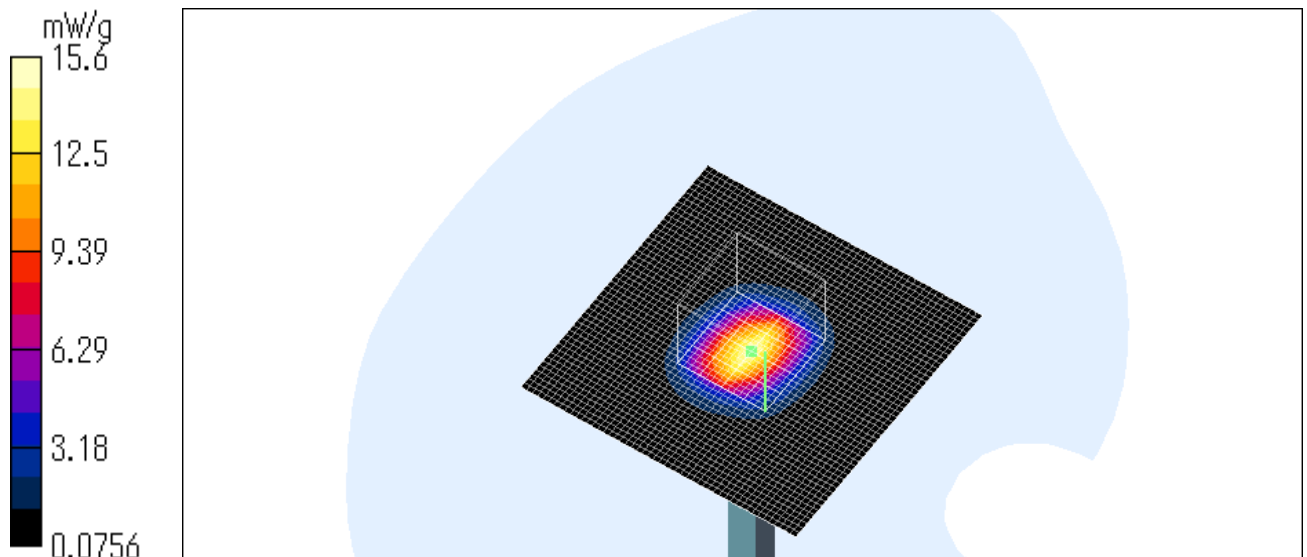
Test date = 01 / 06 / 04

Reference Value = 98 V/m

Power Drift = 0.02 dB

Ambient Temperature = 24.8 degree.c

Liquid Temperature = Before 23.0 degree.C , After 23.0 degree.C



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APPENDIX 4 : System Validation Dipole (D2450V2,S/N: 713)

Schmid & Partner Engineering AG

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

Calibration Certificate

2450 MHz System Validation Dipole

Type:

D2450V2

Serial Number:

713

Place of Calibration:

Zurich

Date of Calibration:

November 15, 2002

Calibration Interval:

24 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:

D. Vetter

Approved by:

Volker Kutz

UL Apex Co., Ltd.

Head Office EMC Lab.

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**Schmid & Partner
Engineering AG**

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

DASY

Dipole Validation Kit

Type: D2450V2

Serial: 713

Manufactured: July 5, 2002
Calibrated: November 15, 2002

1. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with head simulating solution of the following electrical parameters at 2450 MHz:

Relative permittivity	38.0	$\pm 5\%$
Conductivity	1.87 mho/m	$\pm 10\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.0 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.

The dipole input power (forward power) was 250mW $\pm 3\%$. The results are normalized to 1W input power.

2. SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm ³ (1 g) of tissue:	54.4 mW/g
averaged over 10 cm ³ (10 g) of tissue:	24.2 mW/g

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3. Dipole impedance and return loss

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay: **1.158 ns** (one direction)
Transmission factor: **0.997** (voltage transmission, one direction)

The dipole was positioned at the flat phantom sections according to section 1 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 2450 MHz: $\text{Re}\{Z\} = \mathbf{51.3\ \Omega}$

$\text{Im}\{Z\} = \mathbf{2.4\ \Omega}$

Return Loss at 2450 MHz **- 31.4 dB**

4. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with body simulating solution of the following electrical parameters at 2450 MHz:

Relative permittivity **51.2** $\pm 5\%$
Conductivity **1.96 mho/m** $\pm 10\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 4.5 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.

The dipole input power (forward power) was $250\text{mW} \pm 3\%$. The results are normalized to 1W input power.

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Date/Time: 11/13/02 21:52:22

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN713_SN1507_HSL2450_131102.da4

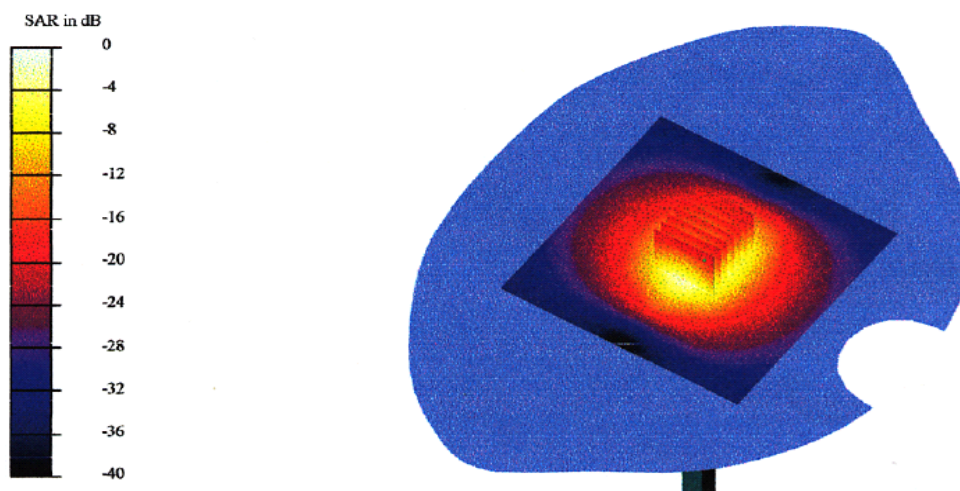
DUT: Dipole 2450 MHz Type & Serial Number: D2450V2 - SN713
Program: Dipole Calibration; Pin = 250 mW; d = 10 mm

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: HSL 2450 MHz ($\sigma = 1.87$ mho/m, $\epsilon = 38.03$, $\rho = 1000$ kg/m³)
Phantom section: FlatSection

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5, 5, 5); Calibrated: 1/24/2002
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN410; Calibrated: 7/18/2002
- Phantom: SAM 4.0 - TP:1006
- Software: DASY4, V4.0 Build 35

Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm
Reference Value = 94.4 V/m
Peak SAR = 29.6 mW/g
SAR(1 g) = 13.6 mW/g; SAR(10 g) = 6.04 mW/g
Power Drift = 0.01 dB



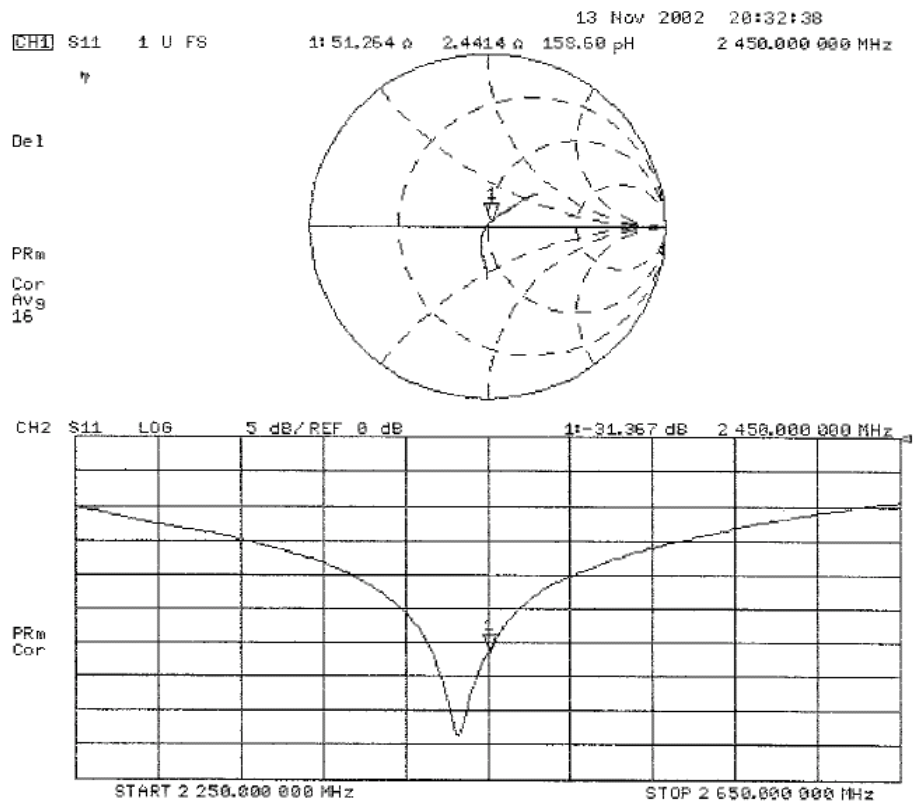
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Date/Time: 11/15/02 14:25:17

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN713_SN1507_M2450_141102.da4

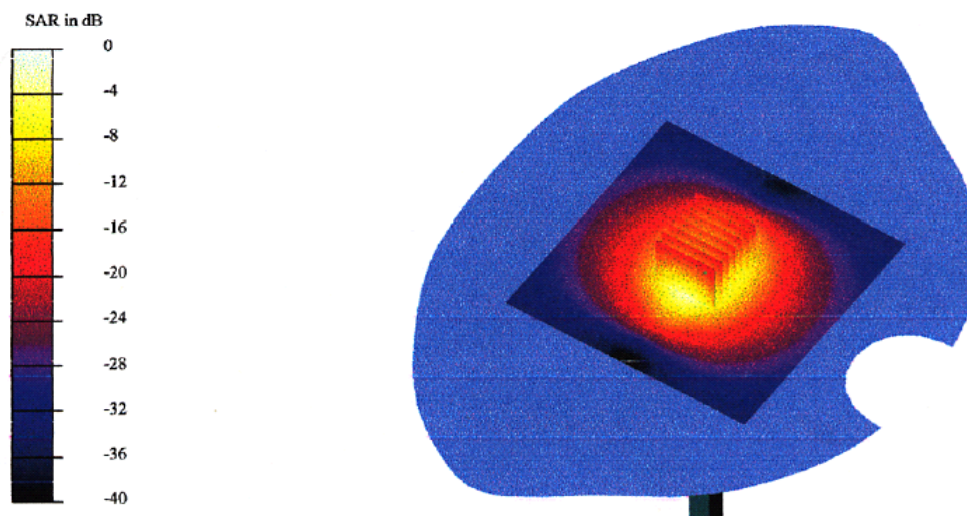
DUT: Dipole 2450 MHz Type & Serial Number: D2450V2 - SN713
Program: Dipole Calibration; Pin = 250 mW; d = 10 mm

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: Muscle 2450 MHz ($\sigma = 1.96$ mho/m, $\epsilon = 51.15$, $\rho = 1000$ kg/m³)
Phantom section: FlatSection

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(4.5, 4.5, 4.5); Calibrated: 1/24/2002
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN410; Calibrated: 7/18/2002
- Phantom: SAM 4.0 - TP:1006
- Software: DASY4, V4.0 Build 35

Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm
Reference Value = 95.2 V/m
Peak SAR = 25 mW/g
SAR(1 g) = 12.9 mW/g; SAR(10 g) = 5.99 mW/g
Power Drift = 0.02 dB



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