

***EMC* SAR - TEST REPORT**

JQA APPLICATION No. : KL80030488R

Name of Product : 2.4GHz Frequency Hopping Spread Spectrum Cordless Telephone

Model/Type No. : KX-TG2356

FCC ID : ACJ96NKX-TG2356

Applicant : Panasonic Communications Co., Ltd.

Address : 1-62, 4-chome, Minoshima, Hakata-ku, Fukuoka, 812-8531 Japan

Manufacturer : Panasonic Communications Co., Ltd.

Address : 1-62, 4-chome, Minoshima, Hakata-ku, Fukuoka, 812-8531 Japan

Receive date of EUT : October 24, 2003

Final Judgement : **Passed**

TEST RESULTS IN THIS REPORT are obtained in use of equipment that is traceable to National Institute of Advanced Industrial Science and Technology (AIST) under METI Japan, Communications Research Lab. (CRL) under MPHPT Japan, and Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zürich, Switzerland.

THE TEST RESULTS only responds to the test sample. This test report shall not be reproduced except in full.



Authorized by:



Takashi Yamanaka, Director
JQA KITA-KANSAI Testing Center

DIRECTORY

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TEST REGULATION

FCC Rules and Regulations Parts 2 Subpart J (October 1, 2002)

- Mobile Devices (§2.1091) - Occupational/Controlled Exposure
 - Portable Devices (§2.1093) - General Population/Uncontrolled Exposure

Test procedure:

The SAR measurement procedures were specified in FCC/OET Bulletin 65 Supplement C (July, 2001) and IEEE Std. 1528-200X (Draft 6.5, January 2002).
The exposure limits were specified in ANSI/IEEE C95.1-1999.

GENERAL INFORMATION

Description of the Equipment Under Test (EUT):

- 1) Name : 2.4GHz FHSS Cordless Telephone
2) Model/Type No. : KX-TG2356
3) Product Type : Prototype
4) EUT Authorization : - Verification - Certification - D.o.C.
5) Transmitting Frequency : 2400.914355 MHz - 2480.292773 MHz
6) Receiving Frequency : 2398.914355 MHz - 2478.292773 MHz
7) Max. RF Output Power : 17.67 dBm (Handset), 18.45 dBm (Base Unit)
8) Power Rating : DC 3.6V (Handset), AC 120V 60Hz (Base Unit)

Definitions for symbols used in this test report:

- Black box indicates that the listed condition, standard or equipment is applicable for this Report.
 - Blank box indicates that the listed condition, standard or equipment is not applicable for this Report.

Description of the Antenna:

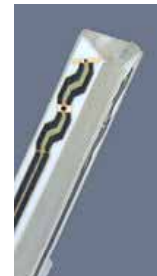
Handset	Type	: Shortening dipole antenna
	Dimensions	: Maximum width 12.5 mm
		: Maximum length 44.6 mm
Location	: Right side	
Base Unit	Type	: Collinear antenna
	Dimensions	: Maximum width 13.3 mm
		: Maximum length 144.0 mm
Location	: Right side	

Battery Option:

Handset : Ni-MH Battery Pack HHR-P104
Base Unit : None (supplied by AC Adapter PQLV1)

Probe Specification:

Construction	: Symmetrical design with triangular core Built-in optical fiber for surface detection system Built-in shielding against static changes
Calibration	: In air form 10 MHz to 2.5 GHz In head tissue simulating liquid (HSL) and muscle tissue simulating liquid at 900 MHz, 1800 MHz (accuracy $\pm 9.5\%$; $k=2$) and 2450 MHz (accuracy $\pm 8.9\%$; $k=2$)
Frequency	: 10 MHz to 3 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Directivity	: ± 0.2 dB in HSL (rotation around probe axis) ± 0.4 dB in HSL (rotation normal probe axis)
Dynamic Range	: $5 \mu\text{W/g}$ to $>100 \text{ mW/g}$; Linearity: ± 0.2 dB
Surface Detection	: ± 0.2 mm repeatability in air and clear liquids 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



Twin SAM Phantom:

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X, CENELEC 50361 and IEC 62209. It enables the dosimetric evaluation of left and right head 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 : Volume Approx. 25 liters
 Dimensions : 810 × 1000 × 500 mm (H × L × W)

Mounting Device for Transmitters:

The Mounting Device enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).



Typical Composition of Ingredients for Liquid Tissue:

Ingredients (% by weight)	Frequency (MHz)					
	835		1900		2450	
	Head	Body	Head	Body	Head	Body
Water	41.45	52.40	54.90	40.40	62.70	73.20
Salt (NaCl)	1.45	1.40	0.18	0.50	0.50	0.04
Sugar	56.00	45.00	0.00	58.00	0.00	0.00
HEC	1.00	1.00	0.00	1.00	0.00	0.00
Bactericide	0.10	0.10	0.00	0.10	0.00	0.00
Triton X-100	0.00	0.00	0.00	0.00	36.80	0.00
DGBE	0.00	0.00	44.92	0.00	0.00	26.70

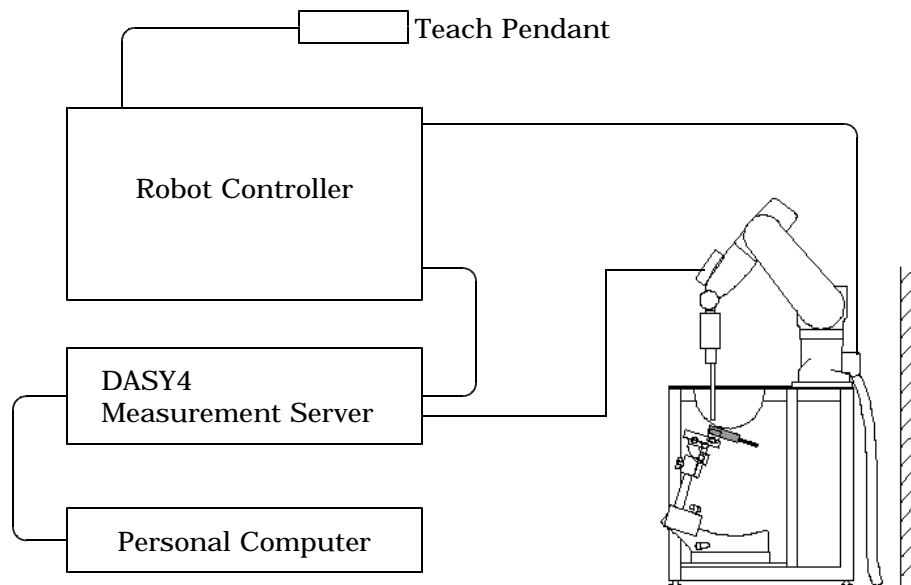
Salt : 99% Pure Sodium Chloride Sugar : 98% Pure Sucrose
 Water : De-ionized, 16 MΩ⁺ resistivity HEC : Hydroxyethyl Cellulose
 DGBE : 99% Di (ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
 Triton X-100 (ultra pure) : Polyethylene glycol mono [4-(1,1,3,3-tetramethylbutyl)phenyl]ether

The composition of ingredients is according to FCC/OET Bulletin 65 Supplement C (July, 2001).

SAR MEASUREMENT SET-UP

These measurements are performed using the DASY4 automated dosimetric assessment system (manufactured by Schmid & Partner Engineering AG (SPEAG) in Zürich, Switzerland). It consists of high precision robotics system, cell controller system, DASY4 measurement server, personal computer with DASY4 software, data acquisition electronic (DAE) circuit, the Electro-optical coupler (EOC), near-field probe, and the twin SAM phantom containing the equivalent tissue. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF).

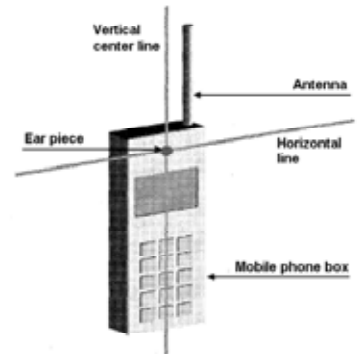
The Robot is connected to the cell controller to allow software manipulation of the robot. The DAE is connected to the EOC. The DAE performs the signal amplification, signal multiplexing, A/D conversion, offset measurements, mechanical surface detection, collision detection, etc. The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the DASY4 measurement server.



TEST CONFIGURATION POSITIONS

Cheek/Touch Position:

1. Position the device with the vertical center line of the body of the device and the horizontal line crossing the center of the ear piece in a plane parallel to the sagittal plane of the phantom.
2. While maintaining the device in this plane, align the vertical center line with the reference plane containing the three ear and mouth reference points (M, RE and LE) and align the center of the ear piece with the line RE-LE.
3. Translate the mobile phone box towards the phantom with the ear piece aligned with the line RE-LE until the phone touches the ear.
4. While maintaining the device in the reference plane and maintaining the phone contact with the ear, move the bottom of the box until any point on the front side is in contact with the cheek of the phantom or until contact with the ear is lost.



Ear/Tilt Position:

1. Position the device in the "Cheek/Touch Position".
2. While maintaining the device in the reference plane and pivoting against the ear, move it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost.



Test Set-up (Photographs):

Left Head

Cheek/Touch Position



Ear/Tilt Position



Right Head

Cheek/Touch Position



Ear/Tilt Position



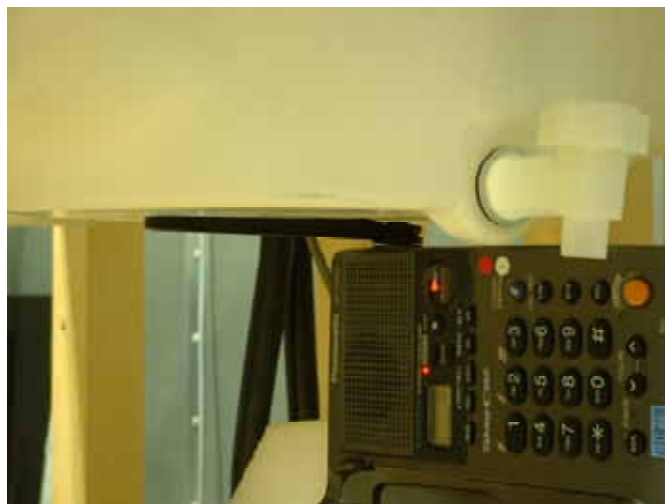
Body Worn Configuration (Handset):

For body-worn operating configurations, the device is tested against a flat phantom representing the user body. A headset is connected to the device. The Belt-clip is supplied with the device as an accessory, then the device with the belt-clip is 0 cm on distance from the flat phantom. It is recommended for testing body-worn SAR compliance.



Body Worn Configuration (Base Unit):

For body-worn operating configurations, the device is tested against a flat phantom representing the user body. The antenna of the device is 0 cm on distance from the flat phantom.



MEASUREMENT PROCESS

Area Scan for Maximum Search:

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 and the horizontal grid spacing was 10 mm × 10 mm. The evaluation on the measured area scan gives the interpolated maximum (hot spot) of the measured area.

Cube Scan for Spatial Peak SAR Evaluation:

The 1g and 10g peak evaluations were available for the predefined cube 5×5×7 scans. The grid spacing was 8 mm × 8 mm × 5 mm. The first procedure is an extrapolation to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation to get all points within the measured volume in a 1mm grid (35000 points). In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is moved around until the highest averaged SAR is found. This last procedure is repeated for a 10g cube. If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

Extrapolation:

The extrapolation is based on a least square algorithm. Through the points in the first 3 cm in all z-axis, polynomials of order four are calculated. This polynomial is then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from one another.

Interpolation:

The maximum interpolated value is searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) are computed by the 3D spline algorithm. The 3D spline is composed of three one-dimensional splines with the "Not a knot"-condition (x, y and z -directions). The volume is integrated with the trapezoidal algorithm.

MEASUREMENT UNCERTAINTIES

Uncertainty Component	Uncertainty value (%)	Probability distribution	Divisor	c_i	Standard uncertainty 1σ (%)	v_i
Measurement System						
Probe calibration	4.8	Normal	1	1	4.8	∞
Axial isotropy	4.7	Rectangular	$\sqrt{3}$	0.7	1.9	∞
Hemispherical isotropy	9.6	Rectangular	$\sqrt{3}$	0.7	3.9	∞
Boundary effect	1.0	Rectangular	$\sqrt{3}$	1	0.6	∞
Linearity	4.7	Rectangular	$\sqrt{3}$	1	2.7	∞
Detection limits	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	∞
Mechanical tolerance	0.4	Rectangular	$\sqrt{3}$	1	0.2	∞
Probe positioning	2.9	Rectangular	$\sqrt{3}$	1	1.7	∞
Extrapolation, interpolation and integration algorithms	1.0	Rectangular	$\sqrt{3}$	1	0.6	∞
Test Sample Related						
Device positioning	3.4	Normal	1	1	3.4	23
Device holder uncertainty	4.6	Normal	1	1	4.6	5
Output power drift	5.0	Rectangular	$\sqrt{3}$	1	2.9	∞
Physical parameters						
Phantom uncertainty	4.0	Rectangular	$\sqrt{3}$	1	2.3	∞
Liquid conductivity - deviation from target values	5.0	Rectangular	$\sqrt{3}$	0.6	1.7	∞
Liquid Conductivity - measurement uncertainty	10.0	Rectangular	$\sqrt{3}$	0.6	3.5	∞
Liquid Permittivity - deviation from target values	5.0	Rectangular	$\sqrt{3}$	0.6	1.7	∞
Liquid Permittivity - measurement uncertainty	5.0	Rectangular	$\sqrt{3}$	0.6	1.7	∞
Combined Standard Uncertainty					11.3	
Expanded Uncertainty (k=2) (confidence interval of 95%)					22.5	

TEST CONDITIONS

SAR Measurement

was performed in the following test site.

Test location:

KAMEOKA EMC Branch Shielded Room
9-1, Ozaki, Inukanno, Nishibetsuin-Cho, Kameoka-Shi, Kyoto, 621-0126, Japan

Test instruments used in SAR measurement:

Name	Model No.	Device ID	Last Cal. Date	Cal. Interval
● - E-Field Probe	ET3DV6	S - 1	February, 2003	1 Year
○ - E-Field Probe	ET3DV6	S - 2		
● - DASY3 DAE	DAE3 V1	S - 3	January, 2003	1 Year
○ - Validation Dipole	D900V2	S - 4		
○ - Validation Dipole	D1800V2	S - 5		
● - Validation Dipole	D2450V2	S - 6	February, 2003	2 Years

Additional instruments used in test system validation:

Name	Model No.	Device ID	Last Cal. Date	Cal. Interval
● - Signal Generator	MG3681A	B - 3	January, 2003	1 Year
● - Power Meter	E4417A	B - 51	August, 2003	1 Year
● - Power Sensor	E9300B	B - 32	June, 2003	1 Year
● - Power Amplifier	A0840-3833-R	A - 34	N/A	N/A
● - Network Analyzer	5719ET	B - 53	September, 2003	1 Year
● - Dielectric Probe Kit	85070D	B - 54	N/A	N/A

Test instruments used to measure conducted power output:

Name	Model No.	Device ID	Last Cal. Date	Cal. Interval
● - Power Meter	E4417A	B - 51	August, 2003	1 Year
● - Power Sensor	E9321A	B - 52	May, 2003	1 Year
○ - Fixed Attenuator	54-10	D - 82		
○ - Fixed Attenuator	54-10	D - 83		

EUT TUNE-UP PROCEDURE

The following procedures had been used to prepare the EUT for the SAR test.

To setup the desire channel frequency and the maximum output power, RF test mode prepared by the manufacturer was used to program the EUT.

Communication system : Cordless Telephone
Modulation type : Frequency Hopping Spread Spectrum (FHSS)

Channel	Frequency
01	2400.914355
45	2440.156641
90	2480.292773

Maximum conducted power was measured by replacing the antenna with an adapter for conductive measurements, before and after the SAR measurements was done.

EUT Modification

- - No modifications were conducted by JQA to achieve compliance to applied levels.
- - To achieve compliance to applied levels, the following change(s) were made by JQA during the compliance test.

The modification(s) will be implemented in all production models of this equipment.

Applicant : N/A Date : N/A

Typed Name : N/A Position : N/A

Responsible Party

Responsible Party of Test Item(Product)

Responsible party :

Contact Person :

Signatory

Deviation from Standard

- - No deviations from the standard described in page 3.
- - The following deviations were employed from the standard described in page 3.

TEST RESULTS
(Handset)

Head Configuration

The requirements are **● - Passed** **○ - Not Passed**
The Maximum SAR (1g) is 0.0928 mW/g at 2400.914355 MHz
Phantom Position **● - Left Head** **○ - Right Head**
Device Position **○ - Cheek/Touch** **● - Ear/Tilt**
Antenna Position **○ - In** **○ - Out** **● - Fixed**
Modulation Type FHSS
Measurement Uncertainty 22.5 %

Remarks: _____

Body-worn Configuration

The requirements are **● - Passed** **○ - Not Passed**
The Maximum SAR (1g) is 0.0730 mW/g at 2400.914355 MHz
Modulation Type FHSS
Measurement Uncertainty 22.5 %

Remarks: _____

TEST RESULTS
(Base Unit)

Body-worn Configuration

The requirements are

● - Passed

○ - Not Passed

The Maximum SAR (1g) is

0.176 mW/g at 2440.156641 MHz

Modulation Type

FHSS

Measurement Uncertainty

22.5 %

Remarks: _____

SUMMARY

GENERAL REMARKS :

The EUT was tested according to the requirements of FCC Rules and Regulations Part 2 Subpart J (October 1, 2002) under the test configuration, as shown in page 7.

The conclusion for the test items of which are required by the applied regulation is indicated under the final judgement.

FINAL JUDGEMENT :

The "as received" sample;

- - fulfill the test requirements of the regulation mentioned on page 3.
- - fulfill the test requirements of the regulation mentioned on page 3, but with certain qualifications.
- - doesn't fulfill the test regulation mentioned on page 3.

Begin of testing : October 31, 2003

End of testing : November 1, 2003

- JAPAN QUALITY ASSURANCE ORGANIZATION -

Approved by :

Issued by :



Akio Hosoda
Manager
EMC Div.
JQA KITA-KANSAI Testing Center



Shigeru Kinoshita
Deputy Manager
EMC Div.
JQA KITA-KANSAI Testing Center

EUT PHOTOGRAPHS

Handset



Handset with belt-clip :



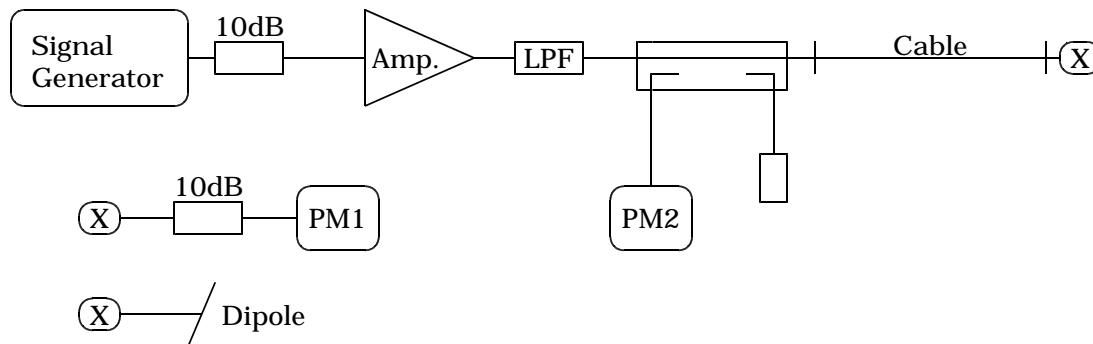
Base Unit



TEST SYSTEM VALIDATION

The power meter PM1 (including 10dB Attenuator) measures the forward power at the location of the validation dipole connector. The signal generator is adjusted for 250 mW at the dipole connector and the power meter PM2 is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2.

The dipole antenna is matched to be used near flat phantom filled with tissue simulating solution. A specific distance holder is used in the positioning of the antenna to ensure correct spacing between the phantom and the dipole.



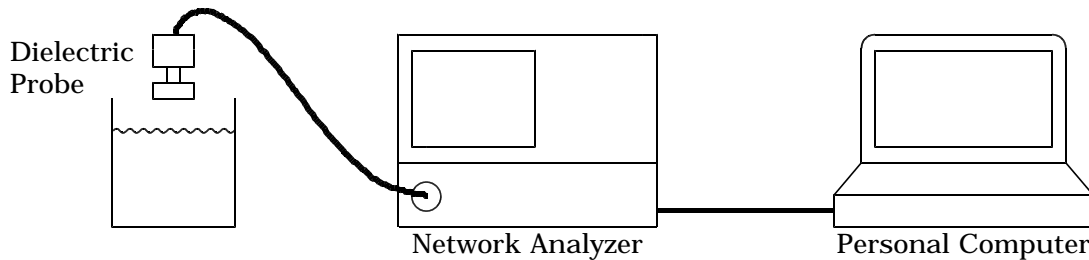
System Validation Results:

System Validation Dipole: D2450V2, S/N: 714						
Ambient Conditions: 23°C 50%		Depth of Liquid: 15.0 cm		Test Date: October 31, 2003		
Liquid		Parameters	Target	Measured	Deviation [%]	Limit [%]
Medium	Temp. [°C]					
Head 2450MHz	24.0	ϵ_r	39.20	37.82	-3.52	± 5
		σ	1.80	1.835	+1.94	± 5
		<i>I_g SAR (mW/g)</i>	13.0	13.2	+1.54	± 10
Ambient Conditions: 22°C 51% Depth of Liquid: 15.0 cm Test Date: November 1, 2003						
Muscle 2450MHz	22.0	ϵ_r	52.70	53.17	+0.89	± 5
		σ	1.95	1.993	+2.21	± 5
		<i>I_g SAR (mW/g)</i>	13.6	13.1	-3.68	± 10

Note) Please refer to Appendix for the result presentation in plot format.

TISSUE SIMULANT VERIFICATION

The tissue dielectric parameters of the tissue medium at the middle of a device transmission band should be within $\pm 5\%$ of the parameters specified at that target frequency. It is verified by using the dielectric probe and the network analyzer.



Tissue Verification Results:

Liquid		Parameters	Target	Measured	Deviation [%]	Limit [%]
Medium	Temp. [°C]					
Ambient Conditions: 23°C 50%		Test Date: October 31, 2003				
Head 2450MHz	24.0	ϵ_r	39.20	37.82	-3.52	± 5
		σ	1.80	1.835	+1.94	± 5
Ambient Conditions: 22°C 51%		Test Date: November 1, 2003				
Muscle 2450MHz	22.0	ϵ_r	52.70	53.17	+0.89	± 5
		σ	1.95	1.993	+2.21	± 5

SAR MEASUREMENT DATA
(Handset)

Modulation Type: FHSS (Duty Cycle: 9.04 %, Crest Factor: 11.07)								
Left Head Position			Depth of Liquid: 15.0 cm			Test Date: October 31, 2003		
EUT Set-up Configuration		Frequency		Power [dBm]		Limit [mW/g]	SAR (1g) [mW/g]	Tissue Temp. [°C]
EUT Position	Antenna	Ch.	MHz	Start	End			
Cheek/Touch	Fixed	01	2400.914355	17.39	17.36	1.6	0.0335	23.6
		45	2440.156641	17.67	17.65		0.0312	23.5
		90	2480.292773	17.51	17.49		0.0321	23.5
Ear/Tilt	Fixed	01	2400.914355	17.39	17.36	1.6	0.0928	23.6
		45	2440.156641	17.67	17.65		0.0831	23.5
		90	2480.292773	17.51	17.49		0.0654	23.5
Right Head Position			Depth of Liquid: 15.0 cm			Test Date: October 31, 2003		
Cheek/Touch	Fixed	01	2400.914355	17.39	17.36	1.6	0.0277	23.9
		45	2440.156641	17.67	17.65		0.0298	23.7
		90	2480.292773	17.51	17.49		0.0244	23.6
Ear/Tilt	Fixed	01	2400.914355	17.39	17.36	1.6	0.0612	23.7
		45	2440.156641	17.67	17.65		0.0549	23.7
		90	2480.292773	17.51	17.49		0.0462	23.7
Flat Position			Depth of Liquid: 15.0 cm			Test Date: November 1, 2003		
EUT Set-up Configuration		Frequency		Power [dBm]		Limit [mW/g]	SAR (1g) [mW/g]	Liquid Temp. [°C]
Separation	Antenna	Ch.	MHz	Start	End			
0 cm	Fixed	01	2400.914355	17.39	17.36	1.6	0.0730	22.0
		45	2440.156641	17.67	17.65		0.0567	22.0
		90	2480.292773	17.51	17.49		0.0518	22.0

- Note 1) Power Measured : ● - Conducted ○ - ERP ○ - EIRP
 2) Please refer to Appendix for the result presentation in plot format.

Tester : Yasuhisa Sakai

SAR MEASUREMENT DATA
(Base Unit)

Modulation Type: FHSS (Duty Cycle: 8.46 %, Crest Factor: 11.82)								
Flat Position		Depth of Liquid: 15.0 cm			Test Date: November 1, 2003			
EUT Set-up Configuration		Frequency		Power [dBm]		Limit [mW/g]	SAR (1g) [mW/g]	Liquid Temp. [°C]
Separation	Antenna	Ch.	MHz	Start	End			
0 cm	Fixed	01	2400.914355	18.18	18.18	1.6	0.150	22.0
		45	2440.156641	18.31	18.31		0.176	22.0
		90	2480.292773	18.45	18.45		0.171	22.0

- Note 1) Power Measured : ● - Conducted ○ - ERP ○ - EIRP
2) Please refer to Appendix for the result presentation in plot format.

Tester : Yasuhisa Sakai

APPENDIX

No.	Content	No. of page(s)
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