



SAR EVALUATION REPORT

Report No. : 23KE0051-HO-1

Applicant : NIHON KOHDEN CORPORATION

Type of Equipment : Telemetry Unit

Model No. : ZB-101AA

FCC ID : B6BZB-101AA

**Test standard : FCC47CFR 2.1093
FCC OET Bulletin 65, Supplement C**

Test Result : Complied

Max SAR Measured : 0.736W/kg(Body, Face , 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: July 8, 2003

Tested by:

Miyo Ikuta
Head Office EMC Lab.

Approved by:

Tetsuo Maeno
Site Manager of Head Office EMC Lab.

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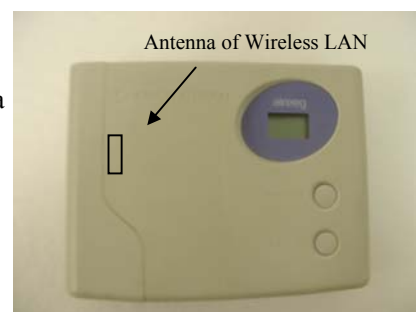
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SECTION 1 : Client information

Company Name : NIHON KOHDEN CORPORATION
Brand Name : NIHON KOHDEN
Address : 1-31-4 Nishiochiai Shinjuku-ku, Tokyo, 161-8560, Japan ,
Telephone Number : 81-3-5996-8066
Facsimile Number : 81-3-5996-8103
Contact Person : Kazuteru Yanagihara

SECTION 2 : Equipment under test (E.U.T.)**2.1 Identification of E.U.T.**

APPLICANT : NIHON KOHDEN CORPORATION
Type of Equipment : Telemetry Unit
Model No. : ZB-101AA
Serial No. : 91002
Rating : DC 3.3V +/- 0.3V
Country of Manufacture : JAPAN
Receipt Date of Sample : July 07,2003
Condition of EUT : Production prototype
Tx Frequency : 2412MHz~2462MHz
Modulation : DSSS [DBPSK,DQPSK,CCK]
Max.Output Power Tested : 16.25dBmPeak Conducted
Antenna Type : C-coupling exciter circuit Antenna
Position of Antenna : See Photograph of right
Size of EUT : W147.5*L54.0*H114.5
Battery option : Only one model with EUT
Category Identified : Portable device



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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).

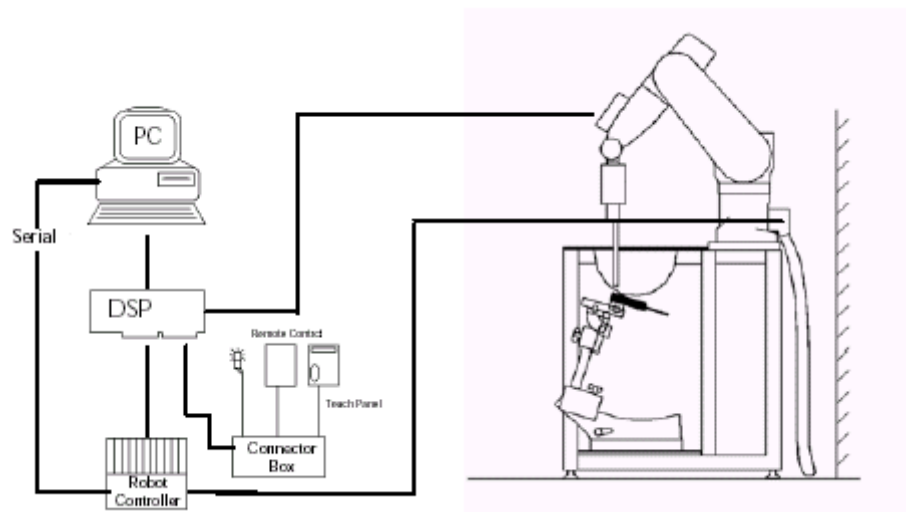
2 IEEE/ANSI Std. C95.1-1992 limits are used to determine compliance with FCC ET Docket 93-62.

SECTION 4 : Dosimetry assessment setup

These measurements were performed with the automated near-field scanning system DASY3 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: 1684 (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, IEE P1528 and CENELEC EN50361.

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4.1 Configuration and peripherals



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

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
2. An arm extension for accommodating the data acquisition electronics (DAE).
3. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
4. A data acquisition electronic (DAE), which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
5. A unit to operate the optical surface detector, which is connected to the EOC.
6. 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.
7. 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.
8. A computer operating Windows 98
9. DASY3 software
10. Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
11. The SAM phantom enabling testing left-hand and right-hand usage.
12. The device holder for handheld EUT.
13. Tissue simulating liquid mixed according to the given recipes (see Application Note).
14. System validation dipoles 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

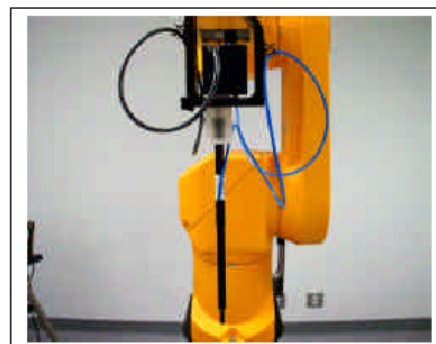
Distance from probe tip to dipole centers: 2.7 mm

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 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.

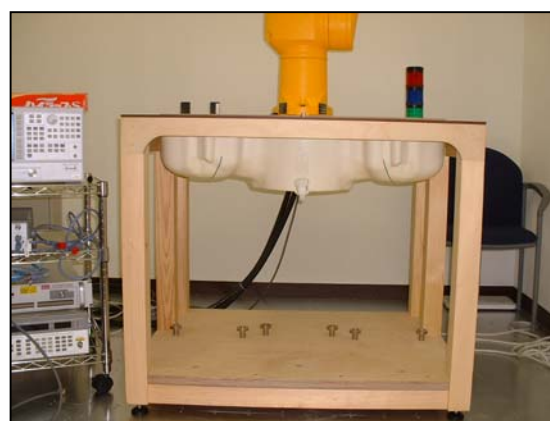
Shell Thickness:

2 +/-0.2 mm

Filling Volume:

Approx. 25 liters

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



SAM Phantom

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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 couldn't be used at this SAR measurement.



Device Holder

SECTION 5 : Test system specifications

Positioner

Robot:	Stäubli Unimation Corp. Robot Model: RX60L
Repeatability:	0.02 mm
No. of axis:	6

Data Acquisition Electronic (DAE) System

Cell Controller

Processor:	Pentium III
Clock Speed:	450 MHz
Operating System:	Windows 98
Data Card:	DASY3 PC-Board

Data Converter

Features:	Signal Amplifier, multiplexer, A/D converter, and control logic
Software:	DASY3 software
Connecting Lines:	Optical downlink for data and status info. Optical uplink for commands and clock

PC Interface Card

Function:	24 bit (64 MHz) DSP for real time processing Link to DAE3 16-bit A/D converter for surface detection system serial link to robot direct emergency stop output for robot
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E-Field Probe

Model:	ET3DV6
Serial No.:	1684
Construction:	Triangular core fiber optic detection system
Frequency:	10 MHz to 6 GHz
Linearity:	+/-0.2 dB (30 MHz to 3 GHz)

Phantom

Type:	SAM Twin Phantom V4.0
Shell Material:	Fiberglass
Thickness:	2.0 +/-0.2 mm
Volume:	Approx. 20 liters

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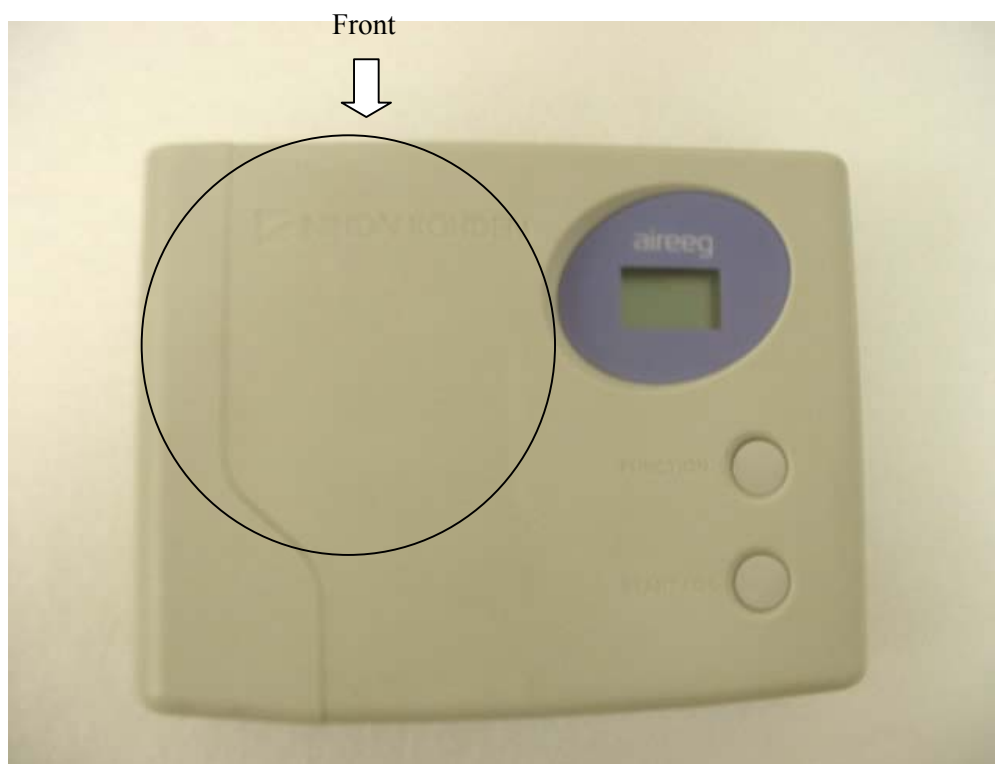
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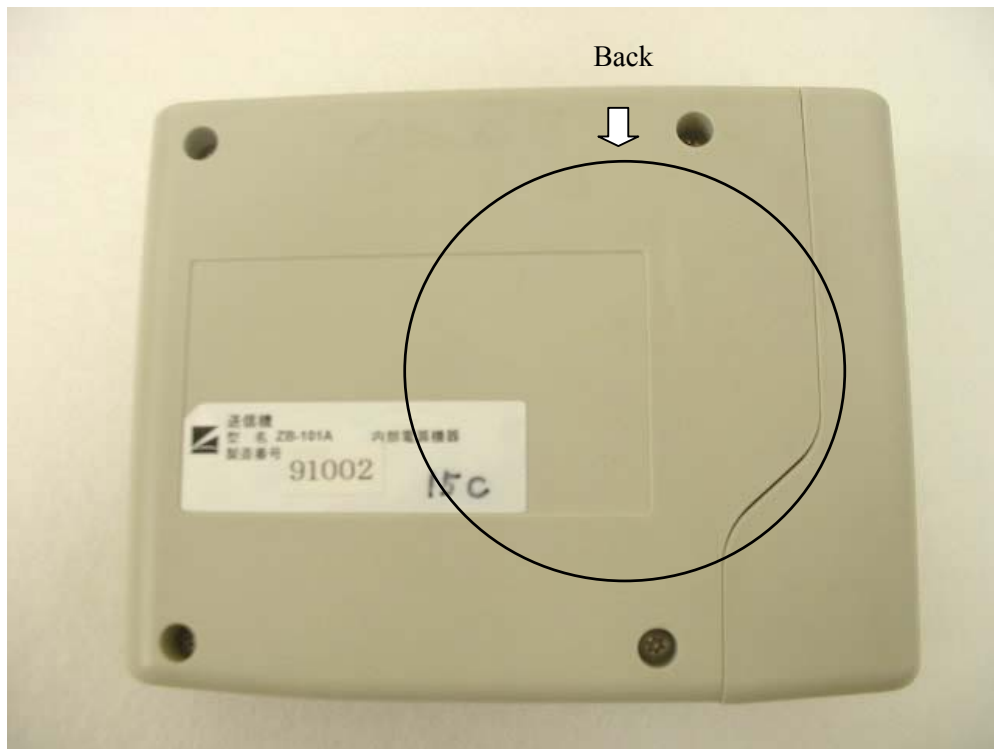
SECTION 6 : Test setup of EUT

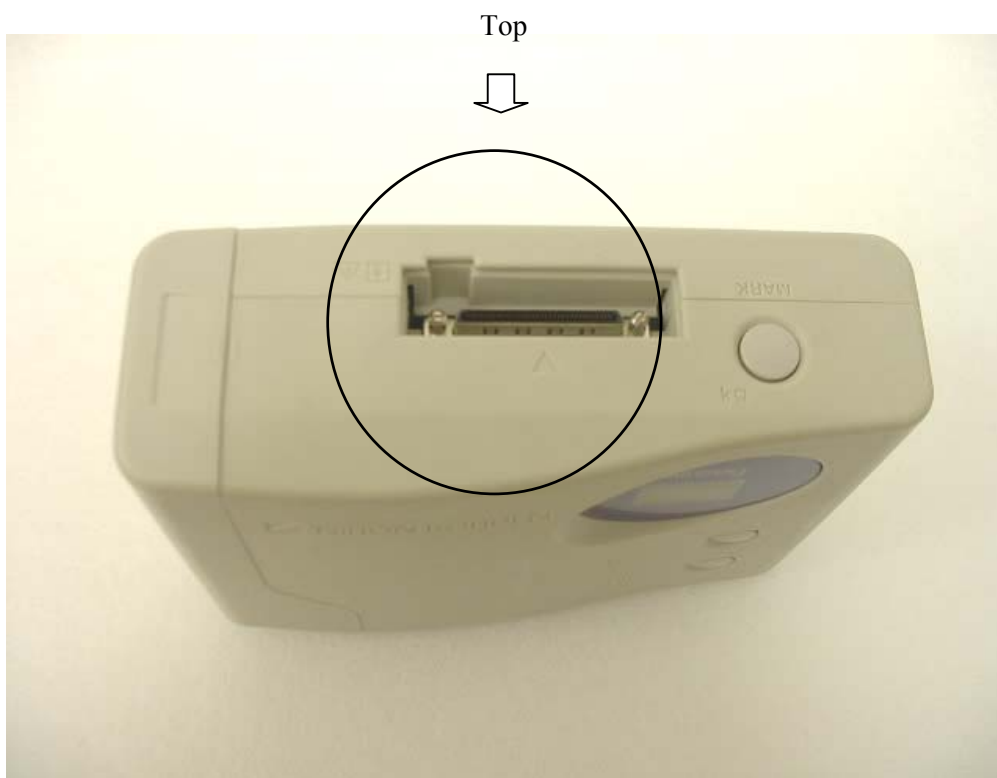
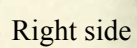
6.1 Photographs of test setup

This EUT is operated with put on the waist. At that time , this EUT could be considered to touch or get close to their bodies. In order to assume these situation, we performed the test at the following positions. Please refer to "APPENDIX 1" for more details.

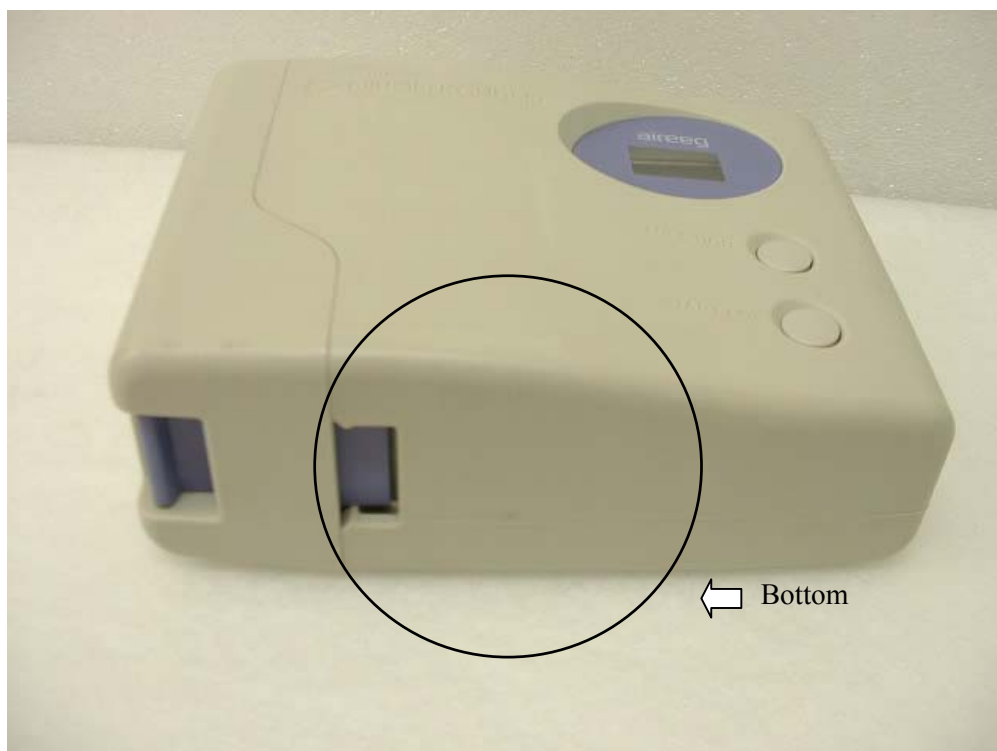
- 1.Front : We performed the test with front of EUT touching to the center of flat phantom.
- 2.Back : We performed the test with Back of EUT touching to the center of flat phantom.
- 3.Left side : We performed the test with left side of EUT touching to the center of flat phantom.
- 4.Right side : We performed the test with right side of EUT touching to the center of flat phantom.
- 5.Top : We performed the test with top of EUT touching to the center of flat phantom.
- 6.Bottom : We performed the test with bottom of EUT touching to the center of flat phantom.







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6.2 EUT Tune-up procedure

In order to measure SAR value, we used continuous transmission mode. The test set up mode was prepared by manufacturer.

Value of Crest Factor = 1 was used for SAR testing according modulation (DSSS) of the EUT.

The test configuration tested at the low, middle and high frequency channels (2412MHz,2437MHz and 2462MHz) of wireless LAN.

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SECTION 7 : Measurement uncertainty

The uncertainty budget has been determined for the DASY3 measurement system according to the NIS81 [13] and the NIST1297 [6] documents and is given in the following Table.

Error Description	Uncertainty value $\pm$ %	Probability distribution	divisor	(ci)1lg	Standard Uncertainty (1g)	vi or veff
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	± 5.5	Rectangular	$\sqrt{3}$	1	± 3.2	∞
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	± 1.4	Rectangular	$\sqrt{3}$	1	± 0.8	∞
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	± 3.9	Rectangular	$\sqrt{3}$	1	± 2.3	∞
Test Sample Related						
Device positioning	± 6.0	Rectangular	$\sqrt{3}$	1	± 6.7	7
Device holder uncertainty	± 5.0	Rectangular	$\sqrt{3}$	1	± 5.9	5
Power drift	± 5.0	Rectangular	$\sqrt{3}$	1	± 2.9	∞
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.)	± 10.0	Rectangular	$\sqrt{3}$	0.64	± 3.7	∞
Liquid permittivity (target)	± 10.0	Rectangular	$\sqrt{3}$	0.6	± 3.5	∞
Liquid permittivity (meas.)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Combined Standard Uncertainty					± 14.1	
Expanded Uncertainty (k=2)					± 28.2	

SECTION 8 : Simulated tissue liquid parameter**8.1 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.

8.1.1 Head 2450MHz

Type of liquid : **Head 2450 MHz**
Ambient temperature (deg.c.) : **23.8**
Relative Humidity (%) : **68**
Liquid depth (cm) : **15.9**

Date : July 08,2003

Measured By : Miyo Ikuta

DIELECTRIC PARAMETERS MEASUREMENT RESULTS						
Liquid Temp [deg.c]		Parameters	Target Value	Measured	Deviation [%]	Limit [%]
Before	After					
23.8	23.8	Relative Permittivity ϵ_r	39.2	35.9	-8.4	+/-10
		Coductivity σ [mho/m]	1.80	1.81	0.5	+/-5

8.1.2 Muscle 2450MHz

Type of liquid : **Muscle 2450 MHz**
Ambient temperature (deg.c.) : **21.0**
Relative Humidity (%) : **58**
Liquid depth (cm) : **15.1**

Date : July 08,2003

Measured By : Miyo Ikuta

DIELECTRIC PARAMETERS MEASUREMENT RESULTS						
Liquid Temp [deg.c]		Parameters	Target Value	Measured	Deviation [%]	Limit [%]
Before	After					
21.3	21.3	Relative Permittivity ϵ_r	52.7	48.9	-7.2	+/-10
		Conductivity σ [mho/m]	1.95	2.03	+4.1	+/-5

8.2 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 9 : 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. And SAR plot is attached in the APPENDIX 3. IEEE P1528 Recommended Reference Value

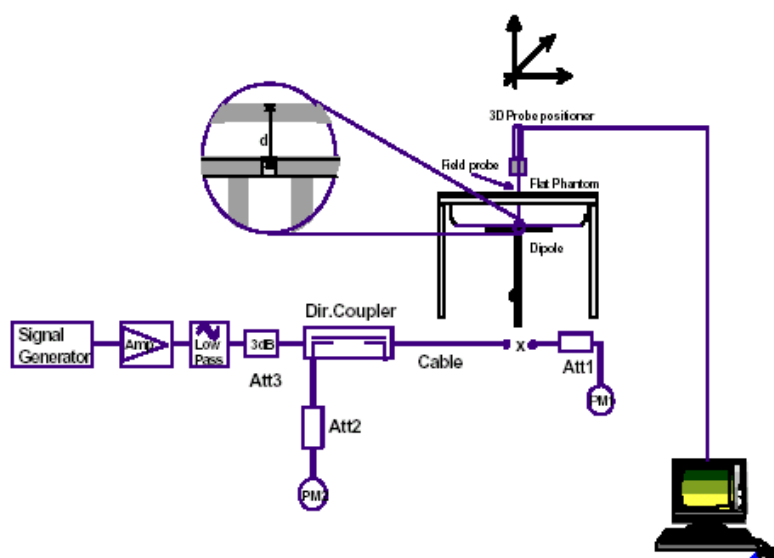
Type of liquid : **HEAD 2450MHz**
 Frequency : **2450MHz**
 Liquid depth (cm) : **15.9**
 Ambient temperature (deg.c.) : **23.8**
 Relative Humidity (%) : **68**
 Dipole : **D2450V2 SN:713**
 Power : **250mW**

Date : July 08,2003

Measured By : Miyo Ikuta

SYSTEM PERFORMANCE CHECK									
Liquid (HEAD 2450MHz)						System dipole validation target & measured			
temperature (deg.c.)		Relative Permittivity ϵ_r		Conductivity σ [mho/m]		SAR 1g [W/kg]		Deviation [%]	Limit [%]
Before	Afterx	Target	Measured	Target	Measured	Target	Measured		
23.8	23.8	39.2	35.9	1.80	1.81	13.1	13.9	+6.1	+/-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 10 : 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 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 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 30 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 [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 SAR value at the same location as in Step 1. If the value changed by more than 5%, the evaluation was repeated.

SECTION 11 : 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.

**NOTE:GENERAL POPULATION/UNCONTROLLED EXPOSURE
SPATIAL PEAK(averaged over any 1g of tissue) LIMIT
1.6 W/kg**

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SECTION 12 : SAR Measurement results**12.1 Conducted power measurement results**

Date : July 08,2003

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	5.9	10	0.35	16.25	42.17	5.7	10	0.35	16.05	40.27	-4.5	+/-5
2437	5.8	10	0.35	16.15	41.21	5.7	10	0.35	16.05	40.27	-2.3	+/-5
2462	5.3	10	0.35	15.65	36.73	5.1	10	0.35	15.45	35.08	-4.5	+/-5

12.2 Body 2450MHz SAR

Liquid Depth (cm) : **15.1** Model : **ZB-101AA**
 Parameters : $\epsilon_r = 48.9, \sigma = 2.03$ Serial No. : **91002**
 Ambient Temperature[deg.c.] : **22.8** Modulation : **DSSS**
 Relative Humidity (%) : **58** Crest factor : **1**

Date : July 08,2003

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	
Mid	2437	Flat	Fixed	Front	0	21.8	21.8	0.695
Mid	2437	Flat	Fixed	Back	0	21.8	21.8	0.0481
Mid	2437	Flat	Fixed	Left side	0	22.0	21.8	0.0162
Mid	2437	Flat	Fixed	Right side	0	21.8	21.6	0.0073
Mid	2437	Flat	Fixed	Top	0	21.6	21.3	0.0462
Mid	2437	Flat	Fixed	Bottom	0	21.3	21.3	0.0632
Low	2412	Flat	Fixed	Front	0	21.3	21.3	0.736
High	2462	Flat	Fixed	Front	0	21.3	21.3	0.429
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 13 : Equipment & calibration information

Name of Equipment	Manufacture	Model number	Serial number	Calibration	
				Last Cal	due date
Power Meter	Agilent	E4417A	GB41290639	2002/11/08	2003/11/07
Power Sensor	Agilent	E9300B	US40010300	2002/11/14	2003/11/13
Power Sensor	Agilent	E9327A	US40440544	2003/02/21	2004/02/20
S-Parameter Network Analyzer	Agilent	8753ES	US39174808	2000/10/05	2003/10/04
Signal Generator	Rohde&Schwarz	SML03	100332	2003/06/24	2004/06/23
RF Amplifier	OPHIR	5056F	1005	2003/02/06	2004/02/05
Dosimetric E-Field Probe	Schmid&Partner Engineering AG	ET3DV6	1684	2002/11/20	2003/11/19
Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE3 V1	509	2003/04/10	2004/04/09
Robot,SAM Phantom	Schmid&Partner Engineering AG	DASY3	I021834	N/A	N/A
Attenuator	Agilent.	US40010300	08498-60012	2002/12/24	2003/12/23
Attenuator	HIROSE ELECTRIC Co.,LTD	AT-110	-	2003/02/04	2004/02/03
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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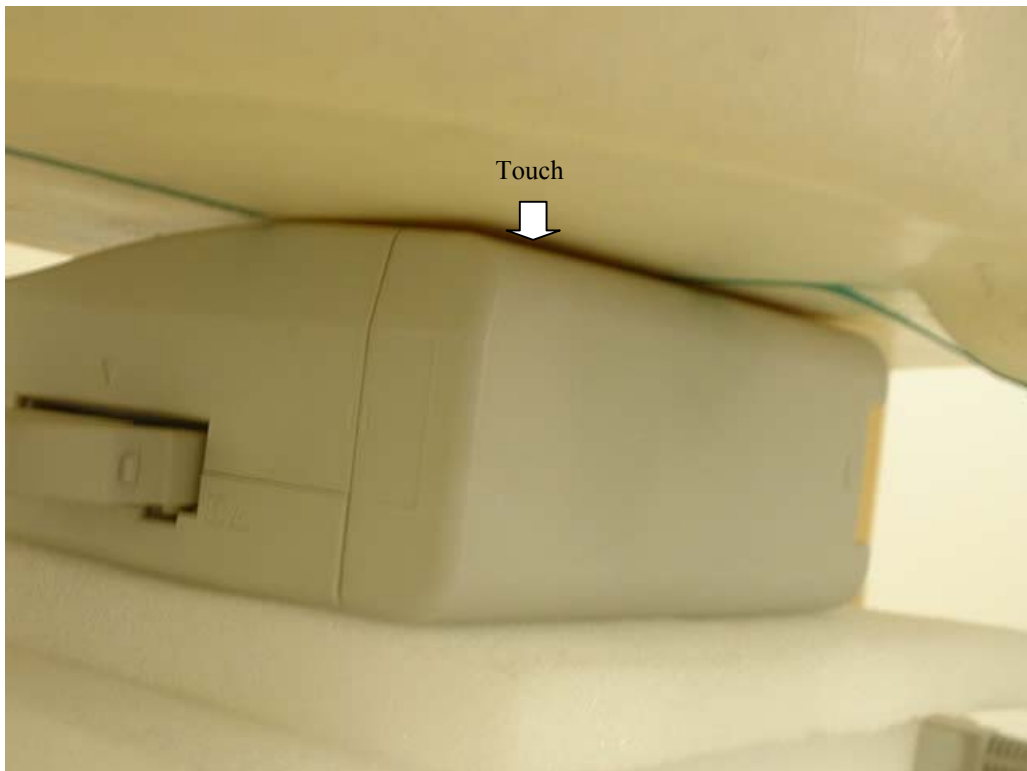
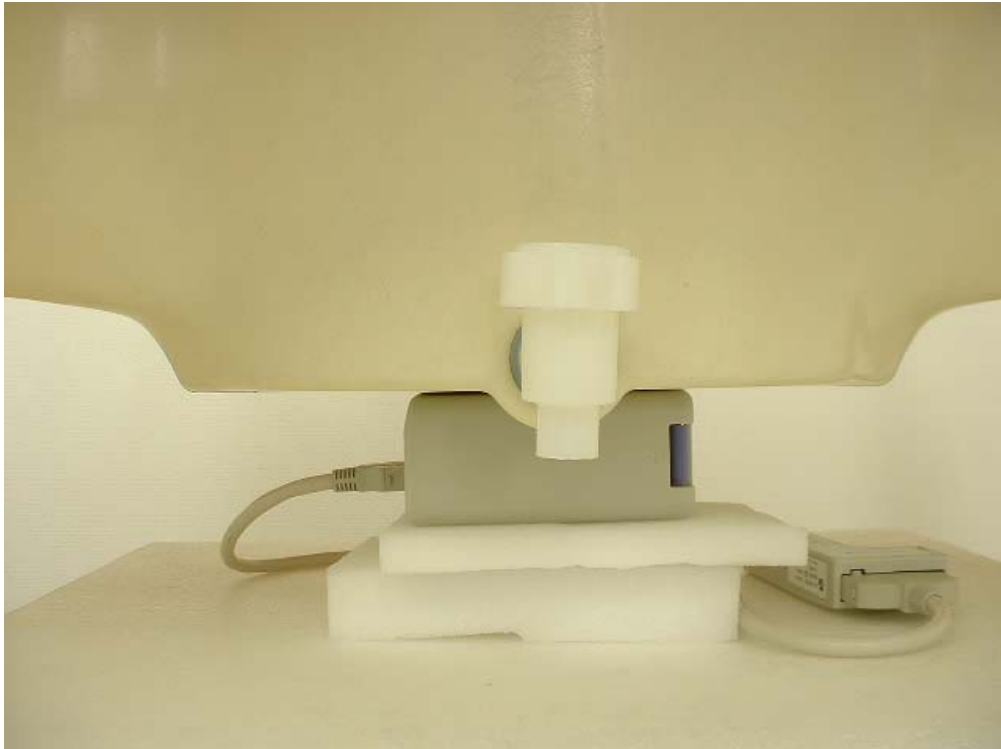
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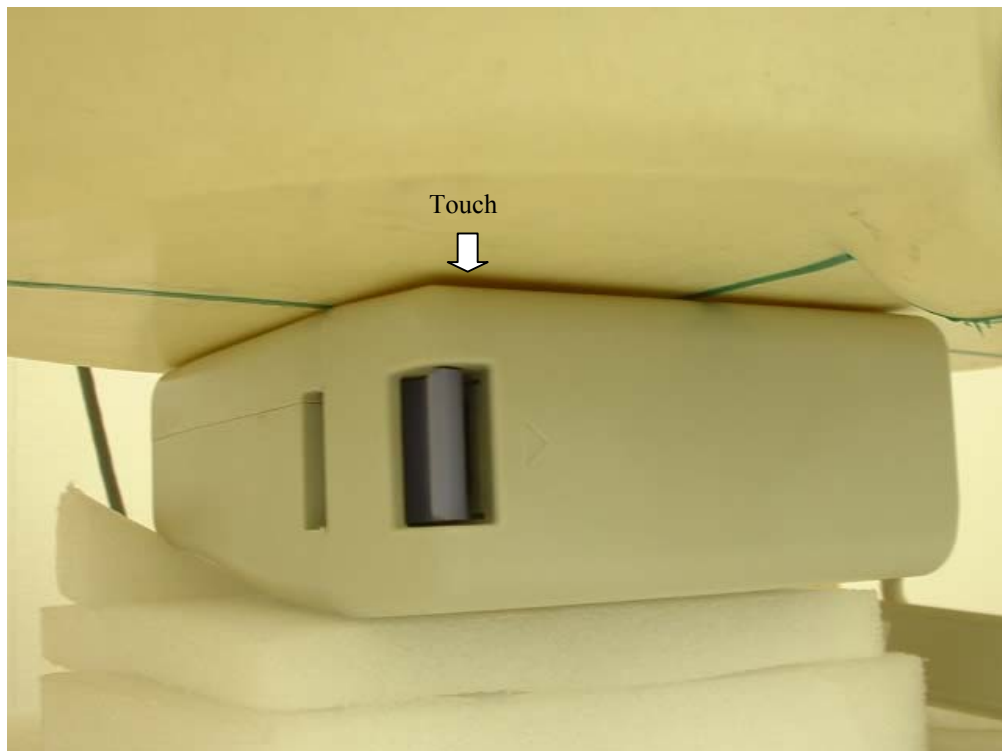
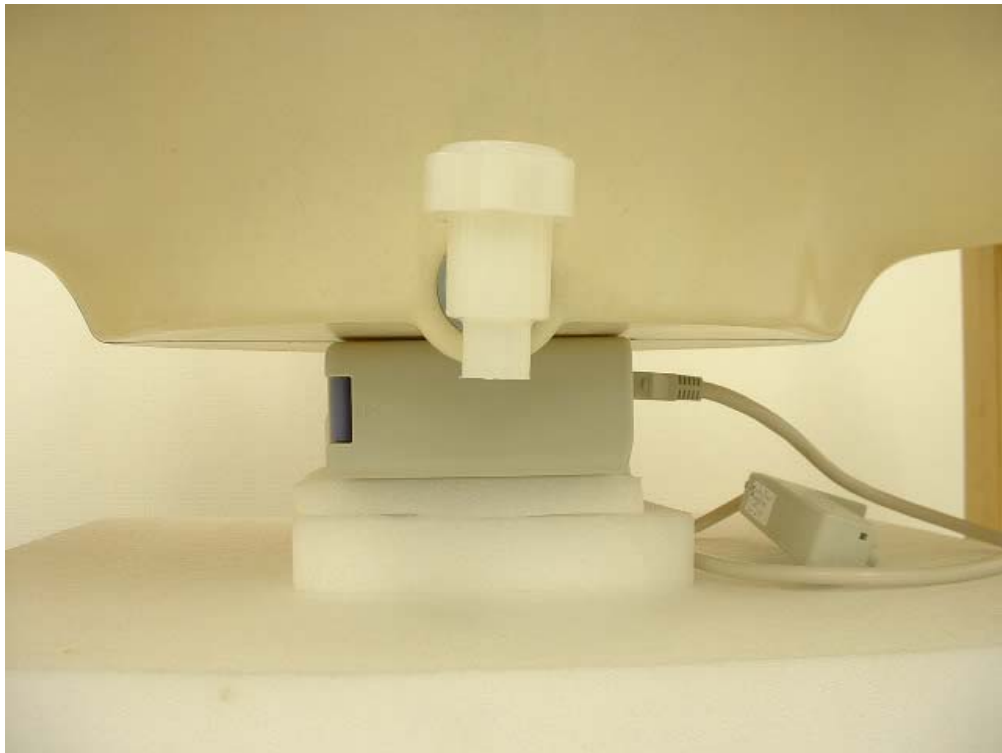
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APPENDIX 1 : Photographs of test setup

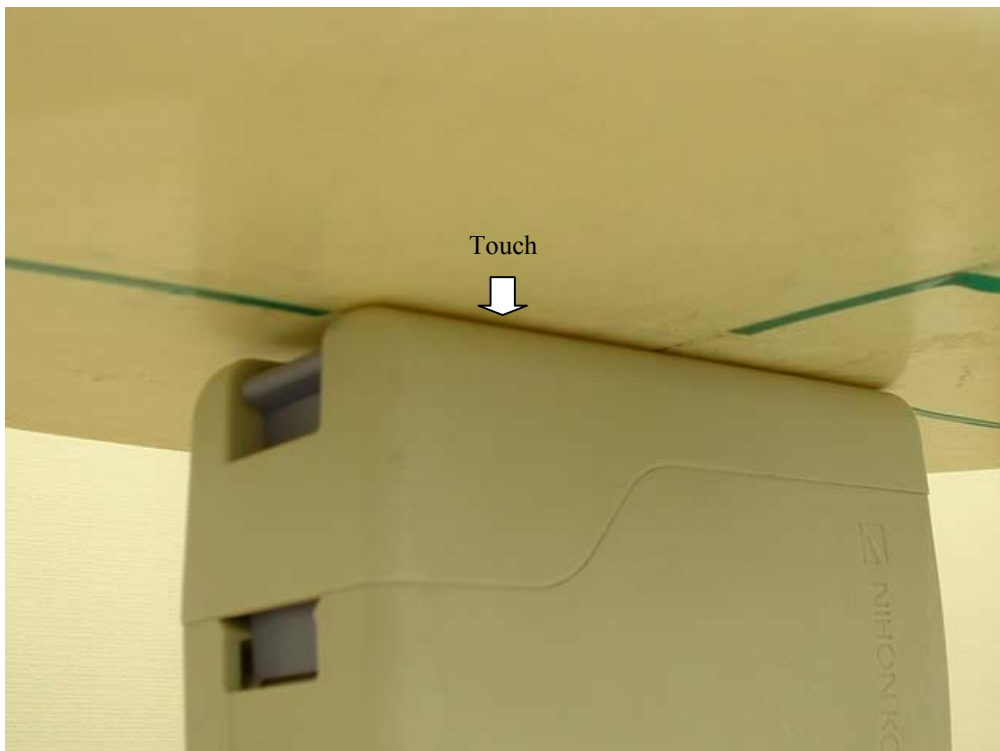
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Back



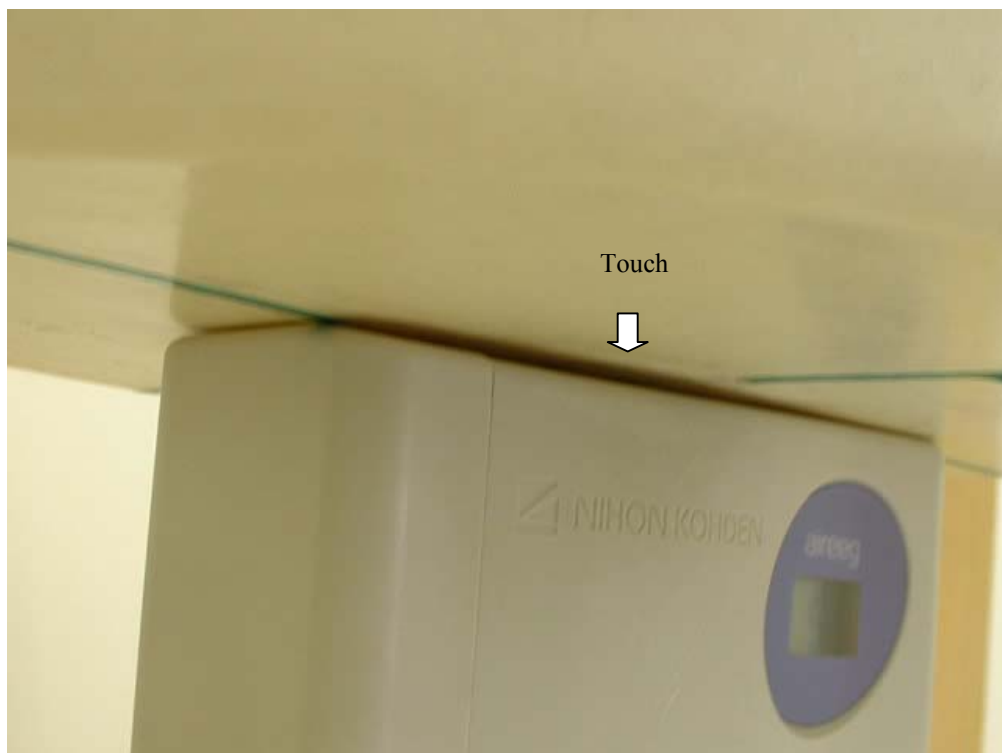
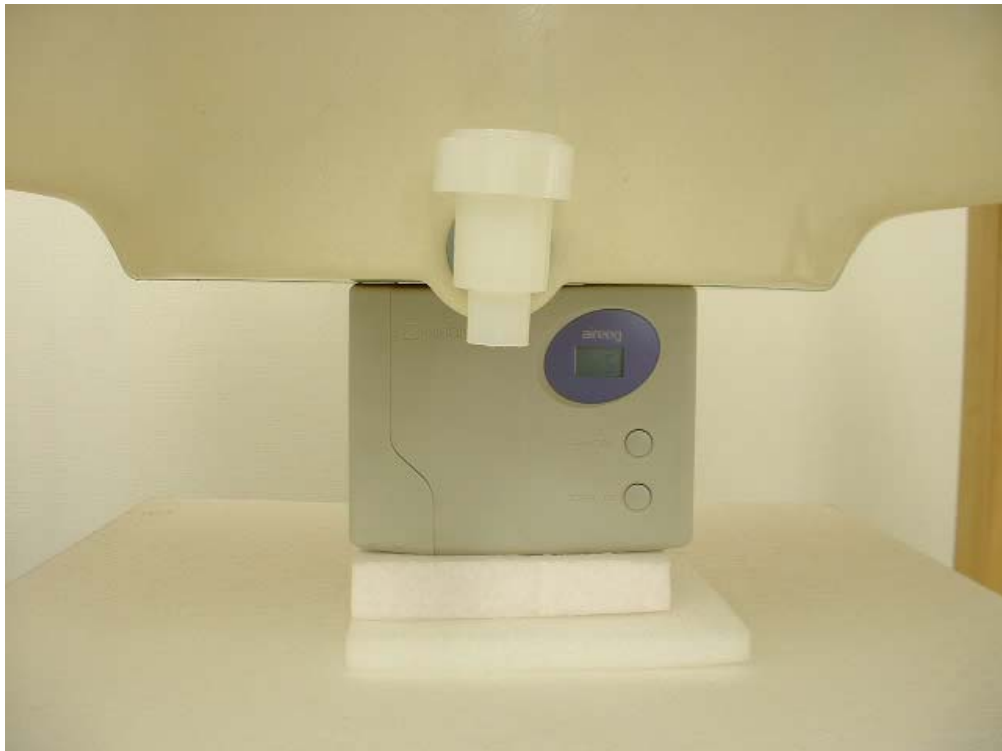
Left Side



Right Side



Top



Bottom

