



**ANSI/IEEE Std. C95.1-1992**

in accordance with the requirements of  
FCC Report and Order: ET Docket 93-62, and OET Bulletin 65 Supplement C



**FCC TEST REPORT**

**For**

**Wireless-N Touchscreen Controller**

**Model:**

**DMRW1000xxx, where x can be 0-9, A-Z, hyphen or blank**

**Trade Name: LINKSYS by Cisco**

*Issued to*

**Cisco-Linksys LLC**  
**121 Theory Drive Irvine, CA 92617 (USA)**

*Issued by*

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# 1. CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

**Applicant:** Cisco-Linksys LLC  
 121 Theory Drive Irvine, CA 92617 (USA)

**Equipment Under Test:** Wireless-N Touchscreen Controller

**Trade Name:** LINKSYS by Cisco

**Model Number:** DMRW1000xxx, where x can be 0-9, A-Z, hyphen or blank

**Date of Test:** November 3 ~ 4, 2008

**Device Category:** PORTABLE DEVICES

**Exposure Category:** GENERAL POPULATION/UNCONTROLLED EXPOSURE

APPLICABLE STANDARDS	
STANDARD	TEST RESULT
FCC OET 65 Supplement C	No non-compliance noted
Deviation from Applicable Standard	
None	

The device was tested by Compliance Certification Services Inc. in accordance with the measurement methods and procedures specified in OET Bulletin 65 Supplement C (Edition 01-01). The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Approved by:

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Rex Lai  
 Section Manager  
 Compliance Certification Services Inc.



## 2. EUT DESCRIPTION

<b>Product</b>	Wireless-N Touchscreen Controller
<b>Trade Name</b>	LINKSYS by Cisco
<b>Model Number</b>	DMRW1000xxx, where x can be 0-9, A-Z, hyphen or blank
<b>Model Discrepancy</b>	The means of all x (x= 0-9, A-Z, hyphen or blank) on model number is just for marketing purpose only.
<b>Frequency Range</b>	802.11a: 5150 ~ 5250 MHz 5725 ~ 5850 MHz 802.11b: 2412 ~ 2462 MHz 802.11g: 2412 ~ 2462 MHz
<b>Max. O/P Power: (Conducted/Peak)</b>	802.11a 5150 ~ 5250 MHz: 11.51 dBm 802.11a 5150 ~ 5250 MHz HT20: 14.83 dBm 802.11a 5150 ~ 5250 MHz HT40: 12.21 dBm 802.11a 5725 ~ 5850 MHz: 14.03 dBm 802.11a 5725 ~ 5850 MHz HT20: 17.71 dBm 802.11a 5725 ~ 5850 MHz HT40: 17.45 dBm 802.11b: 17.70 dBm 802.11g: 16.98 dBm 802.11g HT20: 18.06 dBm 802.11g HT40: 17.97 dBm
<b>Max. SAR (1g):</b>	802.11a 5150 ~ 5250 MHz: 0.696 W/kg 802.11a 5150 ~ 5250 MHz HT20: 0.707 W/kg 802.11a 5150 ~ 5250 MHz HT40: 0.301 W/kg 802.11a 5725 ~ 5850 MHz: 0.302 W/kg 802.11a 5725 ~ 5850 MHz HT20: 0.282 W/kg 802.11a 5745 ~ 5850 MHz HT40: 0.259 W/kg 802.11b: 0.635 W/kg 802.11g: 0.411 W/kg 802.11g HT20: 0.731 W/kg 802.11g HT40: 0.702 W/kg
<b>Modulation Technique</b>	802.11a: Orthogonal Frequency Division Multiplexing (OFDM) 802.11b: Direct Sequence Spread Spectrum (DSSS) 802.11g: Orthogonal Frequency Division Multiplexing (OFDM)
<b>Antenna Specification</b>	Antenna type: PIFA antenna

**Remark:** The sample selected for test was prototype that approximated to production product and was provided by manufacturer.



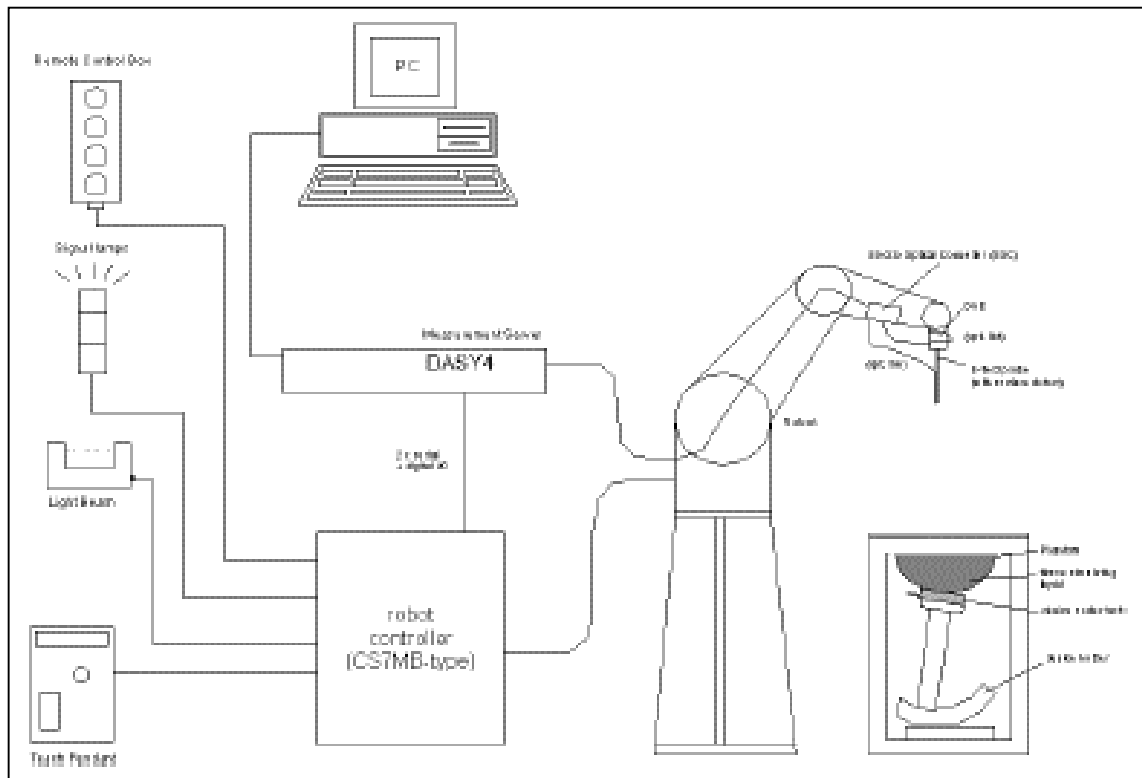
### **3. REQUIREMENTS FOR COMPLIANCE TESTING DEFINED BY THE FCC**

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 [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 for an uncontrolled environment and 8.0 mW/g for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992 [6]. 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.

### **4. DOSIMETRIC ASSESSMENT SYSTEM**

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  $\pm 0.02$  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 dosimetric probe EX3DV4-SN: 3552 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure with accuracy of better than  $\pm 10\%$ . The spherical isotropy was evaluated with the procedure and found to be better than  $\pm 0.25$  dB. The phantom used was the SAM Twin Phantom as described in FCC supplement C, IEEE P1528 and EN50361.

#### 4.1 MEASUREMENT SYSTEM DIAGRAM



**The DASY4 system for performing compliance tests consists of the following items:**

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- 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.
- A data acquisition electronics (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.
- 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.
- 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.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing validating the proper functioning of the system.

## 4.2 SYSTEM COMPONENTS

### DASY4 Measurement Server



The DASY4 measurement server is based on a PC/104 CPU board with a 166MHz low-power Pentium, 32MB chip disk and 64MB RAM. The necessary circuits for communication with either the DAE3 electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY4 I/O-board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation.

The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server. Calibration: No calibration required.

### Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE3) consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE3 box is 200M $\Omega$ ; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

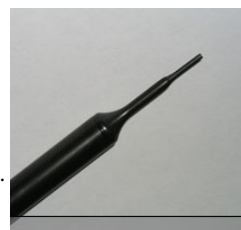


### EX3DV4 Isotropic E-Field Probe for Dosimetric Measurements

- Construction:** Symmetrical design with triangular core  
Built-in shielding against static charges  
PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
- Calibration:** Basic Broad Band Calibration in air: 10-3000 MHz.  
Conversion Factors (CF) for HSL 900 and HSL 1800  
CF-Calibration for other liquids and frequencies upon request.
- Frequency:** 10 MHz to > 6 GHz; Linearity:  $\pm 0.2$  dB (30 MHz to 3 GHz)
- Directivity:**  $\pm 0.3$  dB in HSL (rotation around probe axis)  
 $\pm 0.5$  dB in HSL (rotation normal to probe axis)
- Dynamic Range:** 10  $\mu$ W/g to > 100 mW/g; Linearity:  $\pm 0.2$  dB  
(noise: typically < 1  $\mu$ W/g)

- Dimensions:** Overall length: 330 mm (Tip: 20 mm)  
Tip diameter: 2.5 mm (Body: 12 mm)  
Distance from probe tip to dipole centers: 1 mm

- Application:** High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.



Interior of probe



E-Field probe EX3DV4

### SAM Phantom (V4.0)

**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:**  $2 \pm 0.2$  mm

**Filling Volume:** Approx. 25 liters

**Dimensions:** Height: 810mm; Length: 1000mm; Width: 500mm

### Device Holder for SAM Twin Phantom

**Construction:** In combination with the Twin SAM Phantom V4.0 or Twin SAM, the Mounting Device (made from POM) 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, and flat phantom).



### System Validation Kits

**Construction:** Symmetrical dipole with 1/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

**Frequency:** 450, 900, 1800, 2450, 5800 MHz

**Return loss:** > 20 dB at specified validation position

**Power capability:** > 100 W ( $f < 1\text{GHz}$ ); > 40 W ( $f > 1\text{GHz}$ )

**Dimensions:**  
450V2: dipole length: 270 mm; overall height: 330 mm  
D900V2: dipole length: 149 mm; overall height: 330 mm  
D1800V2: dipole length: 72 mm; overall height: 300 mm  
D2450V2: dipole length: 51.5 mm; overall height: 300 mm  
D5GHzV2: dipole length: 25.5 mm; overall height: 290 mm





## 5. EVALUATION PROCEDURES

### DATA EVALUATION

The DASY4 post processing software (SEMCAD) 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 parameters:	- Sensitivity	$Norm_i, a_{i0}, a_{i1}, a_{i2}$
	- Conversion factor	$ConvF_i$
	- Diode compression point	$dcp_i$
Device parameters:	- Frequency	$f$
	- Crest factor	$cf$
Media parameters:	- Conductivity	$\sigma$
	- Density	$\rho$

These parameters must be set correctly in the software. They can be found in the component documents or be imported into the software from the configuration files issued for the DASY 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:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

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:

E-field probes: 
$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

H-field probes: 
$$H_i = \sqrt{V_i} \cdot \frac{a_{i10} + a_{i11}f + a_{i12}f^2}{f}$$

with	$V_i$	= Compensated signal of channel i	(i = x, y, z)
	$Norm_i$	= Sensor sensitivity of channel i	(i = x, y, z)
		$\mu V/(V/m)^2$ for E0field 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	
	$H_i$	= Magnetic field strength of channel i in A/m	

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

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

- with  $SAR$  = local specific absorption rate in mW/g  
 $E_{tot}$  = total field strength in V/m  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in g/cm<sup>3</sup>

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.

$$P_{pwe} = \frac{E_{tot}^2}{3770} \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

- with  $P_{pwe}$  = Equivalent power density of a plane wave in mW/cm<sup>2</sup>  
 $E_{tot}$  = total electric field strength in V/m  
 $H_{tot}$  = total magnetic field strength in A/m



## **SAR MEASUREMENT PROCEDURES**

The procedure for assessing the peak spatial-average SAR value consists of the following steps:

- **Power Reference Measurement**

The reference and drift jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

- **Area Scan**

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY4 software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought-up, grid was at to **15 mm by 15 mm** and can be edited by a user.

- **Zoom Scan**

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default zoom scan measures **5x5x7** points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more than one maximum, the number of Zoom Scans has to be enlarged accordingly (The default number inserted is 1).

- **Power Drift measurement**

The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same settings. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. In the properties of the Drift job, the user can specify a limit for the drift and have DASY4 software stop the measurements if this limit is exceeded.

- **Z-Scan**

The Z Scan job measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. A user can anchor the grid to the current probe location. As with any other grids, the local Z-axis of the anchor location establishes the Z-axis of the grid.

## SPATIAL PEAK SAR EVALUATION

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1529 standard. It can be conducted for 1 g and 10 g.

The DASY4 system allows evaluations that combine measured data and robot positions, such as:

- maximum search
- extrapolation
- boundary correction
- peak search for averaged SAR

During a maximum search, global and local maximum searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

### Extrapolation

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation.

Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Cube Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation. For a grid using 5x5x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1 g and 10 g cubes.

### Boundary effect

For measurements in the immediate vicinity of a phantom surface, the field coupling effects between the probe and the boundary influence the probe characteristics. Boundary effect errors of different dosimetric probe types have been analyzed by measurements and using a numerical probe model. As expected, both methods showed an enhanced sensitivity in the immediate vicinity of the boundary. The effect strongly depends on the probe dimensions and disappears with increasing distance from the boundary. The sensitivity can be approximately given as:

$$S \approx S_o + S_b \exp\left(-\frac{z}{a}\right) \cos\left(\pi \frac{z}{\lambda}\right)$$

Since the decay of the boundary effect dominates for small probes ( $a \ll \lambda$ ), the cos-term can be omitted. Factors  $S_b$  (parameter Alpha in the DASY4 software) and  $a$  (parameter Delta in the DASY4 software) are assessed during probe calibration and used for numerical compensation of the boundary effect. Several simulations and measurements have confirmed that the compensation is valid for different field and boundary configurations.

This simple compensation procedure can largely reduce the probe uncertainty near boundaries. It works well as long as:

- the boundary curvature is small
- the probe axis is angled less than 30° to the boundary normal
- the distance between probe and boundary is larger than 25% of the probe diameter
- the probe is symmetric (all sensors have the same offset from the probe tip)

Since all of these requirements are fulfilled in a DASY4 system, the correction of the probe boundary effect in the vicinity of the phantom surface is performed in a fully automated manner via the measurement data extraction during post processing.



## 6. MEASUREMENT UNCERTAINTY

UNCERTAINTY BUDGE ACCORDING TO IEEE P1528						
Error Description	Uncertainty Value $\pm\%$	Probability distribution	Divisor	C <sub>1</sub> 1g	Standard unc.(1g/10g) $\pm\%$	V <sub>1</sub> or V <sub>eff</sub>
<b>Measurement System</b>						
Probe calibration	$\pm 4.8$	normal	1	1	$\pm 4.8$	$\infty$
Axial isotropy of probe	$\pm 4.6$	rectangular	$\sqrt{3}$	$(1-C_p)^{1/2}$	$\pm 1.9$	$\infty$
Sph. Isotropy of probe	$\pm 9.7$	rectangular	$\sqrt{3}$	$(C_p)^{1/2}$	$\pm 3.9$	$\infty$
Probe linearity	$\pm 4.5$	rectangular	$\sqrt{3}$	1	$\pm 2.7$	$\infty$
Detection Limit	$\pm 0.9$	rectangular	$\sqrt{3}$	1	$\pm 0.6$	$\infty$
Boundary effects	$\pm 8.5$	rectangular	$\sqrt{3}$	1	$\pm 4.8$	$\infty$
Readoutelectronics	$\pm 1.0$	normal	1	1	$\pm 1.0$	$\infty$
Response time	$\pm 0.9$	rectangular	$\sqrt{3}$	1	$\pm 0.5$	$\infty$
Integration time	$\pm 1.2$	rectangular	$\sqrt{3}$	1	$\pm 0.8$	$\infty$
Mech Constrains of robot	$\pm 0.5$	rectangular	$\sqrt{3}$	1	$\pm 0.2$	$\infty$
Probe positioning	$\pm 2.7$	rectangular	$\sqrt{3}$	1	$\pm 1.7$	$\infty$
Extrap. And integration	$\pm 4.0$	rectangular	$\sqrt{3}$	1	$\pm 2.3$	$\infty$
RF ambient conditiona	$\pm 0.54$	rectangular	$\sqrt{3}$	1	$\pm 0.43$	$\infty$
<b>Test Sample Related</b>						
Device positioning	$\pm 2.2$	normal	1	1	$\pm 2.23$	11
Device holder uncertainty	$\pm 5$	normal	1	1	$\pm 5.0$	7
Power drift	$\pm 5$	rectangular	$\sqrt{3}$	1	$\pm 2.9$	$\infty$
<b>Phantom and Set up</b>						
Phantom uncertainty	$\pm 4$	rectangular	$\sqrt{3}$	1	$\pm 2.3$	$\infty$
Liquid conductivity	$\pm 5$	rectangular	$\sqrt{3}$	0.6	$\pm 1.7$	$\infty$
Liquid conductivity	$\pm 5$	rectangular	$\sqrt{3}$	0.6	$\pm 3.5/1.7$	$\infty$
Liquid permittivity	$\pm 5$	rectangular	$\sqrt{3}$	0.6	$\pm 1.7$	$\infty$
Liquid permittivity	$\pm 5$	rectangular	$\sqrt{3}$	0.6	$\pm 1.7$	$\infty$
<b>Combined Standard Uncertainty</b>						
					$\pm 12.14/11.76$	
<b>Coverage Factor for 95%</b>						
		kp=2				
<b>Expanded Standard Uncertainty</b>						
					$\pm 24.29/23.51$	

Table: Worst-case uncertainty for DASY4 assessed according to IEEE P1528.

The budge is valid for the frequency range 300 MHz to 6G Hz and represents a worst-case analysis.



## 7. EXPOSURE LIMIT

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

<u>Whole-Body</u>	<u>Partial-Body</u>	<u>Hands, Wrists, Feet and Ankles</u>
0.4	8.0	2.0

(B).Limits for General Population/Uncontrolled Exposure (W/kg)

<u>Whole-Body</u>	<u>Partial-Body</u>	<u>Hands, Wrists, Feet and Ankles</u>
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 individuals 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).

**NOTE**  
**GENERAL POPULATION/UNCONTROLLED EXPOSURE**  
**PARTIAL BODY LIMIT**  
**1.6 W/kg**



### 8. TYPICAL COMPOSITION OF INGREDIENTS FOR LIQUID TISSUE PHANTOMS

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

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

Salt: 99+% Pure Sodium Chloride

Sugar: 98+% Pure Sucrose

Water: De-ionized, 16 MΩ<sup>+</sup> 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



## 9. MEASUREMENT RESULTS

### 9.1 SYSTEM PERFORMANCE CHECK

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications. The system performance check results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

#### SYSTEM PERFORMANCE CHECK MEASUREMENT CONDITIONS

- The measurements were performed in the flat section of the SAM twin phantom filled with Body simulating liquid of the following parameters.
- The DASY4 system with an E-field probe EX3DV4 SN: 3552 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15 mm (below 1 GHz) and 10 mm (above 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 10mm was aligned with the dipole.
- Special 7x7x7 fine cube was chosen for cube integration (dx=dy=dz= 5 mm).
- Distance between probe sensors and phantom surface was set to 3.0 mm.
- The dipole input power (forward power) was 250 mW±3%.
- The results are normalized to 1 W input power.

#### Reference SAR values

The reference SAR values were using measurement results indicated in the dipole calibration document (see table below)

Frequency (MHz)	1g SAR	10g SAR	Local SAR at Surface (Above Feed Point)	Local SAR at Surface (y = 2cm offset from feed point)
900	10.3	6.57	16.4	5.4
1800	38.2	20.3	69.5	6.8
2450(Body)	52.8	8.76	128.8	N/A





**SYSTEM PERFORMANCE CHECK RESULTS**

**Dipole:** D2450V2 SN: 728

**Date:** November 3, 2008      **Ambient condition:** Temperature 24.6°C; Relative humidity: 53%

Body Simulating Liquid			Parameters	Target	Measured	Deviation[% ]	Limited[% ]
f(MHz)	Temp. [°C]	Depth [cm]					
2450.00	23.60	15.00	Permittivity:	52.70	52.00	-1.33	± 5
			Conductivity:	1.95	1.98	1.54	± 5
			1 g SAR:	52.80	54.80	3.79	± 5

**Dipole:** D5GMHz SN:1004

**Date:** November 4, 2008      **Ambient condition:** Temperature 24.4°C; Relative humidity: 53%

Body Simulating Liquid			Parameters	Target	Measured	Deviation[% ]	Limited[% ]
f(MHz)	Temp. [°C]	Depth [cm]					
5200.00	23.40	15.00	Permittivity:	49.02	48.20	-1.67	± 5
			Conductivity:	5.29	5.38	1.70	± 5
			1 g SAR:	31.36	32.48	3.57	± 5

**Dipole:** D5GMHz SN:1004

**Date:** November 4, 2008      **Ambient condition:** Temperature 24.4°C; Relative humidity: 53%

Body Simulating Liquid			Parameters	Target	Measured	Deviation[% ]	Limited[% ]
f(MHz)	Temp. [°C]	Depth [cm]					
5800.00	23.40	15.00	Permittivity:	48.20	47.00	-2.49	± 5
			Conductivity:	6.00	6.24	4.00	± 5
			1 g SAR:	28.84	29.52	2.36	± 5



## 9.2 TEST LIQUID CONFIRMATION

### SIMULATING LIQUIDS PARAMETER CHECK

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine if the dielectric parameters are within the tolerances of the specified target values

The relative permittivity and conductivity of the tissue material should be within  $\pm 5\%$  of the values given in the table below. 5% may not be easily achieved at certain frequencies. Under such circumstances, 10% tolerance may be used until more precise tissue recipes are available

### IEEE SCC-34/SC-2 P1528 RECOMMENDED TISSUE DIELECTRIC PARAMETERS

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in P1528

Target Frequency (MHz)	Head		Body	
	$\epsilon_r$	$\sigma$ (S/m)	$\epsilon_r$	$\sigma$ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800-2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	45.3	5.27	48.2	6.00



**SIMULATING LIQUIDS PARAMETER CHECK RESULTS**

**Date:** November 3, 2008      **Ambient condition:** Temperature 24.6°C; Relative humidity: 53%

Body Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
2450.00	23.60	15.00	Permittivity:	52.70	52.00	-1.33	± 5
			Conductivity:	1.95	1.98	1.54	± 5

**Date:** November 4, 2008      **Ambient condition:** Temperature 24.4°C; Relative humidity: 53%

Body Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
5200.00	23.40	15.00	Permittivity:	49.02	48.20	-1.67	± 5
			Conductivity:	5.29	5.38	1.70	± 5

**Date:** November 4, 2008      **Ambient condition:** Temperature 24.4°C; Relative humidity: 53%

Body Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
5800.00	23.60	15.00	Permittivity:	48.20	47.00	-2.49	± 5
			Conductivity:	6.00	6.24	4.00	± 5



### 9.3 EUT TUNE-UP PROCEDURES AND TEST MODE

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

- The client supplied a special driver to program the EUT, allowing it to continually transmit the specified maximum power and change the channel frequency.
- The output power(dBm) we measured before SAR test in different channel
- Performing the middle channel first
- There are four test mode: Tip Touched / Left (edge) Touched / Right (edge) Touched / Bottom Flat Touched, using 802.11b mode to find worst mode and using worst mode to do final test.

The output power for low/middle/high channel is :

#### 802.11b/g output Power (Peak)(dBm):

Power Frequency	802.11b 1M	802.11g 6M
1(2412 MHz)	17.45	16.66
6(2437 MHz)	<b>17.70</b>	<b>16.98</b>
11(2462 MHz)	16.68	15.56

#### 802.11g HT20 output Power (Peak)(dBm):

Power Frequency	Chain 0 6.5M	Chain 1 6.5M	HT20 Total power 6.5M
1(2412 MHz)	13.39	16.20	18.03
6(2437 MHz)	13.49	16.20	<b>18.06</b>
11(2462 MHz)	11.70	13.84	15.91

#### 802.11g HT40 output Power (Peak)(dBm):

Power Frequency	Chain 0 13.5M	Chain 1 13.5M	HT40 Total power 13.5M
Low(2422 MHz)	11.54	14.04	15.98
Middle(2437 MHz)	13.58	16.01	<b>17.97</b>
High(2452 MHz)	13.52	15.78	17.81



**802.11a output Power (Peak)(dBm):**

Frequency	Power	Normal 6M
5180 MHz		10.52
5200 MHz		10.88
5220 MHz		<b>11.51</b>
5745 MHz		13.91
5785 MHz		13.58
5825 MHz		<b>14.03</b>

**802.11a HT20 output Power (Peak)(dBm):**

Frequency	Power	Chain 0 6.5M	Chain 1 6.5M	HT20 Total power 6.5M
5180 MHz		10.79	12.55	14.77
5200 MHz		10.80	12.55	14.77
5220 MHz		11.08	12.45	<b>14.83</b>
5745 MHz		9.01	10.77	12.99
5785 MHz		13.46	15.01	17.31
5825 MHz		13.80	15.45	<b>17.71</b>

**802.11a HT40 output Power(dBm):**

Frequency	Power	Chain 0 13.5M	Chain 1 13.5M	HT40 Total power 13.5M
5190 MHz		8.03	10.12	<b>12.21</b>
5755 MHz		7.70	9.72	11.84
5795 MHz		13.43	15.26	<b>17.45</b>



9.4 SAR MEASUREMENTS RESULTS

Body position Tip / Bottom / Left / Right Touched

802.11b: Duty Cycle =100 %, Crest Factor: 1, Rate=1M,				Depth of liquid: 15.0 cm		
Sep. [mm]	Antenna	Channel	Frequency [MHz]	Liquid Temp[°C]	SAR(1g) (W/kg)	Limit (W/kg)
0mm Tip Touched	Fixed	Middle	2437	23.6	<b>0.635</b>	1.6
0mm Left Touched	Fixed	Middle	2437	23.6	0.020	1.6
0mm Right Touched	Fixed	Middle	2437	23.6	0.112	1.6
0mm Bottom Touched	Fixed	Middle	2437	23.6	0.418	1.6

Notes:

1. Bottom face in parallel with flat phantom. for Bottom Touch
2. See attachment for the result presentation in plot format.
3. The SAR measured at the middle channel for this configuration at least 3 dB lower (0.8mW/g) than SAR limit (1.6mW/g), thus testing at low and high channel is optional.



**Body position Tip Touched**

802.11g: Duty Cycle =100 %, Crest Factor: 1, Rate=6M,				Depth of liquid: 15.0 cm		
Sep. [mm]	Antenna	Channel	Frequency [MHz]	Liquid Temp[°C]	SAR(1g) (W/kg)	Limit (W/kg)
0mm Tip Touched	Fixed	Middle	2437	23.6	<b>0.411</b>	1.6
802.11g HT20: Duty Cycle =100 %, Crest Factor: 1, Rate=6.5M,				Depth of liquid: 15.0 cm		
Sep. [mm]	Antenna	Channel	Frequency [MHz]	Liquid Temp[°C]	SAR(1g) (W/kg)	Limit (W/kg)
0mm Tip Touched	Fixed	Middle	2437	23.6	<b>0.731</b>	1.6
802.11g HT40: Duty Cycle =100 %, Crest Factor: 1, Rate=13.5M,				Depth of liquid: 15.0 cm		
Sep. [mm]	Antenna	Channel	Frequency [MHz]	Liquid Temp[°C]	SAR(1g) (W/kg)	Limit (W/kg)
0mm Tip Touched	Fixed	Middle	2437	23.6	<b>0.702</b>	1.6
Notes:						
<ol style="list-style-type: none"> <li>1. Bottom face in parallel with flat phantom. for Bottom Touch</li> <li>2. See attachment for the result presentation in plot format.</li> <li>3. The SAR measured at the middle channel for this configuration at least 3 dB lower (0.8mW/g) than SAR limit (1.6mW/g), thus testing at low and high channel is optional.</li> </ol>						



Body position Tip Touched

802.11a: Duty Cycle =100 %, Crest Factor: 1, Rate=6M,				Depth of liquid: 15.0 cm		
Sep. [mm]	Antenna	Channel	Frequency [MHz]	Liquid Temp[°C]	SAR(1g) (W/kg)	Limit (W/kg)
0mm Tip Touched	Fixed	Middle	5200	23.4	<b>0.696</b>	1.6
	Fixed	High	5825	23.4	<b>0.302</b>	
802.11a HT20: Duty Cycle =100 %, Crest Factor: 1, Rate=6.5M,				Depth of liquid: 15.0 cm		
Sep. [mm]	Antenna	Channel	Frequency [MHz]	Liquid Temp[°C]	SAR(1g) (W/kg)	Limit (W/kg)
0mm Tip Touched	Fixed	Middle	5200	23.4	<b>0.707</b>	1.6
	Fixed	High	5825	23.4	<b>0.282</b>	
802.11a HT40: Duty Cycle =100 %, Crest Factor: 1, Rate=13.5M,				Depth of liquid: 15.0 cm		
Sep. [mm]	Antenna	Channel	Frequency [MHz]	Liquid Temp[°C]	SAR(1g) (W/kg)	Limit (W/kg)
0mm Tip Touched	Fixed		5190	23.4	<b>0.301</b>	1.6
	Fixed	High	5795	23.4	<b>0.259</b>	
Notes:						
1. Bottom face in parallel with flat phantom. for Bottom Touch						
2. See attachment for the result presentation in plot format.						
3. The SAR measured at the middle channel for this configuration at least 3 dB lower (0.8mW/g) than SAR limit (1.6mW/g), thus testing at low and high channel is optional.						





### 10. EQUIPMENT LIST & CALIBRATION STATUS

Name of Equipment	Manufacturer	Type/Model	Serial Number	Calibration Cycle(days)	Calibration Due
S-Parameter Network Analyzer	Agilent	E8358A	US40260243	365	07/06/09
Electronic Probe kit	Hewlett Packard	85070D	N/A	N/A	N/A
Power Meter	Agilent	E4416A	GB41291611	365	04/06/09
Power Sensor	Agilent	8481H	US40441097	365	04/07/09
Thermometer	Amarell	4046	25058	3650	10/02/14
Signal Generator	Agilent	E8257C	US42340162	365	07/14/09
Data Acquisition Electronics (DAE)	SPEAG	DAE3	905	365	03/27/09
Dosimetric E-Field Probe	SPEAG	EX3DV4	3552	365	11/19/08
2450 MHz System Validation Dipole	SPEAG	D2450V2	728	730	04/10/10
Probe Alignment Unit	SPEAG	LB (V2)	348	N/A	N/A
Robot	Staubli	RX90B L	F02/5T69A1/A/01	N/A	N/A
SAM Twin Phantom V4.0	SPEAG	N/A	N/A	N/A	N/A
Devices Holder	SPEAG	N/A	N/A	N/A	N/A
Head/ Muscle 2450 MHz	CCS	H/M 2450A	N/A	N/A	N/A
Head/ Muscle 5200 MHz	CCS	H/M5200A	N/A	N/A	N/A
Head/ Muscle 5800 MHz	CCS	H/M5800A	N/A	N/A	N/A

## 11. FACILITIES

All measurement facilities used to collect the measurement data are located at

- No. 81-1, Lane 210, Bade Rd. 2, Luchu Hsiang, Taoyuan Hsien, Taiwan, R.O.C.
- No. 11, Wu-Kung 6 Rd, Wu-Ku Hsiang, Wu-Ku Industrial District, Taipei Hsien, (248) Taiwan.
- No. 199, Chunghsen Road, Hsintien City, Taipei Hsien, Taiwan, R.O.C.

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### **13. ATTACHMENTS**

<b>Exhibit</b>	<b>Content</b>
1	System Performance Check Plots
2	SAR Test Plots

**END OF REPORT**