SAR Evaluation Report

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

For

(Class II Permissive Change)

Handheld Voice/Data Terminal with Dual-Band CDMA Modem,
DSSS Wireless LAN Card, & Bluetooth Module

MODEL: 700C

FCC ID: HN2SB555-2

May 26, 2004

REPORT NO: 04U2716-1A

Prepared for

550 SECOND ST. SE

CEDAR RAPIDS

IA 52401-2023, USA

Prepared by

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CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

DATES OF TEST: May 25-26, 2004

APPLICANT:	Intermec Technologies Corporation 550 SECOND ST. SE CEDAR RAPIDS, IA 52401-2023, USA
MODEL:	700C
FCC ID:	HN2SB555-2
DEVICE CATEGORY:	PORTABLE DEVICES
EXPOSURE CATEGORY:	GENERAL POPULATION/UNCONTROLLED EXPOSURE

Application Type: Class II Permissive Change
New Bluetooth radio card (FCC ID: EHABTS080)

Tx Frequency: 1850 to 1910 MHz for CDMA PCS band
824.0 to 849.0 MHz for CDMA Cellular Band
2412 to 2462 MHz for 802.11b; 2402 to 2480 MHz for Bluetooth

Max. SAR (1g):

- CDMA PCS Band
  Head - Tilted position
  0.673 mW/g; 0.638 mW/g (Co-location)
  Body - Right side
  0.983 mW/g; 0.972 mW/g (Co-location)
- CDMA Cellular Band
  Head - Tilted position
  0.193 mW/g; 0.183 mW/g (Co-location)
  Body - Back side
  0.283 mW/g; 0.289 mW/g (Co-location)

FCC Rule Part(s): 24 E for CDMA PCS Band (1850 to 1910 MHz);
22 H for CDMA Cellular Band (824.0 to 849.0 MHz)

Antenna Type: External Stubby,

- P/N: 805-606-204 for CDMA PCS Band;
- P/N: 805-606-102 for CDMA PCS & Cellular Band

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in FCC OET 65 Supplement C (released on 6/29/2001 see Test Report).

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Hsin-Fu Shih

Hsin-Fu Shih (Sunny Shih)
Senior Engineer

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1. EQUIPMENT UNDER TEST (EUT) DESCRIPTION

Type of EUT: Handheld Voice/Data Terminal with Dual-Band CDMA Modem, DSSS Wireless LAN Card (802.11b), & Bluetooth Module.

Radio module	FCC ID
Dual-Band CDMA Modem	HN2SB555-2
Wireless LAN Card (802.11b)	HN22011B-2
Bluetooth Module	EHABTS080

Co-located transmitter operating configurations with optional Bluetooth radio card has been evaluated as described in this report.

Battery: 7.2V Lithium-Ion (P/N: 318-013-001)

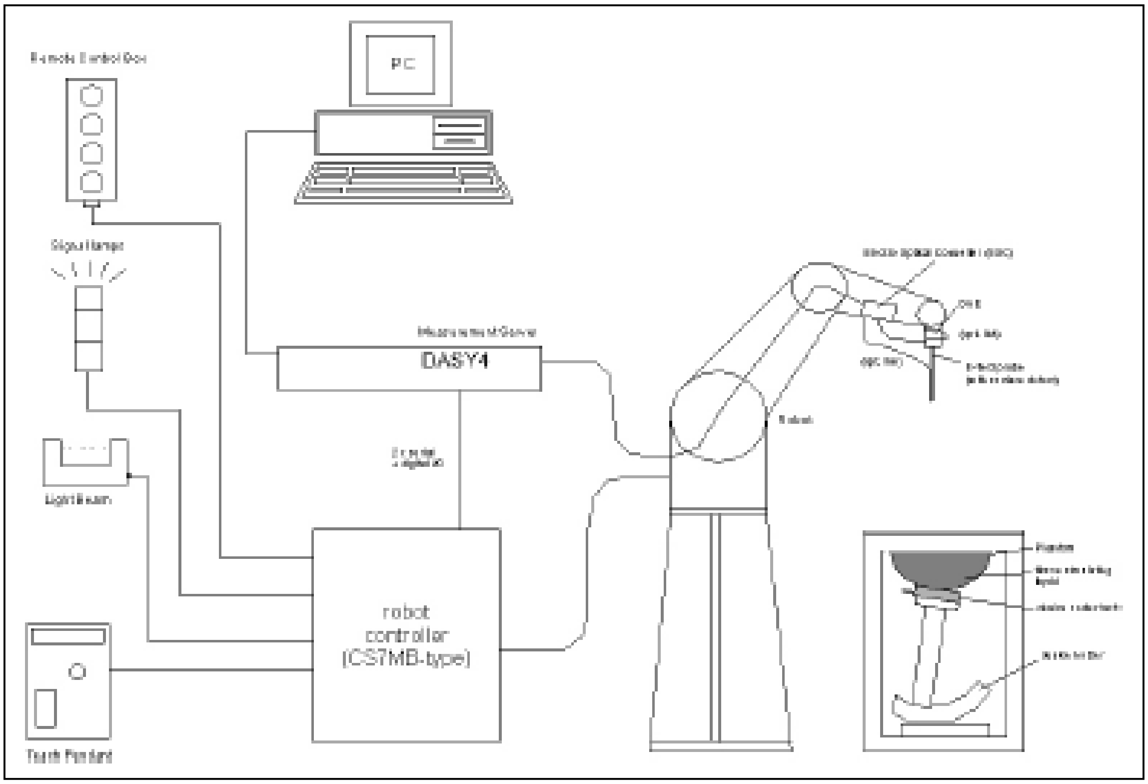
2. REQUIREMENTS FOR COMPLIANCE TESTING DEFINED BY THE FCC

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.

3. 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 ± 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 ES3DV2-SN: 3021 (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 ±10%. The spherical isotropy was evaluated with the procedure 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 EN50361.

3.1. MEASUREMENT SYSTEM DIAGRAM



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

- A standard high precision 6-axis robot (St¨aubli 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.

3.2. SYSTEM COMPONENTS

DASY4 MEASUREMENT SERVER

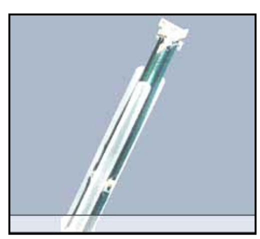
The DASY4 measurement server is based on a PC/104 CPU board with a 166MHz low-power Pentium, 32MB chip disk and 64MB RAM. The necessary circuits for communication with either the DAE3 electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained 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 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

ES3DV2 ISOTROPIC E-FIELD PROBE FOR DOSIMETRIC MEASUREMENTS

Construction:	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycolether)
Calibration:	Basic Broad Band Calibration in air: 10-2500 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: ± 0.2 dB
Directivity:	± 0.2 dB in HSL (rotation around probe axis); ± 0.3 dB in tissue material (rotation normal to probe axis)
Dynamic Range:	5 μW/g to > 100 mW/g; Linearity: ± 0.2 dB
Dimensions:	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.7 mm
Application:	General dosimetry up to 6 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones


Interior of probe


Isotropic E-Field Probe

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 ±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, flat phantom).

SYSTEM VALIDATION KITS

Construction: Symmetrical dipole with l/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 < 1GHz); > 40 W (f > 1GHz)

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

4. 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	σ
	- Density	ρ

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:
$$E_i = \sqrt{\frac{V_i}{Norm_i \bullet ConvF}}$$

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

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
aij = Sensor sensitivity factors for H-field probes
f = Carrier frequency (GHz)
Ei = Electric field strength of channel i in V/m
Hi = 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

σ = conductivity in [mho/m] or [Siemens/m]

ρ = equivalent tissue density in g/cm^3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

The power flow density is calculated assuming the excitation field as a free space field.

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

with P_{pwe} = Equivalent power density of a plane wave in mW/cm^2

E_{tot} = total electric field strength in V/m

H_{tot} = total magnetic field strength in A/m

SAR SYSTEM 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. 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 settings can be edited by a user. When an area scan has measured all reachable points, it computes the field maximum found in the scanned area, within a range of the global maximum. If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

- **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 5 x 5 x 7 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 then one maximum, the number of Zoom Scans has to be enlarged accordingly. For dosimetric application, it is necessary to assess the peak spatial SAR value averaged over a volume. For this purpose, fine resolution volume scans need to be performed at the peak SAR location(s) determined during the Area Scan.

- **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:

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

Since the decay of the boundary effect dominates for small probes ($a \ll \lambda$), the cos-term can be omitted. Factors Sb (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 postprocessing.

5. MEASUREMENT UNCERTAINTY

UNCERTAINTY BUDGE ACCORDING TO IEEE P1528								
Error Description	Uncertainty Value [%]	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc.(1g)	Std. Unc. (10g)	(vi) v_{eff}
Measurement System								
Probe Calibration	±4.8	N	1	1	1	±4.8%	±4.8%	∞
Axial Isotropy	±4.7	R	$\sqrt{3}$	0.7	0.7	±1.9%	±1.9%	∞
Hemispherical Isotropy	±9.6	R	$\sqrt{3}$	0.7	0.7	±3.9%	±3.9%	∞
Boundary Effects	±1.0	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Linearity	±4.7	R	$\sqrt{3}$	1	1	±2.7%	±2.7%	∞
System Detection Limits	±1.0	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Readout Electronics	±1.0	N	$\sqrt{3}$	1	1	±1.0%	±1.0%	∞
Response Time	±0.8	R	$\sqrt{3}$	1	1	±0.5%	±0.5%	∞
Integration Time	±2.6	R	$\sqrt{3}$	1	1	±1.5%	±1.5%	∞
RF Ambient Condition	±1.59	R	$\sqrt{3}$	1	1	±0.9%	±0.9%	∞
Probe Positioner	±1.6	R	$\sqrt{3}$	1	1	±0.2%	±0.2%	∞
Probe Positioning	±2.9	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
Max. SAR Eval.	±1.0	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Test sample Related								
Device Positioning	±1.1	N	1	1	1	±1.1%	±1.1%	145
Device Holder	±3.6	N	1	1	1	±3.6%	±3.6%	5
Power Drift	±5.0	R	$\sqrt{3}$	1	1	±2.9%	±2.9%	∞
Phantom and Setup								
Phantom Uncertainty	±4.0	R	$\sqrt{3}$	1	1	±2.3%	±2.3%	∞
Liquid Conductivity (target)	±5.0	R	$\sqrt{3}$	0.64	0.43	±1.8%	±1.2%	∞
Liquid Conductivity (meas.)	±2.5	N	1	0.64	0.43	±1.6%	±1.1%	∞
Liquid Peermittivity (target)	±5.0	R	$\sqrt{3}$	0.6	0.49	±1.7%	±1.4%	∞
Liquid Permittivity (meas.)	±2.5	N	1	0.6	0.49	±1.5%	±1.2%	∞
Combined Std. Uncertainty						±9.8%	±9.6%	330
Expanded STD Uncertainty						***±19.6%***	***±19.2%***	

Table: Worst-case uncertainty for DASY4 assessed according to IEEE P1528.
The budge is valid for the frequency range 300MHz – 3GHz and represents a worst-case analysis.

6. EXPOSURE LIMIT

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

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

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

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

NOTE 1: See Section 1 for discussion of exposure categories.

NOTE 2: 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.

NOTE 3: At frequencies above 6.0 GHz, SAR limits are not applicable and MPE limits for power density should be applied at 5 cm or more from the transmitting device.

NOTE 4: The time averaging criteria for field strength and power density do not apply to general population SAR limit of 47 CFR §2.1093

NOTE
GENERAL POPULATION/UNCONTROLLED EXPOSURE
PARTIAL BODY LIMIT
1.6 mW/g

7. MEASUREMENT RESULTS

7.1. SIMULATING LIQUIDS PARAMETER CHECK

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameters are within the tolerances of the specified target values. The relative permittivity and conductivity of the tissue material should be within ± 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.

TISSUE DIELECTRIC PARAMETERS FOR HEAD AND BODY PHANTOMS

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	
	ε_r	σ (S/m)	ε_r	σ (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	35.3	5.27	48.2	6.00

(ε_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3)

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^+ 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

SIMULATING LIQUIDS PARAMETER CHECK RESULTS

Date: May 25, 2004
Ambient condition: Ambient Temperature = 24°C; Relative humidity = 37%

Simulating Liquid				Parameters		Target	Measured	Deviation (%)	Limit (%)
Medium	f (MHz)	Temp. (°C)	Depth (cm)						
Head	1900	23	15	ε"	Relative Permittivity (ϵ_r):	40.0	39.9907	-0.02	± 5
				13.2617	Conductivity (σ):	1.40	1.402	0.13	± 5

Note: Interpolated medium parameters used for SAR evaluation.

The conductivity (σ) can be given as:

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

where f = target f * 10^6

$\epsilon_0 = 8.854 * 10^{-12}$

Simulating Liquid Parameter Check Results @ 1900MHz

Ambient temperature = 24.0 deg. C; Liquid temperature = 23.0 deg.C
May 25, 2004 10:34 AM

Frequency	e'	e''
1.710000000 GHz	40.7100	12.7820
1.720000000 GHz	40.6683	12.8069
1.730000000 GHz	40.6285	12.8120
1.740000000 GHz	40.5942	12.8450
1.750000000 GHz	40.5464	12.8737
1.760000000 GHz	40.5051	12.9108
1.770000000 GHz	40.4658	12.9437
1.780000000 GHz	40.4260	12.9585
1.790000000 GHz	40.3873	12.9880
1.800000000 GHz	40.3736	13.0113
1.810000000 GHz	40.3359	13.0432
1.820000000 GHz	40.3033	13.0568
1.830000000 GHz	40.2559	13.0737
1.840000000 GHz	40.2220	13.1246
1.850000000 GHz	40.1727	13.1489
1.860000000 GHz	40.1504	13.1804
1.870000000 GHz	40.0893	13.1916
1.880000000 GHz	40.0527	13.2203
1.890000000 GHz	40.0309	13.2515
1.900000000 GHz	39.9907	13.2617
1.910000000 GHz	39.9499	13.2875

SIMULATING LIQUIDS PARAMETER CHECK RESULTS (CONTINUED)

Date: May 25, 2004
Ambient condition: Ambient Temperature = 24°C; Relative humidity = 37%

Simulating Liquid				Parameters		Target	Measured	Deviation (%)	Limit (%)
Medium	f (MHz)	Temp. (°C)	Depth (cm)						
Muscle	1900	23	15	є"	Relative Permittivity (ϵ_r):	53.3	53.6339	0.63	± 5
				14.3651	Conductivity (σ):	1.52	1.5184	-0.11	± 5

Note: Interpolated medium parameters used for SAR evaluation.

The conductivity (σ) can be given as:

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

where f = target f * 10^6

$\epsilon_0 = 8.854 * 10^{-12}$

Simulating Liquid Parameter Check Results @ 1900MHz

Ambient temperature = 24.0 deg. C; Liquid temperature = 23.0 deg.C
May 25, 2004 11:04 AM

Frequency	e'	e''
1.710000000 GHz	54.2332	13.8189
1.720000000 GHz	54.2096	13.8625
1.730000000 GHz	54.1734	13.8796
1.740000000 GHz	54.1313	13.9093
1.750000000 GHz	54.0925	13.9402
1.760000000 GHz	54.0540	13.9860
1.770000000 GHz	54.0231	14.0253
1.780000000 GHz	53.9851	14.0452
1.790000000 GHz	53.9669	14.0811
1.800000000 GHz	53.9587	14.1010
1.810000000 GHz	53.9347	14.1090
1.820000000 GHz	53.9128	14.1338
1.830000000 GHz	53.8810	14.1455
1.840000000 GHz	53.8562	14.1953
1.850000000 GHz	53.8104	14.2277
1.860000000 GHz	53.7772	14.2635
1.870000000 GHz	53.7189	14.2898
1.880000000 GHz	53.6832	14.3103
1.890000000 GHz	53.6673	14.3423
1.900000000 GHz	53.6339	14.3651
1.910000000 GHz	53.6052	14.3948

SIMULATING LIQUIDS PARAMETER CHECK RESULTS (CONTINUED)

Date: May 26, 2004
Ambient condition: Ambient Temperature = 24°C; Relative humidity = 38%

Simulating Liquid				Parameters		Target	Measured	Deviation (%)	Limit (%)
Medium	f (MHz)	Temp. (°C)	Depth (cm)						
Head	835	23	15	ϵ"	Relative Permittivity (ϵ_r):	41.5	42.0407	1.30	± 5
				19.7866	Conductivity (σ):	0.90	0.9191	2.13	± 5

Note: Interpolated medium parameters used for SAR evaluation.

The conductivity (σ) can be given as:

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

where f = target f * 10^6

$\epsilon_0 = 8.854 * 10^{-12}$

Simulating Liquid Parameter Check Results @ 835 MHz

Ambient temperature = 23.5 deg. C; Liquid temperature = 22.0 deg.C
May 26, 2004 09:48 AM

Frequency	e'	e''
750.000000 MHz	43.0227	20.1340
755.000000 MHz	42.9479	20.0598
760.000000 MHz	42.8775	20.0425
765.000000 MHz	42.8325	20.0303
770.000000 MHz	42.7849	19.9625
775.000000 MHz	42.7311	19.9533
780.000000 MHz	42.6568	19.9051
785.000000 MHz	42.5976	19.9091
790.000000 MHz	42.5489	19.8662
795.000000 MHz	42.4704	19.8319
800.000000 MHz	42.4430	19.8608
805.000000 MHz	42.3925	19.8413
810.000000 MHz	42.3501	19.8091
815.000000 MHz	42.2997	19.8225
820.000000 MHz	42.2468	19.8044
825.000000 MHz	42.1744	19.8082
830.000000 MHz	42.0730	19.7990
835.000000 MHz	42.0407	19.7866
840.000000 MHz	41.9952	19.7991
845.000000 MHz	41.9189	19.7367
850.000000 MHz	41.8230	19.7120
855.000000 MHz	41.7817	19.6929
860.000000 MHz	41.7099	19.6725
865.000000 MHz	41.6322	19.5927
870.000000 MHz	41.5758	19.5486
875.000000 MHz	41.5152	19.5571
880.000000 MHz	41.4819	19.5171
885.000000 MHz	41.4296	19.5134
890.000000 MHz	41.3672	19.4728
895.000000 MHz	41.3533	19.4581
900.000000 MHz	41.3171	19.4503

SIMULATING LIQUIDS PARAMETER CHECK RESULTS (CONTINUED)

Date: May 26, 2004
Ambient condition: Ambient Temperature = 24°C; Relative humidity = 38%

Simulating Liquid				Parameters		Target	Measured	Deviation (%)	Limit (%)
Medium	f (MHz)	Temp. (°C)	Depth (cm)						
Muscle	835	23	15	ε"	Relative Permittivity (ϵ_r):	55.2	56.4476	2.26	± 5
				20.8501	Conductivity (σ):	0.97	0.9685	-0.15	± 5

Note: Interpolated medium parameters used for SAR evaluation.

The conductivity (σ) can be given as:

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

where f = target f * 10^6

$\epsilon_0 = 8.854 * 10^{-12}$

Simulating Liquid Parameter Check Results @ 835 MHz

Ambient temperature = 23.5 deg. C; Liquid temperature = 22.0 deg.C
May 26, 2004 01:57 PM

Frequency	e'	e"
750.000000 MHz	57.1043	21.2632
755.000000 MHz	57.0657	21.2059
760.000000 MHz	57.0206	21.1276
765.000000 MHz	56.9703	21.0993
770.000000 MHz	56.9487	21.0491
775.000000 MHz	56.9241	20.9886
780.000000 MHz	56.8552	20.9329
785.000000 MHz	56.8061	20.9286
790.000000 MHz	56.7861	20.9370
795.000000 MHz	56.7206	20.8812
800.000000 MHz	56.7263	20.8914
805.000000 MHz	56.7040	20.8545
810.000000 MHz	56.6943	20.8642
815.000000 MHz	56.6265	20.8670
820.000000 MHz	56.6197	20.8638
825.000000 MHz	56.5726	20.8701
830.000000 MHz	56.5058	20.8505
835.000000 MHz	56.4476	20.8501
840.000000 MHz	56.4306	20.8670
845.000000 MHz	56.3581	20.7951
850.000000 MHz	56.2979	20.7521
855.000000 MHz	56.2461	20.7281
860.000000 MHz	56.1916	20.6946
865.000000 MHz	56.1477	20.6032
870.000000 MHz	56.1063	20.5439
875.000000 MHz	56.0397	20.5274
880.000000 MHz	56.0294	20.4885
885.000000 MHz	56.0014	20.4570
890.000000 MHz	55.9559	20.4327
895.000000 MHz	55.9405	20.4280
900.000000 MHz	55.9337	20.4039

7.2. 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 Head simulating liquid of the following parameters.
- The DASY4 system with an E-fileld probe ET3DV6 SN: 1577 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 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
- Special 5 x 5 x 7 fine cube was chosen for cube integration(dx=dy=7.5mm; dz=5mm).
- Distance between probe sensors and phantom surface was set to 4 mm.
- The dipole input power (forward power) was 250 mW±3%.
- The results are normalized to 1 W input power.

REFERENCE SAR VALUES

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 of ±10%. The system performance check results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.
IEEE P1528 Recommended Reference Value

Frequency (MHz)	1 g SAR	10 g SAR	Local SAR at surface (Above feed point)	Local SAR at surface (y=2cm offset from feed point)
300	3.0	2.0	4.4	2.1
450	4.9	3.3	7.2	3.2
835	9.5	6.2	14.1	4.9
900	10.8	6.9	16.4	5.4
1450	29.0	16.0	50.2	6.5
1800	38.1	19.8	69.5	6.8
1900	39.7	20.5	72.1	6.6
2450	52.4	24.0	104.2	7.7
3000	63.8	25.7	140.2	9.5

SYSTEM PERFORMANCE CHECK RESULTS @ SYSTEM VALIDATION DIPOLE: D2450V2 SN: 706

Ambient condition: Temperature = 24°C; Relative humidity = 37% **Date:** May 25, 2004

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth [cm]					
1900.00	23.00	15.00	1g SAR:	39.7	38.40	-3.27	± 10

SYSTEM PERFORMANCE CHECK RESULTS @ SYSTEM VALIDATION DIPOLE: D835V2 SN: 4d002

Ambient condition: Temperature = 24°C Relative humidity = 38% **Date:** May 26, 2004

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth [cm]					
835	23	15	1g SAR:	9.5	9.56	0.63	± 10

7.3. SAR MEASUREMENTS RESULTS

1. CDMA PCS Band - Right Tilt Position

CDMA PCS Band - Duty cycle: 100%; Crest factor: 1 Depth of liquid: 15 cm

EUT Position	Antenna	Ch. #	f [MHz]	*Power Reference [V/m]		SAR_1g [mW/g]	
				Before	After	Measured	Limited
Right Tilted	805-606-204	25	1851.25	15.90	1.94	0.673	1.6
Right Tilted	805-606-204	25	1851.25	16.00	15.90	0.638**	1.6
Right Tilted	805-606-102	1175	1908.75	11.00	10.95	0.377	1.6
Right Tilted	805-606-102	1175	1908.75	10.80	10.87	0.375**	1.6

1. Notes:
2. *: Power reference measured from DASY System measurement job “Power reference measurement”.
3. **: Co-located SAR measurement result with the WLAN and Bluetooth radio card. (Transmitting simultaneously)
4. Antennas - P/N: 805-606-204 (Single band PCS); P/N: 805-606-102 (Dual band).
5. Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.

2. CDMA PCS Band - Body Position

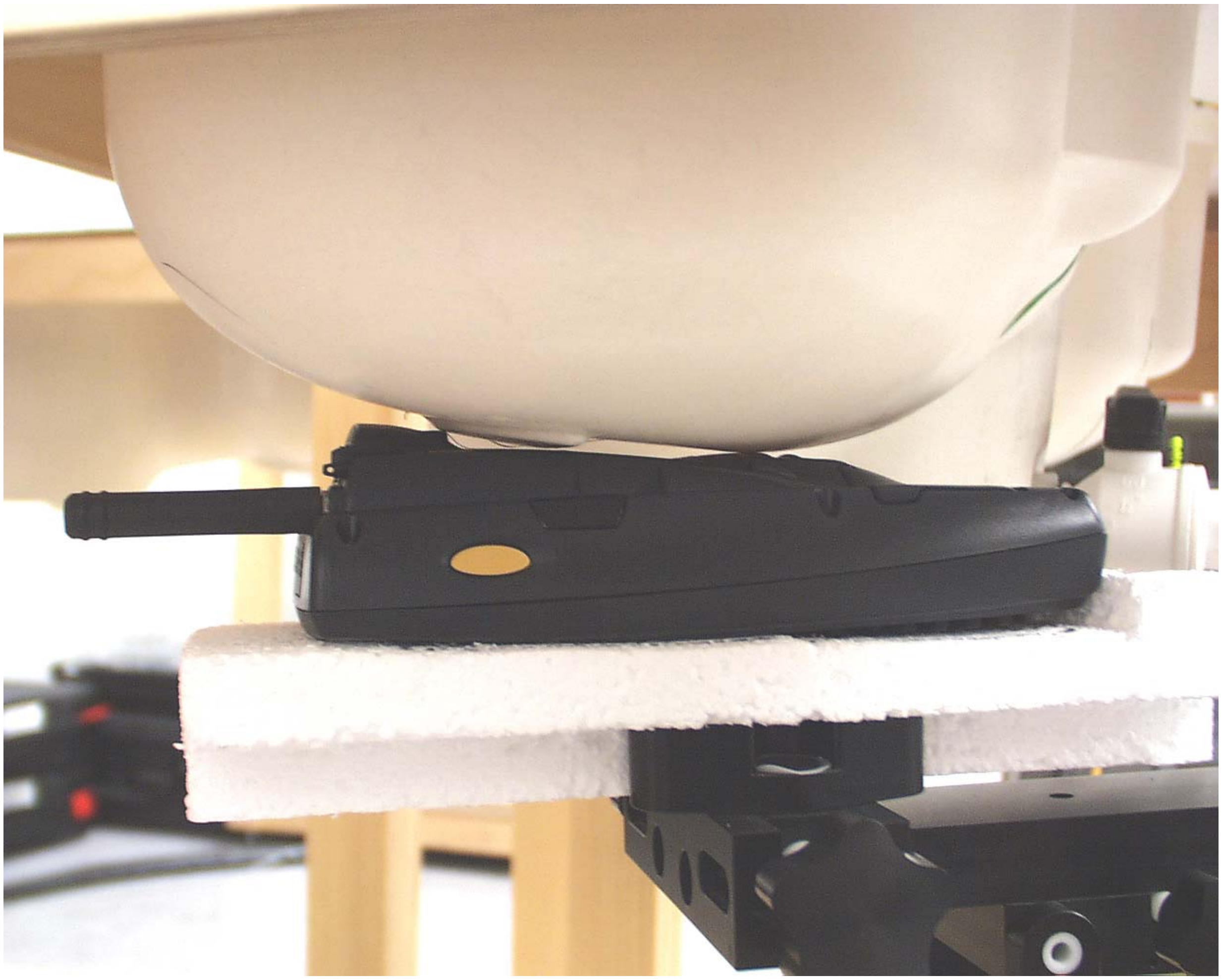
CDMA PCS band - Duty cycle: 100%; Crest factor: 1 Depth of liquid: 15 cm

EUT Position	Antenna	Ch. #	f [MHz]	*Power Reference [V/m]		SAR_1g [mW/g]	
				Before	After	Measured	Limited
Right side	805-606-204	25	1851.25	20.10	20.13	0.983	1.6
Right side	805-606-204	25	1851.25	20.00	19.95	0.972**	1.6

Notes:

1. *: Power reference measured from DASY System measurement job “Power reference measurement”.
2. **: Co-located SAR measurement result with the WLAN and Bluetooth radio card. (Transmitting simultaneously)
3. Antenna - P/N: 805-606-204 (Single band PCS).
4. Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.

3. CDMA Cellular Band - Right Touch Position



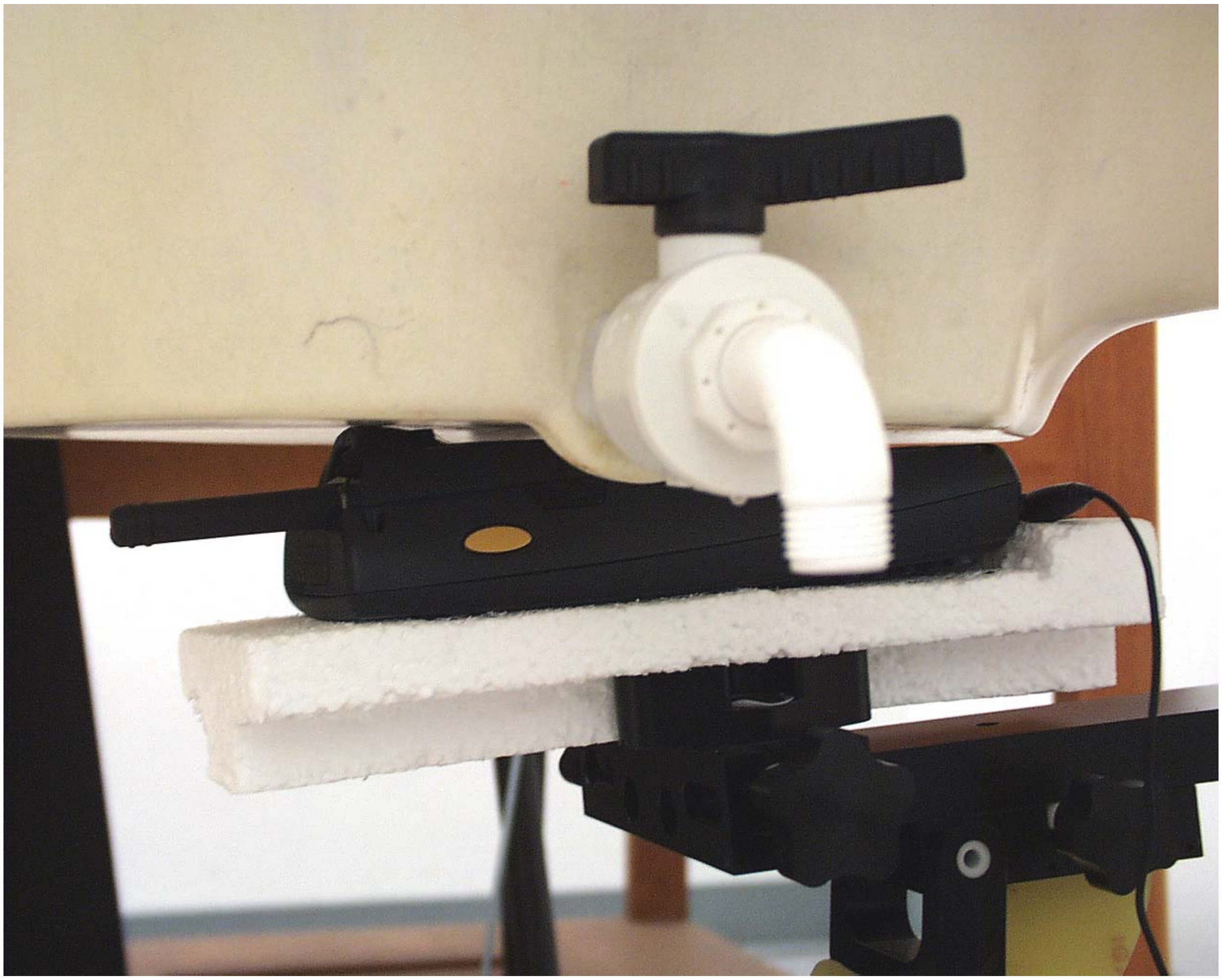
CDMA PCS band - Duty cycle: 100%; Crest factor: 1 Depth of liquid: 15 cm

EUT Position	Antenna	Ch. #	f [MHz]	*Power Reference [V/m]		SAR_1g [mW/g]	
				Before	After	Measured	Limited
Right Touched	805-606-102	363	835.89	10.09	10.07	0.193	1.6
Right Touched	805-606-102	363	835.89	10.40	10.38	0.183**	1.6

Notes:

1. *: Power reference measured from DASY System measurement job “Power reference measurement”.
2. **: Co-located SAR measurement result with the WLAN and Bluetooth radio card. (Transmitting simultaneously)
3. Antenna - P/N: 805-606-102 (Dual band).
4. Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.

4. CDMA Cellular band - Body Position



CDMA PCS band - Duty cycle: 100%; Crest factor: 1 Depth of liquid: 15 cm

EUT Position	Antenna	Ch. #	f [MHz]	*Power Reference [V/m]		SAR_1g [mW/g]	
				Before	After	Measured	Limited
Back side	805-606-102	363	835.89	8.33	8.37	0.283	1.6
Back side	805-606-102	363	835.89	8.47	8.50	0.289**	1.6

Notes:

1. *: Power reference measured from DASY System measurement job “Power reference measurement”.
2. **: Co-located SAR measurement result with the WLAN and Bluetooth radio card. (Transmitting simultaneously)
3. Antennas - P/N: 805-606-102 (Dual band).
4. Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.

8. EUT PHOTOS

EUT PHOTOS (1/3)

EUT PHOTOS (2/3)

EUT PHOTOS (3/3)

9. EQUIPMENT LIST & CALIBRATION STATUS

Name of Equipment	Manufacturer	Type/Model	Serial Number	Cal. Due date
S-Parameter Network Analyzer	Agilent	8753ES-6	US39173569	8/8/04
Electronic Probe kit	Hewlett Packard	85070C	N/A	N/A
Power Meter	Hewlett Packard	436A	2709A29209	7/15/04
Power Sensor	Hewlett Packard	8482A	2349A08568	7/15/04
Amplifier	Mini-Circuits	ZVE-8G	0360	N/A
Amplifier	Mini-Circuits	ZHL-42W	D072701-5	N/A
Radio Communication Tester	Rohde & Schwarz	CMU 200	838114/032	12/1/04
Data Acquisition Electronics (DAE)	SPEAG	DAE3 V1	500	12/23/04
Dosimetric E-Field Probe	SPEAG	ES3DV2	3021	7/29/04
System Validation Dipole	SPEAG	D835V2	4d002	1/12/06
System Validation Dipole	SPEAG	D1900V2	5d043	1/17/2006
Probe Alignment Unit	SPEAG	LB (V2)	261	N/A
Robot	Staubli	RX90B L	F00/5H31A1/A/01	N/A
SAM Twin Phantom	SPEAG	TP-1785	QD 000 P40 CA	N/A
SAM Twin Phantom	SPEAG	TP-1015	N/A	N/A
Simulating Liquids	CCS	H1900	N/A	Within 24 hrs of first test
Simulating Liquids	CCS	M1900	N/A	Within 24 hrs of first test
Simulating Liquids	CCS	H835	N/A	Within 24 hrs of first test
Simulating Liquids	CCS	M835	N/A	Within 24 hrs of first test

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11. ATTACHMENTS

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End of Report