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Auden Techno. Corp. RF Testing Lab

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SAR EVALUATION REPORT

Test Report No.：	**SAR – 00679**
Applicant：	**BenQ Corporation**
	(明基電通股份有限公司)
Trade Name：	**BenQ**
Model Name：	**C260**
EUT Type：	**Single-Mode Cellular Phone (PCS CDMA)**
Dates of Test：	**Jun. 2、30, 2003**
Test Environment：	**Ambient Temperature： 22 ± 2 ℃**
	Relative Humidity： ＜ 60％
Test Specification：	**ANSI/IEEE Std. C95.1-1992**
	IEEE Std. P1528-200X

1. The test operations have to be performed with cautious behavior, the test results are as attached.
2. The test results are under chamber environment of Auden. Auden does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples.
3. The measurement report has to be written approval of Auden. It may only be reproduced or published in full.

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Testing Center Manager

Auden Techno. Corp. RF Testing Lab

Contents

1. Description of Equipment Under Test (EUT)

Applicant：	**BenQ Corporation** 18 Jihu Road, Neihu, Taipei 114, Taiwan, R.O.C.
EUT Type：	Single-Mode Cellular Phone (PCS CDMA)
Trade Name：	BenQ
Model Name：	C260
FCC ID：	JVPH1322
Test Device：	Production Unit
Mobile Phone Serial No.：	71380001
Tx Frequency：	1851.25 – 1908.75 MHz (PCS CDMA)
Rx Frequency：	1931.25 – 1988.75 MHz (PCS CDMA)
Max. RF Output Power：	0.322 W PCS CDMA (25.11 dBm- Conducted)
Max. SAR Measurement：	1.49 W/kg PCS CDMA Head SAR 0.456 W/kg PCS CDMA Body SAR
Antenna Manufacturer：	Auden Techno. Corp.
Antenna Type：	Fixed Type
Antenna Dimensions：	Height：24.6 mm / Width：8.5 mm
Device Category：	Portable Device
RF Exposure Environment：	General Population / Uncontrolled
Battery Option：	Standard
Application Type：	Certification

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 IEEE Std. P1528-200X.

Figure 1. EUT Photo

2. Introduction

The Auden Techno. Corp. RF Testing Laboratory has performed measurements of the maximum potential exposure to the user of **BenQ Corporation Trade Name：BenQ Model(s)：C260**. The test procedures, as described in American National Standards, Institute C95.1 – 1992〔1〕, FCC OET Bulletin65-1997 were employed and they specify the maximum exposure limit of 1.6mW/g as averaged over any 1 gram of tissue for portable devices being used within 20cm of the used in the uncontrolled environment. A description of the product and operating configuration, detailed summary of the test results, methodology and procedures used in the equipment used are included within this test report.

3. SAR Definition

Specific Absorption Rate (SAR) is defined as the time derivative (rate) of the incremental energy (dw) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Figure 2).

$$\mathrm{SAR} = \frac{d}{dt}\left(\frac{dw}{dm}\right) = \frac{d}{dt}\left(\frac{dw}{\rho dv}\right)$$

Figure 2. SAR Mathematical Equation

SAR is expressed in units of Watts per kilogram (W/kg)

$$\mathrm{SAR} = \frac{\sigma E^2}{\rho}$$

Where：

σ = conductivity of the tissue (S/m)

ρ = mass density of the tissue (kg/m^3)

E = RMS electric field strength (V/m)

＊**Note**：

The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane〔2〕

4. SAR Measurement Setup

These measurements were performed with the automated near-field scanning system DASY4 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than ±0.025mm. 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 (length = 300mm) to the data acquisition unit.

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The Measurement Server is based on a PC/104 CPU board with a 166MHz low-power Pentium, 32MB chipdisk 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 PC consists of the Intel Pentium 4 2.4GHz computer with Windows2000 system and SAR Measurement Software DASY4, Post Processor SEMCAD, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection…etc. is connected to the Electro-optical converter (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the Measurement Server.

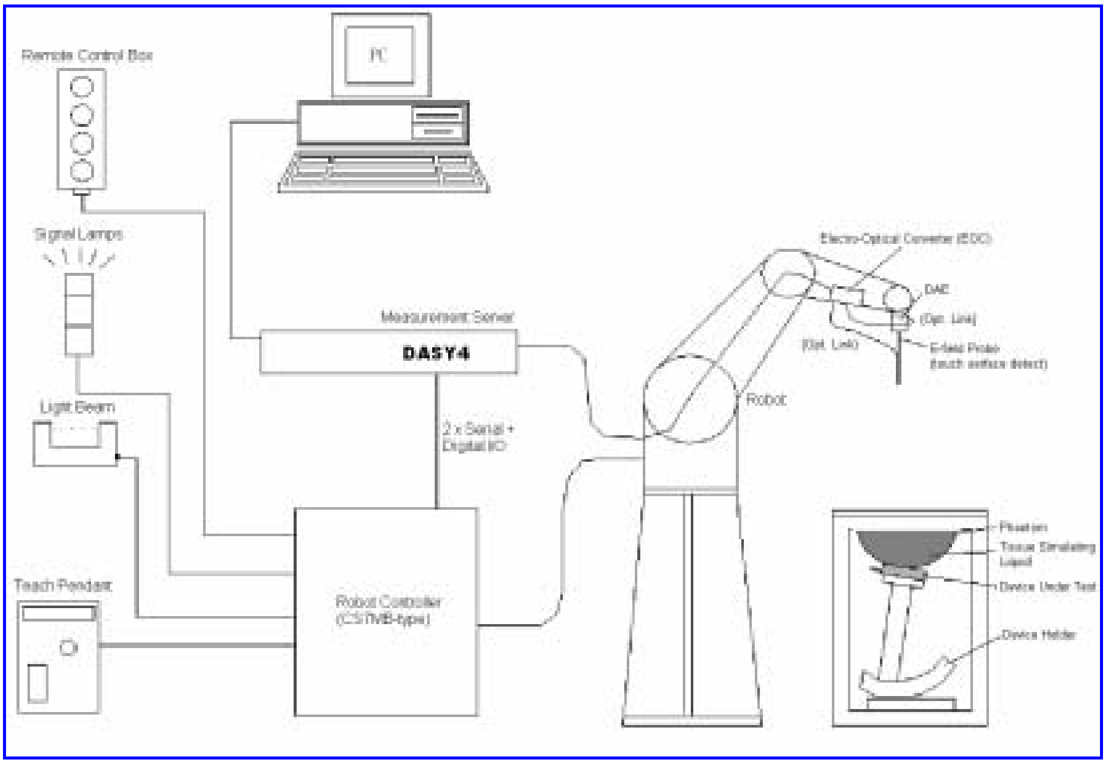


Figure 3. SAR Lab Test Measurement Setup

The 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 PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in〔3〕.

5. System Components

5.1 DASY4 E-Field Probe System

The SAR measurements were conducted with the dosimetric probe ET3DV6 (manufactured by SPEAG), designed in the classical triangular configuration〔3〕and optimized for dosimetric evaluation. The probes is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped when reaching the maximum.

5.1.1 ET3DV6 E-Field Probe Specification

Construction	Symmetrical design with triangular core
	Built-in optical fiber for surface detection
	System (ET3DV6 only)
	Built-in shielding against static charges
	PEEK enclosure material
	(resistant to organic solvents, e.q., glycol)
Calibration	In air from 10 MHz to 2.5 GHz
	In brain and muscle simulating tissue at
	frequencies of 450MHz, 900MHz, 1.8GHz and 2.45GHz
	(accuracy ±8%)
	Calibration for other liquids and frequencies upon request
Frequency	10 MHz to > 6 GHz; 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 µW/g to > 100mW/g; Linearity: ±0.2dB
Surface Detection	± 0.2 mm repeatability in air and clear liquids
	over diffuse reflecting surface(ET3DV6 only)
Dimensions	Overall length: 330mm
	Tip length: 16mm
	Body diameter: 12mm
	Tip diameter: 6.8mm
	Distance from probe tip to dipole centers: 2.7mm
Application	General dosimetry up to 3GHz
	Compliance tests of mobile phones
	Fast automatic scanning in arbitrary phantoms

Figure 4.
ET3DV6 E-field Probe

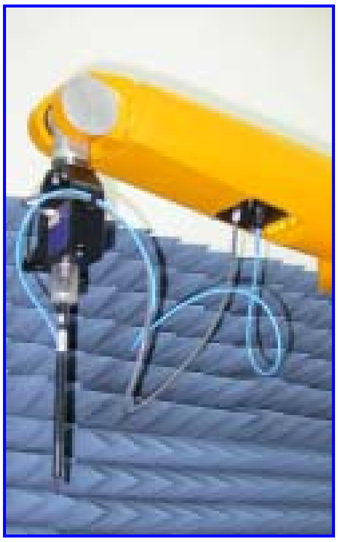


Figure 5.
Probe setup on robot

5.1.2 ET3DV6 E-Field Probe Calibration

Each probe is calibrated according to a dosimetric assessment procedure described in〔4〕with accuracy better than ± 10%. The spherical isotropy was evaluated with the procedure described in〔5〕and found to be better than ± 0.25dB. The sensitivity parameters (NormX, NormY, and NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.
The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1GHz, and in a wave guide above 1GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.
E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C\frac{\Delta T}{\Delta t}$$

Where：

Δt = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

ΔT = Temperature increase due to RF exposure.

Or

$$SAR = \frac{|E|^2 \sigma}{\rho}$$

Where：

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m^3).

5.2 Data Acquisition Electronic (DAE) System

Cell Controller

Processor：	Intel Pentium 4
Clock Speed：	2.4GHz
Operating System：	Windows 2000 Professional

Data Converter

Features：	Signal Amplifier, multiplexer, A/D converter, and control logic
Software：	DASY4 v4.1 (Build 47) & SEMCAD v1.6 (Build 115)
Connecting Lines：	Optical downlink for data and status info
	Optical uplink for commands and clock

5.3 Robot

Positioner：	Stäubli Unimation Corp. Robot Model: RX90L
Repeatability：	±0.025 mm
No. of Axis：	6

5.4 Measurement Server

Processor：	PC/104 with a 166MHz low-power Pentium
I/O-board：	Link to DAE3
	16-bit A/D converter for surface detection system
	Digital I/O interface
	Serial link to robot
	Direct emergency stop output for robot

5.5 Device Holder for Transmitters

In combination with the SAM Twin Phantom V4.0, the Mounting Device (POM) 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 repeat ably positioned according to the IEEE SCC34-SC2 and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, and 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〔6〕. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

Larger DUT cannot be tested using this device holder. Instead a support of bigger polystyrene cubes and thin polystyrene plates is used to position the DUT in all relevant positions to find and measure spots with maximum SAR values. Therefore those devices are normally only tested at the flat part of the SAM.

Figure 6. Device Holder

5.6 Phantom - SAM v4.0

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.

Figure 7. SAM Twin Phantom

Shell Thickness	2 ± 0.2 mm
Filling Volume	Approx. 25 liters
Dimensions	810×1000×500 mm (H×L×W)

Table 1. Specification of SAM v4.0

5.7 Data Storage and Evaluation

5.7.1 Data Storage

The DASY4 software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension .DA4. The postprocessing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

5.7.2 Data Evaluation

The DASY4 postprocessing 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	Normi, ai0, ai1, ai2
	- Conversion factor	ConvFi
	- Diode compression point	dcpi
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 they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter 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 $\boldsymbol{V_i}$ = compensated signal of channel i (i = x, y, z)

$\boldsymbol{U_i}$ = input signal of channel i (i = x, y, z)

$\boldsymbol{cf}$ = crest factor of exciting field (DASY parameter)

$\boldsymbol{dcp_i}$ = 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：

$$H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$$

with V_i = compensated signal of channel i (i = x, y, z)

$Norm_i$ = sensor sensitivity of channel i (i = x, y, z)

µ V/(V/m)^2 for E-field 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

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 set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

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

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

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

6. Test Equipment List

Manufacturer	Name of Equipment	Type / Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Dosimetric E-Filed Probe	ET3DV6	1720	May. 15, 2003	May. 15, 2004
SPEAG	Dosimetric E-Filed Probe	ET3DV6	1753	May 23, 2003	May 23, 2004
SPEAG	900MHz System Validation Kit	D900V2	172	Dec. 17, 2002	Dec. 17, 2003
SPEAG	1800MHz System Validation Kit	D1800V2	265	May 14, 2003	May 14, 2004
SPEAG	2450MHz System Validation Kit	D2450V2	712	Jul. 15, 2002	Jul 15, 2003
SPEAG	Data Acquisition Electronics	DAE3	393	Dec. 18, 2002	Dec. 18, 2003
SPEAG	Device Holder	N/A	N/A	NCR	NCR
SPEAG	Phantom	SAM V4.0	1009	NCR	NCR
SPEAG	Robot	Staubli RX90L	F00/589B1/A/01	NCR	NCR
SPEAG	Software	DASY4 V4.1 Build 47	N/A	NCR	NCR
SPEAG	Software	SEMCAD V1.6 Build 115	N/A	NCR	NCR
SPEAG	Measurement Server	SE UMS 001 BA	1021	NCR	NCR
Agilent	Wireless Communication Test Set	8960(E5515C)	GB41450409	Feb. 18, 2002	Feb. 18, 2004
Agilent	S-Parameter Network Analyzer	8720ES	US39172472	May 15, 2003	May 14, 2004
Agilent	Dielectric Probe Kit	85070C	US99360094	NCR	NCR
Agilent	Power Meter	E4418B	GB40206143	May 16, 2003	May 15, 2004
Agilent	Power Sensor	8481H	3318A0779	Jun. 28, 2002	Jun. 28, 2003
Agilent	Signal Generator	8648C	3847A05201	Jun. 28, 2001	Jun. 28, 2003
Mini-Circuits	Power Amplifier	ZHL-42W-SMA	D111103#5	NCR	NCR
Rhode & Schwarz	Universal Radio Communication Tester	CMU200	838207/024	Mar. 18, 2003	Mar. 19, 2004

Table 2. Test Equipment List

7. Tissue Simulating Liquids

The Head and Muscle mixtures consist of a viscous gel using hydroxethylcellullouse (HEC) gelling agent and saline solution. Preservation with a bacteriacide is added and visual inspection is made to ensure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the tissue.

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an 85070C Dielectric Probe Kit and an 8720ES Network Analyzer.

INGREDIENT	FREQUENCY			
	HSL900 – Head (800-1000MHz)	MSL900 - Muscle (800-1000MHz)	HSL1800 - Head (1700-2000MHz)	MSL1800-Muscle (1700-2000MHz)
Water	51.07 %	65.45 %	54.88 %	69.91 %
HEC	0.23 %	0.00 %	0 %	0 %
Sugar	47.31 %	34.31 %	0 %	0 %
Preventol	0.24 %	0.10 %	0 %	0 %
Salt	1.15 %	0.62 %	0.21 %	0.13 %
Glycol monobutyl	0 %	0 %	44.91 %	29.96 %
Dielectric Parameters at 22°	f = 900 MHz εr = 41.0 ,σ= 0.96 S/m	f = 900 MHz εr = 56.5 ,σ= 0.99 S/m	f = 1800 MHz εr = 40.5 ,σ= 1.35 S/m	f = 1800 MHz εr = 54.6 ,σ= 1.39 S/m
	f = 835 MHz εr = 42.0 ,σ= 0.89 S/m	f = 835 MHz εr = 56.6 ,σ= 0.93 S/m	f = 1900 MHz εr = 39.8 ,σ= 1.42 S/m	f = 1900 MHz εr = 54.2 ,σ= 1.50 S/m

Table 3. Recipes for Head & Muscle Tissue Simulating Liquids

IEEE SCC-34/SC-2 in 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 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 equation and extrapolated according to the head parameter specified in P1528.

Target Frequency	Head		Body	
(MHz)	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)				

Table 4. Tissue dielectric parameters for head and body phantoms

7.1 Liquid Confirmation

7.1.1 Parameters

Liquid Verify								
Ambient Temperature： 22±2 ℃；Relative Humidity：＜60％								
Liquid Tyep	**Frequency**	**Temp (℃)**	**Parameters**	**Target Value**	**Measured Value**	**Deviation (%)**	**Limit (%)**	**Measured Date**
1900 MHz Head	1800	23.1	ε r	40	39.993	0.0 %	±5 %	Jun. 2, 2003
			σ	1.4	1.34342	-4.0 %	±5 %	
	1851	23.1	ε r	40	39.7664	-0.6 %	±5 %	
			σ	1.4	1.40297	0.2 %	±5 %	
	1880	23.1	ε r	40	39.6206	-1.0 %	±5 %	
			σ	1.4	1.43434	2.5 %	±5 %	
	1910	23.1	ε r	40	39.4806	-1.3 %	±5 %	
			σ	1.4	1.46214	4.4 %	±5 %	
1900 MHz Body	1800	22.7	ε r	53.3	53.5021	0.4 %	±5 %	Jun. 30, 2003
			σ	1.52	1.45975	-3.9 %	±5 %	
	1851	22.7	ε r	53.3	53.3746	0.1 %	±5 %	
			σ	1.52	1.50426	-1.3 %	±5 %	
	1880	22.7	ε r	53.3	53.2647	-0.1 %	±5 %	
			σ	1.52	1.53221	0.7 %	±5 %	
	1910	22.7	ε r	53.3	53.2203	-0.1 %	±5 %	
			σ	1.52	1.56285	2.6 %	±5 %	

Table 5. Measured Tissue dielectric parameters for head and body phantoms

7.1.2 Liquid Depth

The liquid level was during measurement 15cm ±0.5cm.

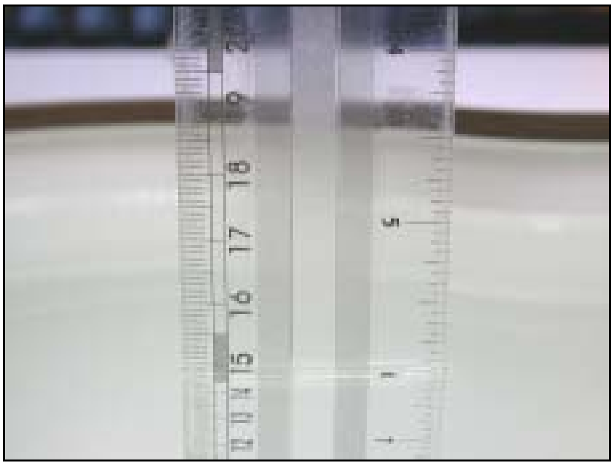


Figure 8. Head-Tissue-Simulating-Liquid 1900MHz

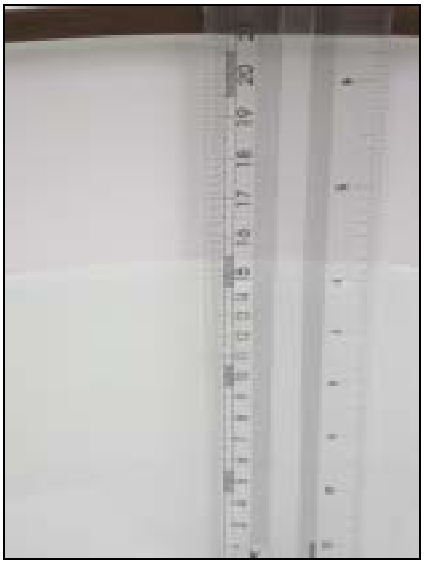


Figure 9. Muscle-Tissue-Simulating-Liquid 1900MHz

8. Measurement Process

8.1 Device and Test Conditions

The Test Device was provided by **BenQ Corporation** for this evaluation. The spatial peak SAR values were assessed for the lowest, middle and highest channels defined by **CDMA2000 US PCS** (Ch25=1851.25MHz, Ch600=1880.00MHz, Ch1175=1908.75MHz) systems. The handset was placed into simulated call mode (PCS CDMA mode) using manufacturers test codes. Such test signals offer a consistent means for testing SAR and are recommended for evaluating SAR.

※Test Mode Setup Method

1. Enter SAR menu： ***#727#**
2. Change
   Mode：**CDMA**
   Band：**PCS**
3. Ch： **25** (1851.25MHz)
   600 (1880.00MHz)
   1175 (1908.75MHz)
4. HDET： (Conductive = **25** dBm)

8.2 System Performance Check

8.2.1 Symmetric Dipoles for System Validation

Construction	Symmetrical dipole with l/4 balun enables measurement of feed point impedance with NWA matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor Calibration Calibrated SAR value for specified position and input power at the flat phantom in brain simulating solutions.
Frequency	900, 1800, 2450MHz
Return Loss	> 20 dB at specified validation position
Power Capability	> 100 W (f < 1GHz); > 40 W (f > 1GHz)
Options	Dipoles for other frequencies or solutions and other calibration conditions are available upon request
Dimensions	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

Figure 10. Validation Kit

8.2.2 Validation

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of ± 10%. The validation was performed at 900MHz and 1800MHz.

Validation kit	Mixture Type	SAR_{1g} [mW/g]	SAR_{10g} [mW/g]	Date of Calibration
D1800V2-SN265	Head	38.2	20.2	May 14, 2003
	Body	37.56	20.04	

Frequency (MHz)	Power (dBm)	SAR_{1g} (mW/g)	SAR_{10g} (mW/g)	Drift (dB)	Difference percentage		Date
					1g	10g	
1800 (Head)	250mW	8.8	4.7	-0.03	-7.9 %	-6.9 %	Jun. 2, 2003
	Normalize to 1 Watt	35.2	18.8				
1800 (Body)	250mW	9.34	5.06	-0.01	-0.53%	1.0 %	Jun.30, 2003
	Normalize to 1 Watt	37.36	20.24				

8.3 Dosimetric Assessment Setup

8.3.1 Handset Test Position - Head Position

A handset should be initially positioned with the earpiece region pressed against the ear spacer of a head phantom. For the SCC-34/SC-2 head phantom, the device should be positioned parallel to the "N-F" line defined along the base of the ear spacer that contains the "ear reference point". For interim head phantoms, the device should be positioned parallel to the cheek for maximum RF energy coupling. The "test device reference point" is aligned to the "ear reference point" on the head phantom and the "vertical centerline" is aligned to the "phantom reference plane". This is called the "initial ear position". While maintaining these three alignments, the body of the handset is gradually adjusted to each of the following positions for evaluating SAR：

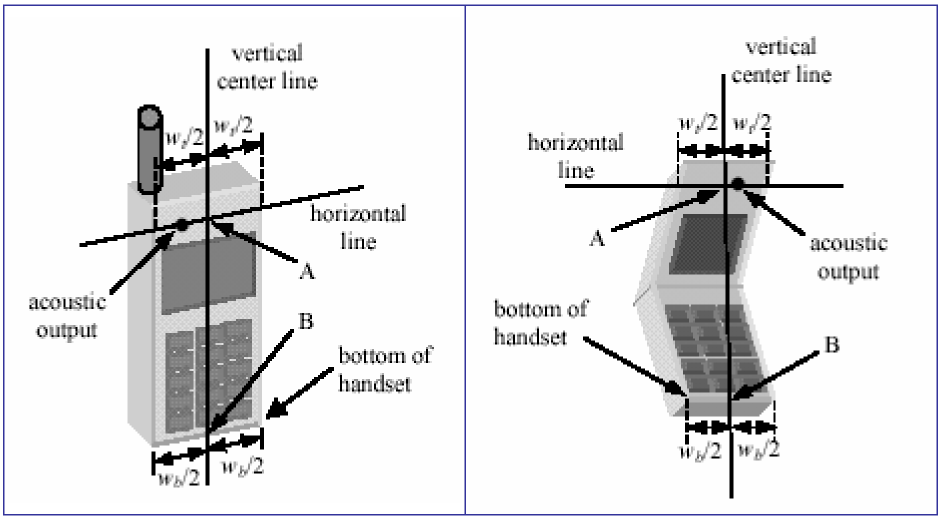


Figure 11.Handset vertical and horizontal Reference Lines - Fixed Case & Clam Shell

1) "Cheek/Touch Position" — the device is brought toward the mouth of the head phantom by pivoting against the "ear reference point" or along the "N-F" line for the SCC-34/SC-2 head phantom.
This test position is established:
i) When any point on the display, keypad or mouthpiece portions of the handset is in contact with the phantom.
ii) (Or) when any portion of a foldout, sliding or similar keypad cover opened to its intended self-adjusting normal use position is in contact with the cheek or mouth of the phantom.
For existing head phantoms — when the handset loses contact with the phantom at the pivoting point, rotation should continue until the device touch the cheek of the phantom or breaks its last contact from the ear spacer.

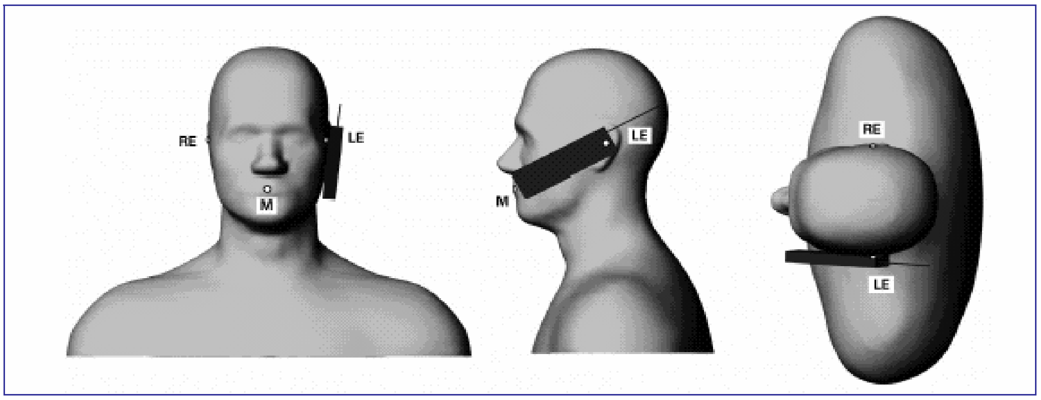


Figure 12. Phone Position 1, Cheek or Touch Position

2) "Ear/Tilt Position" — With the handset aligned in the "Cheek/Touch Position":
i) If the earpiece of the handset is not in full contact with the phantom's ear spacer (in the "Cheek/Touch position") and the peak SAR location for the "Cheek/Touch" position is located at the ear spacer region or corresponds to the earpiece region of the handset, the device should be returned to the "initial ear position" by rotation it away from the mouth until the earpiece is in full contact with the ear spacer.
ii) (Otherwise) the handset should be moved (translated) away from the cheek perpendicular to the line passes through both "ear reference points" (note: one of these ear reference points may not physically exist on a split head model) for approximate 2-3cm. While it is in this position, the handset is tilted away from the mouth with respect to the "test device reference point" by 15°. After the tilt, it is then moved (translated) back toward the head perpendicular to the line passes through both "ear reference points" until the device touches the phantom or the ear spacer. If the antenna touches the head first, the positioning process should be repeated with a tilt angle less than 15° so that the device and its antenna would touch the phantom simultaneously. This test position may require a device holder or positioner to achieve the translation and tilting with acceptable positioning repeatability.

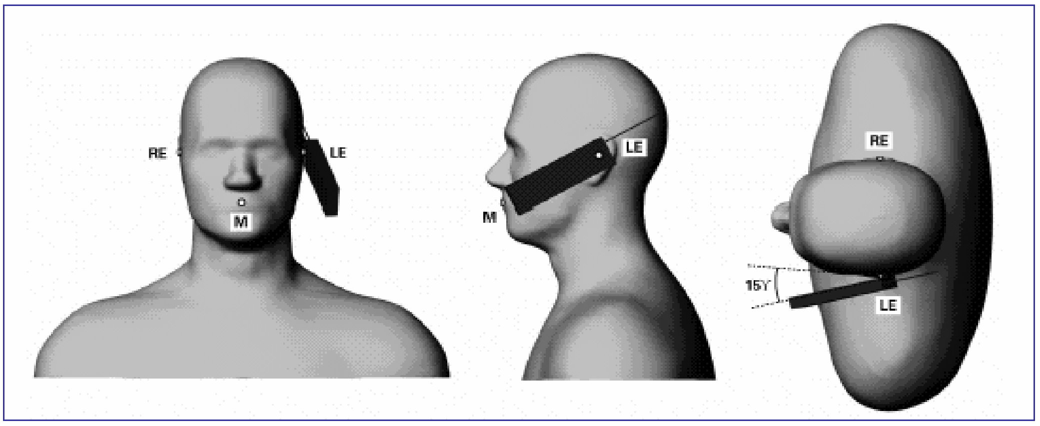


Figure 13. Phone Position 2, Tilted Position

8.3.2 Handset Test Position – Body-Worn

Body-Worn Configuration

Body–worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations. Devices with a headset output should be tested with a headset connected to the device.
Body-worn accessories may not always be supplied or available as options for some devices that are intended to be authorized for body-worn use. A separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances.
For this test：

□ The EUT is placed into the holster/belt clip and the holster is positioned against the surface of the phantom in a normal operating position.

■ Since this EUT doesn't supply any body-worn accessory to the end user, a distance of 1.5 cm was tested to confirm the necessary "minimum SAR separation distance".
(＊**Note**：this distance includes the 2 mm phantom shell thickness.)

8.3.3 Measurement Procedures

The evaluation was performed with the following procedures：

Surface Check： A surface check job gathers data used with optical surface detection. It determines the distance from the phantom surface where the reflection from the optical detector has its peak. Any following measurement jobs using optical surface detection will then rely on this value. The surface check performs its search a specified number of times, so that the repeatability can be verified.

Reference： The reference job measures the field at a specified reference position, at 4 mm from the selected section's grid reference point.

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 can find the maximum locations even in relatively coarse grids. When an area scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. Any following zoom scan within the same procedure will then perform fine scans around these maxima. The area covered the entire dimension of the EUT and the horizontal grid spacing was 15 mm × 15 mm.

Zoom Scan： Zoom scans are used to assess the highest averaged SAR for cubic averaging volumes with 1 g and 10 g of simulated tissue. The zoom scan measures 5 x 5 x 7 points in a 32 x 32 x 30 mm cube whose base faces are centered around the maxima returned from a preceding area scan within the same procedure.

Drift： The drift job measures the field at the same location as the most recent reference job within the same procedure, with the same settings. The drift measurement gives the field difference in dB from the last reference measurement. Several drift measurements are possible for each reference measurement. This allows monitoring of the power drift of the device in the batch process.If the value changed by more than 5%, the evaluation was repeated.

8.4 Spatial Peak SAR Evaluation

The DASY4 software includes all numerical procedures necessary to evaluate the spatial peak SAR values. Based on the Draft: SCC-34, SC-2, WG-2 - Computational Dosimetry, IEEE P1529/D0.0 (Draft Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) Associated with the Use of Wireless Handsets - Computational Techniques), a new algorithm has been implemented. The spatial-peak SAR can be computed over any required mass.

The base for the evaluation is a "cube" measurement in a volume of (32x32x30)mm^3 (5x5x7 points). The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan. If the 10g cube or both cubes are not entirely inside the measured volumes, the system issues a warning regarding the evaluated spatial peak values within the Postprocessing engine (SEMCAD). This means that if the measured volume is shifted, higher values might be possible. To get the correct values you can use a finer measurement grid for the area scan. In complicated field distributions, a large grid spacing for the area scan might miss some details and give an incorrectly interpolated peak location.

The entire evaluation of the spatial peak values is performed within the Postprocessing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into three stages:

Interpolation and Extrapolation

The probe is calibrated at the center of the dipole sensors which is located 1 to 2.7mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated.

In DASY4, the choice of the coordinate system defining the location of the measurement points has no influence on the uncertainty of the interpolation, Maxima Search and SAR extrapolation routines. The interpolation, Maxima Search and extrapolation routines are all based on the modified Quadratic Shepard's method [7].

9. Measurement Uncertainty

Measurement uncertainties in SAR measurements are difficult to quantify due to several variables including biological, physiological, and environmental. However, we estimate the measurement uncertainties in SAR to be less than ± 27 %〔8〕.

According to ANSI/IEEE C95.3〔9〕, the overall uncertainties are difficult to assess and will vary with the type of meter and usage situation. However, accuracy's of ±1 to 3 dB can be expected in practice, with greater uncertainties in near-field situations and at higher frequencies (shorter wavelengths), or areas where large reflecting objects are present. Under optimum measurement conditions, SAR measurement uncertainties of at least ±2dB can be expected.

According to CENELEC〔10〕, typical worst-case uncertainty of field measurements is ±5 dB. For well-defined modulation characteristics the uncertainty can be reduced to ±3 dB.

Source of Uncertainty	Uncertainty Value	Probability Distribution	Divisor	c_i	Standard Uncertainty ±1% (1-g)	v_i or V_{eff}
Type-A	0.9 %	Normal	1	1	0.9	9
Measurement System						
Probe Calibration	7 %	Normal	2	1	3.5	∞
Axial Isotropy	0.2dB	Rectangular	$\sqrt{3}$	$\sqrt{0.5}$	1.9	∞
Hemispherical Isotropy	9.6 %	Rectangular	$\sqrt{3}$	$\sqrt{0.5}$	3.9	∞
Spatial Resolution	0 %	Rectangular	$\sqrt{3}$	1	0	∞
Boundary Effect	11.0 %	Rectangular	$\sqrt{3}$	1	6.4	∞
Linearity	0.2dB	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	∞
RF Ambient Conditions	3.0 %	Rectangular	$\sqrt{3}$	1	1.73	∞
Probe Positioner Mech. Const.	0.4 %	Rectangular	$\sqrt{3}$	1	0.2	∞
Probe Positioning	0.35 %	Rectangular	$\sqrt{3}$	1	0.2	∞
Extrapolation and Integration	3.9 %	Rectangular	$\sqrt{3}$	1	2.3	∞
Test sample Related						
Test sample Positioning	4.7 %	Normal	1	1	4.7	5
Device Holder Uncertainty	6.1 %	Normal	1	1	6.1	5
Drift of Output Power	5.0 %	Rectangular	$\sqrt{3}$	1	2.9	∞
Phantom and Setup						
Phantom Uncertainty (Including temperature effects)	4.0%	Rectangular	$\sqrt{3}$	1	2.3	∞
Liquid Conductivity (target)	5.0%	Rectangular	$\sqrt{3}$	0.6	1.7	∞
Liquid Conductivity (meas.)	10.0%	Rectangular	$\sqrt{3}$	0.6	3.4	∞
Liquid Permittivity (target)	5.0%	Rectangular	$\sqrt{3}$	0.6	1.7	∞
Liquid Permittivity (meas.)	5.0%	Rectangular	$\sqrt{3}$	0.6	1.7	∞
Combined standard uncertainty		RSS			13.5	88.7
Expanded uncertainty (Coverage factor = 2)		Normal (k=2)			27	

Table 6. Uncertainty Budget of DASY

10. SAR Test Results Summary

10.1PCS CDMA 1900MHz SAR Test Results – Head

Ambient：

Temperature (℃)：	22 ± 2	Relative HUMIDITY (%)：	< 60

Liquid：

Mixture Type：	HSL1900	Liquid Temperature (℃)：	23.1
Dielectric Constant：	39.6206	Depth of liquid (cm)：	15
Conductivity：	1.43434		

Measurement：

Crest Factor：	1	Probe S/N：	1720

Frequency		Mode	Power (dBm)	Phantom Position	Antenna Position	SAR_{1g} [mW/g]	Power Drift	Remark
MHz	Ch.							
1851.25	25	PCS CDMA	24.96	Right-Cheek	Fixed	1.4	-0.1	-
1880.00	600	PCS CDMA	24.97	Right-Cheek	Fixed	1.4	-0.05	-
1908.75	1175	PCS CDMA	24.99	Right-Cheek	Fixed	1.13	-0.08	-
1851.25	25	PCS CDMA	24.97	Right-Tilted	Fixed	0.335	-0.1	-
1880.00	600	PCS CDMA	24.97	Right-Tilted	Fixed	0.33	-0.2	-
1908.75	1175	PCS CDMA	25.02	Right-Tilted	Fixed	0.225	-0.1	-
1851.25	25	PCS CDMA	24.98	Left-Cheek	Fixed	1.48	-0.2	-
1880.00	600	PCS CDMA	25.00	Left-Cheek	Fixed	1.49	0.2	-
1908.75	1175	PCS CDMA	24.96	Left-Cheek	Fixed	1.27	-0.1	-
1851.25	25	PCS CDMA	24.99	Left-Tilted	Fixed	0.325	-0.05	-
1880.00	600	PCS CDMA	24.98	Left-Tilted	Fixed	0.35	-0.2	-
1908.75	1175	PCS CDMA	25.02	Left-Tilted	Fixed	0.244	-0.04	-
ANSI / IEEE C95.1 1992 - Safety Limit Spatial Peak Uncontrolled Exposure/General Population					Brain 1.6 W/kg (mW/g) Averaged over 1 gram			

Figure 14. Left Head SAR Test Setup (Cheek)

Figure 15. Left Head SAR Test Setup (Tilted)

Figure 16. Right Head SAR Test Setup (Cheek)

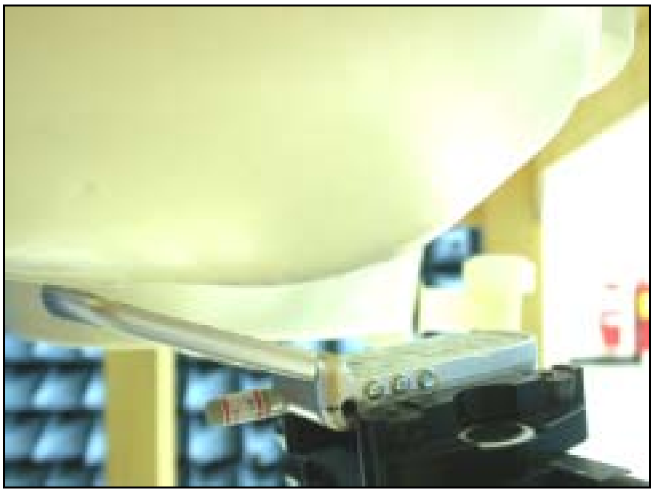


Figure 17. Right Head SAR Test Setup (Tilted)

Figure 18. Body SAR Test Setup (Flat Section)

Figure 19. Body SAR Test Setup (Flat Section)

10.2PCS CDMA 1900MHz SAR Test Results-Body

Ambient：

Temperature (℃)：	22 ± 2	Relative HUMIDITY (%)：	< 60

Liquid：

Mixture Type：	MSL1900	Liquid Temperature (℃)：	22.1
Dielectric Constant：	53.3746	Depth of liquid (cm)：	15
Conductivity：	1.50426		

Measurement：

Crest Factor：	1	Probe S/N：	1753

Frequency		Mode	Power (dBm)	Phantom Position	Antenna Position	SAR_{1g} [mW/g]	Power Drift	Remark
MHz	Ch.							
1851.25	25	PCS CDMA	25.11	Flat	Fixed	0.456	-0.02	-
1880.00	600	PCS CDMA	25.04	Flat	Fixed	0.415	-0.1	-
1908.75	1175	PCS CDMA	24.92	Flat	Fixed	0.4	-0.06	-
ANSI / IEEE C95.1 1992 - Safety Limit Spatial Peak Uncontrolled Exposure/General Population						Brain 1.6 W/kg (mW/g) Averaged over 1 gram		

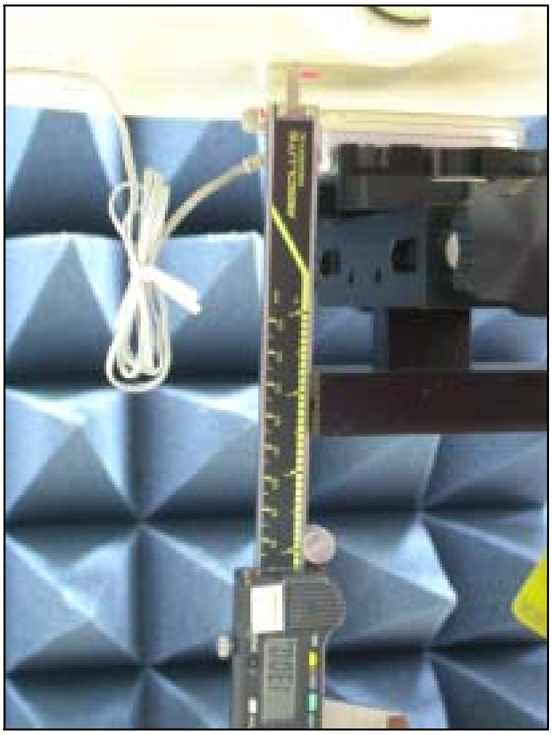


Figure 20. Body SAR Test Setup (Flat Section)

10.3 ANSI/IEEE C95.1 – 1992 RF Exposure Limit

Human Exposure	**Population Uncontrolled Exposure (W/kg) or (mW/g)**	**Occupational Controlled Exposure (W/kg) or (mW/g)**
Spatial Peak SAR* (Brain)	1.60	8.00
Spatial Peak SAR** (Whole Body)	0.08	0.40
Spatial Peak SAR*** (Hands / Feet / Ankle / Wrist)	4.00	20.00

Table 7. Safety Limits for Partial Body Exposure

Notes：

* The Spatial Peak value of the SAR averaged over any 1 gram of tissue.
(defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

** The Spatial Average value of the SAR averaged over the whole – body.

*** The Spatial Peak value of the SAR averaged over any 10 grams of tissue.
(defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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 persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

11. Conclusion

The SAR test values found for the portable mobile phone **BenQ Corporation Trade Name：BenQ Model(s)：C260**, are below the maximum recommended level of 1.6 W/kg (mW/g).

12. References

[1] ANSI/IEEE C95.1-1991, "*American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300KHz to 100GHz",* New York: IEEE, Aug. 1992.

[2] NCRP, National Council on Radiation Protection and Measurements, "*Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields"*, NCRP report NO. 86, 1986.

[3] T. Schmid, O. Egger, and N. Kuster, "*Automatic E-field scanning system for dosimetric assessments*", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp, 105-113, Jan. 1996.

[4] K. Pokovič, T. Schmid, and N. Kuster, "*Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequency*", in ICECOM'97, Dubrovnik, October 15-17, 1997, pp.120-124.

[5] K. Pokovič, T. Schmid, and N. Kuster, "*E-field probe with improved isotropy in brain simulating liquids*", in Proceedings of the ELMAR, Zadar, Croatia, 23-25 June, 1996, pp.172-175.

[6] N. Kuster, and Q. Balzano, "*Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz"*, IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.

[7] Robert J. Renka, "*Multivariate Interpolation Of Large Sets Of Scattered Data*", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988 , pp. 139-148.

[8] N. Kuster, R. Kastle, T. Schmid, *Dosimetric evaluation of mobile communications equipment with known precision*, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.

[9] ANSI/IEEE C95.3-1991, "*IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave,* New York: IEEE, Aug. 1992.

[10] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), *Human Exposure to Electromagnetic Fields High-frequency*: 10KHz-300GHz, Jan. 1995.

Appendix A – System Performance Check

Test Laboratory: AUDEN TECHNO CORP. RF Testing Lab   Date/Time: 06/02/03 14:05:51

System Performance Check at 1800MHz-3

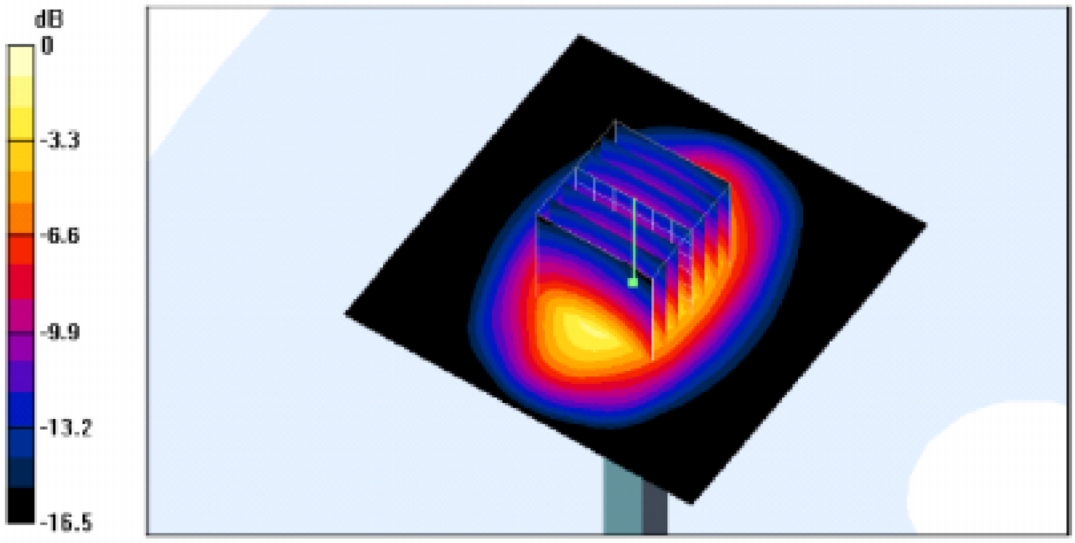
DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2-SN265
Program: SAR-00679

Communication System: CW 1800MHz; Frequency: 1800 MHz;Duty Cycle: 1:1
Medium: Head 1800MHz (σ = 1.34342 mho/m, ε_r = 39.993, ρ = 1000 kg/m^3)
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1720; ConvF(5.2, 5.2, 5.2); Calibrated: 5/15/2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn393; Calibrated: 12/18/2002
- Phantom: SAM 12; Type: SAM v4.0; Serial: TP:1009
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

System Performance Check/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 91 V/m
Power Drift = -0.03 dB
Maximum value of SAR = 9.95 mW/g

System Performance Check/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 14.6 W/kg
SAR(1 g) = 8.8 mW/g; SAR(10 g) = 4.7 mW/g
Reference Value = 91 V/m
Power Drift = -0.03 dB
Maximum value of SAR = 9.87 mW/g



0 dB = 9.87mW/g

Head-Tissue-Simulating-Liquid 1900MHz

Test Laboratory: AUDEN TECHNO CORP. RF Testing Lab   Date/Time: 06/30/03 05:45:29

System Performance Check at 1800MHz

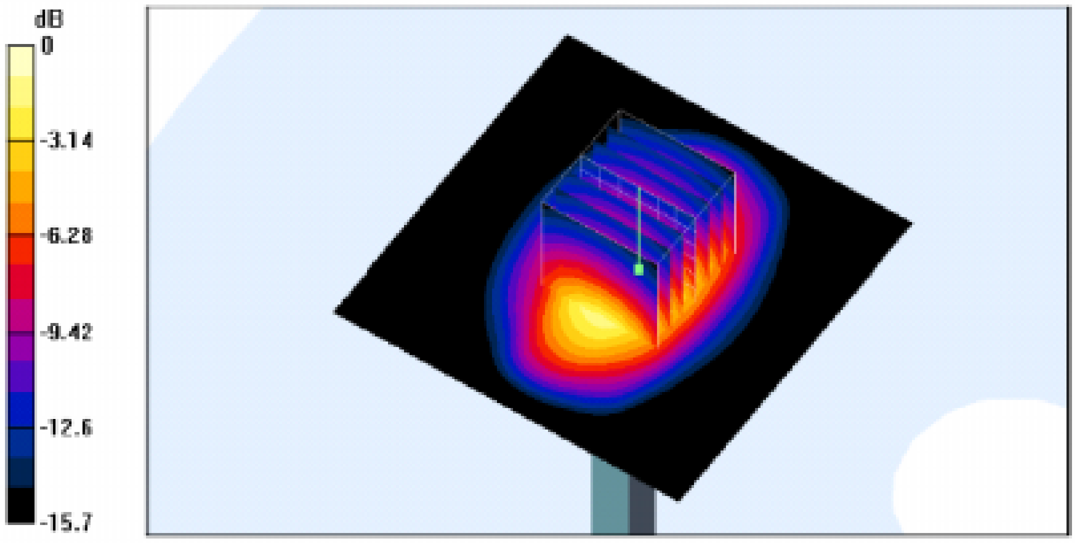
DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2-SN265
Program: SAR-00679

Communication System: CW 1800MHz; Frequency: 1800 MHz;Duty Cycle: 1:1
Medium: Body 1800MHz (σ = 1.45975 mho/m, ε_r = 53.5021, ρ = 1000 kg/m^3)
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1753; ConvF(4.9, 4.9, 4.9); Calibrated: 5/23/2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn393; Calibrated: 12/18/2002
- Phantom: SAM 12; Type: SAM v4.0; Serial: TP:1009
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

System Performance Check/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 88.4 V/m
Power Drift = -0.01 dB
Maximum value of SAR = 10.6 mW/g

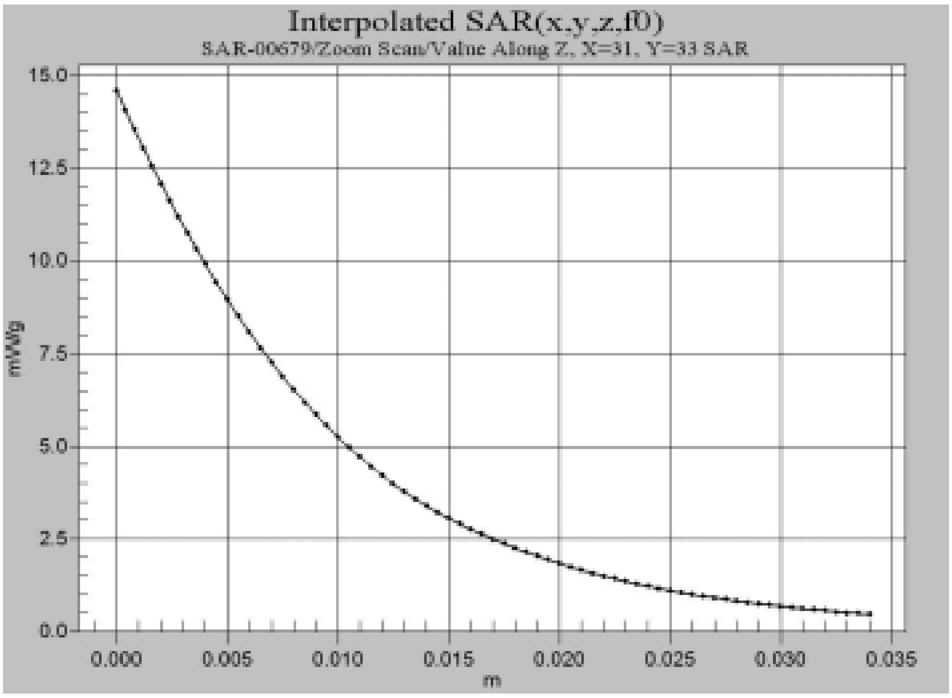
System Performance Check/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 15.2 W/kg
SAR(1 g) = 9.34 mW/g; SAR(10 g) = 5.06 mW/g
Reference Value = 88.4 V/m
Power Drift = -0.01 dB
Maximum value of SAR = 10.6 mW/g



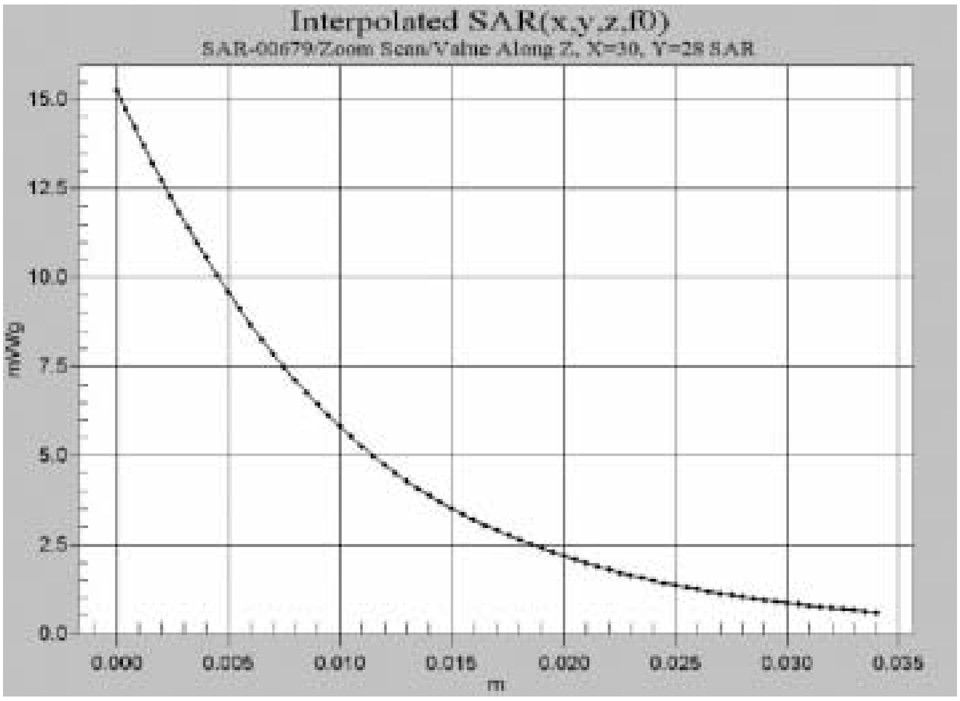
0 dB = 10.6mW/g

Muscle-Tissue-Simulating-Liquid 1900MHz

Z-axis Plot of System Performance Check



Head-Tissue-Simulating-Liquid 1900MHz



Muscle-Tissue-Simulating-Liquid 1900MHz