SAR Evaluation Report

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

for

Tri-Bands (PCS/DCS/GSM) Smart Phone

MODEL: Voq A11

FCC ID: N7NVOQA11

January 9, 2004

REPORT NO: 03U2438-3

Prepared for

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Prepared by

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CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

DATES OF TEST: January 5, 6 and 9 2004

APPLICANT:	Sierra Wireless, Inc. 13811 Wireless Way, Richmond British Columbia V6V 3A4, Canada
MODEL:	Voq A11
FCC ID:	N7NVOQA11
DEVICE CATEGORY:	PORTABLE DEVICES
EXPOSURE CATEGORY:	GENERAL POPULATION/UNCONTROLLED EXPOSURE

Test Sample is a:	Production unit
Modulation type:	GSM+GPRS
Operating Mode:	Maximum continuous output
Tx Frequency:	GSM850: 824.2 MHz to 848.8 MHz GSM1900: 1850.2 MHz to 1909.8 MHz
Max. O/P Power: (Conducted/Peak)	GSM850: 31.8 dBm (1 slot); 31.8 dBm (2 slots) GSM1900: 29.7 dBm (1 slot); 29.9 dBm (2 slots)
Max. SAR (1g):	GSM850: 0.333 mW/g @ Right head touched position 1.01 mW/g @ Body worn position (2 slots) GSM1900: 0.578 mW/g @ Left head tilted position 0.762 mW/g @ Body worn position (2 slots)
Application Type:	Certification
FCC Rule Part(s):	§ 22.901(d) & 24E

Note: This device contains GSM1800 function not operational in US territories. This report is only applicable for GSM850 and GSM1900 PCS 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.

Steve Cheng

Steve Cheng

EMC Engineering Manager

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1. EQUIPMENT UNDER TEST (EUT) DESCRIPTION

The following is the information provided by the applicant.

This device contains GSM1800 function not operational in US territories. This report is only applicable for GSM850 and GSM1900 PCS band.

Type/Model No.: Voq A11

Series No.: S0312030000500J

Modulation Type: GSM+GPRS

TX Frequency: GSM1900 - 1850.2 MHz to 1909.8 MHz

GSM1800 - 1710.2 MHz to 1784.8 MHz

GSM850 - 824.2 MHz to 848.8 MHz

Duty Cycle: 12.5% (1 slot); 25% (2 slots @ GPRS mode)

Battery: Only one model with EUT

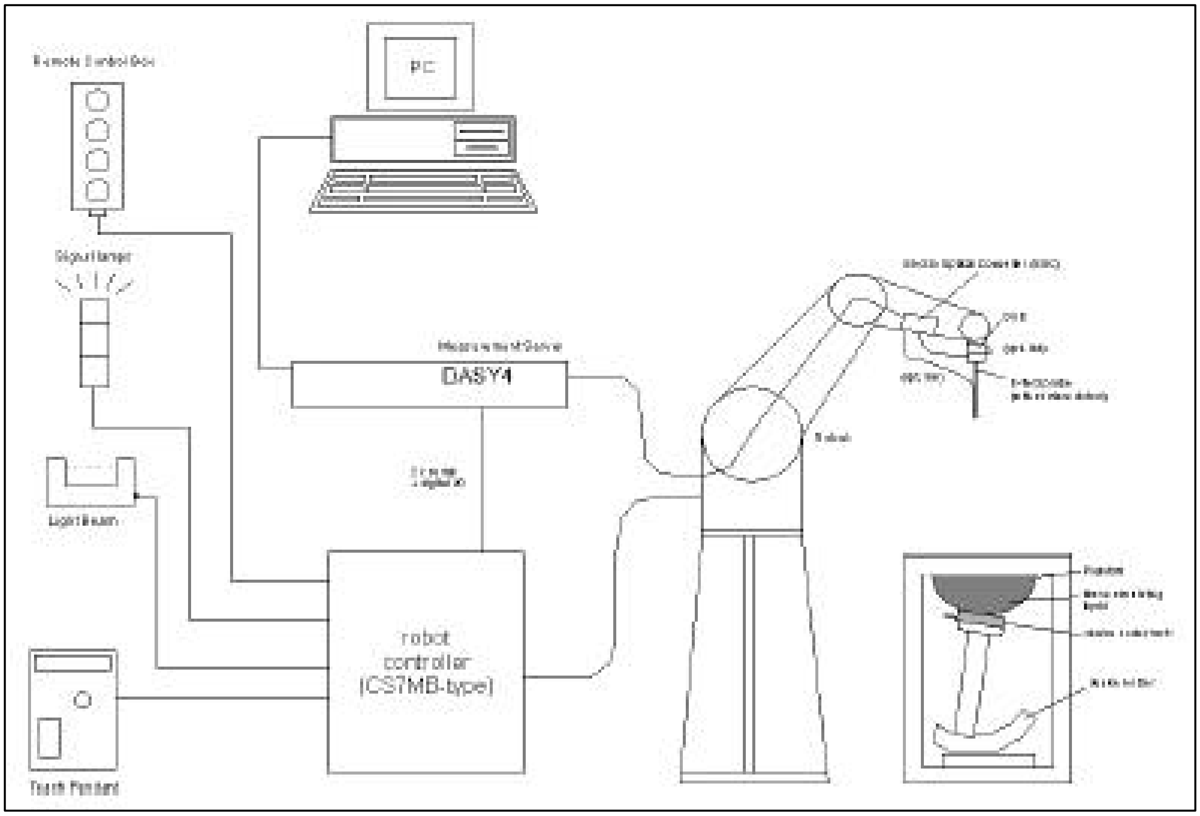
2. REQUIREMENTS FOR COMPLIANCE TESTING DEFINED BY THE FCC

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. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 mW/g for an uncontrolled environment and 8.0 mW/g for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992. According to the Supplement C of OET Bulletin 65 “Evaluating Compliance with FCC Guide-lines for Human Exposure to Radio frequency Electromagnetic Fields", released on Jun 29, 2001 by the FCC, the device should be evaluated at maximum output power (radiated from the antenna) under “worst-case” conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

3. DOSIMETRIC ASSESSMENT SETUP

These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9 m), which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The SAR measurements were conducted with the 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 described in [7] with accuracy of better than ±10%. The spherical isotropy was evaluated with the procedure described in [8] and found to be better than ±0.25 dB. The phantom used was the SAM Twin Phantom as described in FCC supplement C, IEE P1528 and CENELEC EN50361.

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.

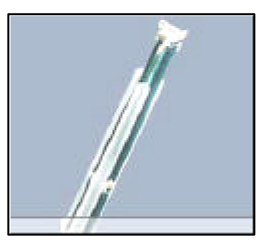
The measurement server performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection 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

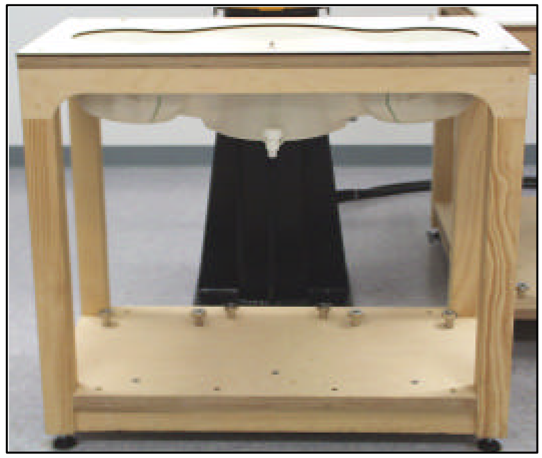
Construction:	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycolether)
Calibration:	Basic Broad Band Calibration in air: 10-2500 MHz. Conversion Factors (CF) for HSL 900 and HSL 1800 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)



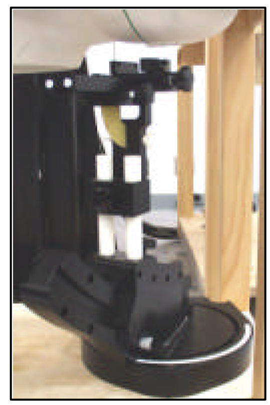
Construction: The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X, CENELEC 50361 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A 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	r

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 μV/(V/m)^2 for E0field Probes	(i = x, y, z)
$ConvF$	= 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.

$$SAR = E_{tot}^2 \cdot \frac{s}{r \cdot 1000}$$

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]

r = 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. EUT ARRANGEMENT

Please refer to IEEE P1528 illustration below.

7.1 ANTHROPOMORPHIC HEAD PHANTOM

Figure 7-1a shows the front, back and side views of SAM. The point “M” is the reference point for the center of mouth, “LE” is the left ear reference point (ERP), and “RE” is the right ERP. The ERPs are 15 mm posterior to the entrance to ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 7-1b. The plane passing through the two ear reference points and M is defined as the Reference Plane. The line N-F (Neck-Front) perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 7-1c). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines should be marked on the external phantom shell to facilitate handset positioning. Posterior to the N-F line, the thickness of the phantom shell with the shape of an ear is a flat surface 6 mm thick at the ERPs. Anterior to the N-F line, the ear is truncated as illustrated in Figure 7-1b. The ear truncation is introduced to avoid the handset from touching the ear lobe, which can cause unstable handset positioning at the cheek.

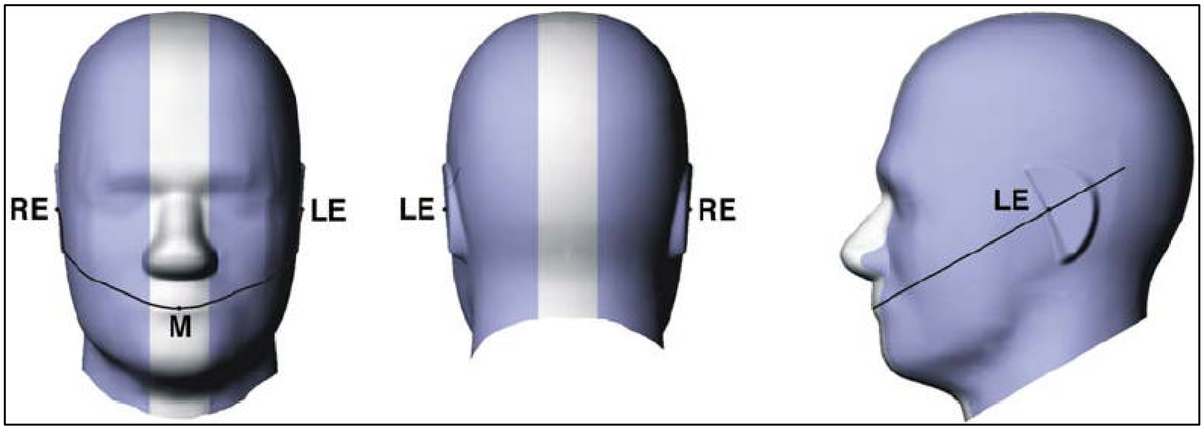


Figure 7-1a
Front, back and side view of SAM (model for the phantom shell)

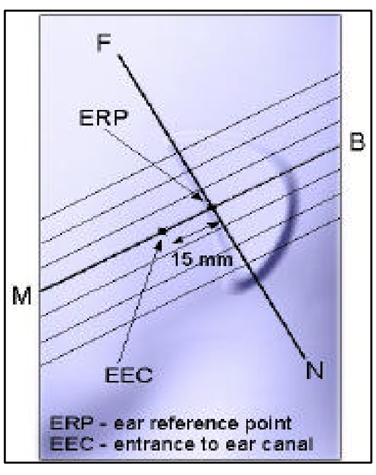


Figure 7-1b
Close up side view of phantom showing the ear region

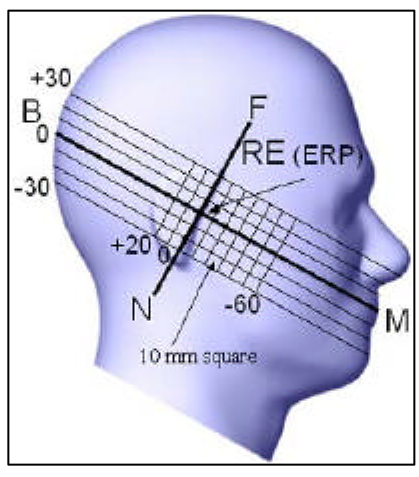


Figure 7-1c
Side view of the phantom showing relevant markings and the 7 cross sectional plane locations

7.2 DEFINITION OF THE "CHEEK/TOUCH" POSITION

The "cheek" or "touch" position is defined as follows:

a. Ready the handset for talk operation, if necessary. For example, for handsets with a cover piece, open the cover. (If the handset can also be used with the cover closed both configurations must be tested.)

b. Define two imaginary lines on the handset: the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width wt of the handset at the level of the acoustic output (point A on Figures 7-2a and 7-2b), and the midpoint of the widt h wb of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 7-2a). The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output. However, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset (see Figure 7-2b), especially for clamshell handsets, handsets with flip pieces, and other irregularly-shaped handsets.

c. Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 7-2c), such that the plane defined by the vertical center line and the horizontal line of the handset is approximately parallel to the sagittal plane of the phantom.

d. Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the pinna.

e. e) While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to MB-NF including the line MB (called the reference plane).

f. Rotate the handset around the vertical centerline until the handset (horizontal line) is symmetrical with respect to the line NF.

g. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE and maintaining the handset contact with the pinna, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the pinna (cheek). See Figure 7-2c. The physical angles of rotation should be noted.

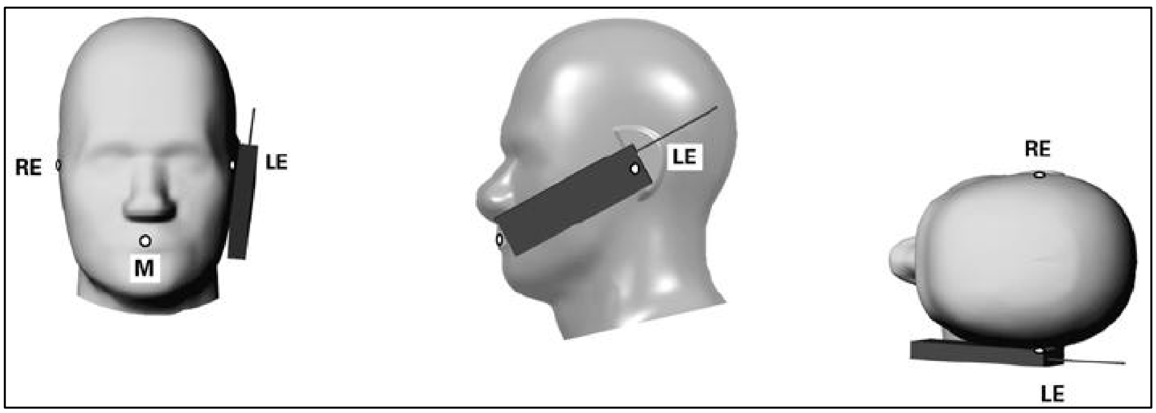


Figure 7.2c

Phone "cheek" or "touch" position. The reference points for the right ear (RE), left ear LE) and mouth (M), which define the reference plane for handset positioning, are indicated.

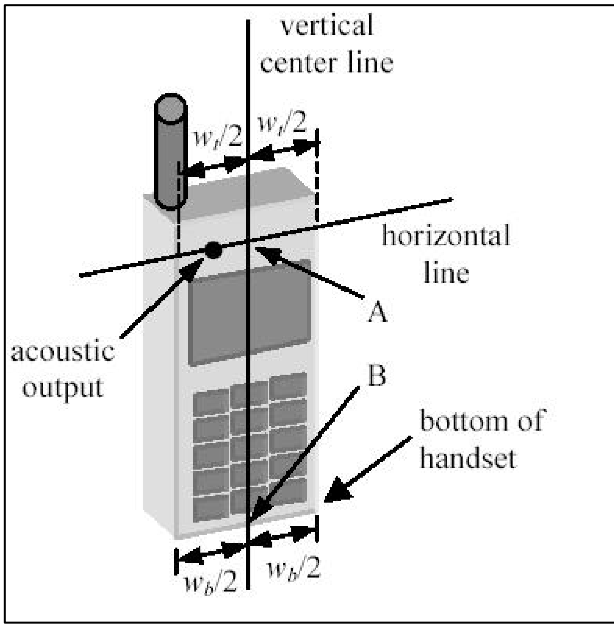


Figure 7.2a

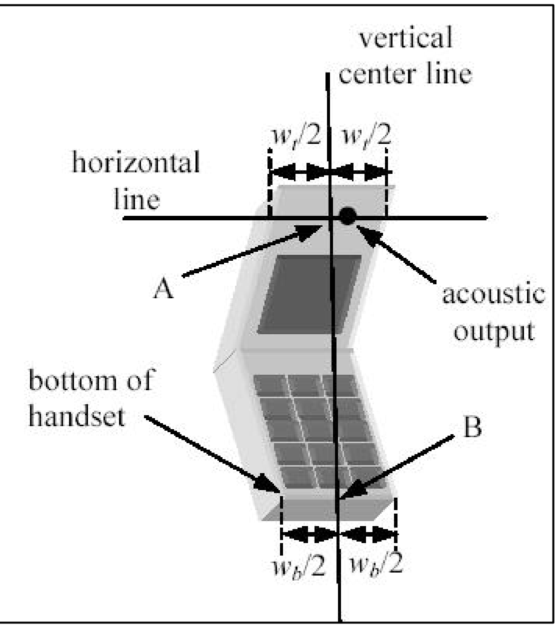


Figure 7.2b

7.3 DEFINITION OF THE "TILTED" POSITION

The "tilted" position is defined as follows:

a. Repeat steps (a) – (g) of 7.2 to place the device in the "cheek position."
b. While maintaining the orientation of the handset move the handset away from the pinna along the line passing through RE and LE in order to enable a rotation of the handset by 15 degrees.
c. Rotate the handset around the horizontal line by 15 degrees.
d. While maintaining the orientation of the handset, move the handset towards the phantom on a line passing through RE and LE until any part of the handset touches the ear. The tilted position is obtained when the contact is on the pinna. If the contact is at any location other than the pinna (e.g., the antenna with the back of the phantom head), the angle of the handset should be reduced. In this case, the tilted position is obtained if any part of the handset is in contact with the pinna as well as a second part of the handset is contact with the phantom (e.g., the antenna with the back of the head).

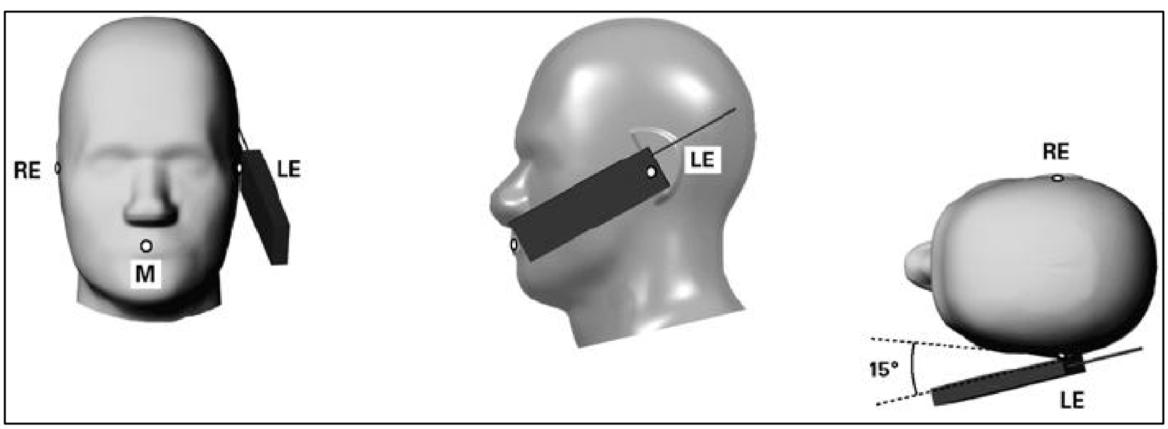


Figure 7-3

Phone "tilted" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for handset positioning, are indicated.

8. MEASUREMENT RESULTS

8.1. 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

Ambient condition: Temperature = 22.5°C; Relative humidity = 32% **Date:** January 5, 2004

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
900	21	15	Permitivity:	41.5	40.0639	-3.46	± 5
			Conductivity:	0.97	0.9697	-0.03	± 5

Ambient condition: Temperature: 22.5°C; Relative humidity: 32% **Date:** January 5, 2004

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
835	21	15	Permitivity:	41.5	41.5347	0.08	± 5
			Conductivity:	0.9	0.914	1.56	± 5

Ambient condition: Temperature = 22.5°C; Relative humidity = 32% **Date:** January 5, 2004

Body Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
835	21	15	Permitivity:	55.2	55.4575	0.47	± 5
			Conductivity:	0.97	0.9613	-0.90	± 5

Ambient condition: Temperature = 22.5°C; Relative humidity = 31% **Date:** January 6, 2004

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
1800	21	15	Permitivity:	40	40.2784	0.70	± 5
			Conductivity:	1.4	1.467	4.79	± 5

Ambient condition: Temperature = 22.5°C; Relative humidity = 31% **Date:** January 6, 2004

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
1900	21	15	Permitivity:	40	41.03	2.58	± 5
			Conductivity:	1.4	1.3947	-0.38	± 5

Ambient condition: Temperature = 22.5°C; Relative humidity = 31% **Date:** January 6, 2004

Body Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
1900	21	15	Permitivity:	53.3	52.9099	-0.73	± 5
			Conductivity:	1.52	1.594	4.87	± 5

Ambient condition: Temperature = 22.5°C; Relative humidity = 32% **Date:** January 9, 2004

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
1800	21	15	Permitivity:	40	40.3072	0.77	± 5
			Conductivity:	1.4	1.457	4.07	± 5

Ambient condition: Temperature = 22.5°C; Relative humidity = 32% **Date:** January 9, 2004

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth (cm)					
1900	21	15	Permitivity:	40	39.805	-0.49	± 5
			Conductivity:	1.4	1.4635	4.54	± 5

8.2. 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 Isotropic E-Field Probe ES3DV2-SN: 3021 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 4mm.
- 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

Dipole: D900V2 SN: 108

Date: January 5, 2004

Ambient condition: Temperature = 22.5°C; Relative humidity = 31%

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth [cm]					
900	21.0	15.00	Permitivity:	41.5	40.0639	-3.46	± 5
			Conductivity:	0.97	0.9697	-0.03	± 5
			1g SAR:	10.8	10.88	0.74	± 10

Dipole: D1800V2 SN: 294

Date: January 6, 2004

Ambient condition: Temperature = 22.5°C; Relative humidity = 31%

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth [cm]					
1800	21.0	15.00	Permitivity:	40	40.2784	0.70	± 5
			Conductivity:	1.4	1.467	4.79	± 5
			1g SAR:	38.1	39.64	4.04	± 10

Dipole: D1800V2 SN: 294

Date: January 9, 2004

Ambient condition: Temperature = 22.5°C; Relative humidity = 32%

Head Simulating Liquid			Parameters	Target	Measured	Deviation[%]	Limited[%]
f (MHz)	Temp. [°C]	Depth [cm]					
1800	21.0	15.00	Permitivity:	40	40.3072	0.77	± 5
			Conductivity:	1.4	1.457	4.07	± 5
			1g SAR:	38.1	39.36	3.31	± 10

8.3. EUT TUNE-UP PROCEDURES

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

To setup the desire channel frequency and the maximum output power. A Radio Communication Tester “R&S, model CMU 200” was used to program the EUT.

GSM850
GSM mode
Network Support: GSM only
Main Service: Circuit Switched
Power Setting: PCL: 5 (33dBm)
GPRS Mode
Service Selection: Test Mode A
Main Service: Packet Data (Multislot Class 10: 2 uplink slots and 4 downlink slots)
Network Support: GSM+GPRS
Power Setting: 0 (39dBm)

GSM1900
GSM mode
Network Support: GSM only
Main Service: Circuit Switched
Power Setting: PCL: 0 (30dBm)
GPRS Mode
Service Selection: Test Mode A
Main Service: Packet Data (Multislot Class 10: 2 uplink slots and 4 downlink slots)
Network Support: GSM+GPRS
Power Setting: 0 (36dBm)

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

8.4. SAR MEASUREMENT RESULTS

Left Touched Position

GSM850: Duty Cycle: 12.5% (Crest Factor: 8) Depth of liquid: 15.0 cm

EUT Position	Antenna	Frequency		*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
		Channel	MHz	Before	After			
Left Touched	Fixed	128	824.2	31.8	31.8	21.0	0.308	1.6
		188	836.2	31.3	31.3	21.0	0.308	
		251	848.8	30.8	30.8	21.0	0.332	

GSM1900: Duty Cycle: 12.5% (Crest Factor: 8)

EUT Position	Antenna	Frequency		*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
		Channel	MHz	Before	After			
Left Touched	Fixed	512	1850.2	29.7	--	--	**	1.6
		632	1874.2	29.6	29.6	21.0	0.328	
		810	1909.9	29.6	--	--	**	

Notes:
1. *: Peak power
2. **: The SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, testing at the high and low channels is option.
3. Please refer to attachment for the result presentation in plot format.

Left Tilted Position

GSM850: Duty Cycle: 12.5% (Crest Factor: 8) Depth of liquid: 15.0 cm

EUT Position	Antenna	Frequency		*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
		Channel	MHz	Before	After			
Left Tilted	Fixed	128	824.2	31.8	--	--	**	1.6
		188	836.2	31.3	31.3	21.0	0.117	
		251	848.8	30.8	--	--	**	

GSM1900: Duty Cycle: 12.5% (Crest Factor: 8)

EUT Position	Antenna	Frequency		*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
		Channel	MHz	Before	After			
Left Tilted	Fixed	512	1850.2	29.7	29.7	21.0	0.578	1.6
		632	1874.2	29.6	29.6	21.0	0.468	
		810	1909.9	29.6	29.6	21.0	0.429	

Notes:
1. *: Peak power
2. Please refer to attachment for the result presentation in plot format.

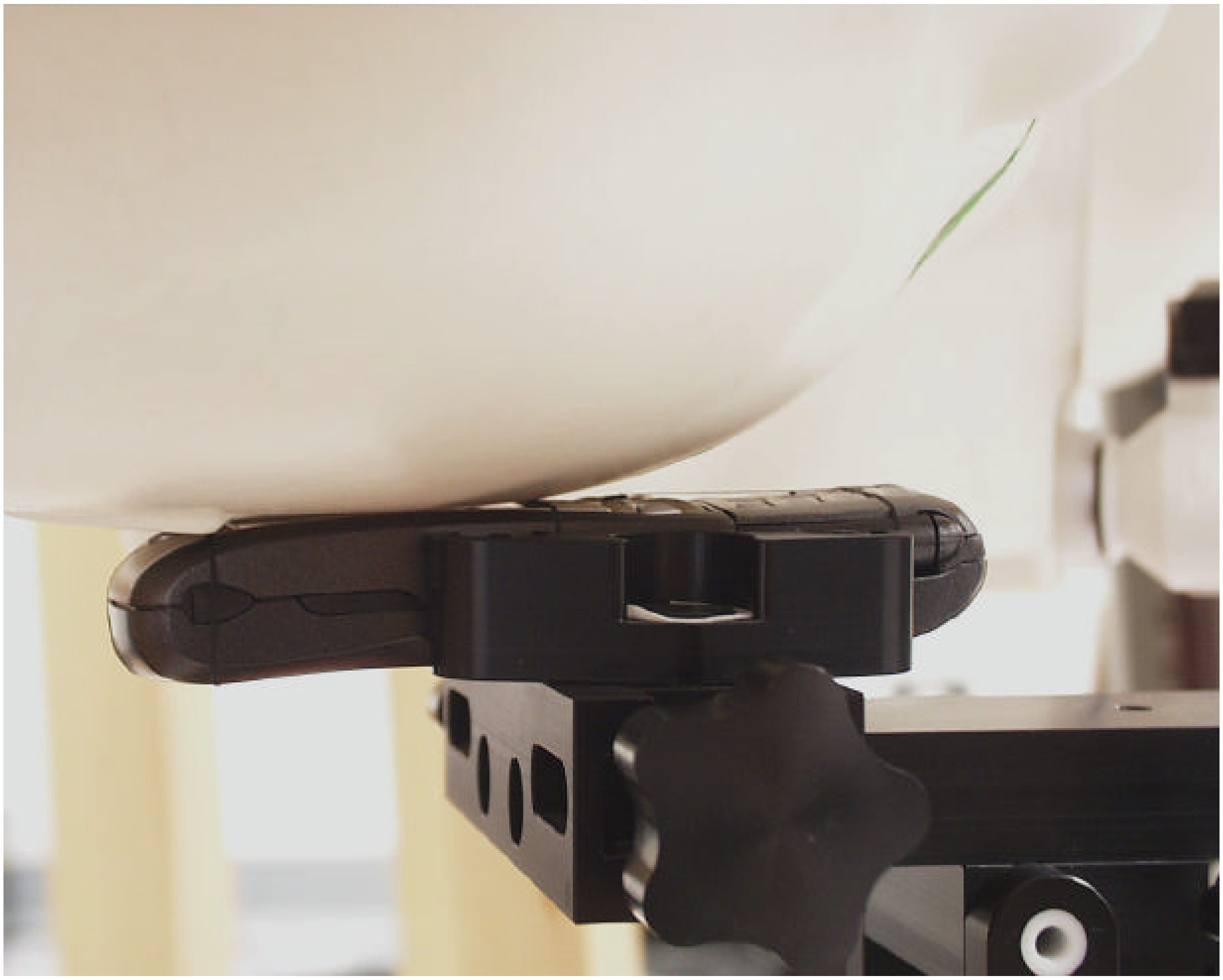
Left Tilted Position (Keypad opened)

GSM1900: Duty Cycle: 12.5% (Crest Factor: 8) Depth of liquid: 15.0 cm

EUT Position	Antenna	Frequency		*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
		Channel	MHz	Before	After			
Left Tilted	Fixed	512	1850.2	29.7	29.7	21.0	0.505	1.6

Notes:
3. *: Peak power
4. Please refer to attachment for the result presentation in plot format.

Right Touched Position



GSM850: Duty Cycle: 12.5% (Crest Factor: 8) Depth of liquid: 15.0 cm

EUT Position	Antenna	Frequency		*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
		Channel	MHz	Before	After			
Right Touched	Fixed	128	824.2	31.8	31.8	21.0	0.317	1.6
		188	836.2	31.3	31.3	21.0	0.304	
		251	848.8	30.8	30.8	21.0	0.333	

GSM1900: Duty Cycle: 12.5% (Crest Factor: 8)

EUT Position	Antenna	Frequency		*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
		Channel	MHz	Before	After			
Right Touched	Fixed	512	1850.2	29.7	--	--	**	1.6
		632	1874.2	29.6	29.6	21.0	0.306	
		810	1909.9	29.6	--	--	**	

Notes:
1. *: Peak power
2. **: The SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, testing at the high and low channels is option.
3. Please refer to attachment for the result presentation in plot format.

Right Tilted Position

GSM850: Duty Cycle: 12.5% (Crest Factor: 8) Depth of liquid: 15.0 cm

EUT Position	Antenna	Frequency		*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
		Channel	MHz	Before	After			
Right Tilted	Fixed	128	824.2	31.8	--	--	**	1.6
		188	836.2	31.3	31.3	21.0	0.113	
		251	848.8	30.8	--	--	**	

GSM1900: Duty Cycle: 12.5% (Crest Factor: 8)

EUT Position	Antenna	Frequency		*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
		Channel	MHz	Before	After			
Right Tilted	Fixed	512	1850.2	29.7	29.7	21.0	0.572	1.6
		632	1874.2	29.6	29.6	21.0	0.461	
		810	1909.9	29.6	29.6	21.0	0.431	

Notes:
1. *: Peak power
2. **: The SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, testing at the high and low channels is option.
3. Please refer to attachment for the result presentation in plot format.

Body Position (GSM850)

GSM850: Duty Cycle = 12.5% (Crest Factor: 8) Depth of liquid: 15.0 cm

Sep. dist._cm	Channel	Frequency_MHz	*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
			Before	After			
With holster	128	824.2	31.8	--	--	**	1.6
	188	836.2	31.3	31.3	21.0	0.630	
	251	848.8	30.8	--	--	**	

GSM850/GPRS Mode: Duty Cycle = 25% (Crest Factor: 4) Depth of liquid: 15.0 cm

Sep. dist._cm	Channel	Frequency_MHz	*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
			Before	After			
With holster	128	824.2	31.8	31.8	21.0	0.872	1.6
	188	836.2	31.3	31.3	21.0	1.01	
	251	848.8	30.8	30.8	21.0	0.897	

Notes:
1. *: Peak power
2. **: The SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, testing at the high and low channels is option.
3. A separation distance of 0 cm between the back of the holster and flat phantom.
4. The Ear-microphone wire connected to the phone to simulate hands-free operation in a body-worn configuration.
5. Please refer to attachment for the result presentation in plot format.

Body Position (GSM1900)

GSM1900: Duty Cycle = 12.5% (Crest Factor: 8) Depth of liquid: 15.0 cm

Sep. dist._cm	Channel	Frequency_MHz	*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
			Before	After			
With holster	512	1850.2	29.7	29.7	--	**	1.6
	632	1874.2	29.6	29.6	21.0	0.350	
	810	1909.9	29.6	29.6	--	**	

GSM1900/GPRS Mode: Duty Cycle = 25% (Crest Factor: 4) Depth of liquid: 15.0 cm

Sep. dist._cm	Channel	Frequency_MHz	*Conducted Pwr_dBm		Liquid Temp_°C	**SAR** (1g) (W/kg)	Limit (W/kg)
			Before	After			
With holster	512	1850.2	29.7	29.7	21.0	0.762	1.6
	632	1874.2	29.8	29.8	21.0	0.721	
	810	1909.9	29.9	29.9	21.0	0.719	

Notes:

6. *: Peak power
7. **: The SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, testing at the high and low channels is option.
8. A separation distance of 0 cm between the back of the holster and flat phantom.
9. The Ear-microphone wire connected to the phone to simulate hands -free operation in a body-worn configuration.
10. Please refer to attachment for the result presentation in plot format.

9. EUT PHOTOS

EUT PHOTOS

EUT PHOTOS

EUT PHOTOS

10. 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
Signal General	HP	83732B	US34490599	4/4/04
Power Meter	Giga-tronics	8651A	8651404	5/12/04
Power Sensor	Giga-tronics	80701A	1834588	2/18/04
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	2/14/04
Data Acquisition Electronics (DAE)	SPEAG	DAE3 V1	427	2/4/04
Dosimetric E-Field Probe	SPEAG	ES3DV2	3021	7/29/04
System Validation Dipole	SPEAG	D900V2	108	4/10/04
System Validation Dipole	SPEAG	D1800V2	294	4/19/04
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	SPEAG	H1800	N/A	Within 24 hrs of first test
Simulating Liquids	SPEAG	H1900	N/A	Within 24 hrs of first test
Simulating Liquids	SPEAG	M1900	N/A	Within 24 hrs of first test
Simulating Liquids	SPEAG	H900	N/A	Within 24 hrs of first test
Simulating Liquids	SPEAG	H835	N/A	Within 24 hrs of first test
Simulating Liquids	SPEAG	M835	N/A	Within 24 hrs of first test

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12. ATTACHMENTS

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