



Author Data Daoud S. Attayi	Dates of Test July 18 – August 12 , 2002	Test Report No RIM-0207-04
Approved	Rev	FCC ID : L6AR6510IN

## SAR Compliance Test Report

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**Statement of Compliance:** Research In Motion Limited, declares under its sole responsibility that the product to which this declaration relates, is in conformity with the appropriate RF exposure standards, recommendations and guidelines. It also declares that the product was tested in accordance with the appropriate measurement standards, guidelines and recommended practices. Any deviations from these standards, guidelines and recommended practices are noted below:

(none)

**Device Category:** This wireless handheld is a portable device, designed to be used in direct contact with the user's head, hand and to be carried in an approved holster when carried on the user's body.

**RF exposure environment:** This wireless portable device has been shown to be in compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in OET Bulletin 65 Supplement C (Edition 01-01), FCC 96-326 and IEEE Std. C95.1-1999 and had been tested in accordance with the measurement procedures specified in OET Bulletin 65 Supplement C (Edition 01-01) and ANSI/IEEE Std. C95.3-1991.

Approved by:	Signatures	Date
Paul G. Cardinal, Ph.D. Manager, Compliance & Certification		August 15, 2002

<b>Tested and documented by:</b> Daoud S. Attayi Compliance Specialist		August 13, 2002
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8.2.2 BODY -WORN TEST CONFIGURATION (EAR-MICROPHONE JACK)	20
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APPENDIX A: SAR DISTRIBUTION COMPARISON FOR THE ACCURACY VERIFICATION

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## 1.0 OPERATING CONFIGURATIONS AND TEST CONDITIONS

### 1.1 Pictures of Handheld

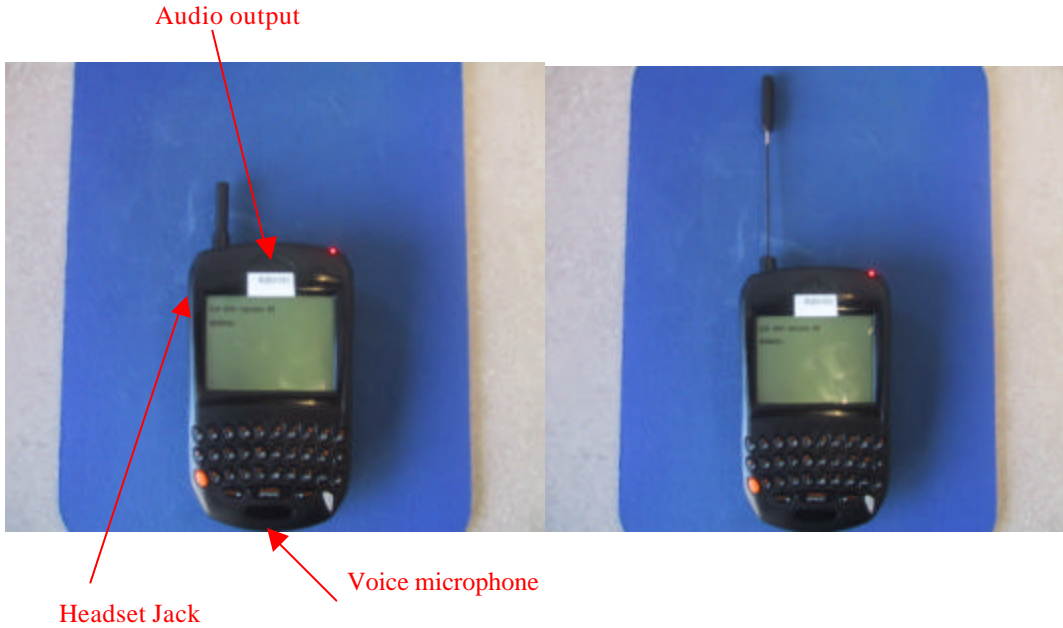


Figure 1. BlackBerry Wireless Handheld

### 1.2 Antenna description

<b>Type</b>	External whip antenna
<b>Location</b>	Left side
<b>Configuration</b>	Helix

Table 1. Antenna description

### 1.3 Handheld description

<b>Handheld Model</b>	R6510IN
<b>FCC ID</b>	L6AR6510IN
<b>Serial Number</b>	R4DV-001
<b>Prototype or Production Unit</b>	Pre-production
<b>Mode(s) of Operation</b>	TDMA
<b>Maximum pulsed average conducted RF Output Power</b>	28.38 dBm
<b>Tolerance in Power Setting</b>	±1.60 dB
<b>Duty Cycle</b>	2:6
<b>Transmitting Frequency Range (s)</b>	806 – 825 MHz

Table 2. Test device description

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#### 1.4 Body worn accessories

##### Holster

The holster, with integral belt-clip, is designed to allow the BlackBerry Wireless Handheld to slide in only one way, and that is with the keyboard side facing the user (facing the belt-clip) while in the holster. This positioning has the benefit of protecting the keypad and the large LCD from damage.

The middle portion of Figure 2 shows the holster with the handheld keyboard side facing the user and with the keyboard side facing away from user. The photo on the right shows that the device with the keyboard away from the user does not fit into the holster.



**Figure 2. Body-worn holster ASY-04465-001**



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The device-to-phantom spacing when the handheld is in the holster is 15 mm as shown in the bottom portion of Figure 2.

## 1.5 Headsets

The RIM Blackberry Wireless handheld was tested with (for worst case scan) and without headset model number HDW-03458-001. It was found that the SAR values were lower while the headset was attached as shown in the Table 16 and 17.

## 1.6 Procedure used to establish the test signal

The units are loaded with SW so that it could be set to transmit at maximum power and duty cycle without the need of a base station. The SW is called BERBUG. To run the test, the following BERBUG commands are used which can be typed in with the keypad on the unit.

When the battery is installed, a berbug prompt will appear on the LCD. Then proceed with the following.

- tx fre XXX.XXXX (this set the transmit frequency, low band = 806.0125 MHz, midband = 815.500 MHz, high band = 824.9875 MHz)
- tx pse (this set transmitter in pseudo training mode)
- frame 3 (this set the transmitter to transmit 2 slots per frame. "frame 6" will cause the transmitter to transmit 1 slot per frame.)
- mode tx (this set the transmitter to transmit)

## 2.0 DESCRIPTION OF THE TEST EQUIPMENT

### 2.1 SAR measurement system

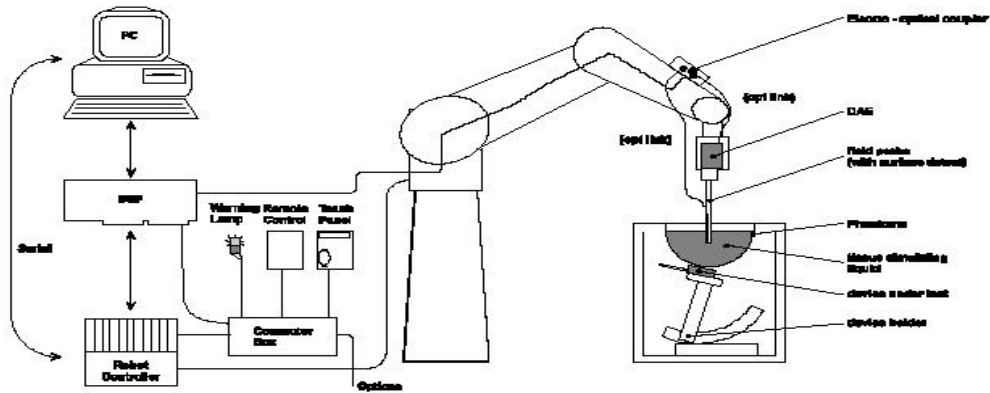
SAR measurements were performed using a Dosimetric Assessment System (DASY3), an automated SAR measurement system manufactured by Schmid & Partner Engineering AG (SPEAG), of Zurich, Switzerland.

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

- A standard high precision 6-axis robot (Stäubli RX family) with controller 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 DAE module 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 Electro-optical coupler (EOC).
- A unit to operate the optical surface detector which is connected to the EOC.
- The EOC performs the conversion from an optical signal into the digital electric signal of the DAE. The EOC is connected to the PC plug-in card.
- The functions of the PC plug-in card based on a DSP is to perform the time critical tasks such as signal filtering, surveillance of the robot operation fast movement interrupts.
- A computer operating Windows NT.

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- DASY3 software version 3.1C.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The generic 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 (see Application Note).
- System validation dipoles allowing for the validation of proper functioning of the system.



**Figure 3: System Description**

### 2.1.1 Equipment List

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
SCHMID & Partner Engineering AG	E-field probe	ET3DV6	1644	26/11/2002
SCHMID & Partner Engineering AG	E-field probe	ET3DV6	1642	26/07/2003
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE3)	DAE3 V1	473	26/11/2002
SCHMID & Partner Engineering AG	Dipole Validation Kit	D835V2	446	12/11/2003
Agilent Technologies	Signal generator	HP 8648C	4037U03155	20/03/2003
Agilent Technologies	Power meter	437B	3125U10666	06/08/2003
Agilent Technologies	Power sensor	8482A	US37291628	06/08/2003
Agilent Technologies	Power meter	E4419B	GB40202821	20/03/2003
Agilent Technologies	Power sensor	8482A	US37295126	21/03/2003
Amplifier Research	Amplifier	5S1G4M3	300986	CNR
Agilent Technologies	Network analyzer	8753ES	US39174857	21/03/2003

**Table 3. Equipment list**





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## 2.2 Description of the test setup

Before a SAR test is conducted the Handheld and the DASY equipment are setup as follows:

### 2.2.1 Handheld and base station simulator setup

The units are loaded with SW so that it can be set to transmit at maximum power and duty cycle without the need of a base station. The SW is called BERBUG. When the battery is installed, a berbug prompt will appear on the LCD. Then proceed with the steps outlined in Section 1.6 of this report.

### 2.2.2 DASY setup

- Turn the computer on and log on to Windows NT.
- Start DASY3 software by clicking on the icon located on the Windows desktop. Once the software loads, click on the Change to Robot toolbar button to open the State and Robot Monitoring Windows.
- Once the DASY State dialog opens you can ignore all errors and click OK to open the Robot Monitoring window.
- Mount the DAE unit and the probe. Turn on the DAE unit.
- Turn the Robot Controller on by turning the main power switch to the horizontal position
- Align the probe and click the align probe in the light beam button to correct the probe offset.
- Open a program and configure it to the proper parameters
- Establish a connection between the Handheld and the communications test instrument. Place the Handheld on the stand and adjust it under the phantom.
- Start SAR measurements.

## 3.0 ELECTRIC FIELD PROBE CALIBRATION

### 3.1 Probe Specification

SAR measurements were conducted using the dosimetric probe ET3DV6, designed by Schmid & Partner Engineering AG for the measurement of SAR. The probe is constructed using the thin film technique, with printed resistive lines on ceramic substrates. It has a symmetrical design with triangular core, built-in optical fiber for the surface detection system and built-in shielding against static discharge. The probe is sensitive to E-fields and thus incorporates three small dipoles arranged so that the overall response is close to isotropic. The table below summarizes the technical data for the probe.



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Property	Data
Frequency range	30 MHz – 3 GHz
Linearity	<b>±0.1 dB</b>
Directivity (rotation around probe axis)	<b>= ±0.2 dB</b>
Directivity (rotation normal to probe axis)	<b>±0.4 dB</b>
Dynamic Range	5 mW/kg – 100 W/kg
Probe positioning repeatability	<b>±0.2 mm</b>
Spatial resolution	< 0.125 mm <sup>3</sup>

**Table 4. Probe specification**

### 3.2 Probe calibration and measurement errors

The probe was calibrated on 26/11/2001 with an accuracy better than **±10%**. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe were tested. The probe calibration parameters are shown on Appendix D.

## 4.0 SAR MEASUREMENT SYSTEM VERIFICATION

Prior to conducting SAR evaluation, the measurements were validated using the dipole validation kit and a flat phantom. A power level of 1.0 W was applied to the dipole antenna. The verification results are in the table below with a comparison to reference values. Printouts are shown in Appendix A. All the measured parameters are satisfactory.

### 4.1 System accuracy verification for head adjacent use

f (MHz)	Limits / Measured	SAR (W/kg) 1 g/ 10 g	Dielectric Parameters		Liquid Temp (°C)
			$\epsilon_r$	$\sigma$ [S/m]	
835	Measured	11.5 / 7.2	42.6	0.94	21.7
	Recommended Limits	10.7 / 6.8	42.3	0.91	N/A

**Table 5. System accuracy (validation for head adjacent use)**



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#### 4.2 System accuracy verification for hand and body-worn use

f (MHz)	Limits / Measured	SAR (W/kg) 1 g/ 10g	Dielectric Parameters		Liquid Temp (°C)
			$\epsilon_r$	$\sigma$ [S/m]	
835	Measured	11.5 / 7.2	40.5	0.91	20.8
	Recommended Limits	10.7 / 6.8	42.3	0.91	N/A

Table 6. System accuracy (validation for hand and body-worn use)

#### 5.0 PHANTOM DESCRIPTION

The Generic Twin Phantom, manufactured by SPEAG, was used during the SAR measurements. The phantom is made of a fiberglass shell integrated with a wooden table.

The generic twin phantom is a fiberglass shell phantom with 2 mm shell thickness. It has three measurement areas:

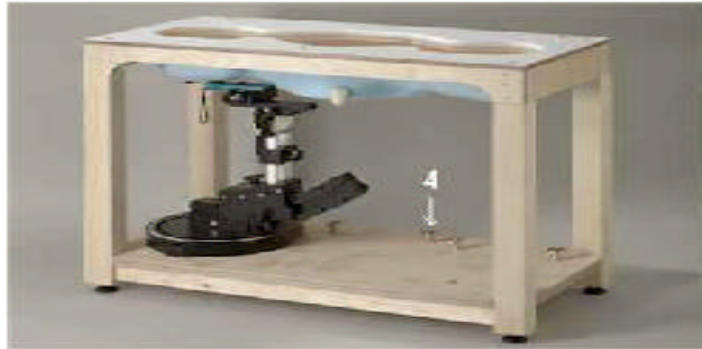
- Left hand
- Right hand
- Flat phantom

The phantom table dimensions are: 100x50x85 cm (LxWxH). The table is intended for use with free standing robots.

The bottom shelf contains three pair of bolts for locking the device holder in place. The device holder positions are adjusted to the standard measurement positions in the three sections. Only one device holder is necessary if two phantoms are used (e.g., for different solutions).

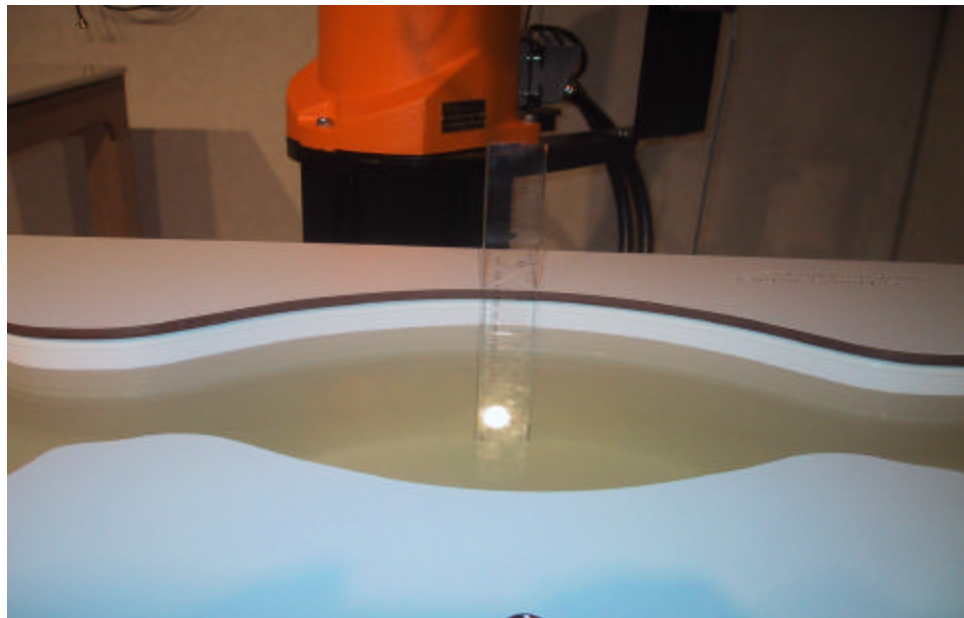
A white cover is provided to top the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on the cover are possible; however the optical surface detector does not work properly at the cover surface. Place a sheet of white paper on the cover when using optical surface detection.

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**Figure 4**  
**Generic Twin Phantom**

Liquid depth is about 18 cm as shown in the photo below according to SPEAG's recommendation to fill up the phantom about 1 inch lower than the top surface.



**Figure 5**  
**Generic Twin Phantom filled with liquid for testing**



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## 6.0 TISSUE DIELECTRIC PROPERTY

### 6.1 Composition of tissue simulant

The composition of the brain and muscle simulating liquids for 800-900 MHz and 1800-1900 MHz are shown in the table below.

INGREDIENT	MIXTURE – 800-900 MHz		MIXTURE – 1800-1900 MHz	
	Brain %	Muscle %	Brain %	Muscle %
Water	51.07	65.45	54.88	69.91
Sugar	47.31	34.31	0	0
Salt	1.15	0.62	0.21	0.13
HEC	0.23	0	0	0
Bactericide	0.24	0.10	0	0
DGBE	0	0	44.91	29.96

Table 7. Tissue simulant recipe

#### 6.1.1 Equipment

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
Pyrex, England	Graduated Cylinder	N/A	N/A	N/A
Pyrex, USA	Beaker	N/A	N/A	N/A
Acculab	Weight Scale	V1-1200	018WB2003	N/A
Hart Scientific	Digital Thermometer	61161-302	21352860	10/09/2003
IKA Works Inc.	Hot Plate	RC Basic	3.107433	N/A

Table 8. Tissue simulant preparation equipment

#### 6.1.2 Preparation procedure

##### 800-900 MHz liquids

- Fill the container with **water**. Begin heating and stirring.
- Add the **Cellulose**, the **preservative substance** and the **salt**. After several hours, the liquid will become more transparent again. The container must be covered to prevent evaporation.
- Add **Sugar**. Stir it well until the sugar is sufficiently dissolved.
- Keep the liquid hot but below the boiling point for at least an hour. The container must be covered to prevent evaporation.

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- Remove the container from, and turn the hotplate off and allow the liquid to cool off to room temperature prior to performing dielectric measurements.

### 1800-1900 MHz liquid

- Fill the container with **water**. Begin heating and stirring.
- Add the **salt** and **Glycol**. The container must be covered to prevent evaporation.
- Keep the liquid hot but below the boiling point for at least an hour. The container must be covered to prevent evaporation.
- Remove the container from, and turn the hotplate off and allow the liquid to cool off to room temperature prior to performing dielectric measurements.

## 6.2 Electrical parameters of the tissue simulating liquid

The tissue dielectric parameters shall be measured before a batch can be used for SAR measurements to ensure that the simulated tissue was properly made and will simulate the desired human characteristics. Limits and measured electrical parameters are show in the table below.

Recommended limits are adopted from IEEE Std 1528-200X, Draft 6.3 – April8, 2001

“ Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Environmental Techniques”

and from FCC Tissue Dielectric Properties web page at <http://www.fcc.gov/fcc-bin/dielec.sh>

f (MHz)	Tissue Type	Limits / Measured	Dielectric Parameters		Liquid Temp (°C)
			$\epsilon_r$	$\sigma$ [S/m]	
835	Head	Measured	42.6	0.94	21.8
		Recommended Limits	41.5	0.90	N/A
	Muscle	Measured	56.5	0.99	20.8
		Recommended Limits	56.1	0.95	N/A

**Table 9. Electrical parameters of tissue simulating liquid**

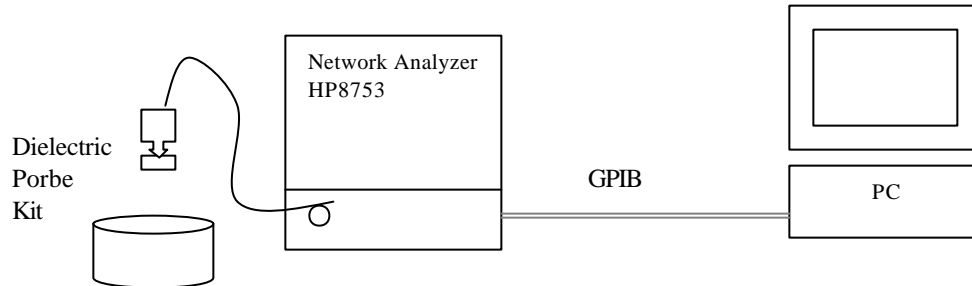
### 6.2.1 Equipment

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
Agilent Technologies	Network Analyzer	8753ES	US39174857	21/03/2003
Agilent Technologies	Dielectric probe kit	HP 85070C	US9936135	CNR
Dell	PC using GPIB card	GX110	347	N/A
Hart Scientific	Digital Thermometer	61161-302	21352860	10/09/2003

**Table 10. Equipment required for electrical parameter measurements**

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### Test Configuration



**Figure 6: Test configuration**

#### 6.2.3 Procedure

1. Turn NWA on and allow at least 30 minutes for warm up.
2. Mount dielectric probe kit so that interconnecting cable to NWA will not be moved during measurements or calibration.
3. Pour de-ionized water and measure water temperature ( $\pm 1^\circ$ ).
4. Set water temperature in HP-Software (Calibration Setup).
5. Perform calibration.
6. Validate calibration with dielectric material of known properties (e.g. polished ceramic slab with  $>8\text{mm}$  thickness  $\epsilon' = 10.0$ ,  $\epsilon'' = 0.0$ ). If measured parameters do not fit within tolerance, repeat calibration ( $\pm 0.2$  for  $\epsilon'$ :  $\pm 0.1$  for  $\epsilon''$ ).
7. Relative permittivity  $\epsilon_r = \epsilon'$  and conductivity can be calculated from  $\epsilon''$   

$$\sigma = \omega \epsilon_0 \epsilon''$$
8. Measure liquid shortly after calibration.
9. Stir the liquid to be measured. Take a sample ( $\sim 50\text{ml}$ ) with a syringe from the center of the liquid container.
10. Pour the liquid into a small glass flask. Hold the syringe at the bottom of the flask to avoid air bubbles.
11. Put the dielectric probe in the glass flask. Check that there are no air bubbles in front of the opening in the dielectric probe kit.
12. Perform measurements.
13. Adjust medium parameters in DASY3 for the frequencies necessary for the measurements ('Setup Config', select medium (e.g. Brain 900 MHz) and press 'Option'-button.
14. Select the current medium for the frequency of the validation (e.g. Setup Medium Brain 900 MHz).

Sample calculation for 835 MHz head tissue dielectric parameters using data from Table 11.

Relative permittivity  $\epsilon_r = \epsilon' = 42.60$

Conductivity  $\sigma = \omega \epsilon_0 \epsilon'' = 2 \times 3.1416 \times 835 \text{ e}+6 \times 8.854\text{e}-12 \times 20.2394 = 0.9402 \text{ S/m}$



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 August 12, 2002 09:33 AM

**Title**  
**SubTitle**  
 August 12, 2002 09:47 AM

Frequency	e'	e''
800.000000 MHz	42.0019	20.3645
805.000000 MHz	42.9381	20.3391
810.000000 MHz	42.8718	20.3203
815.000000 MHz	42.8063	20.2635
820.000000 MHz	42.7539	20.2847
825.000000 MHz	42.6977	20.2532
830.000000 MHz	42.6617	20.2321
835.000000 MHz	42.6030	20.2394
840.000000 MHz	42.5141	20.2134
845.000000 MHz	42.4584	20.1885
850.000000 MHz	42.4510	20.1808
855.000000 MHz	42.3807	20.1714
860.000000 MHz	42.2962	20.1458
865.000000 MHz	42.2377	20.1334
870.000000 MHz	42.1519	20.1298
875.000000 MHz	42.1077	20.1239
880.000000 MHz	42.0771	20.0934
885.000000 MHz	42.0038	20.0868
890.000000 MHz	41.9376	20.0833
895.000000 MHz	41.9166	20.0758
900.000000 MHz	41.8510	20.0524
905.000000 MHz	41.8148	20.0401
910.000000 MHz	41.7238	20.0255
915.000000 MHz	41.7028	20.0087
920.000000 MHz	41.6332	19.9930

Frequency	e'	e''
800.000000 MHz	40.6671	19.6220
805.000000 MHz	40.6246	19.6010
810.000000 MHz	40.6063	19.6277
815.000000 MHz	40.6059	19.6386
820.000000 MHz	40.5636	19.6498
825.000000 MHz	40.5518	19.6527
830.000000 MHz	40.5141	19.6361
835.000000 MHz	40.4559	19.6569
840.000000 MHz	40.3854	19.6287
845.000000 MHz	40.3229	19.5883
850.000000 MHz	40.2693	19.5771
855.000000 MHz	40.1529	19.5218
860.000000 MHz	40.0506	19.4942
865.000000 MHz	39.9738	19.4806
870.000000 MHz	39.8521	19.4291
875.000000 MHz	39.7584	19.4011
880.000000 MHz	39.6592	19.3852
885.000000 MHz	39.5798	19.3642
890.000000 MHz	39.5061	19.3422
895.000000 MHz	39.4479	19.3360
900.000000 MHz	39.3716	19.3154
905.000000 MHz	39.3223	19.3170
910.000000 MHz	39.2809	19.3263
915.000000 MHz	39.2525	19.3610
920.000000 MHz	39.2305	19.3646

Frequency	e'	e''
800.000000 MHz	56.5999	21.4197
805.000000 MHz	56.6112	21.4199
810.000000 MHz	56.5787	21.4075
815.000000 MHz	56.5620	21.3438
820.000000 MHz	56.5789	21.3525
825.000000 MHz	56.5548	21.3257
830.000000 MHz	56.5572	21.2776
835.000000 MHz	56.5263	21.2870
840.000000 MHz	56.4718	21.2609
845.000000 MHz	56.4509	21.2332
850.000000 MHz	56.4058	21.2260
855.000000 MHz	56.3411	21.1937
860.000000 MHz	56.2501	21.1886
865.000000 MHz	56.1924	21.1816
870.000000 MHz	56.0770	21.1490
875.000000 MHz	56.0209	21.1259
880.000000 MHz	55.9472	21.1101
885.000000 MHz	55.8951	21.1180
890.000000 MHz	55.8431	21.1101
895.000000 MHz	55.7802	21.0855
900.000000 MHz	55.7464	21.0652
905.000000 MHz	55.7000	21.0503
910.000000 MHz	55.6675	21.0665
915.000000 MHz	55.6655	21.0281
920.000000 MHz	55.6179	21.0037

Table 11. 835 MHz head and muscle tissue dielectric parameters





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## 7.0 SAR SAFETY LIMITS

Standards/Guideline	Localized SAR Limit (W/kg) General public (uncontrolled)	Localized SAR Limits (W/kg) Workers (controlled)
ICNIRP (1998) Standard	2.0 (10g)	10.0 (10g)
IEEE C95.1 (1999) Standard	1.6 (1g)	8.0 (1g)

**Table 12. SAR safety limits for Controlled / Uncontrolled environment**

Human Exposure	Localized SAR Limits (W/kg) 10g, ICNIRP (1998) Standard	Localized SAR Limits (W/kg) 1g, IEEE C95.1 (1999) Standard
Spatial Average (averaged over the whole body)	0.08	0.08
Spatial Peak (averaged over any "x" g of tissue)	2.00	1.60
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.00	4.00

**Table 13. SAR safety limits**

**Uncontrolled Environments** are defined as locations where there is exposure of individuals who have no knowledge or control of their exposure.

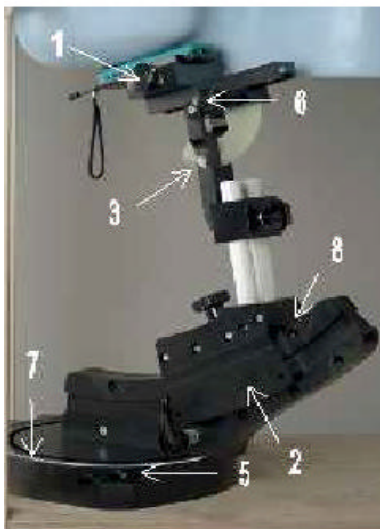
**Controlled Environments** are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

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## 8.0 DEVICE POSITIONING

### 8.1 Device holder for generic twin phantom

The Handheld was positioned for all test configurations using the DASY3 holder. The device holder facilitates the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. The devices can be easily, accurately and with repeatability positioned according to FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).



**Figure 7**  
**Device Holder**

1. Put the phone in the clamp mechanism (1) and hold it straight while tightening. (Curved phones or phones with asymmetrical ear pieces should be positioned so that the ear piece is in the symmetry plane of the clamp).
2. Adjust the sliding carriage (2) to 90°. Then adjust the phone holder angle (3) until the reference line of the phone is horizontal (parallel to the flat phantom bottom). The phone reference line is defined as the front tangential line between the ear piece and the center of the device bottom (or the center of the flip hinge). For devices with parallel front and back sides, the phone holder angle (3) is 0°.
3. Place the device holder at the desired phantom section and move it securely against the positioning pins (4). The screw in front of the turning plate can be applied for correct positioning (5). (Do not tighten it too strongly).
4. Shift the phone clamp (6) so that the ear piece is exactly below the ear marking of the phantom. The phone is now correctly positioned in the holder for all standard phantom measurements, even after changing the phantom or phantom section.

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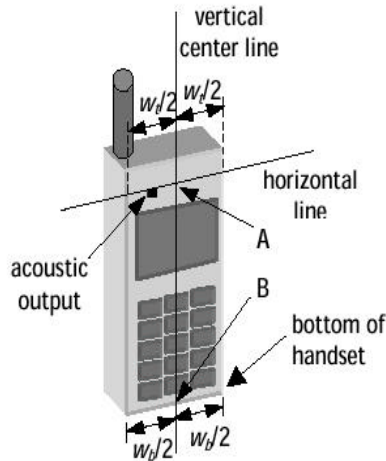
5. Adjust the device position angles to the desired measurement position.
6. After fixing the device angles, move the phone fixture up until the phone touches the ear marking. (The point of contact depends on the design of the device and the positioning angle).

## 8.2 Description of the test positioning

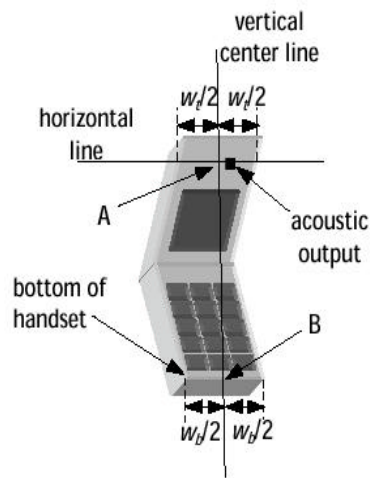
### 8.2.1 Test Positions of Device Relative to Head

The handset was tested in two test positions against the head phantom, the “cheek” position and the “tilted” position, on both left and right sides of the phantom.

The handset was tested in the above positions according to IEEE 1528-Draft 6.1 “Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”.



**Figure 8a – Handset vertical and horizontal reference lines – fixed case**

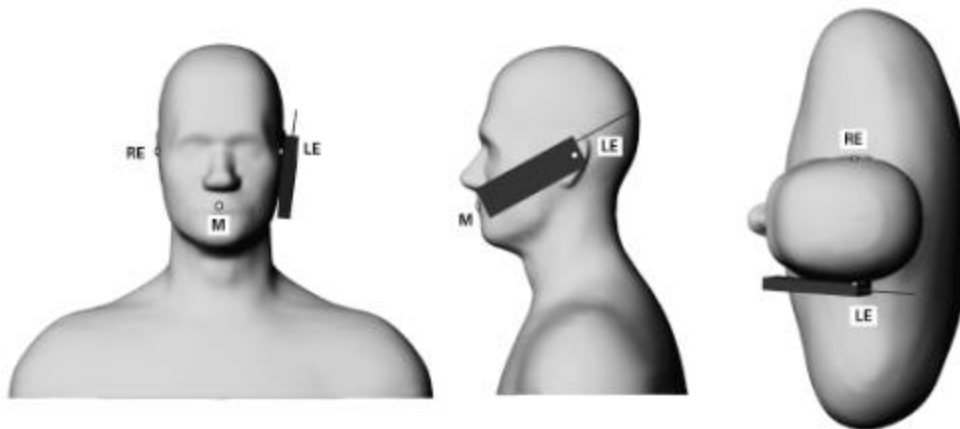


**Figure 8b – Handset vertical and horizontal reference lines – “clam-shell”**

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### 8.2.1.1 Definition of the “cheek” position

- 1) Ready the handset for talk operation, if necessary. For example, for handsets with a cover piece, open the cover.
- 2) 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  $w_t$  of the handset at the level of the acoustic output (point A on Figures 8a and 8b), and the midpoint of the width  $w_b$  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 8a). 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 8b), especially for clamshell handsets, handsets with flip pieces, and other irregularly shaped handsets.
- 3) 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 8), such that the plane defined by the vertical center line and the horizontal center line is in a plane approximately parallel to the sagittal plane of the phantom.
- 4) Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear.
- 5) While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is the plane normal to MB (“mouth-back”) - NF (“neck-front”) including the line MB (reference plane).
- 6) Rotate the phone around the vertical centerline until the phone (horizontal line) is symmetrical with respect to the line NF.
- 7) While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the ear (cheek).

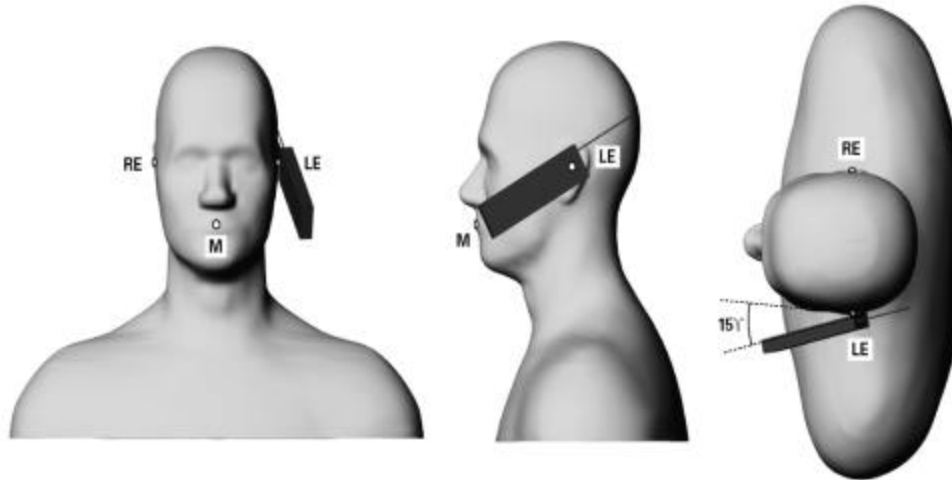


**Figure 9 – Phone position 1, “cheek” or “touch” position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.**

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### 8.2.1.2 Definition of the “Tilted” Position

- 1) Repeat steps 1 to 7 of 5.4.1 (in this report 8.2.1.1) to replace the device in the “cheek position.”
- 2) While maintaining the device in the reference plane (described above) and pivoting against the ear, move the device outward away from the mouth by an angle of 15 degrees, or until the antenna touches the phantom.



**Figure 10 – Phone position 2, “tilted position.” The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.**

### 8.2.2 Body Holster Configuration

A body worn holster, as shown on Figure 2, was tested with the Wireless Handheld for FCC RF exposure compliance. The EUT was positioned in the holster case and the belt clip was placed against the flat section of the phantom. A headset was then connected to the handheld to simulate hands-free operation in a body worn holster configuration.



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## 8.0 High Level Evaluation

### 9.1 Maximum search

The maximum search is automatically performed after each coarse scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacing. After the coarse scan measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations.

### 9.2 Extrapolation

The extrapolation can be used in z-axis scans with automatic surface detection. The SAR values can be extrapolated to the inner phantom surface. The extrapolation distance is the sum of the probe sensor offset, the surface detection distance and the grid offset. The extrapolation is based on fourth order polynomial functions. The extrapolation is only available for SAR values.

### 9.3 Boundary correction

The correction of the probe boundary effect in the vicinity of the phantom surface is done in the standard (worst case) evaluation; the boundary effect is reduced by different weights for the lowest measured points in the extrapolation routine. The result is a slight overestimation of the extrapolated SAR values (2% to 8%) depending on the SAR distribution and gradient. The advanced evaluation makes a full compensation of the boundary effect before doing the extrapolation. This is only possible for probes with specifications on the boundary effect.

### 9.4 Peak search for 1g and 10g cube averaged SAR

The 1g and 10g peak evaluations are only available for the predefined cube 5x5x7 scan. The routines are verified and optimized for the grid dimensions used in these cube measurements. The measure volume of 32x32x35mm mm contains about 35g of tissue. The first procedure is an extrapolation (incl. Boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation to get all points within the measured volume in a 1mm grid (35000 points). In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is then moved around until the highest averaged SAR is found. This last procedure is repeated for a 10 g cube. If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

## 10.0 MEASUREMENT UNCERTAINTIES

Uncertainty Component	Tolerance (± %)	Probability Distribution	Sensitivity coefficient (1-g)	Sensitivity coefficient (10-g)	1-g Standard Uncertainty (±%)	10-g Standard Uncertainty (±%)
<b>Measurement System</b>						
Probe Calibration ( $k=1$ )	4.8	Normal	1	1	4.8	4.8
Axial Isotropy	4.7	Rectangle	0.7	0.7	1.9	1.9
Hemispherical Isotropy	9.6	Rectangle	0.7	0.7	3.9	3.9
Boundary Effect	11.0	Rectangle	1	1	6.4	6.4
Linearity	4.7	Rectangle	1	1	2.7	2.7
System Detection Limits	1.0	Rectangle	1	1	0.6	0.6
Readout Electronics	1.0	Normal	1	1	1.0	1.0
Response Time	0.8	Rectangle	1	1	0.5	0.5
Integration Time	1.8	Rectangle	1	1	1.1	1.1
RF Ambient Conditions	3.0	Rectangle	1	1	1.7	1.7
Probe Positioner Mechanical Tolerance	0.4	Rectangle	1	1	0.2	0.2
Probe Positioning with respect to Phantom Shell	2.9	Rectangle	1	1	1.7	1.7
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	3.9	Rectangle	1	1	2.3	2.3
<b>Test sample Related</b>						
Test Sample Positioning		Normal	1	1	6.7	6.7
Device Holder Uncertainty		Normal	1	1	5.9	5.9
Output Power Variation - SAR drift measurement	5	Rectangle	1	1	2.9	2.9
<b>Phantom and Tissue Parameters</b>						
Phantom Uncertainty (shape and thickness tolerances)	4.0	Rectangle	1	1	2.3	2.3
Liquid Conductivity - deviation from target values	5.0	Rectangle	0.7	0.5	2.0	1.4
Liquid Conductivity - measurement uncertainty	10.0	Rectangle	0.7	0.5	4.0	2.9
Liquid Permittivity - deviation from target values	5.0	Rectangle	0.6	0.5	1.7	1.4
Liquid Permittivity - measurement uncertainty	5.0	Rectangle	0.6	0.5	1.7	1.4
<b>Combined Standard Uncertainty</b>		RSS			14.9	14.5
<b>Expanded Uncertainty (95% CONFIDENCE LEVEL)</b>					29.8	29.0

Table 14. Measurement uncertainty



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## 11.0 TEST RESULTS

### 11.1 SAR Measurement results at highest power measured against the head

Mode	f (MHz)	Conducted pulse average power (dBm)	Antenna Configuration	SAR, averaged over 1 g (W/Kg)			SAR, averaged over 1 g (W/Kg)		
				Left-hand			Right-hand		
				Chamber Temp (C) °	Cheek	Tilted	Chamber Temp (C) °	Cheek	Tilted
TDMA	806.0125	28.35	retracted	21.7	0.76	0.84	22.1	0.90	0.98
	806.0125	28.35	extended	21.7	0.51	0.59	22.2	-	-
	815.5000	28.35	retracted	22.0	0.75	0.82	22.2	0.91	<b>1.03</b>
	815.5000	28.35	extended	22.0	-	-	22.2	0.70	0.76
	824.9880	28.45	retracted	22.1	0.73	0.76	22.2	0.85	0.93
	824.9880	28.45	extended	22.2	-	-	22.2	-	-

Table 15. SAR results for head configuration

### 11.2 SAR Measurement results at highest power measured against the body using Holster

Mode	f (MHz)	Conducted pulse average power (dBm)	Antenna Configuration	Chamber Temp. (C) °	SAR, averaged over 1 g (W/kg)	SAR, averaged over 1 g with headset (W/kg)
TDMA	806.0125	28.35	Retracted	22.7	<b>0.53</b>	0.52
	806.0125	28.35	Extended	22.7	0.46	-
	815.5000	28.35	Retracted	22.8	0.51	-
	815.5000	28.35	Extended	22.8	0.44	-
	824.9880	28.45	Retracted	22.8	0.49	-
	824.9880	28.45	Extended	22.7	-	-

Table 16. SAR results with holster for body configuration





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**1.3 SAR Measurement results at highest power measured for hand.**

Mode	f (MHz)	Conducted pulse average power (dBm)	Device Configuration Touching Phantom	Antenna Configuration	Chamber Temp. (C) °	SAR, averaged over 10 g (W/kg)	SAR, averaged over 10 g with the headset (W/kg)
	806.0125	28.35	Back side	retracted	22.9	<b>0.87</b>	0.81
	815.5000	28.35	Back side	retracted	23.0	0.61	-
	824.9880	28.45	Back side	retracted	23.0	0.53	-

**Table 17. SAR results for hand configuration**



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## 12.0 REFERENCES

[1] EN 50360: 2001, Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields (300 MHz – 3 GHz)

[2] EN 50361: 2001, Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz – 3 GHz)

[3] ICNIRP, International Commission on Non-Ionizing Radiation Protection (1998), Guidelines for limiting exposure in time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz).

[4] Council Recommendation 1999/519/EC of July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)

[5] IEEE C95.3-1991, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.

[6] IEEE C95.1-1999, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[7] OET Bulletin 65 (Edition 97-01) Supplement C (Edition 01-01), Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

[8] FCC 96-326, Guidelines for Evaluating the Environmental Effects of Radio-Frequency Radiation.

[9] DASY 3 DOSIMETRIC ASSESSMENT SYSTEM SOFTWARE MANUAL  
Schmid & Partner Engineering AG, August 99.