SAR Compliance Test Report

Testing Lab:
Research In Motion Limited
305 Phillip Street
Waterloo, Ontario
Canada N2L 3W8
Phone: 519-888-7465
Fax: 519-880-8173
Web site: www.rim.net

Applicant:
Research In Motion Limited
295 Phillip Street
Waterloo, Ontario
Canada N2L 3W8
Phone: 519-888-7465
Fax: 519-888-6906
Web site: www.rim.net

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 approved accessories 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	Paul G Cardinal	03 Oct., 2003
Tested and documented by: Daoud Attayi Compliance Specialist	Daoud Attayi	Sep. 30, 2003

CONTENTS

1.0 OPERATING CONFIGURATIONS AND TEST CONDITIONS

1.1 Picture of Handheld

Figure 1. BlackBerry Wireless Handheld

1.2 Antenna description

Type	Internal fixed antenna
Location	Left Side
Configuration	Internal fixed antenna

Table 1. Antenna description

1.3 Handheld description

Handheld Model	R6030GN		
FCC ID	L6AR6030GN		
Serial Number	205NA-303X6		
Prototype or Production Unit	Pre-production		
Mode(s) of Operation	GSM 850	DCS 1800	PCS 1900
Maximum conducted RF Output Power	32.00 dBm	30.00 dBm	31.00 dBm
Tolerance in Power Setting	31.7 ± 0.3 dB	29.7 ± 0.3 dB	30.7 ± 0.3 dB
Duty Cycle	1:8	1:8	1:8
Transmitting Frequency Range (s)	824.20-948.80 MHz	1710.20-1784.80 MHz	1850.20-1909.80 MHz

Table 2. Test device description

Note: DCS 1800 band cannot be used in North America, therefore there is no SAR results presented in this report for FCC submission. A separate report is generated for this band.

1.4 Body worn accessories

Holsters and Folding Leather Case

The holsters, with integral belt-clip, is designed to allow the BlackBerry 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. Photo to the right shows that the device with keyboard away from the user does not fit into the holster.

Figure 2. Top photo shows Body-Worn Plastic Holster ASY-03991-001, Leather Swivel Hoslter HDW-04890-001 and Folding Leather Case HDW-04889-001

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

1.5 Headsets

The RIM Blackberry Wireless handheld was tested with and without headset model number HDW-03458-001. The SAR values are shown in Table 15.

1.6 Procedure used to establish the test signal

The Handheld was put into test mode for the SAR measurements by enabling a call via a Rohde & Schwartz CMU 200 Base Station Simulator test instrument. A SIM card was placed in the Handheld to enable the interaction between the BSS communications test instrument and the Handheld. The CMU 200 communications test instrument then sent out a command for the Handheld to transmit at full power at the specified frequency.

2.0 DESCRIPTION OF THE TEST EQUIPMENT

2.1 SAR measurement system

SAR measurements were performed using a Dosimetric Assessment System (DASY4), an automated SAR measurement system manufactured by Schmid & Partner Engineering AG (SPEAG), of Zurich, Switzerland.

The DASY4 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.
· DASY4 software version 3.1C.
· 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 (see Application Note).
· System validation dipoles allowing for the validation of proper functioning of the system.

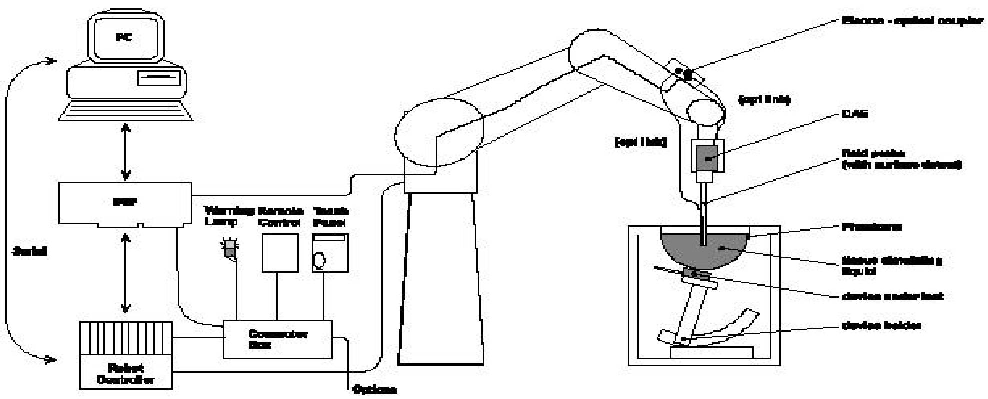

Figure 3: System Description

2.1.1 Equipment List

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
SCHMID & Partner Engineering AG	E-field probe	ET3DV6	1644	21/10/2003
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE3)	DAE3 V1	472	19/08/2004
SCHMID & Partner Engineering AG	Dipole Validation Kit	D835V2	446	21/08/2005
SCHMID & Partner Engineering AG	Dipole Validation Kit	D1900V2	545	22/08/2005
Agilent Technologies	Signal generator	HP 8648C	4037U03155	01/08/2005
Agilent Technologies	Power meter	E4419B	GB40202821	31/07/2004
Agilent Technologies	Power sensor	8482A	US37295126	07/08/2004
Amplifier Research	Amplifier	5S1G4M3	300986	CNR
Agilent Technologies	Network analyzer	8753ES	US39174857	31/07/2004
Rohde & Schwarz	Digital communication tester	CMU 200	100250	03/04/2004

Table 3. Equipment list

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

- Insert SIM card into the Handheld's SIM card slot and power it up.
- Turn on the CMU 200 test set and set the carrier frequency and power to the appropriate values.
- Connect an antenna to the RF IN/OUT of the communication test set and place it close to the Handheld.

2.2.2 DASY setup

- Turn the computer on and log on to Windows NT.
- Start DASY4 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.

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

Table 4. Probe specification

3.2 Probe calibration and measurement errors

The probe was calibrated on 21/10/2002 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)
			ε_r	σ [S/m]	
835	Measured	10.0 / 6.5	41.3	0.89	22.2
	Recommended Limits	9.6 / 6.2	43.3	0.91	N/A
1900	Measured	40.9 / 21.2	39.9	1.46	23.2
	Recommended Limits	41.2 / 21.3	40.2	1.46	N/A

Table 5. System accuracy (Validation for Head Adjacent use)

5.0 PHANTOM DESCRIPTION

The SAM 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 SAM 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.

Liquid depth of = 15 cm is maintained in the phantom for all the measurement.

Figure 4
SAM Twin Phantom

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 800–900MHz		MIXTURE 1800–1900MHz	
	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 6. 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	15/09/2005
IKA Works Inc.	Hot Plate	RC Basic	3.107433	N/A

Table 7. 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.
- 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 characteristic. Limits and measured electrical parameters are show in the table below.
Recommended limits are adopted from IEEE P1528/D1.2, April 21, 2003: " Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", SPEAG dipole calibration certificates 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)
			ε_r	σ [S/m]	
835	Head	Measured	41.3	0.89	22.2
		Recommended Limits	43.3	0.91	N/A
	Muscle	Measured	53.1	0.97	22.0
		Recommended Limits	55.2	0.97	N/A
1900	Head	Measured	39.9	1.46	23.2
		Recommended Limits	40.2	1.46	N/A
	Muscle	Measured	51.0	1.53	22.0
		Recommended Limits	53.3	1.52	N/A

Table 8. 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	31/07/2004
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	15/09/2005

Table 9. Equipment required for electrical parameter measurements

6.2.2 Test Configuration

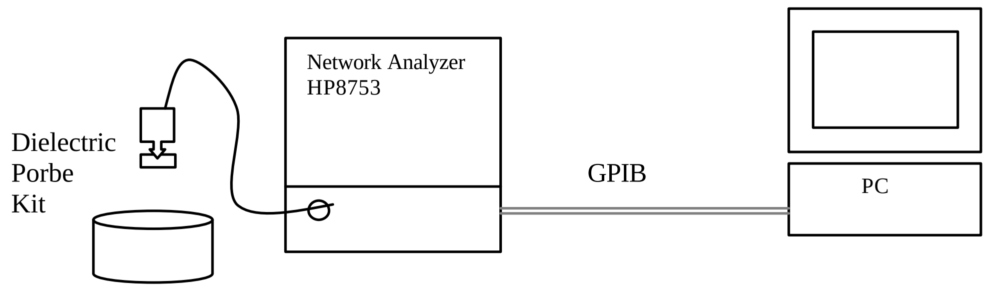

Figure 5: Test configuration

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 (±1°).
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 >8mm thickness ε'=10.0, ε''=0.0). If measured parameters do not fit within tolerance, repeat calibration (±0.2 for ε': ±0.1 for ε'').
7. Relative permittivity $\varepsilon r = \varepsilon'$ and conductivity can be calculated from ε''
   $\sigma = \omega \varepsilon_0 \varepsilon''$
8. Measure liquid shortly after calibration.
9. Stir the liquid to be measured. Take a sample (~50ml) 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 DASY4 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 10.

Relative permittivity $\varepsilon r = \varepsilon'$ = 41.29

Conductivity $\sigma = \omega \varepsilon_0 \varepsilon''$ = 2 x 3.1416 x 835 e+6 x 8.854e-12 x 19.214 = 0.89 S/m

Title

SubTitle

September 29, 2003 09:51 AM

Frequency	e'	e"
800.000000 MHz	41.6859	19.2809
801.000000 MHz	41.6622	19.2816
802.000000 MHz	41.6487	19.2797
803.000000 MHz	41.6609	19.2924
804.000000 MHz	41.6283	19.2794
805.000000 MHz	41.6424	19.2591
806.000000 MHz	41.6258	19.2851
807.000000 MHz	41.5993	19.2542
808.000000 MHz	41.5951	19.2660
809.000000 MHz	41.5819	19.2640
810.000000 MHz	41.5692	19.2834
811.000000 MHz	41.5602	19.2372
812.000000 MHz	41.5325	19.2607
813.000000 MHz	41.5245	19.2574
814.000000 MHz	41.4983	19.2268
815.000000 MHz	41.5284	19.2452
816.000000 MHz	41.4911	19.2713
817.000000 MHz	41.4768	19.2643
818.000000 MHz	41.5087	19.2501
819.000000 MHz	41.4819	19.2359
820.000000 MHz	41.4768	19.2425
821.000000 MHz	41.4234	19.2090
822.000000 MHz	41.4319	19.2065
823.000000 MHz	41.4121	19.2172
824.000000 MHz	41.4148	19.2322
825.000000 MHz	41.4121	19.2275
826.000000 MHz	41.3924	19.2381
827.000000 MHz	41.3691	19.1967
828.000000 MHz	41.3719	19.2116
829.000000 MHz	41.3497	19.2124
830.000000 MHz	41.3569	19.2049
831.000000 MHz	41.3446	19.2030
832.000000 MHz	41.3127	19.2064
833.000000 MHz	41.3243	19.1767
834.000000 MHz	41.2953	19.1899
835.000000 MHz	41.2885	19.2074
836.000000 MHz	41.2780	19.1735
837.000000 MHz	41.2643	19.2034
838.000000 MHz	41.2744	19.2057
839.000000 MHz	41.2515	19.1649
840.000000 MHz	41.2062	19.1931
841.000000 MHz	41.2039	19.1884

Title

SubTitle

September 30, 2003 09:58 AM

Frequency	e'	e"
800.000000 MHz	53.5004	20.9868
801.000000 MHz	53.4994	20.9545
802.000000 MHz	53.4718	20.9598
803.000000 MHz	53.4831	20.9629
804.000000 MHz	53.4708	20.9629
805.000000 MHz	53.4618	20.9561
806.000000 MHz	53.4312	20.9681
807.000000 MHz	53.4560	20.9608
808.000000 MHz	53.4370	20.9575
809.000000 MHz	53.3996	20.9495
810.000000 MHz	53.4094	20.9474
811.000000 MHz	53.3997	20.9858
812.000000 MHz	53.3702	20.9358
813.000000 MHz	53.4052	20.9416
814.000000 MHz	53.3728	20.9151
815.000000 MHz	53.3759	20.9098
816.000000 MHz	53.3414	20.9401
817.000000 MHz	53.3404	20.8915
818.000000 MHz	53.3588	20.8975
819.000000 MHz	53.3343	20.9242
820.000000 MHz	53.3136	20.8827
821.000000 MHz	53.3306	20.9002
822.000000 MHz	53.2824	20.8909
823.000000 MHz	53.2913	20.9168
824.000000 MHz	53.2427	20.8744
825.000000 MHz	53.2910	20.8862
826.000000 MHz	53.2530	20.8734
827.000000 MHz	53.2445	20.8500
828.000000 MHz	53.2269	20.8632
829.000000 MHz	53.2416	20.8426
830.000000 MHz	53.2409	20.8718
831.000000 MHz	53.2032	20.8590
832.000000 MHz	53.1816	20.8295
833.000000 MHz	53.1846	20.8683
834.000000 MHz	53.1861	20.8415
835.000000 MHz	53.1530	20.8712
836.000000 MHz	53.1413	20.8383
837.000000 MHz	53.1463	20.8213
838.000000 MHz	53.1390	20.8307
839.000000 MHz	53.0957	20.8313
840.000000 MHz	53.1228	20.7845
841.000000 MHz	53.0936	20.8236

Table 10. 835 MHz head and muscle tissue dielectric parameters

Title

SubTitle

September 23, 2003 04:48 PM

Frequency	e'	e''
1.700000000 GHz	40.5599	13.3717
1.710000000 GHz	40.5165	13.3904
1.720000000 GHz	40.4784	13.3999
1.730000000 GHz	40.4477	13.4144
1.740000000 GHz	40.4283	13.4409
1.750000000 GHz	40.3797	13.4631
1.760000000 GHz	40.3458	13.4765
1.770000000 GHz	40.2974	13.4895
1.780000000 GHz	40.2577	13.5097
1.790000000 GHz	40.2272	13.5429
1.800000000 GHz	40.2113	13.5578
1.810000000 GHz	40.1879	13.5835
1.820000000 GHz	40.1645	13.6121
1.830000000 GHz	40.1417	13.6495
1.840000000 GHz	40.1061	13.6643
1.850000000 GHz	40.0780	13.6988
1.860000000 GHz	40.0453	13.7241
1.870000000 GHz	40.0259	13.7682
1.880000000 GHz	40.0055	13.7947
1.890000000 GHz	39.9621	13.8209
1.900000000 GHz	39.9230	13.8564
1.910000000 GHz	39.8973	13.9014
1.920000000 GHz	39.8670	13.9373
1.930000000 GHz	39.8196	13.9726
1.940000000 GHz	39.7788	13.9976
1.950000000 GHz	39.7375	14.0381
1.960000000 GHz	39.7144	14.0637
1.970000000 GHz	39.6955	14.0984
1.980000000 GHz	39.6527	14.1223
1.990000000 GHz	39.6219	14.1532
2.000000000 GHz	39.5911	14.1783

Title

SubTitle

September 25, 2003 11:04 AM

Frequency	e'	e''
1.700000000 GHz	51.6902	13.7469
1.710000000 GHz	51.6461	13.7782
1.720000000 GHz	51.6090	13.8112
1.730000000 GHz	51.5666	13.8486
1.740000000 GHz	51.5374	13.8684
1.750000000 GHz	51.5229	13.9087
1.760000000 GHz	51.4715	13.9361
1.770000000 GHz	51.4466	13.9848
1.780000000 GHz	51.4267	14.0153
1.790000000 GHz	51.3966	14.0613
1.800000000 GHz	51.3655	14.0906
1.810000000 GHz	51.3477	14.1337
1.820000000 GHz	51.3298	14.1698
1.830000000 GHz	51.2974	14.2076
1.840000000 GHz	51.2513	14.2393
1.850000000 GHz	51.2282	14.2874
1.860000000 GHz	51.1902	14.3199
1.870000000 GHz	51.1410	14.3659
1.880000000 GHz	51.1078	14.3913
1.890000000 GHz	51.0703	14.4137
1.900000000 GHz	51.0203	14.4439
1.910000000 GHz	51.0158	14.4556
1.920000000 GHz	50.9692	14.4659
1.930000000 GHz	50.9223	14.5015
1.940000000 GHz	50.9066	14.5307
1.950000000 GHz	50.8701	14.5542
1.960000000 GHz	50.8414	14.5885
1.970000000 GHz	50.8230	14.6244
1.980000000 GHz	50.7985	14.6554
1.990000000 GHz	50.7584	14.6905
2.000000000 GHz	50.7359	14.7273

Table 11. 1900 MHz head and muscle tissue dielectric parameters

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 (10g)

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).

8.0 DEVICE POSITIONING

8.1 Device holder for SAM Twin Phantom

The Handheld was positioned for all test configurations using the DASY4 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).

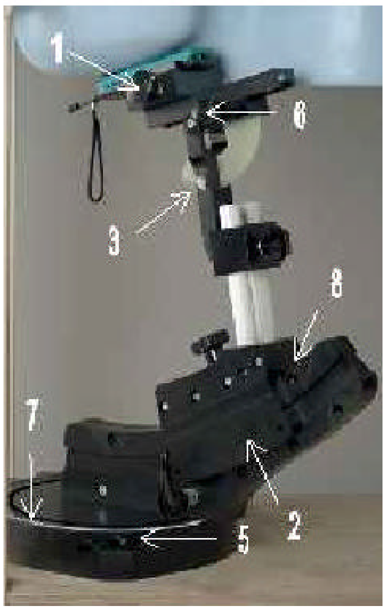

Figure 6
Device Holder

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.

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 P1528/D1.2, April 21, 2003: “Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”.

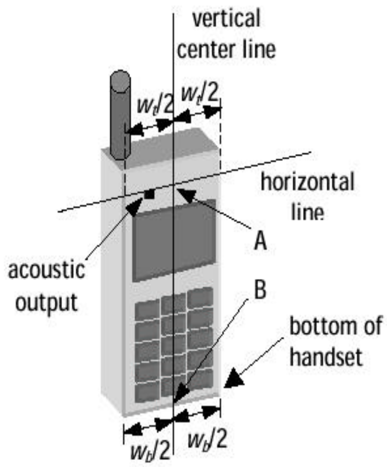

Figure 7a – Handset vertical and horizontal reference lines – fixed case

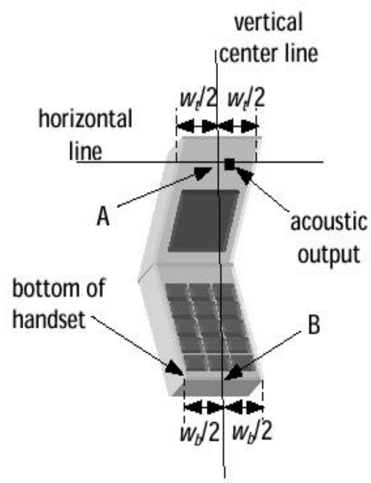

Figure 7b – Handset vertical and horizontal reference lines – “clam-shell”

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 *wt* of the handset at the level of the acoustic output (point A on Figures 7a and 7b), and the midpoint of the width *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 7a). 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 7b), 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 7), 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).

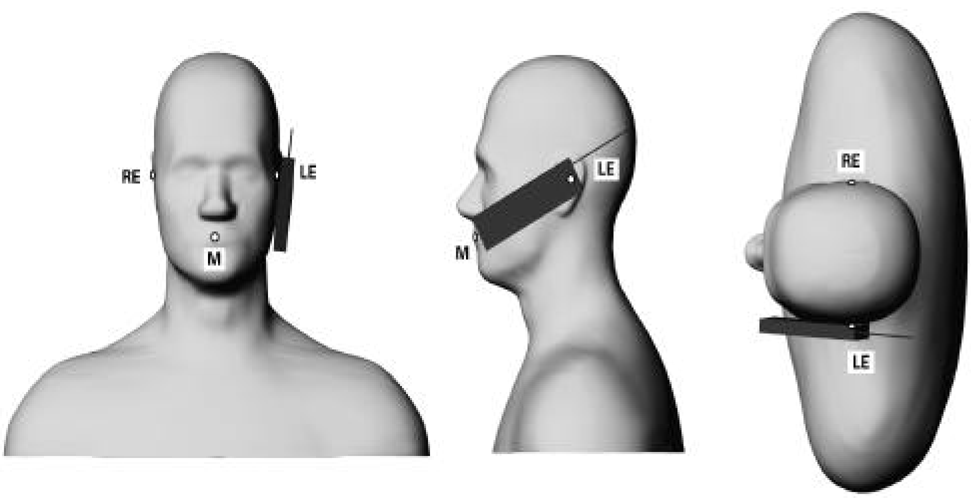

Figure 8 – Phone position 1, "cheek" or "touch" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

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**.**

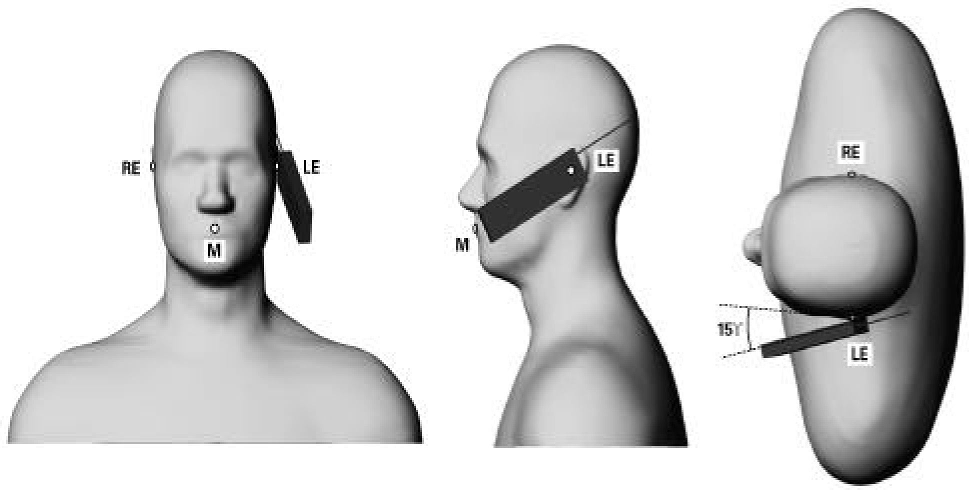

Figure 9 – Phone position 2, "tilted position." The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

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.

9.0 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

DASY4 Uncertainty Budget
According to IEEE P1528 [1]

Error Description	Uncertainty value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) 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	1	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 Conditions	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.4 %	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	±2.9 %	N	1	1	1	±2.9 %	±2.9 %	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 Permittivity (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						±10.3 %	±10.0 %	330
Expanded STD Uncertainty						**±20.6 %**	**±20.1 %**	

Table 14. Measurement uncertainty

11.0 TEST RESULTS

11.1 SAR Measurement results at highest power measured against the head

Mode	f (MHz)	Conducted Output Power (dBm)	SAR, averaged over 1 g (W/Kg) Left-hand			SAR, averaged over 1 g (W/Kg) Right-hand		
			Liquid Temp (°C)	Cheek	Tilted	Liquid Temp (°C)	Cheek	Tilted
GSM 850	824.20	-	-	-	-	-	-	-
	*836.80	32.1	22.2	**0.53**	0.29	22.1	0.38	0.27
	848.80	-	-	-	-	-	-	-
PCS 1900	1850.20	31.3	23.3	1.07	-	22.9	0.71	-
	*1880.00	31.1	23.4	1.25	0.34	22.8	0.78	0.54
	1909.80	31.1	23.4	**1.44**	-	22.8	0.76	-

Table 15. SAR results for head configuration

11.2 SAR measurement results at highest power measured against the body using Holster and Leather Swivel Holster

Mode	f (MHz)	Conducted Output Power (dBm)	Liquid Temp (°C)	SAR, averaged over 1 g (W/kg) Holster	SAR, averaged over 1 g with headset (W/kg) Holster	SAR, averaged over 1 g (W/kg) Leather Swivel Holster	SAR, averaged over 1 g with headset (W/kg) Leather Swivel Holster
GSM 850	824.20	-	-	-	-	-	-
	*836.80	32.1	22.1	**0.35**	0.22	0.32	0.20
	848.80	-	-	-	-	-	-
PCS 1900	1850.20	-	-	-	-	-	-
	*1880.00	31.1	22.0	**0.27**	0.23	0.21	0.21
	1909.80	-	-	-	-	-	-

Table 16. SAR results with Holster and Leather Swivel Holster for body worn configuration

11.3 SAR measurement results at highest power measured against the body using Folding Leather Case for inside a shirt pocket configuration

Mode	f (MHz)	Conducted Output Power (dBm)	Liquid Temp (°C)	Side touching flat phantom	SAR, averaged over 1 g (W/kg)
GSM 850	824.20	-	-	Front	-
	*836.80	32.1	21.9	Front	0.46
	848.80	-	-	Front	-
	824.20	-	-	Back	-
	*836.80	32.1	22.0	Back	**0.66**
	848.80	-	-	Back	-
PCS 1900	1850.20	-	-	Front	-
	*1880.00	31.1	23.2	Front	0.63
	1908.80	-	-	Front	-
	1850.20	31.3	23.1	Back	1.06
	1880.00	31.1	23.2	Back	1.49
	1908.80	31.1	23.0	Back	**1.51**

Table 16. SAR results with Folding Leather Case for inside a shirt pocket configuration

* Supplement C: Middle channel testing is sufficient only if SAR < 3dB below limit see PN 02-1438

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 4 DOSIMETRIC ASSESSMENT SYSTEM SOFTWARE MANUAL V4.1 Schmid & Partner Engineering AG, April 2003.

[10] IEEE P1528/D1.2, April 21, 2003: Recommended Practice for Determining the Peak Spatial-Average Specific Aborption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.