SAR Compliance Test Report

Testing Lab:

RIM Testing Services (RTS)
305 Phillip Street
Waterloo, Ontario
Canada N2L 3W8
Phone: 519-888-7465
Fax: 519-880-8173

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.com

Statement of Compliance: RIM Testing Services 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.

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 OET SAR Measurement Requirements for 3 – 6 GHz, 10-06, FCC 96-326, IEEE Std. C95.1-1999, Health Canada's Safety Code 6, as reproduced in RSS-102 issue 2-2005 and has been tested in accordance with the measurement procedures specified in OET Bulletin 65 Supplement C (Edition 01-01), FCC OET SAR Measurement Procedures for 802.11 a/b/g Transmitters 10-06, ANSI/IEEE Std. C95.3-1991, IEEE 1528-2003, IEC 62209-1-2005, DASY4 manual which follows draft IEC 62209 – Part 2 and Health Canada's Safety Code 6.

Tested and documented by:	**Signatures**	**Date**
Daoud Attayi Senior Compliance Specialist	Daoud Attayi	03-Nov-2006

Reviewed & Approved by:

Paul G. Cardinal, Ph.D. Director	Paul G Cardinal	03-Dec-2006

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1.0 OPERATING CONFIGURATIONS AND TEST CONDITIONS

1.1 Picture of Handheld

Please refer to Appendix E.

Figure 1. BlackBerry Wireless Handheld

1.2 Antenna description

Type	Internal fixed antenna
Location	Back bottom centre
Configuration	Internal fixed antenna

Table 1. Antenna description

1.3 Handheld description

Handheld Model	RBG41GW					
FCC ID	L6ARBG40GW					
PIN	20502F1E ; 20502F1C (LCD1), 20502F1C (LCD2), 2053032F (LCD3)					
Prototype or Production Unit	Production					
Mode(s) of Operation in North America	1-slot GSM850 GSM1900		2-slots GSM 850 GSM 1900	2-slots GPRS 850 GPRS 1900	* Bluetooth	
Maximum nominal conducted RF Output Power	32.3 dBm 30.3 dBm		30.3 dBm 28.3 dBm	30.3 dBm 28.3 dBm	- 0.5 dBm	
Tolerance in Power Setting on centre channel	± 0.50 dB		± 0.50 dB	± 0.50 dB	N/A	
Duty Cycle	1:8		2:8	2:8	N/A	
Tx Frequency Range	824.2 – 848.8 1850.2 – 1909.8		824.2 – 848.8 1850.2 – 1909.8	824.2 – 848.8 1850.2 – 1909.8	2402-2483	
WLAN Mode(s) of Operation in North America	802.11b	802.11g	802.11a (low band)	802.11a (middle band)	802.11a (upper band I	802.11a (upper band II)
Maximum nominal conducted RF Output Power	18.00	17.00	14.50	18.00	18.00	18.00
Tolerance in Power Setting on centre channel	± 0.50 dB		± 0.50 dB	± 0.50 dB	± 0.50 dB	± 0.50 dB
Duty Cycle	1:1		1:1	1:1	1:1	1:1
Tx Frequency Range (MHz)	2412-2484		5180-5240	5260-5320	5500-5700	5749-5805

Table 2. Test device description

The handheld supports GSM/GPRS 900, GSM/GPRS 1800, 802.11a (5500MHz) bands that are not operational in North America, therefore no data is presented in this report.

* Bluetooth application is for hands-free operation with headset only. Therefore, no head SAR testing with BT on is required.

1.4 Body worn accessories (holsters)

The BlackBerry Wireless Handheld has been tested with the following holsters which all contain metal components and the separation distance between the handheld and the user's body is listed in the table below. All of the holsters are designed with the intended handheld orientation being with the LCD facing the belt clip. Proper positioning is vital for protection of the LCD display, and to help maximize the battery life of the handheld. The handheld can also be placed in the holsters with the backside facing the belt clip. Body SAR measurement were carried out with the worst-case configuration front LCD side and back side towards the belt clip.

Holster Type	Model / Part Number	Separation (mm)
Holster 1	HDW-13789-001	21.5
Holster 2	HDW-13143-00x	22.0

Please refer to Appendix E.

Figure 2. Body-worn holsters

1.5 Headsets

The BlackBerry Wireless Handheld was tested with and without the following headset model numbers.

1) HDW-03458-001 (Mono)
2) HDW-12420-001 (Stereo)

1.6 Battery

The BlackBerry Wireless Handheld was tested with the following Lithium Ion Battery.

1) BAT-11005-001

1.7 LCDs

The BlackBerry Wireless Handheld will be sold with either of the following three LCDs with identical design specifications and ratings. One SAR scan on a second sample with LCD 2 showed no significant change in SAR (slight change due to setup), therefore SAR testing is not necessary on all three LCDs.

1) LCD-11059-001 / 004
2) LCD-11059-002 / 004 (Alternate)
3) LCD-11059-003 / 004 (Alternate)

1.8 Procedure used to establish test signal

The Handheld was put into test mode for SAR measurements by placing a voice call from a Rohde & Schwarz CMU 200 Communications Test Instrument. The power control level was set to command the handheld to transmit at full power at the specified frequency. Other parameters include: Channel type = full rate, discontinuous transmission off, frequency hopping off. A Rohde & Schwarz CBT Bluetooth Tester was used to establish a connection with the EUT's Bluetooth radio. Worst case SAR was evaluated with Bluetooth on.

Radioscope software was used to command the Handheld to transmit at specifc 802.11 a/b/g WLAN band, maximum power, desired frequency and modulation type/data rate.

1.9 Highlights of the FCC OET SAR Measurement Requirements for 3-6 GHz and Measurement Procedures for 802.11 a/b/g Transmitter that were followed

• Maintained dielectric parameter uncertainty as close to ± 5.0% of the target value as possible.
• Liquid depth from SAM ERP or flat phantom was kept at 15 cm.
• Probe Requirement: Used SPEAG probe model EX3DV4 for 2.4 – 6 GHz SAR testing specs are outlined below:

Probe tip to sensor center	1.0 mm
Probe tip diameter is	2.5 mm
Probe calibration uncertainty	< 15 % for f = 2.45 to < 6.0 GHz
Probe calibration range	± 100 MHz

• Area scan resolution 10mm
• System accuracy validation was conducted within ± 100 MHz of device mid-band frequency and results were within ± 10 % of the manufacturers target value for each band except, 802.11a upper band II (5800 Mhz) which was measured higher than 10 %.
• Zoom Scan: The following settings were used for the validation and measurement.

Closet Measurement Point to Phantom	2.0 mm
Zoom Scan (x,y) Resolution	4.3mm
Zoom Scan (z) Resolution	3 mm
Zoom Scan Volume	30.1 x 30.1 x 21 mm
Zoom Scan Grid Points	8 x 8 x 8

• Frequency Channel Configuration: 802.11 b/g modes are tested on "default test channels" 1, 6 and 11.
• 802.11a was tested for UNII operations on channels 36 and 48 in the lower band 5.15 – 5.25 GHz band; channels 52 and 64 in the 5.25 – 5.35 GHz band; channels 149 and 161 in the 5.8 GHz band.
• For each frequency band, testing at higher rates and higher modulations is not required when the maximum average output power for each of these configurations is less than ¼ dB higher than those measured at the lowest data rate.
• SAR is not required for 802.11g channels when the maximum average output power is less than ¼ dB higher than that measured on the corresponding 802.11b channels. The average output power for 802.11a should be measured on all channels in each frequency band..
• SAR test was conducted on each "default test channel" and each band with the worst case modulation that resulted in maximum duty cycle of 99.5 %.
• Conducted power measurements:

802.11a (low band)		802.11a (mid band)		802.11a (upper band I)	
Chan	**Coducted Power (dBm)**	**Chan**	**Coducted Power (dBm)**	**Chan**	**Coducted Power (dBm)**
36	14.55	52	18.21	104	18.21
40	14.52	56	18.18	116	18.05
44	14.56	60	18.16	124	18.00
48	14.58	64	18.03	140	18.12
802.11b		**802.11g**		**802.11a (upper band II)**	
Chan	**Coducted Power (dBm)**	**Chan**	**Coducted Power (dBm)**	**Chan**	**Coducted Power (dBm)**
1	18.10	1	14.00	149	18.04
6	18.05	6	17.15	153	17.91
11	18.05	11	14.00	157	17.90
				161	17.50

Table 3. 802.11 a/b/g channel vs. conducted power

		802.11a (lower band)	**802.11a (middle band)**	**802.11a (upper band I/II)**	**802.11g**			**802.11b**
		Channel 36	**Channel 52**	**Channel 149**	**Channel 6**			**Channel 6**
Data Rate (Mbits)	**Mod.**	**Coducted Power (dBm)**	**Coducted Power (dBm)**	**Coducted Power (dBm)**	**Coducted Power (dBm)**	**Data Rate (Mbits)**	**Mod.**	**Coducted Power (dBm)**
6	BPSK	14.53	18.21	18.04	17.15	1	BPSK	18.10
9	BPSK	14.61	17.96	17.95	17.20	2	DQPSK	18.10
12	QPSK	14.59	16.16	15.75	15.50	5.5	CCK	18.10
18	QPSK	14.45	16.16	15.71	15.60	11	CCK	18.00
24	16-QAM	14.45	15.20	14.85	14.50	22	ERP-PBCC	18.00
36	16-QAM	14.48	15.17	14.80	14.50	33	ERP-PBCC	18.00
48	64-QAM	13.60	13.35	13.00	13.00			
54	64-QAM	13.58	13.35	12.96	13.0			

Table 4. 802.11 a/b/g modulation type / data rate vs. conducted power

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 DASY 4 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 that performs the signal amplification, signal multiplexing, A/D 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 that 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 2000.
· DASY 4 software version 4.7.
· 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 section 6.1).
· System validation dipoles allowing for the validation of proper functioning of the system.

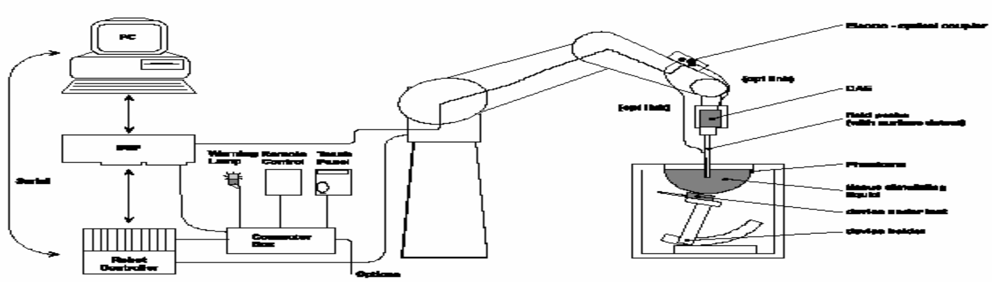

Figure 3. System Description

2.1.1 Equipment List

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
SCHMID & Partner Engineering AG	E-field probe	ET3DV6	1643	03/16/2007
SCHMID & Partner Engineering AG	E-field probe	EX3DV4	3548	12/12/2006
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE3)	DAE3 V1	472	04/26/2007
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE3)	DAE3 V1	473	03/09/2007
SCHMID & Partner Engineering AG	Dipole Validation Kit	D835V2	446	01/07/2007
SCHMID & Partner Engineering AG	Dipole Validation Kit	D1900V2	545	01/06/2007
SCHMID & Partner Engineering AG	Dipole Validation Kit	D2450V2	747	12/14/2007
SCHMID & Partner Engineering AG	Dipole Validation Kit	D5GHzV2	1033	11/22/2007
Agilent Technologies	Signal generator	HP 8648C	4037U03155	09/13/2007
Agilent Technologies	Signal generator	8360B	3844A00927	09/28/2007
Agilent Technologies	Power meter	N1911A	GB45100234	09/25/2008
Agilent Technologies	Power sensor	N1921A	US44510427	05/30/2007
Giga-tronic	Power meter	8541C	1837762	11/29/2006
Giga-tronic	Power sensor	80401A	1835838	11/29/2006
Amplifier Research	Amplifier	5S1G4M3	300986	CNR
CPI Wireless Solutions	Amplifier	VZC-6961K4	SK4310E5	CNR
Agilent Technologies	Network analyzer	8753ES	US39174857	09/28/2007
Rohde & Schwarz	Base Station Simulator	CMU 200	109747	02/08/2007
Rohde & Schwarz	CBT Bluetooth Tester	-	100034	06/15/2007

Table 5. Equipment list

2.2 Description of the test setup

Before SAR measurements are conducted, the Handheld and the DASY equipment are setup as follows:

2.2.1 Handheld and base station simulator setup

- Power up the Handheld.
- Turn on the base station simulator and set the radio channel 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 2000.
- Start the DASY4 software by clicking on the icon located on the Windows desktop.
- 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 by clicking the 'Align probe in light beam' button.
- Open a file and configure the proper parameters - probe, medium, communications system etc.
- 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 Specifications

SAR measurements were conducted using the dosimetric probe ET3DV6 and EX3DV4, 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 fibre 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}
Probe model EX3DV4 for 2.4 – 6 GHz	
Probe tip to sensor center	1.0 mm
Probe tip diameter is	2.5 mm
Probe calibration uncertainty	< 15 % for f = 2.45 to < 6.0 GHz
Probe calibration range	± 100 MHz

Table 6. Probe specifications

3.2 Probe calibration and measurement errors

The probe ET3DV6 was calibrated on March 19, 2006 with an accuracy better than ±10% and < 15 % for probe EX3DV4 (2-6 GHz). 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 measurements, the system was validated using the dipole validation kit and the flat section of the SAM phantom. A power level of 1.0W 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 within the allowed tolerances.

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 (11/13/2006)	9.05 / 5.89	41.62	0.87	23.8
	Recommended Limits	9.10 / 5.93	41.50	0.90	N/A
1900	Measured (11/09/2006)	39.3 / 20.5	38.33	1.45	23.8
	Recommended Limits	39.5 / 20.7	40.00	1.40	N/A
2450	Measured (10/18/2006)	57.6 / 26.3	37.63	1.85	22.5
	Measured (10/19/2006)	57.9 / 26.7	37.63	1.85	22.5
	Recommended Limits	53.8 / 24.9	39.2	1.80	N/A
5200	Measured (10/20/2006)	76.1 / 22.0	35.02	4.88	22.7
	Measured (10/23/2006)	76.1 / 22.0	35.02	4.88	23.0
	Measured (10/24/2006)	76.5 / 22.1	34.04	4.56	23.6
	Recommended Limits	76.9 / 21.7	36.0	4.66	N/A
5500	Measured (10/26/2006)	* 96.1 / 27.0	33.67	4.96	23.4
	Recommended Limits	82.0 / 23.0	35.60	4.96	N/A
5800	Measured (10/31/2006)	* 90.5 / 25.4	33.57	5.49	23.0
	Measured (11/01/2006)	* 87.5 / 24.5	33.57	5.49	23.0
	Recommended Limits	79.8 / 22.1	35.30	5.27	N/A

Table 7. System accuracy (validation for head adjacent use)

* Dipole validation result for 5800 MHz is higher than the manufacturer's measured value by more than 10%. Due to challenges for 5-6 GHz SAR testing, manufacturer specified system verification uncertainty of ± 19.9 % for 1 g and ± 19.5 % 10 g SAR.

5.0 PHANTOM DESCRIPTION

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

The SAM Twin Phantom is a fibreglass shell phantom with 2 mm shell thickness. It has three measurement areas:
Left side head
Right side head
Flat phantom

The phantom table dimensions are: 100x50x85 cm (LxWxH). The table is intended for use with freestanding 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 measurements.

Figure 4. SAM Twin Phantom

6.0 TISSUE DIELECTRIC PROPERTIES

6.1 Composition of tissue simulant

The composition of the brain and muscle simulating liquids for 800-6000 MHz are shown in the table below.

INGREDIENT	MIXTURE 800-900MHz		MIXTURE 1800-1900MHz		MIXTURE 2450 MHz		MIXTURE 5 – 6 GHz	
	Brain %	Muscle %	Brain %	Muscle %	Brain %	Muscle %	Brain %	Muscle %
Water	40.29	65.45	55.24	69.91	55.0	68.75	64	64-78
Sugar	57.90	34.31	0	0	0	0	0	0
Salt	1.38	0.62	0.31	0.13	0	0	0	0
HEC	0.24	0	0	0	0	0	0	0
Bactericide	0.18	0.10	0	0	0	0	0	0
DGBE	0	0	44.45	29.96	40.0	31.25	0	0
Triton X-100	0	0	0	0	5.0	0	0	0
Additives and Salt	0	0	0	0	0	0	3	2-3
Emulsifiers	0	0	0	0	0	0	15	9-15
Mineral Oil	0	0	0	0	0	0	18	11-18

Table 8. 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
Control Company	Digital Thermometer	15-077-21	51129471	05/20/2007
IKA Works Inc.	Hot Plate	RC Basic	3.107433	N/A

Table 9. 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.

1800-2450 MHz liquid

- Fill the container with water and place it on hotplate. Begin heating and stirring.
- Add the salt, Glycol/Triton X-100. The container must be covered to prevent evaporation.
- Keep the liquid hot enough to dissolve sugar 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.

5-6 GHz liquid

- Fill the container with water and place it on hotplate. Begin heating and stirring.
- Add the additives and Salt, Emulsifiers and Mineral Oil. The container must be covered to prevent evaporation.
- Keep the liquid hot enough to dissolve the ingredients 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 shown in the table below.
Recommended limits are adopted from IEEE P1528-2003:
" Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", DASY 4 manual 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 (11/13/2006)	41.62	0.87	23.8
		Recommended Limits	41.50	0.90	N/A
	Muscle	Measured (11/13/2006)	52.90	0.99	23.5
		Recommended Limits	55.20	0.97	N/A
1900	Head	Measured (11/09/2006)	38.33	1.45	23.8
		Recommended Limits	40.00	1.40	N/A
	Muscle	Measured (11/10/2006)	50.81	1.59	22.8
		Recommended Limits	53.3	1.52	N/A
2450	Head	Measured (10/18/2006)	37.63	1.85	22.5
		Recommended Limits	39.2	1.80	N/A
	Muscle	Measured (10/20/2006)	50.18	1.96	22.2
		Recommended Limits	52.70	1.95	N/A
5200	Head	Measured (10/20/2006)	35.02	4.88	22.7
		Measured (10/24/2006)	34.04	4.56	23.6
		Recommended Limits	36.00	4.66	N/A
	Muscle	Measured (10/23/2006)	47.44	5.55	23.3
		Measured (10/25/2006)	47.02	5.49	23.2
		Recommended Limits	49.00	5.30	N/A
5500	Head	Measured (10/26/2006)	33.67	4.96	23.4
		Recommended Limits	35.30	5.27	N/A
	Muscle	Measured (10/27/2006)	46.03	5.89	23.0
		Recommended Limits	48.20	6.00	N/A
5800	Head	Measured (11/01/2006)	33.57	5.49	23.0
		Recommended Limits	35.3	5.27	N/A
	Muscle	Measured (11/02/2006)	45.15	6.38	22.6
		Recommended Limits	48.20	6.00	N/A

Table 10. 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	09/28/2007
Agilent Technologies	Dielectric probe kit	HP 85070C	US9936135	CNR
Dell	PC using GPIB card	GX110	347	N/A
Control Company	Digital Thermometer	15-077-21	51129471	05/20/2007

Table 11. Equipment required for electrical parameter measurements

6.2.2 Test Configuration

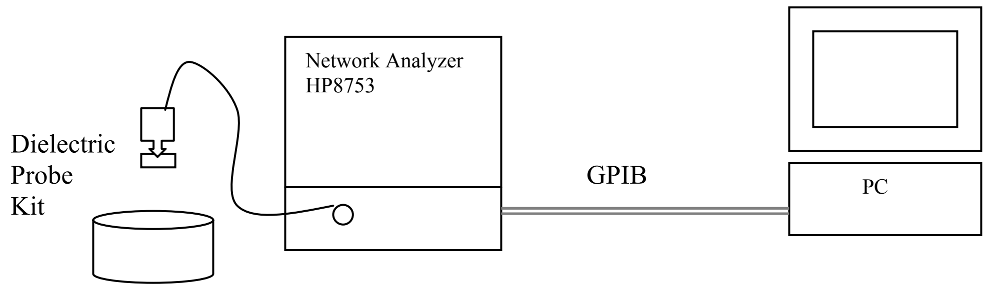

Figure 5. Test configuration

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. Relative permittivity $\varepsilon r = \varepsilon'$ and conductivity can be calculated from ε''
   $\sigma = \omega\, \varepsilon_0\, \varepsilon''$
7. Measure liquid shortly after calibration.
8. Stir the liquid to be measured. Take a sample (~50ml) with a syringe from the center of the liquid container.
9. Pour the liquid into a small glass flask. Hold the syringe at the bottom of the flask to avoid air bubbles.
10. 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.
11. Perform measurements.
12. Adjust medium parameters in DASY4 for the frequencies necessary for the measurements (‘Setup Config’, select medium (e.g. Head 835 MHz) and press ‘Option’-button.
13. Select the current medium for the frequency of the validation (e.g. Setup Medium Brain 835 MHz).

Sample calculation for 835 MHz head tissue dielectric parameters using data from Table 12.

Relative permittivity $\varepsilon r = \varepsilon' = 41.62$
Conductivity $\sigma = \omega\, \varepsilon_0\, \varepsilon'' = (2\pi \times 835 \times 10^6)(8.854 \times 10^{-12})(18.81) = 0.87$ S/m

Frequency	e'	e"
800.000000 MHz	42.0015	18.9402
805.000000 MHz	41.9522	18.9263
810.000000 MHz	41.8919	18.8887
815.000000 MHz	41.8345	18.8777
820.000000 MHz	41.7591	18.8558
825.000000 MHz	41.7198	18.8456
830.000000 MHz	41.6500	18.8177
835.000000 MHz	41.6186	18.8109
840.000000 MHz	41.5245	18.8010
845.000000 MHz	41.5071	18.8010
850.000000 MHz	41.4903	18.8007
855.000000 MHz	41.3966	18.7813
860.000000 MHz	41.3386	18.7929
865.000000 MHz	41.2896	18.7613
870.000000 MHz	41.1954	18.7635
875.000000 MHz	41.1450	18.7735
880.000000 MHz	41.0717	18.7700
885.000000 MHz	41.0324	18.7769
890.000000 MHz	40.9801	18.7876
895.000000 MHz	40.9389	18.7653
900.000000 MHz	40.8521	18.7370

Frequency	e'	e"
800.000000 MHz	53.4610	21.5287
805.000000 MHz	53.3931	21.4889
810.000000 MHz	53.2959	21.4429
815.000000 MHz	53.2088	21.4054
820.000000 MHz	53.1394	21.3512
825.000000 MHz	53.0548	21.3141
830.000000 MHz	52.9765	21.2755
835.000000 MHz	52.8974	21.2928
840.000000 MHz	52.8543	21.2534
845.000000 MHz	52.8128	21.2466
850.000000 MHz	52.7470	21.2595
855.000000 MHz	52.7336	21.2642
860.000000 MHz	52.6578	21.2432
865.000000 MHz	52.6195	21.2623
870.000000 MHz	52.6121	21.2753
875.000000 MHz	52.5436	21.2362
880.000000 MHz	52.4971	21.2531
885.000000 MHz	52.4920	21.2648
890.000000 MHz	52.4748	21.2283
895.000000 MHz	52.4546	21.1827
900.000000 MHz	52.3982	21.1772

Table 12. 835 MHz head and muscle tissue dielectric parameters

Frequency	e'	e"
1.800000000 GHz	38.6359	13.4326
1.805000000 GHz	38.6176	13.4499
1.810000000 GHz	38.6007	13.4485
1.815000000 GHz	38.6060	13.4639
1.820000000 GHz	38.5978	13.4664
1.825000000 GHz	38.5844	13.4898
1.830000000 GHz	38.5523	13.5064
1.835000000 GHz	38.5473	13.5278
1.840000000 GHz	38.5249	13.5296
1.845000000 GHz	38.4967	13.5411
1.850000000 GHz	38.4870	13.5533
1.855000000 GHz	38.4842	13.5762
1.860000000 GHz	38.4706	13.5908
1.865000000 GHz	38.4659	13.6147
1.870000000 GHz	38.4388	13.6255
1.875000000 GHz	38.4237	13.6410
1.880000000 GHz	38.4114	13.6459
1.885000000 GHz	38.3825	13.6668
1.890000000 GHz	38.3547	13.6841
1.895000000 GHz	38.3351	13.6759
1.900000000 GHz	38.3271	13.6958
1.905000000 GHz	38.3104	13.7153
1.910000000 GHz	38.2968	13.7299
1.915000000 GHz	38.2747	13.7351
1.920000000 GHz	38.2626	13.7605

Head

Frequency	e'	e"
1.800000000 GHz	51.2062	14.6803
1.805000000 GHz	51.1857	14.7011
1.810000000 GHz	51.1799	14.7132
1.815000000 GHz	51.1589	14.7237
1.820000000 GHz	51.1491	14.7428
1.825000000 GHz	51.1179	14.7442
1.830000000 GHz	51.1109	14.7824
1.835000000 GHz	51.1012	14.7872
1.840000000 GHz	51.0717	14.8017
1.845000000 GHz	51.0467	14.8124
1.850000000 GHz	51.0096	14.8336
1.855000000 GHz	51.0002	14.8491
1.860000000 GHz	50.9696	14.8685
1.865000000 GHz	50.9608	14.8836
1.870000000 GHz	50.9254	14.9002
1.875000000 GHz	50.9230	14.9135
1.880000000 GHz	50.9200	14.9380
1.885000000 GHz	50.8824	14.9463
1.890000000 GHz	50.8567	14.9762
1.895000000 GHz	50.8328	14.9870
1.900000000 GHz	50.8105	15.0072
1.905000000 GHz	50.7977	15.0298
1.910000000 GHz	50.7767	15.0384
1.915000000 GHz	50.7596	15.0508
1.920000000 GHz	50.7389	15.0628

Muscle

Table 13. 1900 MHz head and muscle tissue dielectric parameters

Frequency	e'	e''	Frequency	e'	e''
2.400000000 GHz	37.7558	13.4544	2.400000000 GHz	50.3560	14.1551
2.405000000 GHz	37.7338	13.4804	2.405000000 GHz	50.3337	14.1677
2.410000000 GHz	37.7270	13.4806	2.410000000 GHz	50.3121	14.1866
2.415000000 GHz	37.7140	13.4967	2.415000000 GHz	50.2949	14.2149
2.420000000 GHz	37.7024	13.5144	2.420000000 GHz	50.2844	14.2244
2.425000000 GHz	37.6854	13.5284	2.425000000 GHz	50.2609	14.2498
2.430000000 GHz	37.6875	13.5488	2.430000000 GHz	50.2459	14.2759
2.435000000 GHz	37.6519	13.5561	2.435000000 GHz	50.2190	14.3128
2.440000000 GHz	37.6430	13.5691	2.440000000 GHz	50.2133	14.3280
2.445000000 GHz	37.6439	13.5906	2.445000000 GHz	50.2005	14.3520
2.450000000 GHz	37.6323	13.6031	2.450000000 GHz	50.1832	14.3600
2.455000000 GHz	37.6282	13.5879	2.455000000 GHz	50.1647	14.3875
2.460000000 GHz	37.6117	13.6072	2.460000000 GHz	50.1467	14.4182
2.465000000 GHz	37.5875	13.6302	2.465000000 GHz	50.1339	14.4319
2.470000000 GHz	37.5714	13.6329	2.470000000 GHz	50.1307	14.4413
2.475000000 GHz	37.5672	13.6532	2.475000000 GHz	50.0962	14.4782
2.480000000 GHz	37.5407	13.6593	2.480000000 GHz	50.0823	14.4901
2.485000000 GHz	37.5095	13.6692	2.485000000 GHz	50.0728	14.5113
2.490000000 GHz	37.4829	13.6944	2.490000000 GHz	50.0506	14.5337
2.495000000 GHz	37.4561	13.7092	2.495000000 GHz	50.0451	14.5574
2.500000000 GHz	37.4506	13.7199	2.500000000 GHz	50.0092	14.5681

Head **Muscle**

Table 14. 2450 MHz head and muscle tissue dielectric parameters

Frequency	e'	e"
4.700000000 GHz	36.8225	16.1529
4.750000000 GHz	36.5707	16.2149
4.800000000 GHz	36.3488	16.2998
4.850000000 GHz	36.1427	16.3627
4.900000000 GHz	35.9415	16.4402
4.950000000 GHz	35.7534	16.5194
5.000000000 GHz	35.5721	16.5818
5.050000000 GHz	35.4304	16.6648
5.100000000 GHz	35.2730	16.7450
5.150000000 GHz	35.1398	16.8380
5.200000000 GHz	35.0211	16.9163
5.250000000 GHz	34.9153	16.9831
5.300000000 GHz	34.8154	17.0803
5.350000000 GHz	34.7352	17.1710
5.400000000 GHz	34.6476	17.2443
5.450000000 GHz	34.5925	17.3358
5.500000000 GHz	34.5388	17.4104

Frequency	e'	e"
4.700000000 GHz	48.3428	18.3795
4.800000000 GHz	48.1351	18.5585
4.900000000 GHz	47.9293	18.7173
5.000000000 GHz	47.7602	18.8821
5.100000000 GHz	47.5856	19.0515
5.200000000 GHz	47.4356	19.2013
5.300000000 GHz	47.2569	19.3624
5.400000000 GHz	47.0402	19.5058
5.500000000 GHz	46.8032	19.6496
5.600000000 GHz	46.5872	19.7661
5.700000000 GHz	46.3973	19.9302
5.800000000 GHz	46.2403	20.0803
5.900000000 GHz	46.0865	20.2486
6.000000000 GHz	45.9058	20.3818

5.300000000 GHz	34.0169	16.0153
5.350000000 GHz	33.9248	16.0628
5.400000000 GHz	33.8383	16.0851
5.450000000 GHz	33.7662	16.1173
5.500000000 GHz	33.6677	16.1457
5.550000000 GHz	33.5713	16.1712
5.600000000 GHz	33.4907	16.2071
5.650000000 GHz	33.4188	16.2288
5.700000000 GHz	33.3107	16.2772
5.750000000 GHz	33.2472	16.2986
5.800000000 GHz	33.1373	16.3338
5.850000000 GHz	33.0912	16.3661
5.900000000 GHz	32.9938	16.3909
5.950000000 GHz	32.9214	16.4245
6.000000000 GHz	32.8188	16.4424

Frequency	e'	e"
4.700000000 GHz	47.6189	18.1568
4.800000000 GHz	47.4615	18.3325
4.900000000 GHz	47.3059	18.4693
5.000000000 GHz	47.0914	18.6267
5.100000000 GHz	46.9045	18.7433
5.200000000 GHz	46.6935	18.8813
5.300000000 GHz	46.4903	19.0089
5.400000000 GHz	46.2590	19.1249
5.500000000 GHz	46.0321	19.2365
5.600000000 GHz	45.8496	19.3336
5.700000000 GHz	45.6600	19.4296
5.800000000 GHz	45.4660	19.5322
5.900000000 GHz	45.2683	19.6291
6.000000000 GHz	45.0755	19.7177

5.550000000 GHz	34.2968	16.8803
5.600000000 GHz	34.1685	16.8980
5.650000000 GHz	34.0685	16.9117
5.700000000 GHz	33.9294	16.9198
5.750000000 GHz	33.8167	16.9576
5.800000000 GHz	33.7093	16.9671
5.850000000 GHz	33.5717	17.0024
5.900000000 GHz	33.4315	17.0151
5.950000000 GHz	33.3248	17.0443
6.000000000 GHz	33.1863	17.0465

Frequency	e'	e"
4.700000000 GHz	47.5058	18.3049
4.800000000 GHz	47.2925	18.4766
4.900000000 GHz	47.0633	18.6194
5.000000000 GHz	46.8529	18.7560
5.100000000 GHz	46.6219	18.8918
5.200000000 GHz	46.4200	19.0234
5.300000000 GHz	46.2029	19.1599
5.400000000 GHz	45.9954	19.2940
5.500000000 GHz	45.7785	19.4274
5.600000000 GHz	45.5656	19.5174
5.700000000 GHz	45.3543	19.6586
5.800000000 GHz	45.1451	19.7792
5.900000000 GHz	44.9350	19.8926
6.000000000 GHz	44.7212	19.9811

Table 15. 5000-6000 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 16. 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 17. 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).

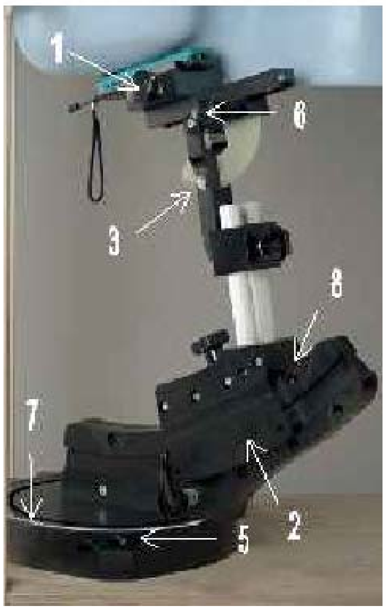

Figure 6. Device Holder

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 earpiece 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 earpiece and the center of the device bottom (or the center of the flip hinge). For devices with parallel front and backsides, 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 earpiece 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 1528- 2003 “Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”.

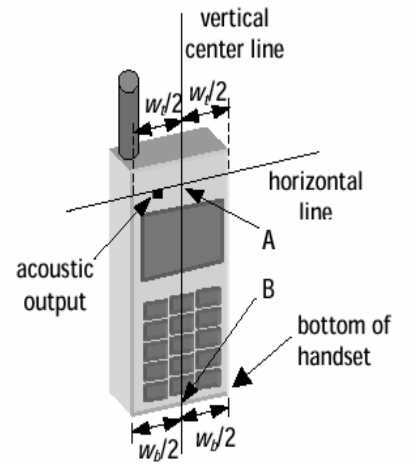

Figure 7a. Handset vertical and horizontal reference lines – fixed case

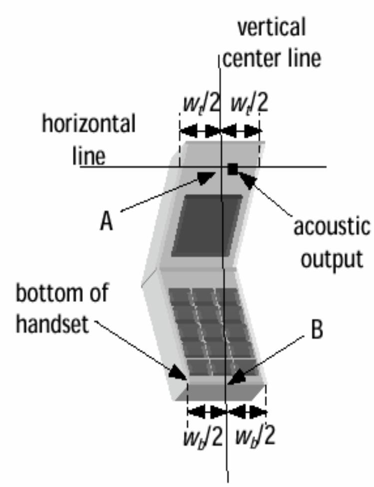

Figure 7b. Handset vertical and horizontal reference lines – “clam-shell”

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).

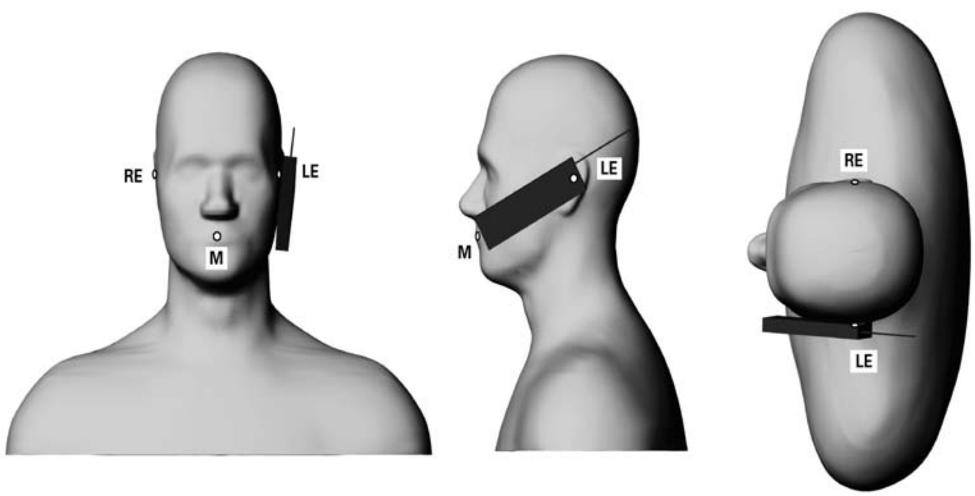

Figure 8. Phone position 1, "cheek" or "touch" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

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**.**

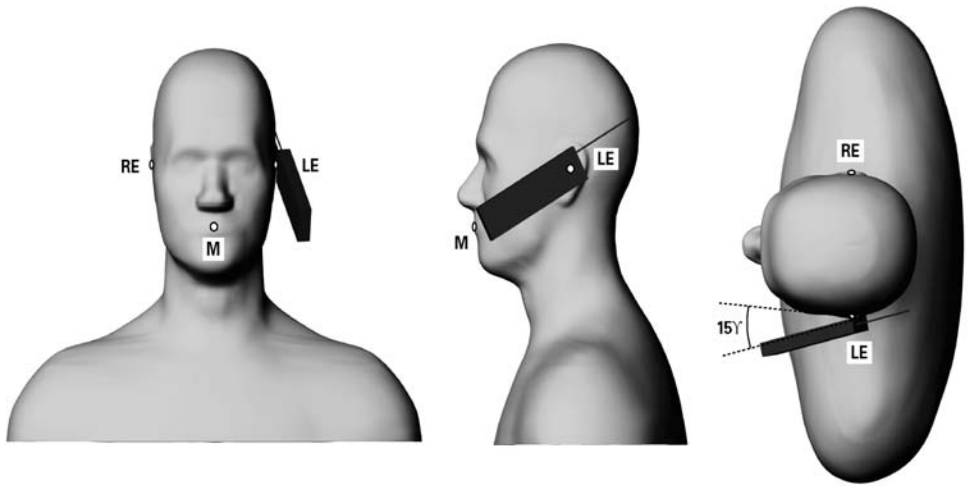

Figure 9. Phone position 2, "tilted position." The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

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 7x7x7 scan. The routines are verified and optimized for the grid dimensions used in these cube measurements.
The measured volume of 30x30x30mm mm with 5mm resolution amounts to 343 measurement points. 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. 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 UNCERTAINTY

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 18. Worst-Case uncertainty budget for DASY4 assessed according to IEEE P1528. Source: Schmid & Partner Engineering AG.

[1] The budget is valid for the frequency range 300MHz - 3 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerably smaller.

DASY4 Uncertainty Budget for the 5 - 6 GHz range								
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	±6.8 %	N	1	1	1	±6.8 %	±6.8 %	∞
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	±2.0 %	R	$\sqrt{3}$	1	1	±1.2 %	±1.2 %	∞
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	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
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 Noise	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Probe Positioning	±9.9 %	R	$\sqrt{3}$	1	1	±5.7 %	±5.7 %	∞
Max. SAR Eval.	±4.0 %	R	$\sqrt{3}$	1	1	±2.3 %	±2.3 %	∞
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						±12.9 %	±12.7 %	330
Coverage Factor for 95%		kp=2						
Expanded STD Uncertainty						**±25.9 %**	**±25.5 %**	

Table 19. Worst-Case uncertainty budget for DASY4 valid for the frequency range 5 - 6GHz. Probe calibration error reflects uncertainty of the narrow-bandwidth EX3DVx probe conversion factor (±50MHz).

11.0 TEST RESULTS

11.1 SAR Measurement results at highest power measured against the head

Mode	Freq. (MHz)	Cond. Output Power (dBm)	SAR, averaged over 1 g (W/kg) Left-hand: Liquid Temp (°C)	Cheek	Tilted	SAR, averaged over 1 g (W/kg) Right-hand: Liquid Temp (°C)	Cheek	Tilted
1-slot GSM 850 MHz	824.2	32.4	23.7	0.76				
	836.6	32.3	23.5	0.77	0.46	23.2	0.75	0.46
	848.8	32.4	23.3	0.76				
	836.6	32.3	23.3	0.75				
* 2-slots GSM 850 MHz	824.2	30.4	23.7	0.96				
	836.6	30.3	23.5	0.97	0.58	23.2	0.94	0.58
	848.8	30.3	23.3	0.96				
1-slot GSM 1900 MHz	1850.2	30.5	23.2	0.92	0.44	23.3	0.72	0.38
	1880.0	30.0	23.4	0.89				
	1909.8	29.8	23.2	0.86				
* 2-slots GSM 1900 MHz	1850.2	28.5	23.2	**1.16**	0.55	23.3	0.91	0.76
	1880.0	28.0	23.4	1.12				
	1909.8	27.8	23.2	1.08				
WLAN 2400 MHz	2412							
	2437	18.05	22.4	0.109	0.117	22.6	0.172	0.148
	2462							
802.11a 5100-5200 MHz (low band)	5180	14.55				22.6	0.018	
	5240	14.58	22.0	0.093	0.090	22.5	0.019	** 0.019
WLAN 5200-5300 MHz (mid band)	5260	18.21	23.1	** 0.105				
	5320	18.03	23.3	0.108	** 0.07			
WLAN 5500-5700 MHz (upper band I)	5520	18.04	23.3	**0.119**	** 0.07	23.2	0.023	0.040
	5580	17.91	23.0	0.103				
	5620	17.90	23.2	0.115				
	5680	17.50	23.3	0.066				
WLAN 5700-5800 MHz (upper band II)	5745	18.04	23.1	** 0.087	0.048	23.5	0.034	
	5805	17.50	23.2	0.075				

Table 20. SAR results for head configuration

* Calculated SAR values for 2-slots DTM GSM modes since the CMU 200 base station simulator does not support GSM DTM 2-slots mode at this time: SAR (2-slots) = SAR (1-slot) * 10^ (1.0 dB / 10)

** If the Power Drift is < - 0.2 dB, then the SAR value must be compensated for by the following formula: SAR (compensated) = SAR (measured) * 10^(|Power Drift (dB)| / 10)

11.2 Calculated worst case combined SAR for simultaneous tramsmission at highest power measured against the head

	SAR, averaged over 1 g (W/kg)		**SAR, averaged over 1 g (W/kg)**	
	Left-hand		**Right-hand**	
Mode	**Cheek**	**Tilted**	**Cheek**	**Tilted**
2-slots GSM 1900	1.16	0.55	0.91	0.76
WLAN 5500-5700 MHz	0.12	0.07	0.02	0.04
2-slots GSM 1900 + WLAN	**1.28**			

Table 21. SAR results for head configuration

11.3 SAR measurement results at highest power measured against the body using accessories.

Mode	Freq. (MHz)	Cond. Power (dBm)	Liquid Temp. (°C)	Holster type / handheld configuration	Body SAR, averaged over 1 g (W/kg)	** Body SAR, averaged over 1 g (W/kg)
2-slots GPRS 850 MHz	824.2	30.4	23.3	Holster 1, back side facing	0.48	0.48
	836.6	30.3	23.5	Holster 1, back side facing	0.49	0.49
	848.8	30.3	23.8	Holster 1, back side facing	0.47	0.47
	836.6		23.5	Holster 1, front side facing	0.47	0.47
	836.6		23.2	Holster 2 , back side facing	0.51	**0.51**
	836.6		23.1	Holster 2 , heaset 1, back side facing	0.40	0.40
	836.6		22.9	Holster 2 , heaset 2, back side facing	0.34	0.34
	836.6		22.8	Holster 2 , back side facing & BT ON	0.50	0.50
	836.6		23.0	No Holster, back side 25 mm away	0.50	0.50
2-slots GPRS 1900 MHz	1850.2	28.5	22.9	Holster 2 , back side facing	0.49	0.49
	1880.0	28.0	22.8	Holster 2 , back side facing	0.50	0.50
	1909.8	27.8	22.7	Holster 2 , back side facing	0.37	0.37
	1880.0		23.0	Holster 1 , back side facing	0.39	0.39
	1880.0		23.2	Holster 2 , front side facing	0.44	0.44
	1880.0		23.4	Holster 2 , back side facing, headset 1 & BT	0.50	0.50
	1880.0		23.5	Holster 2 , back side facing, headset 2	0.47	0.47
	1880.0		23.3	No Holster, back side 25 mm away	0.33	0.33
WLAN 2400 MHz	2412					
	2437	18.05	22.0	Holster , back side facing	0.17	0.17
	2462					
	2437		22.5	Holster , front side facing	0.03	0.03
	2437		22.5	No Holster, back side 25 mm away	0.18	0.18
802.11a 5100-5200 MHz (low band)	5180	14.55	23.3	Holster , back side facing	0.58	0.58
	5240	14.58	23.2	Holster , back side facing	0.36	0.41
	5180		23.1	Holster , front side facing	0.003	0.004
	5180		23.0	No Holster, back side 25 mm away	0.55	0.55
WLAN 5200-5300 MHz (mid band)	5260	18.21	23.1	Holster , back side facing	0.69	0.75
	5320	18.03	23.2	Holster , back side facing	0.68	0.68
	5260		23.4	Holster , front side facing	0.007	0.008
	5260		23.6	No Holster, back side 25 mm away	0.84	0.89
WLAN 5500-	5520	18.04	23.1	Holster , back side facing	0.79	0.79
	5520	17.91	23.2	Holster , front side facing	0.006	0.006

5700 MHz (upper band I)	5580	17.91	22.8	Holster , back side facing	0.84	0.84
	5680	17.50	22.9	Holster , back side facing	1.03	1.03
	5680		22.9	Holster , front side facing	0.007	0.007
	5680		23.0	No Holster, back side 25 mm away	0.91	0.97
WLAN 5700-5800 MHz (upper band II)	5745	18.04	23.0	Holster , back side facing	0.96	1.06
	5805	17.50	23.0	Holster , back side facing	0.92	**1.07**
	5745		23.3	Holster , front side facing	0.004	0.004
	5745		23.2	Holster , back side & headset 1	0.90	0.90
	5745		23.1	No Holster, back side 25 mm away	0.96	1.02

Table 22. SAR results for body-worn configurations

** If the Power Drift is < - 0.2 dB, then the SAR values are compensated for by the the following formula:
SAR (compensated) = SAR (measured) * 10^(|Power Drift (dB)| / 10)

11.4 Calculated worst case combined SAR for simultaneous tramsmission at highest power measured against the body using accessories

Mode	Configuration	Body SAR, averaged over 1 g (W/kg)
2-slots GPRS 850 MHz	Holster 2, back side towards body	0.51
WLAN 5700-5800 MHz	Holster 2, back side towards body	1.07
2-slots GPRS + WLAN	Holster 2, back side towards body	**1.58**

Table 23. SAR results for body worn configuration

12.0 REFERENCES

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