SAR Compliance Test Report

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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 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), ANSI/IEEE Std. C95.3-1991, IEEE 1528-2003, IEC 62209-1-2005, Health Canada's Safety Code 6, EN50360, Australian ARPANSA standard and the Council Recommendation 1999/519/EC and for the basic restrictions related to human exposure to electromagnetic fields and has been tested in accordance with the measurement procedures specified in EN50361 July 2001, IEC 62209-1-2005, Australian Communications Authority Radiocommunications (Electromagnetic Radiation — Human Exposure) Standard: Schedule 1 , Schedule 2 and AS/NZS 2772.2-1988.

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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 section
Configuration	Internal fixed antenna

Table 1. Antenna description

1.3 Handheld description

Handheld Model	RBF20CW		
FCC ID	L6ARBF20CW		
PIN	FFFFFFFF		
Prototype or Production Unit	Production (ASY#: ASY-11785-002, Sample 4 CPR 1528, NO PIN or IMEI available)		
Mode(s) of Operation	Cellular CDMA	PCS CDMA	Bluetooth
Maximum conducted RF Output Power	24.50 dBm	23.50 dBm	- 4.5 dBm
Tolerance in Power Setting on centre channel	± 0.50 dB	± 0.50 dB	N/A
Duty Cycle	1:1	1:1	N/A
Transmitting Frequency Range (MHz)	824.70-848.31 MHz	1851.25-1908.75 MHz	2402-2483

Table 2. Test device description

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 Leather Holsters 2 and 4 with the backside facing the belt clip. Body SAR was evaluated with both configurations for these holsters.

Holster Type	Model / Part Number	Separation (mm)
Plastic Holster 1	ASY-10458-002	15.00
Leather Holster 2	HDW-11939-00x	19.50
Leather Holster 4	ASY-09288-00x	18.00

Please refer to Appendix E.

Figure 2. Body-worn holsters

1.5 Headsets

The BlackBerry Wireless Handheld was tested with and without headset model number HDW-03458-001. The SAR values are shown in Table 19.

1.6 Batteries

The BlackBerry Wireless Handheld was tested with the following Lithium Ion Batteries:

1) BAT-06860-003
2) BAT-06860-003 (Alternate supplier)
3) BAT-06985-002 (Higher capacity, alternate)

1.7 Procedure used to establish the test signal

The Handheld was put into test mode for SAR measurements by enabling a call via a Rohde & Schwarz CMU 200 Base Station Simulator test instrument. The CMU 200 was configured to command the Handheld to transmit at full power at the specified frequency.

A Rohde & Schwarz CBT Bluetooth Tester was used to connect to the Handheld's Bluetooth radio and command it to transmit at maximum power. Worst case SAR was measured with CDMA and Bluetooth bands ON simultaneously.

1.7.1 CDMA 2000 1x

The followings are the **FCC SAR Measurement Procedures for 3G Devices issued in May 2006**, applicable to handsets operating under CDMA 2000, Release 0, with MS Protocol Revision 6 (**P_REV 6**). The default test configuration is to measure SAR in RC3 with an established radio link between the DUT and a communication test set. SAR in RC1 is selectively confirmed according to output power and exposure conditions.

1.7.1.1 Output Power Verification

Maximum output power is verified on the High, Middle and Low channels according to procedures in section 4.4.5.2 of 3GPP2 C.S0011/TIA-98-E. Results for at least steps 3, 4 and 10 of the power measurement procedures should be tabulated in the SAR report as shown on Table 5. Steps 3 and 4 should be measured using SO55 with power control bits in "All Up" condition. TDSO / SO32 may be used instead of SO55 for step 4. Step 10 should be measured using TDSO / SO32 with power control bits in the "Bits Hold" condition (i.e. alternative Up/Down Bits).

1.7.1.2 3GPP2 C.S0011/ TIA-98-E, section 4.4.5.2 Method of Measurement

3. If the mobile station supports Reverse Traffic Channel Radio Configuration 1 and 7 Forward Traffic Channel Radio Configuration 1, set up a call using Fundamental 8 Channel Test Mode 1 with 9600 bps data rate only and perform steps 6 through 8.
4. If the mobile station supports the Radio Configuration 3 Reverse Fundamental 11 Channel and demodulation of Radio Configuration 3, 4, or 5, set up a call using 12 Fundamental Channel Test Mode 3 with 9600 bps data rate only and 13 perform steps 6 through 8.
6. Set the test parameters as specified in Table 3.
7. Send continuously ‘0’ power control bits to the mobile station.
8. Measure the mobile station output power at the mobile station antenna connector.
10. If the mobile station supports the Radio Configuration 3 Reverse Fundamental Channel, Radio Configuration 3 Reverse Supplemental Channel 0 and demodulation of Radio Configuration 3, 4, or 5, set up a call using Supplemental Channel Test Mode 3 with 9600 bps Fundamental Channel and 9600 bps Supplemental Channel 0 data rate, and perform the following:
a) Set the test parameters as specified in Table 4.
b) Send alternating ‘0’ and ‘1’ power control bits to the mobile station using the smallest supported closed loop power control step size supported by the mobile station.
c) Determine the active channel configuration. If the desired channel configuration is not active, increase by 1 dB and repeat the verification. Repeat this step until the desired channel configuration becomes active.
d) Measure the mobile station output power at the mobile station antenna connector and record reading.

Parameter	Units	Value
$\hat{I}_{or}$	dBm/1.23 MHz	-104
$\frac{\text{Pilot } E_c}{I_{or}}$	dB	-7
$\frac{\text{Traffic } E_c}{I_{or}}$	dB	-7.4

Table 3

Parameter	Units	Value
$\hat{I}_{or}$	dBm/1.23 MHz	-86
$\frac{\text{Pilot } E_c}{I_{or}}$	dB	-7
$\frac{\text{Traffic } E_c}{I_{or}}$	dB	-7.4

Table 4

Test Parameters for Maximum RF Output Power for Spreading Rate 1

1.7.1.3 Head SAR Measurements

SAR for head exposure configurations is measured in RC3 with the DUT configured to transmit at full rate using Loopback Service Option SO55. SAR for RC1 is not required when the maximum average output of each channel is less than ¼ dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel in RC1 using the exposure configuration that results in the highest SAR for that channel in RC3.

1.7.1.4 Body SAR Measurements

SAR for body exposure configurations is measured in RC3 with the DUT configured to transmit at full rate on FCH with all other code channels disabled using TDSO / SO32. SAR for multiple code channels (FCH + SCH_n) is not required when the maximum average output of each RF channel is less than ¼ dB higher than that measured with FCH only. Otherwise, SAR is measured on the maximum output channel (FCH + SCH_n) with FCH at full rate and SCH_0 enabled at 9600 bps using the exposure configuration that results in the highest SAR for that channel with FCH only. When multiple code channels are enabled, the DUT output may shift by more than 0.5 dB and lead to higher SAR drifts and SCH dropouts.
Body SAR in RC1 is not required when the maximum average output of each channel is less than ¼ dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel in RC1; with Loopback Service Option SO55, at full rate, using the body exposure configuration that results in the highest SAR for that channel in RC3.

1.7.1.5 1x Ev-DO

For handsets with Ev-Do capabilities, when the maximum average output of each channel in Rev. 0 is less than ¼ dB higher than that measured in RC3 (1x RTT), body SAR for Ev-Do is not required. Otherwise, SAR for Rev. 0 is measured on the maximum output channel at 153.6 kbps using the body exposure configuration that results in the highest SAR for that channel in RC3. SAR for Rev. A is not required when the maximum average output of each channel is less than that measured in Rev. 0 or less than ¼ dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel for Rev. A using a Reverse Data Channel payload size of 4096 bits and a Termination Target of 16 slots defined for Subtype 2 Physical Layer configurations. A Forward Traffic Channel data rate corresponding to the 2-slot version of 307.2 kbps with the ACK Channel transmitting in all slots should be configured in the downlink for both Rev. 0 and Rev. A.

Band	Channel	1x EvDO **(153.6kbps)**	CDMA2000 **RC**	SO2 **Loopback**	SO55 **Loopback**	TDSO SO32 **Loopback**
CDMA 800	1013	24.73	RC1	24.68	24.68	-
			RC3	24.74	24.74	24.73
	384	24.52	RC1	24.47	24.44	-
			RC3	24.55	24.56	24.52
	777	24.58	RC1	24.52	24.52	-
			RC3	24.57	24.57	24.58
Band	Channel	1x EvDO **(153.6kbps)**	CDMA2000 **RC**	SO2 **Loopback**	SO55 **Loopback**	TDSO SO32 **Loopback**
CDMA 1900	25	23.07	RC1	23.07	23.05	-
			RC3	23.15	23.27	23.18
	600	23.44	RC1	23.42	23.42	-
			RC3	23.48	23.47	23.47
	1175	23.52	RC1	23.35	23.34	-
			RC3	23.42	23.44	23.49

Table 5: Conducted RF output power measured for various settings

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.

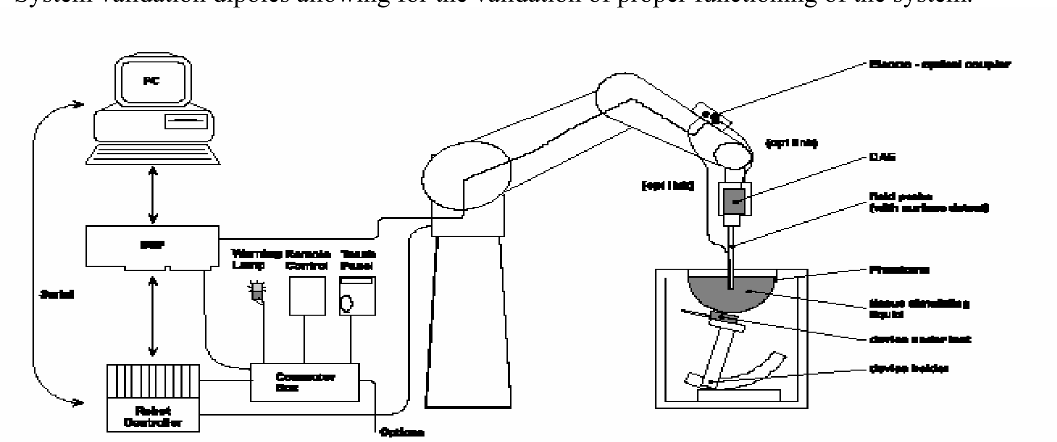

Figure 3. System Description

2.1.1 Equipment List

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
SCHMID & Partner Engineering AG	E-field probe	ET3DV6	1642	01/19/2007
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE3)	DAE3 V1	472	04/25/2007
SCHMID & Partner Engineering AG	Dipole Validation Kit	D835V2	446	01/07/2007
SCHMID & Partner Engineering AG	Dipole Validation Kit	D1900V2	545	01/06/2007
Agilent Technologies	Signal generator	HP 8648C	4037U03155	09/13/2007
Agilent Technologies	Power meter	E4419B	GB40202821	09/14/2006
Agilent Technologies	Power sensor	8482A	US37295126	09/20/2006
Amplifier Research	Amplifier	5S1G4M3	300986	CNR
Agilent Technologies	Network analyzer	8753ES	US39174857	09/14/2006
Rohde & Schwarz	Base Station Simulator	CMU 200	109747	02/08/2007
Rohde & Schwarz	CBT Bluetooth Tester	-	100133	04/11/2007

Table 6. 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

- 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, 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

Table 7. Probe specifications

3.2 Probe calibration and measurement errors

The probe was calibrated on January 19, 2006 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 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 (06/29/2006)	9.39 / 6.12	41.25	0.90	22.0
	Measured (06/30/2006)	8.22 / 5.47	41.25	0.90	22.1
	Recommended Limits	9.1 / 5.93	41.5	0.90	N/A
1900	Measured (06/26/2006)	37.9 / 19.8	38.94	1.44	22.1
	Measured (06/27/2006)	36.0 / 18.9	38.95	1.38	22.2
	Measured (06/28/2006)	41.8 / 21.8	38.95	1.38	22.0
	Measured (07/04/2006)	40.1 / 21.0	38.68	1.44	22.3
	Recommended Limits	39.5 /20.7	40.0	1.40	N/A

Table 8. 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 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 800-900 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 9. 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 10. 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 liquids

- 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 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", 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 (06/28/2006)	41.25	0.90	22.0
		Recommended Limits	41.5	0.90	N/A
	Muscle	Measured (06/29/2006)	54.25	0.95	22.0
		Recommended Limits	55.2	0.97	N/A
1900	Head	Measured (06/26/2006)	38.94	1.44	22.1
		Measured (06/27/2006)	38.95	1.38	22.2
		Measured (07/04/2006)	38.68	1.44	22.3
		Recommended Limits	40	1.40	N/A
	Muscle	Measured (06/27/2006)	50.72	1.55	22.3
		Measured (07/04/2006)	50.71	1.59	22.1
		Recommended Limits	53.3	1.52	N/A

Table 11. 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	09/14/2006
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 12. Equipment required for electrical parameter measurements

6.2.2 Test Configuration

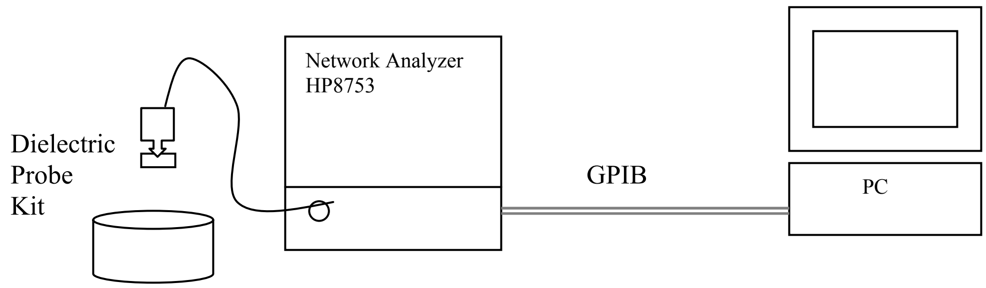

Figure 5. Test configuration

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 900 MHz) and press ‘Option’-button.
13. 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 13.

Relative permittivity $\varepsilon_r = \varepsilon' = 41.25$
Conductivity $\sigma = \omega \varepsilon_0 \varepsilon'' = (2\pi \times 835 \times 10^{6})(8.854 \times 10^{-12})(19.48) = 0.90$ S/m

Title
SubTitle
June 28, 2006 10:55 PM

Frequency	e'	e"
750.000000 MHz	42.6488	19.7584
755.000000 MHz	42.6136	19.7001
760.000000 MHz	42.6860	19.6597
765.000000 MHz	42.6354	19.5837
770.000000 MHz	42.4430	19.3942
775.000000 MHz	42.3384	19.3186
780.000000 MHz	42.3050	19.2974
785.000000 MHz	42.0949	19.1911
790.000000 MHz	41.9532	19.1673
795.000000 MHz	42.0184	19.2964
800.000000 MHz	41.8972	19.3382
805.000000 MHz	41.8604	19.3841
810.000000 MHz	41.7716	19.4331
815.000000 MHz	41.6760	19.4515
820.000000 MHz	41.5868	19.4683
825.000000 MHz	41.4712	19.5191
830.000000 MHz	41.3446	19.5042
835.000000 MHz	41.2489	19.4812
840.000000 MHz	41.1876	19.5017
845.000000 MHz	41.1427	19.4654
850.000000 MHz	41.1287	19.4623
855.000000 MHz	41.0975	19.4330
860.000000 MHz	41.0717	19.3666
865.000000 MHz	41.0788	19.3425
870.000000 MHz	41.0720	19.2868
875.000000 MHz	41.0693	19.2100
880.000000 MHz	41.0711	19.1829
885.000000 MHz	41.0705	19.1466
890.000000 MHz	41.0706	19.0952
895.000000 MHz	41.0801	19.0413
900.000000 MHz	41.0324	18.9948

Head

Title
SubTitle
June 29, 2006 09:51 PM

Frequency	e'	e"
750.000000 MHz	55.4520	21.1338
755.000000 MHz	55.5584	21.0938
760.000000 MHz	55.6353	21.0038
765.000000 MHz	55.6525	20.9815
770.000000 MHz	55.6733	20.9342
775.000000 MHz	55.6490	20.8909
780.000000 MHz	55.6213	20.8026
785.000000 MHz	55.5090	20.7682
790.000000 MHz	55.4320	20.6989
795.000000 MHz	55.3165	20.6787
800.000000 MHz	55.1421	20.6006
805.000000 MHz	55.0013	20.5630
810.000000 MHz	54.8248	20.5617
815.000000 MHz	54.6517	20.5321
820.000000 MHz	54.4858	20.5010
825.000000 MHz	54.3974	20.5093
830.000000 MHz	54.2914	20.4801
835.000000 MHz	54.2532	20.4816
840.000000 MHz	54.2063	20.4862
845.000000 MHz	54.2191	20.5014
850.000000 MHz	54.2812	20.5302
855.000000 MHz	54.2853	20.5474
860.000000 MHz	54.3537	20.5613
865.000000 MHz	54.4503	20.5635
870.000000 MHz	54.5615	20.5482
875.000000 MHz	54.6115	20.5130
880.000000 MHz	54.6722	20.5051
885.000000 MHz	54.7329	20.4965
890.000000 MHz	54.7445	20.4698
895.000000 MHz	54.7501	20.3876
900.000000 MHz	54.6757	20.3535

Muscle

Table 13. 835 MHz head and muscle tissue dielectric parameters

Title

SubTitle

June 26, 2006 05:38 PM

Frequency	e'	e"
1.750000000 GHz	40.2721	13.3659
1.760000000 GHz	40.0505	13.3444
1.770000000 GHz	39.7788	13.3327
1.780000000 GHz	39.5383	13.3838
1.790000000 GHz	39.3423	13.4642
1.800000000 GHz	39.2678	13.5609
1.810000000 GHz	39.2870	13.6591
1.820000000 GHz	39.4053	13.7331
1.830000000 GHz	39.5692	13.7656
1.840000000 GHz	39.7277	13.7781
1.850000000 GHz	39.8080	13.7224
1.860000000 GHz	39.7784	13.6746
1.870000000 GHz	39.6340	13.6153
1.880000000 GHz	39.4247	13.5745
1.890000000 GHz	39.1705	13.5726
1.900000000 GHz	38.9386	13.6116
1.910000000 GHz	38.7636	13.6809

Title

SubTitle

June 27, 2006 04:47 PM

Frequency	e'	e"
1.750000000 GHz	39.5437	12.4458
1.760000000 GHz	39.4405	12.5311
1.770000000 GHz	39.3492	12.6640
1.780000000 GHz	39.3213	12.8286
1.790000000 GHz	39.3275	12.9907
1.800000000 GHz	39.3843	13.0974
1.810000000 GHz	39.4240	13.1532
1.820000000 GHz	39.4990	13.1263
1.830000000 GHz	39.5548	13.0141
1.840000000 GHz	39.5004	12.8652
1.850000000 GHz	39.4719	12.7014
1.860000000 GHz	39.3939	12.5403
1.870000000 GHz	39.3069	12.6288
1.880000000 GHz	39.1996	12.7715
1.890000000 GHz	39.0542	12.8970
1.900000000 GHz	38.9532	13.0801
1.910000000 GHz	38.9338	13.2909

Title

SubTitle

June 27, 2006 05:28 PM

Frequency	e'	e"
1.750000000 GHz	51.2302	14.3563
1.760000000 GHz	51.1593	14.4002
1.770000000 GHz	51.1084	14.3999
1.780000000 GHz	51.0392	14.4540
1.790000000 GHz	51.0415	14.4754
1.800000000 GHz	51.0266	14.5213
1.810000000 GHz	51.0516	14.5486
1.820000000 GHz	51.0790	14.5380
1.830000000 GHz	51.0941	14.5833
1.840000000 GHz	51.0858	14.5983
1.850000000 GHz	51.0276	14.5775
1.860000000 GHz	50.9485	14.5927
1.870000000 GHz	50.8736	14.6191
1.880000000 GHz	50.7868	14.6213
1.890000000 GHz	50.7450	14.6736
1.900000000 GHz	50.7245	14.7077
1.910000000 GHz	50.6902	14.7682

Title

SubTitle

July 04, 2006 04:56 PM

Frequency	e'	e"
1.750000000 GHz	39.5906	12.9004
1.760000000 GHz	39.5201	13.0079
1.770000000 GHz	39.3925	13.1031
1.780000000 GHz	39.2233	13.2474
1.790000000 GHz	39.0686	13.3349
1.800000000 GHz	38.9429	13.3756
1.810000000 GHz	38.8421	13.3841
1.820000000 GHz	38.8474	13.3569
1.830000000 GHz	38.8844	13.3317
1.840000000 GHz	38.9271	13.3055
1.850000000 GHz	38.9998	13.3082
1.860000000 GHz	39.0603	13.3145
1.870000000 GHz	39.0911	13.3772
1.880000000 GHz	39.0109	13.4696
1.890000000 GHz	38.8612	13.5521
1.900000000 GHz	38.6806	13.6337
1.910000000 GHz	38.5149	13.6978

Head

Title

SubTitle

July 04, 2006 05:27 PM

Frequency	e'	e"
1.750000000 GHz	51.4696	14.3876
1.760000000 GHz	51.3605	14.4466
1.770000000 GHz	51.2407	14.5291
1.780000000 GHz	51.1461	14.5778
1.790000000 GHz	51.0538	14.6397
1.800000000 GHz	51.0143	14.6805
1.810000000 GHz	50.9987	14.7091
1.820000000 GHz	50.9767	14.7148
1.830000000 GHz	51.0172	14.7040
1.840000000 GHz	51.0039	14.6952
1.850000000 GHz	51.0251	14.7424
1.860000000 GHz	50.9971	14.7920
1.870000000 GHz	50.9715	14.8504
1.880000000 GHz	50.8939	14.9074
1.890000000 GHz	50.8137	14.9672
1.900000000 GHz	50.7064	15.0053
1.910000000 GHz	50.6327	15.0716

Muscle

Table 14. 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 15. 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 16. 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).

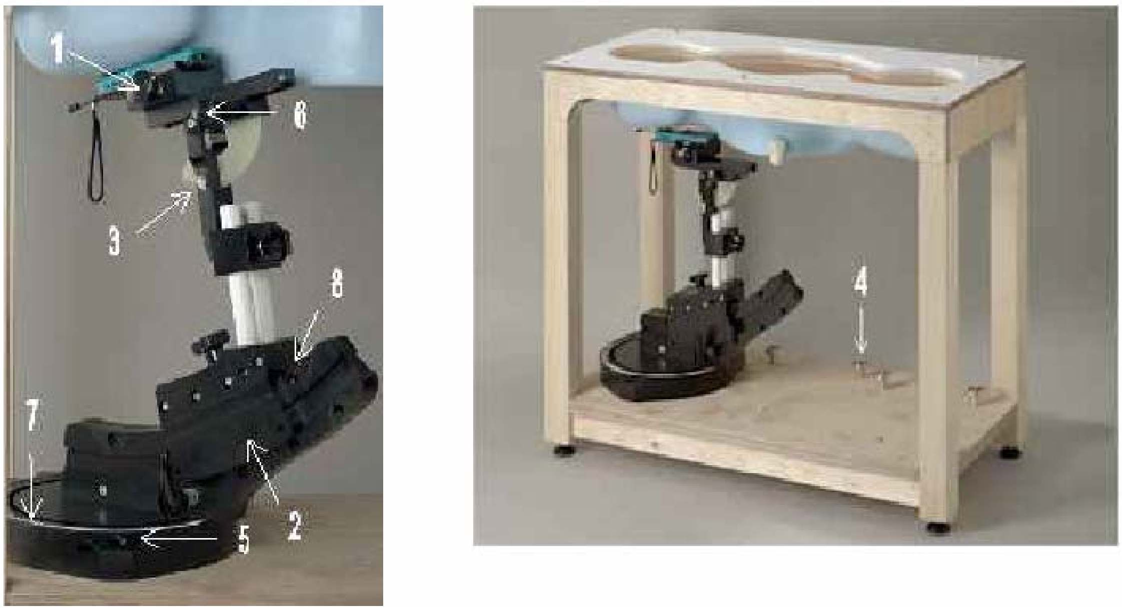

Figure 6. Device Holder

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".

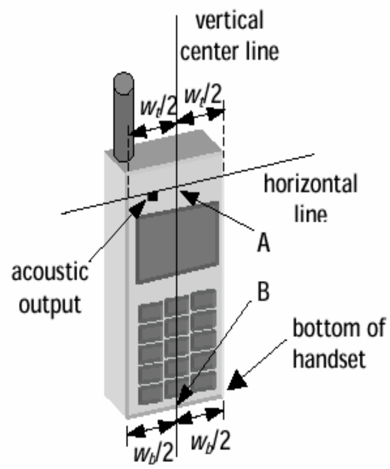

Figure 7a. Handset vertical and horizontal reference lines – fixed case

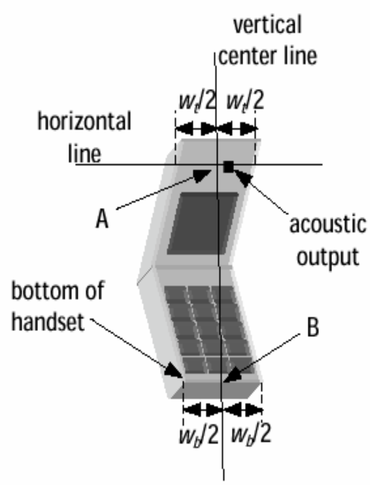

Figure 7b. Handset vertical and horizontal reference lines – "clam-shell"

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).

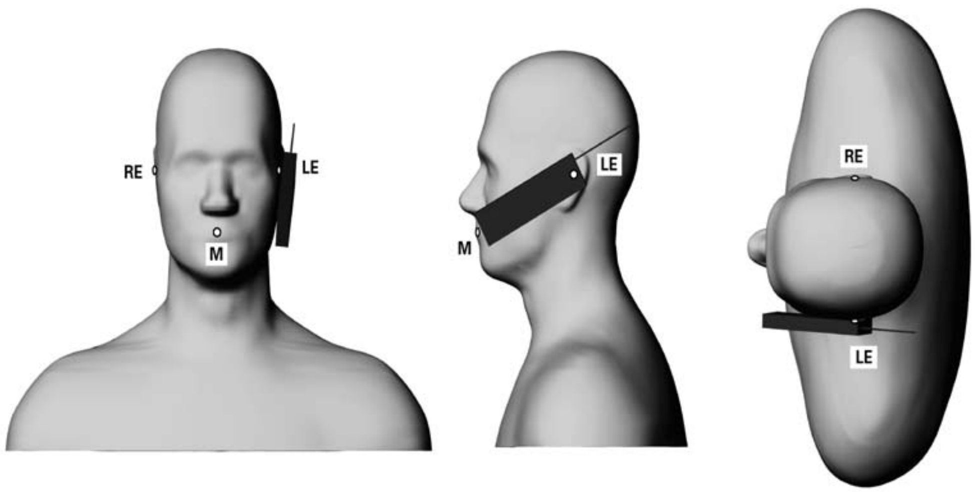

Figure 8. Phone position 1, "cheek" or "touch" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

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**.**

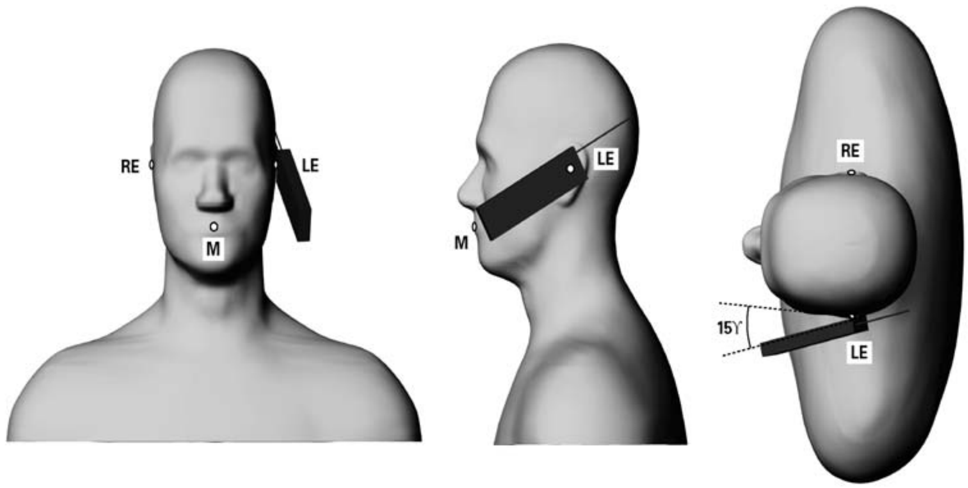

Figure 9. Phone position 2, "tilted position." The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

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 30x30x30 mm with 5 mm 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 (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 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 17. Worst-Case uncertainty budget for DASY4 assessed according to IEEE P1528.

[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.

11.0 TEST RESULTS

11.1 SAR Measurement results at highest power measured against the head

				SAR, averaged over 1g / 10g (W/kg)			SAR, averaged over 1g / 10g (W/kg)		
				Left-hand			Right-hand		
Mode	**f (MHz)**	**Cond. Output Power (dBm)**	**Battery #**	**Liquid Temp (°C)**	**Cheek**	**Tilted**	**Liquid Temp (°C)**	**Cheek**	**Tilted**
CDMA 800	824.70	24.74	1	-	-	-	22.3	1.11 / 0.81	-
	836.52	24.56	1	-	-	-	22.1	1.31 / 0.95	-
	848.52	24.57	1	-	-	-	22.5	**1.38 / 1.00**	-
	836.52	24.56	1	-	-	-	21.9	-	0.61 / 0.46
	824.70	24.74	1	22.3	1.17 / 0.84	-	-	-	-
	836.52	24.56	1	21.7	1.28 / 0.92	-	-	-	-
	848.52	24.57	1	22.2	1.37 / 0.98	-	-	-	-
	836.52	24.56	1	22.1	-	0.59 / 0.45	-	-	-
	848.52	24.57	2	-	-	-	22.2	1.08 / 0.80[1]	-
	848.52	24.57	3	-	-	-	21.6	1.27 / 0.92	-
CDMA 1900	1851.25	23.27	1	-	-	-	22.5	1.39 / 0.82[1]	-
	1880.00	23.47	1	-	-	-	22.3	1.21 / 0.73[1]	-
	1908.50	23.44	1	-	-	-	22.3	0.55 / 0.33[1]	-
	1880.00	23.47	1	-	-	-	22.4	-	0.20 / 0.12
	1880.00	23.47	1	22.6	0.75 / 0.45	-	-	-	-
	1851.25	23.27	1	22.7	-	0.41 / 0.24[1]	-	-	-
	1880.00	23.47	1	22.5	-	1.10 / 0.63	-	-	-
	1908.50	23.44	1	22.8	-	1.14 / 0.64[1]	-	-	-
	1851.25	23.27	2	-	-	-	22.2	1.34 / 0.79[1]	-
	1851.25	23.27	3	-	-	-	22.0	**1.44 / 0.85**[1]	-

Table 18. SAR results for head configuration

[1] Extrapolated SAR values when Power Drift is less than 0.20 dB. Compenstated SAR value is calculated by the following formula: SAR (compensated) = SAR (measured) * 10^(|Power Drift (dB)| / 10)

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

Mode	f (MHz)	Cond. Output Power (dBm)	Batt. #	Liquid Temp (°C)	Accessory	Body SAR, averaged over 1g / 10g (W/kg)
CDMA 800	824.70	24.73	1	21.5	Plastic Holster 1, front facing phantom	0.96 / 0.70
	836.52	24.52	1	21.8	Plastic Holster 1, front facing phantom	0.95 / 0.70
	848.52	24.58	1	21.6	Plastic Holster 1, front facing phantom	0.95 / 0.70
	836.52	24.52	1	21.5	Leather Holster 2, front facing phantom	0.76 / 0.56[2]
	824.70	24.73	1	21.7	Leather Holster 2, back facing phantom	0.86 / 0.63
	836.52	24.52	1	21.8	Leather Holster 2, back facing phantom	0.87 / 0.64[2]
	848.52	24.58	1	21.9	Leather Holster 2, back facing phantom	0.86 / 0.64[2]
	836.52	24.52	1	22.0	Leather Holster 4, front facing phantom	0.54 / 0.37
	836.52	24.52	1	22.1	Leather Holster 4, back facing phantom	0.65 / 0.42
	824.70	24.73	1	21.6	No Holster, 15 mm away, back facing phantom	0.85 / 0.62
	836.52	24.52	1	21.9	No Holster, 15 mm away, back facing phantom	0.91 / 0.67
	848.52	24.58	1	21.3	No Holster, 15 mm away, back facing phantom	0.94 / 0.69
	824.70	24.73	1	22.3	Plastic Holster 1, front facing phantom, with Headset attached	0.69 / 0.51
	824.70	24.73	1	22.5	Plastic Holster 1, front facing phantom, with Bluetooth connected	**1.02 / 0.75**
CDMA 1900	1880.00[1]	23.47	1	22.3	Plastic Holster 1, front facing phantom	0.28 / 0.17[2]
	1880.00	23.47	1	22.1	Leather Holster 2, front facing phantom	0.15 / 0.09
	1851.25	23.18	1	22.0	Leather Holster 2, back facing phantom	0.83 / 0.50[2]
	1880.00	23.47	1	22.1	Leather Holster 2, back facing phantom	1.16 / 0.69
	1908.50	23.49	1	22.0	Leather Holster 2, back facing phantom	1.22 / 0.71[2]
	1880.00	23.47	1	22.3	Leather Holster 4, front facing phantom	0.24 / 0.14[2]
	1851.25	23.18	1	22.2	Leather Holster 4, back facing phantom	1.01 / 0.60
	1880.00	23.47	1	22.1	Leather Holster 4, back facing phantom	1.24 / 0.73
	1908.50	23.49	1	22.0	Leather Holster 4, back facing phantom	1.40 / 0.82[2]
	1851.25	23.18	1	22.0	No Holster, 15 mm away, back facing phantom	1.01 / 0.60[2]
	1880.00	23.47	1	22.2	No Holster, 15 mm away, back facing phantom	1.17 / 0.68
	1908.50	23.49	1	21.8	No Holster, 15 mm away, back facing phantom	**1.55 / 0.87**
	1908.50	23.49	1	22.1	Leather Holster 4, back facing phantom, with Headset attached	1.41 / 0.82[2]
	1908.50	23.49	1	21.9	Leather Holster 4, back facing phantom, with Bluetooth connected	1.24 / 0.73[2]

Table 19. SAR results for body-worn configurations

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

[2] Extrapolated SAR values when Power Drift is less than 0.20 dB. Compenstated SAR value is calculated by the following formula: SAR (compensated) = SAR (measured) * 10^(|Power Drift (dB)| / 10)

12.0 REFERENCES

[1] IEEE 1528-2003: Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

[2] 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)

[3] 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)

[4] 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).

[5] 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)

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

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

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

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

[10] DASY 4 DOSIMETRIC ASSESSMENT SYSTEM SOFTWARE MANUAL V4.7
Schmid & Partner Engineering AG, June 2006.

[11] Health Canada, Safety Code 6, 1999: Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency range from 3 kHz to 300 GHz.

[12] RSS-102, Issue 2, November 2005: Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands).

[13] ARPANSA_ Radio Protection Standard_Radiation Protection Series Publication No. 3 Maximum Exposure Levels to Radiofrequency Fields —3 kHz to 300 GHz

[14] AS/NZS 2772.2-1988 Radiofrequency radiation - Principles and methods of measurement - 300 kHz to 100 GHz

[15] Australian CommunicationsAuthority Radiocommunications (Electromagnetic Radiation — Human Exposure) Standard, Schedule 1 & Schedule 2.

[16] IEC 62209-1, First Edition-2005: Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures –Part 1:

Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)