SAR Compliance Test Report

Testing Lab:	RIM Testing Services (RTS) 440 Phillip Street Waterloo, Ontario Canada N2L 5R9 Phone: 519-888-7465 Fax: 519-746-0189	**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 BlackBerry® Smartphone 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 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, DASY4 manual which follows draft IEC 62209 – Part 2 and Health Canada's Safety Code 6.

Tested and documented by:	Signatures	Date
Shahriar Ninad Compliance Specialist		31-July-2008
Tested and reviewed by:		
Daoud Attayi Senior Compliance Specialist		02-Sep-2008
Approved by:		
Paul G. Cardinal, Ph.D. Director, RIM Testing Services		14-Sep-2008

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1.0 OPERATING CONFIGURATIONS AND TEST CONDITIONS

1.1 Picture of Device

Please refer to Appendix E.

Figure 1. BlackBerry Smartphone

1.2 Antenna description

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

Table 1. Antenna description

1.3 Device description

Device Model	RBZ41GW				
FCC ID	L6ARBZ40GW				
PIN/Serial No.	PIN: 20761849 (GSM/GPRS/EDGE), 20761A7D (BT and Wi-Fi)				
Prototype or Production Unit	Production				
Mode(s) of Operation in North America	1-slot GSM 850 GSM 1900	2-slots EDGE/GPRS 850 1900	Bluetooth	802.11b	802.11g
Maximum nominal conducted RF Output Power (dBm)	33.5 30.5	30.5 27.5	8.50	18.00	17.00
Tolerance in Power Setting on centre channel (dB)	± 0.50	± 0.50	N/A	± 0.50	± 0.50
Duty Cycle	1:8	2:8	N/A	1:1	1:1
Tx Frequency Range (MHz)	824.2 – 848.8 1850.2 – 1909.8	824.2 – 848.8 1850.2 – 1909.8	2402-2483	2412-2462	2412-2462

Table 2. Test device description

The device supports GSM/EDGE/GPRS 900/1800 MHz bands that are not operational in North America, therefore no data is presented in this report for those bands.

1.4 Body worn accessories (holsters)

The device has been tested with the following holster which contains metal components and the separation distance between the device and the user's body is listed in the table below. The holster is designed with the intended device 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 device. The device can also be placed in the holster with the backside facing the belt clip. Body SAR measurements were carried out with the worst-case configuration front LCD side and backside towards the belt clip.

Holster	Model / Part Number	Separation (mm)
* Leather Swivel Holster	HDW-18960-001	20
Horizontal Holster	HDW-18965-001	21
* Koskin Swivel Holster	HDW-19869-001	20

* Identical design, different type of material used with same separation distance.

Table 3: Body worn holster

Please refer to Appendix E.

Figure 2. Body-worn holster

1.5 Headset

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

1) HDW-14322-003

1.6 Battery

The BlackBerry device was tested with the following Lithium Ion Battery pack.

1) BAT-17720-002

1.7 Procedure used to establish test signal

The device 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 device 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.

A proprietary test software was used to command the device to transmit at specifc 802.11 b/g WLAN band, maximum power, desired frequency and modulation type/data rate.

1.8 Highlights of the FCC OET SAR Measurement Requirements for 3-6 GHz and Measurement Procedures for 802.11 b/g Transmitter

- 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

Table 4: Probe specification requirements

- Frequency Channel Configuration: 802.11 b/g modes are tested on “default test channels” 1, 6 and 11.
- 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.
- 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:

802.11b @ 1Mbps		802.11g @ 6Mbps	
Chan	**Cond. Power (dBm)**	**Chan**	**Cond. Power (dBm)**
1	18.18	1	13.80
6	17.85	6	16.50
11	17.75	11	13.50

Table 5: 802.11 b/g channel vs. conducted power

		802.11g Channel 6			802.11b Channel 6
Data Rate (Mbps)	**Mod.**	**Cond. Power (dBm)**	**Data Rate (Mbps)**	**Mod.**	**Cond. Power (dBm)**
6	BPSK	16.60	1	BPSK	17.85
9	BPSK	16.50	2	DQPSK	17.84
12	QPSK	14.70	5.5	CCK	17.70
18	QPSK	14.50	11	CCK	17.65
24	16-QAM	13.20			
36	16-QAM	12.75			
48	64-QAM	10.90			
54	64-QAM	10.72			

Table 6: 802.11 b/g modulation type/data rate vs. conducted power

1.9 Highlights of the FCC OET SAR Evaluation Considerations for Handsets with Multiple Transmitters and Antennas

Unlicensed Transmitters
When there is simultaneous transmission –
Stand-alone SAR not required when
- output ≤ 2·PRef and antenna is > 5.0 cm from other antennas
- output ≤ PRef and antenna is > 2.5 cm from other antennas
- the other antenna(s), which are < 2.5 cm away, has an output ≤ PRef OR max 1g SAR < 1.2 W/kg

Otherwise stand-alone SAR is required
- test SAR on highest output channel for each wireless mode and exposure condition
- if SAR for highest output channel is > 50% of SAR limit, evaluate all channels according to normal procedure

Simultaneous Transmission SAR not required:
Unlicensed only
- when stand-alone 1-g SAR is not required and antenna is > 5 cm from other antennas
- when the other antenna(s), which are < 2.5 cm away, has an output ≤ PRef OR max 1g SAR < 1.2 W/kg

Licensed & Unlicensed
- when the sum of the 1-g SAR is < 1.6 W/kg for all simultaneous transmitting antennas which are < 5 cm from each other.
- when SAR to antenna separation ratio of simultaneous transmitting antenna pair is < 0.3

Simultaneous Transmission SAR required:
Licensed & Unlicensed
- antenna pairs with SAR to antenna separation ratio ≥ 0.3; test is only required for the configuration that results in the highest SAR in standalone configuration for each wireless mode and exposure condition.

	2.45	5.15 - 5.35	5.47 - 5.85	GHz
P_{Ref}	12	6	5	mW
Device output power should be rounded to the nearest mW to compare with values specified in this table.				

Table 7 – Output Power Thresholds for Unlicensed Transmitters

Mode	Configuration	Highest 1 g SAR (W/kg)
BT	Head-Right-Touch	0.0005
	Body-Holster 1-Back	0.0005
802.11b/g	Head-Right-Touch	0.33
	Body-Holster 1-Back	0.10
GSM/GPRS/EDGE	Head- Right -Touch	1.01
	Body-Holster 1-Back	0.59

Table 8 – Highest SAR values for the same configuration

The sum of 1-g SAR values is < 1.6 W/kg for all simultaneous transmitting antennas which are < 5 cm from each other, therefore Simultaneous Transmission SAR is not required.

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 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.

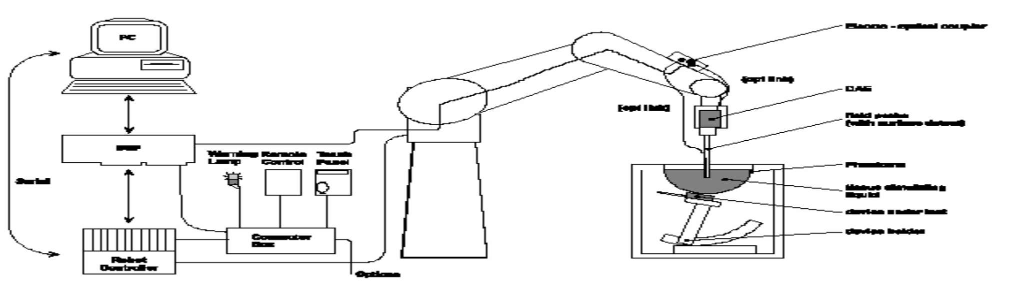

Figure 3. System Description

2.1.1 Equipment List

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
SCHMID & Partner Engineering AG	E-field probe	ET3DV6	1642	01/18/2009
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE3)	DAE3 V1	472	03/05/2009
SCHMID & Partner Engineering AG	Dipole Validation Kit	D835V2	446	01/08/2009
SCHMID & Partner Engineering AG	Dipole Validation Kit	D1900V2	545	01/09/2009
SCHMID & Partner Engineering AG	Dipole Validation Kit	D2450V2	747	11/06/2009
Agilent Technologies	Signal generator	8648C	4037U03155	09/20/2009
Agilent Technologies	Power meter	E4419B	GB40202821	09/19/2008
Agilent Technologies	Power sensor	8481A	MY41095417	09/19/2008
Agilent Technologies	Power meter	N1911A	MY45100905	04/22/2009
Agilent Technologies	Power sensor	N1921A	SG45240281	05/05/2009
Amplifier Research	Amplifier	5S1G4M3	300986	CNR
Agilent Technologies	Network analyzer	8753ES	US39174857	09/19/2008
Rohde & Schwarz	Base Station Simulator	CMU 200	109747	12/04/2008
Rohde & Schwarz	CBT Bluetooth Tester	CBT35	100370	12/06/2008

Table 9. Equipment list

2.2 Description of the test setup

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

2.2.1 Device and base station simulator setup

- Power up the device.
- 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 device.

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 Device and the communications test instrument. Place the Device 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
Probe model EX3DV6	
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 10. Probe specifications

3.2 Probe calibration and measurement uncertinty

The probe ET3DV6 was calibrated 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 (07/25/2008)	8.7 / 5.7	42.28	0.86	22.1
	Measured (07/28/2008)	9.0 / 6.0	42.24	0.87	22.4
	Recommended Limits	9.3 / 6.0	41.50	0.90	N/A
1900	Measured (07/23/2008)	40.0 / 21.0	38.23	1.47	22.2
	Recommended Limits	37.0 / 19.6	40.00	1.40	N/A
2450	Measured (07/18/2008)	56.8 / 26.0	37.57	1.92	22.9
	Measured (07/21/2008)	58.0 / 26.4	37.49	1.93	22.6
	Measured (07/29/2008)	57.8 / 26.4	37.54	1.96	22.4
	Recommended Limits	53.2 / 24.8	39.2	1.80	N/A

Table 11. 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		MIXTURE 2450 MHz	
	Brain %	Muscle %	Brain %	Muscle %	Brain %	Muscle %
Water	40.29	65.45	55.24	69.91	55.0	68.75
Sugar	57.90	34.31	0	0	0	0
Salt	1.38	0.62	0.31	0.13	0	0
HEC	0.24	0	0	0	0	0
Bactericide	0.18	0.10	0	0	0	0
DGBE	0	0	44.45	29.96	40.0	31.25
Triton X-100	0	0	0	0	5.0	0

Table 12. 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	05/12/2009
IKA Works Inc.	Hot Plate	RC Basic	3.107433	N/A

Table 13. 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.

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 (07/25/2008)	42.28	0.86	22.3
		Measured (07/28/2008)	42.24	0.87	22.4
		Recommended Limits	41.50	0.90	N/A
	Muscle	Measured (07/28/2008)	52.45	0.93	22.4
		Recommended Limits	55.20	0.97	N/A
1900	Head	Measured (07/23/2008)	38.23	1.47	22.2
		Recommended Limits	40.00	1.40	N/A
	Muscle	Measured (07/24/2008)	51.01	1.59	22.3
		Recommended Limits	53.30	1.52	N/A
2450	Head	Measured (07/18/2008)	37.57	1.92	22.9
		Measured (07/21/2008)	37.49	1.93	22.6
		Measured (07/29/2008)	37.54	1.96	22.4
		Recommended Limits	39.20	1.80	N/A
	Muscle	Measured (07/18/2008)	50.37	1.94	22.9
		Measured (07/21/2008)	50.54	2.03	22.5
		Measured (07/29/2008)	50.35	2.03	22.5
		Recommended Limits	52.70	1.95	N/A

Table 14. 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	09/19/2008
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	05/12/2009

Table 15. Equipment required for electrical parameter measurements

6.2.2 Test Configuration

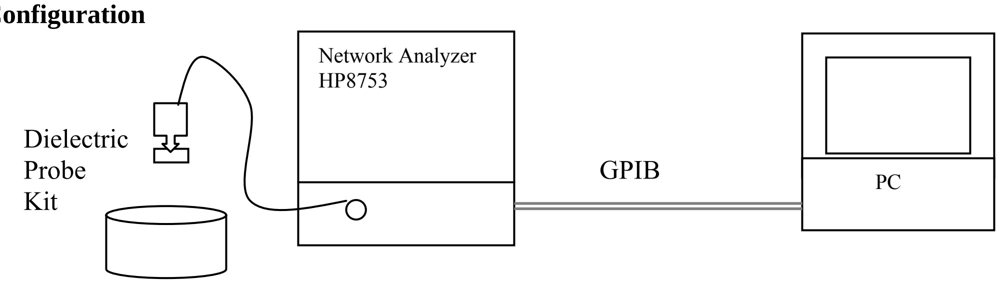

Figure 5. Test configuration

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 16.
Relative permittivity $\varepsilon r = \varepsilon' = 42.28$
Conductivity $\sigma = \omega\, \varepsilon_0\, \varepsilon'' = (2\pi \times 835 \times 10^6)(8.854 \times 10^{-12})(18.48) = 0.86$ S/m

Title

SubTitle

July 25, 2008 04:14 PM

Frequency	e'	e''
800.000000 MHz	42.6254	18.5415
805.000000 MHz	42.5892	18.5513
810.000000 MHz	42.5263	18.5200
815.000000 MHz	42.4664	18.5151
820.000000 MHz	42.4322	18.5032
825.000000 MHz	42.3728	18.4932
830.000000 MHz	42.3214	18.4707
835.000000 MHz	42.2791	18.4772
840.000000 MHz	42.2239	18.4354
845.000000 MHz	42.1490	18.4309
850.000000 MHz	42.1122	18.4466
855.000000 MHz	42.0568	18.3956
860.000000 MHz	41.9970	18.3619
865.000000 MHz	41.9087	18.3675
870.000000 MHz	41.8632	18.3760
875.000000 MHz	41.7862	18.3434
880.000000 MHz	41.7277	18.3359
885.000000 MHz	41.7004	18.3294
890.000000 MHz	41.6828	18.3200
895.000000 MHz	41.6372	18.3141
900.000000 MHz	41.5963	18.3217

Head

Title

SubTitle

July 28, 2008 10:11 AM

Frequency	e'	e''
800.000000 MHz	53.2533	20.1109
805.000000 MHz	53.2420	20.1319
810.000000 MHz	53.1672	20.0965
815.000000 MHz	53.1376	20.1069
820.000000 MHz	53.0984	20.0873
825.000000 MHz	53.0535	20.0644
830.000000 MHz	52.9971	20.0678
835.000000 MHz	52.9479	20.0576
840.000000 MHz	52.8867	20.0412
845.000000 MHz	52.8527	20.0367
850.000000 MHz	52.7875	20.0329
855.000000 MHz	52.7613	20.0150
860.000000 MHz	52.6989	19.9838
865.000000 MHz	52.6293	19.9875
870.000000 MHz	52.5847	19.9981
875.000000 MHz	52.5422	19.9550
880.000000 MHz	52.4753	19.9846
885.000000 MHz	52.4175	19.9793
890.000000 MHz	52.3916	19.9725
895.000000 MHz	52.3567	19.9535
900.000000 MHz	52.3211	19.9712
905.000000 MHz	52.2619	19.9514
910.000000 MHz	52.2266	19.9381
915.000000 MHz	52.1680	19.9544
920.000000 MHz	52.1153	19.9175

Muscle

Table 16. 835 MHz head and muscle tissue dielectric parameters

Title

SubTitle

July 23, 2008 04:20 PM

Frequency	e'	e''
1.800000000 GHz	38.7386	13.5924
1.805000000 GHz	38.7190	13.6071
1.810000000 GHz	38.6918	13.6083
1.815000000 GHz	38.6732	13.6134
1.820000000 GHz	38.6571	13.6172
1.825000000 GHz	38.6163	13.6446
1.830000000 GHz	38.5931	13.6556
1.835000000 GHz	38.5653	13.6784
1.840000000 GHz	38.5483	13.6887
1.845000000 GHz	38.5053	13.6849
1.850000000 GHz	38.4704	13.6942
1.855000000 GHz	38.4380	13.6873
1.860000000 GHz	38.4071	13.6973
1.865000000 GHz	38.3970	13.7216
1.870000000 GHz	38.3628	13.7249
1.875000000 GHz	38.3331	13.7403
1.880000000 GHz	38.3214	13.7360
1.885000000 GHz	38.2948	13.7409
1.890000000 GHz	38.2681	13.7547
1.895000000 GHz	38.2398	13.7607
1.900000000 GHz	38.2295	13.7763
1.905000000 GHz	38.2151	13.7945
1.910000000 GHz	38.2016	13.7945
1.915000000 GHz	38.1811	13.8017
1.920000000 GHz	38.1574	13.8081

Head

Title

SubTitle

July 24, 2008 10:21 AM

Frequency	e'	e''
1.800000000 GHz	51.3334	14.6224
1.805000000 GHz	51.3310	14.6350
1.810000000 GHz	51.3238	14.6587
1.815000000 GHz	51.3239	14.6691
1.820000000 GHz	51.3138	14.6881
1.825000000 GHz	51.2872	14.7208
1.830000000 GHz	51.2661	14.7383
1.835000000 GHz	51.2584	14.7624
1.840000000 GHz	51.2474	14.7822
1.845000000 GHz	51.2186	14.7887
1.850000000 GHz	51.1958	14.8186
1.855000000 GHz	51.1751	14.8503
1.860000000 GHz	51.1740	14.8584
1.865000000 GHz	51.1628	14.8750
1.870000000 GHz	51.1473	14.9026
1.875000000 GHz	51.1282	14.9296
1.880000000 GHz	51.1028	14.9445
1.885000000 GHz	51.0864	14.9693
1.890000000 GHz	51.0528	14.9737
1.895000000 GHz	51.0351	14.9999
1.900000000 GHz	51.0055	15.0118
1.905000000 GHz	51.0042	15.0273
1.910000000 GHz	50.9898	15.0474
1.915000000 GHz	50.9492	15.0656
1.920000000 GHz	50.9376	15.0798

Muscle

Table 17. 1900 MHz head and muscle tissue dielectric parameters

Title
SubTitle
July 18, 2008 03:51 PM

Frequency	e'	e"
2.400000000 GHz	37.7169	13.8757
2.405000000 GHz	37.7004	13.8836
2.410000000 GHz	37.6840	13.9050
2.415000000 GHz	37.6770	13.9244
2.420000000 GHz	37.6733	13.9441
2.425000000 GHz	37.6510	13.9539
2.430000000 GHz	37.6202	13.9734
2.435000000 GHz	37.6013	13.9970
2.440000000 GHz	37.5859	14.0180
2.445000000 GHz	37.5716	14.0435
2.450000000 GHz	37.5679	14.0580
2.455000000 GHz	37.5423	14.0654
2.460000000 GHz	37.5352	14.0853
2.465000000 GHz	37.5166	14.1009
2.470000000 GHz	37.5025	14.1183
2.475000000 GHz	37.4777	14.1391
2.480000000 GHz	37.4650	14.1610
2.485000000 GHz	37.4438	14.1789
2.490000000 GHz	37.4241	14.1984
2.495000000 GHz	37.4073	14.2211
2.500000000 GHz	37.3985	14.2401

Head

Title
SubTitle
July 18, 2008 10:08 PM

Frequency	e'	e"
2.400000000 GHz	50.5019	14.0690
2.405000000 GHz	50.4917	14.0919
2.410000000 GHz	50.4815	14.1113
2.415000000 GHz	50.4662	14.1262
2.420000000 GHz	50.4641	14.1397
2.425000000 GHz	50.4412	14.1567
2.430000000 GHz	50.4236	14.1748
2.435000000 GHz	50.4100	14.1808
2.440000000 GHz	50.4024	14.2125
2.445000000 GHz	50.3872	14.2316
2.450000000 GHz	50.3693	14.2541
2.455000000 GHz	50.3432	14.2725
2.460000000 GHz	50.3205	14.2904
2.465000000 GHz	50.2843	14.2852
2.470000000 GHz	50.2620	14.3176
2.475000000 GHz	50.2540	14.3289
2.480000000 GHz	50.2311	14.3515
2.485000000 GHz	50.2089	14.3625
2.490000000 GHz	50.1861	14.3962
2.495000000 GHz	50.1875	14.4256
2.500000000 GHz	50.1669	14.4606

Muscle

Table 18. 2450 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 19. 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 20. 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 Device 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).

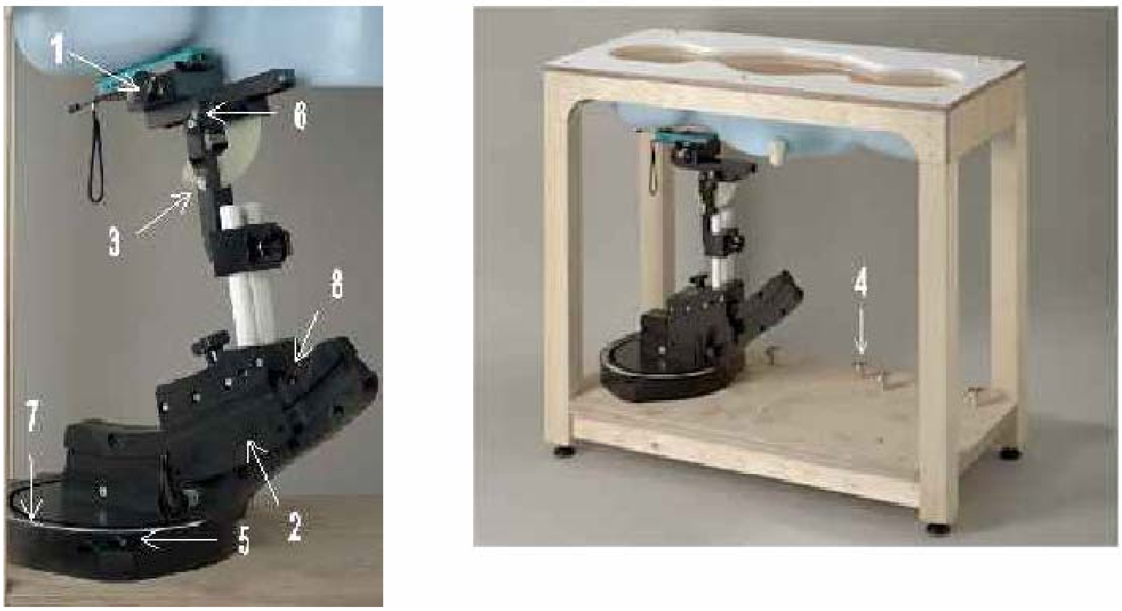

Figure 6. Device Holder

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”.

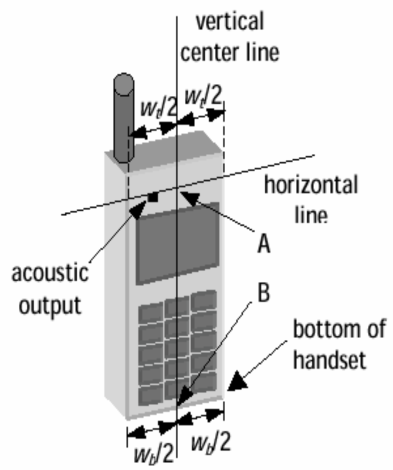

Figure 7a. Handset vertical and horizontal reference lines – fixed case

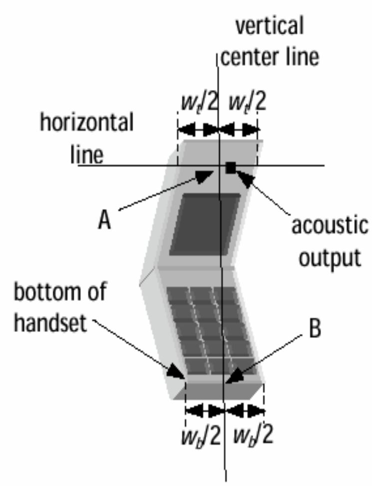

Figure 7b. Handset vertical and horizontal reference lines – “clam-shell”

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).

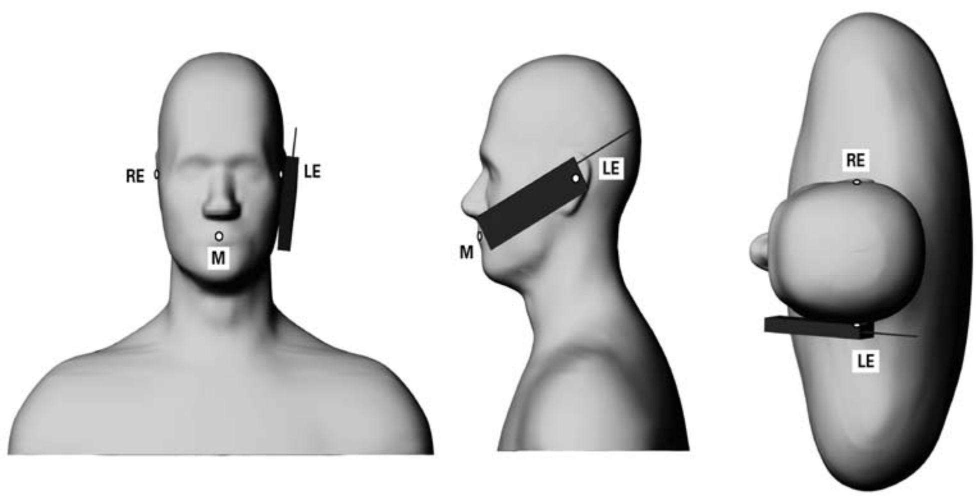

Figure 8. Phone position 1, "cheek" or "touch" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

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**.**

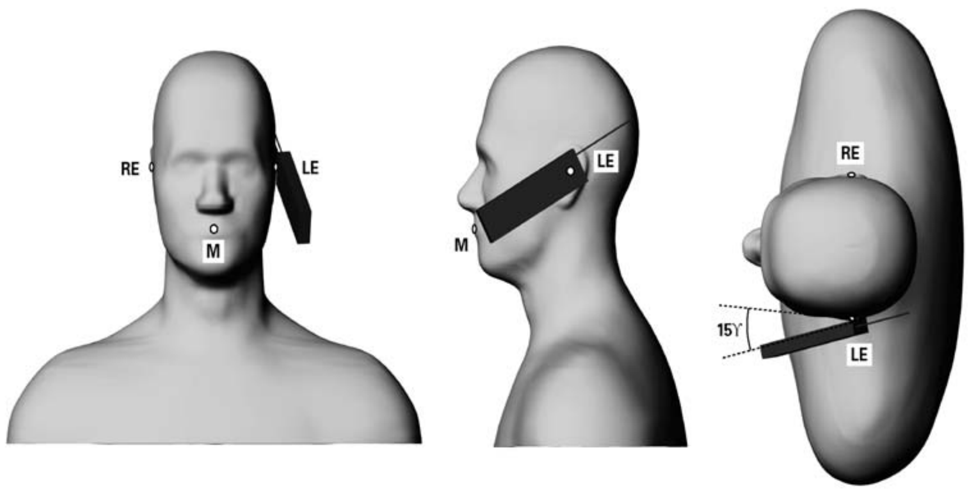

Figure 9. Phone position 2, "tilted position." The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

8.2.2 Body Holster Configuration

A body worn holster, as shown on Figure 2, was tested with the Smartphone 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 device to simulate hands-free operation in a body worn holster configuration.

9.0 HIGH LEVEL EVALUATION

9.1 Maximum search

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

9.2 Extrapolation

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

9.3 Boundary correction

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

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

The 1g and 10g peak evaluations are only available for the predefined cube 5x5x7 scan. The routines are verified and optimized for the grid dimensions used in these cube measurements.
The measured volume of 30x30x30mm with 7.5mm resolution in (x,y) and 5mm resolution in z axis amounts to 175 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 21. 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.

11.0 TEST RESULTS

11.1 SAR Measurement results at highest power measured against the head

Test Position	Mode	f (MHz)	Cond. Output Power (dBm)	Liquid Temp. (°C)	SAR, averaged over 1 g		
					Measured (W/kg)	Power Drift (dB)	*Extrapolated (W/kg)
Right Head Cheek	2-slots GSM/EDGE 850 MHz	824.2	30.6				
		** 836.8	30.7	22.1	0.628	-0.010	0.63
		848.8	30.6				
Right Head 15° Tilt	2-slots GSM/EDGE 850 MHz	824.2	30.6				
		836.8	30.7	22.2	0.412	0.165	0.41
		848.8	30.6				
Right Head Cheek	1-slot GSM 850 MHz	824.2	33.7				
		836.8	33.6	22.3	0.647	0.001	0.65
		848.8	33.6				
Left Head Cheek	2-slots GSM/EDGE 850 MHz	824.2	30.6				
		836.8	30.7	22.3	0.655	0.194	**0.66**
		848.8	30.6				
Left Head 15° Tilt	2-slots GSM/EDGE 850 MHz	824.2	30.6				
		836.8	30.7	22.5	0.408	0.001	0.41
		848.8	30.6				
Left Head Cheek	1-slot GSM 850 MHz	824.2	33.7				
		836.8	33.6	22.4	0.649	0.014	0.65
		848.8	33.6				

Table 22. SAR results for GSM/EDGE 850 for head configuration

* Note 1: If the power drift is ≤ – 0.200 dB, the extrapolated SAR is calculated using the formula:
Extrapolated SAR = (Measured SAR) * 10^(|Power Drift (dB)| / 10)

** Note 2: Supplement C: Middle channel testing is sufficient if SAR < 3 dB below limit

Test Position	**Mode**	**f (MHz)**	**Cond. Output Power (dBm)**	**Liquid Temp. (°C)**	**SAR, averaged over 1 g**		
					Measured (W/kg)	**Power Drift (dB)**	***Extrapolated (W/kg)**
Right Head Cheek	2-slots GSM/EDGE 1900 MHz	1850.2	27.7	22.4	0.663	0.001	0.66
		1880.0	27.5	22.5	0.828	0.037	0.83
		1909.8	27.5	22.5	1.010	0.053	**1.01**
Right Head 15° Tilt	2-slots GSM/EDGE 1900 MHz	1850.2	27.7				
		1880.0	27.5				
		1909.8	27.5	22.4	0.277	0.024	0.28
Right Head Cheek	1-slot GSM 1900 MHz	1850.2	30.6				
		1880.0	30.5				
		1909.8	30.5	22.2	0.948	-0.033	0.95
Left Head Cheek	2-slots GSM/EDGE 1900 MHz	1850.2	27.7				
		1880.0	27.5	22.4	0.683	0.048	0.68
		1909.8	27.5				
Left Head 15° Tilt	2-slots GSM/EDGE 1900 MHz	1850.2	27.7				
		1880.0	27.5	22.5	0.397	0.110	0.40
		1909.8	27.5				
Left Head Cheek	1-slot GSM 1900 MHz	1850.2	30.6				
		1880.0	30.5	22.6	0.731	-0.071	0.73
		1909.8	30.5				

Table 23. SAR results for GSM/EDGE 1900 for head configuration

* Note: If the power drift is ≤ – 0.200 dB, the extrapolated SAR is calculated using the formula:
Extrapolated SAR = (Measured SAR) * 10^(|Power Drift (dB)| / 10)

Test Position	Mode	f (MHz)	Cond. Output Power (dBm)	Liquid Temp. (°C)	SAR, averaged over 1 g		
					Measured (W/kg)	Power Drift (dB)	*Extrapolated (W/kg)
Right Head Cheek	802.11 b 2450 MHz	2412	18.18	23.0	0.326	0.179	0.33
		2437	17.85	23.1	0.153	0.046	0.15
		2462	17.75	23.1	0.088	-0.199	0.09
Right Head 15° Tilt	802.11 b 2450 MHz	2412	18.18	22.9	0.498	-0.016	**0.50**
		2437	17.85				
		2462	17.75				
Left Head Cheek	802.11 b 2450 MHz	2412	18.18	22.8	0.231	-0.153	0.23
		2437	17.85				
		2462	17.75				
Left Head 15° Tilt	802.11 b 2450 MHz	2412	18.18	22.8	0.363	-0.120	0.36
		2437	17.85				
		2462	17.75				
Right Head Cheek	BT 2450 MHz	2402	8.67				
		2441	8.50	22.4	0.000516	0.134	0.0005
		2483	8.17				
Right Head 15° Tilt	BT 2450 MHz	2402	8.67				
		2441	8.50				
		2483	8.17				
Left Head Cheek	BT 2450 MHz	2402	8.67				
		2441	8.50	22.6	0.000255	0.950	0.0003
		2483	8.17				
Left Head 15° Tilt	BT 2450 MHz	2402	8.67				
		2441	8.50				
		2483	8.17				

Table 24. Head SAR results for BT and WiFi/WLAN/802.11b modes

* Note 1: If the power drift is ≤ – 0.200 dB, the extrapolated SAR is calculated using the formula:
Extrapolated SAR = (Measured SAR) * 10^(|Power Drift (dB)|/10)

Note 2: Suppliment C: Middle channel testing is sufficient only if SAR < 3dB below limit.

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

Mode	Freq. (MHz)	Cond. Power (dBm)	Holster type / device configuration	Liquid Temp. (°C)	SAR, averaged over 1 g		
					Measured (W/kg)	Power Drift (dB)	*Extrapolated (W/kg)
2-slots GPRS 850 MHz	836.8	30.7	Leather Swivel Holster, back side facing	22.1	0.59	0.082	**0.59**
	836.8	30.7	Horizontal Holster, back side facing	22.0	0.52	0.011	0.52
	836.8	30.7	Leather Swivel Holster, front side facing	22.0	0.42	0.105	0.42
	836.8	30.7	Leather Swivel Holster, headset , back side facing	21.9	0.46	0.026	0.46
	836.8	30.7	No Holster, back side 25 mm away	22.1	0.40	0.010	0.40
2-slots GPRS 1900 MHz	1880.0	27.5	Leather Swivel Holster, back side facing	22.3	0.287	-0.0655	0.29
	1880.0	27.5	Horizontal Holster, back side facing	22.4	0.282	0.0379	0.28
	1880.0	27.5	Leather Swivel Holster, front side facing	22.1	0.138	-0.0605	0.14
	1880.0	27.5	Leather Swivel Holster, headset , back side facing	22.2	0.296	0.0091	0.30
	1880.0	27.5	No Holster, back side 25 mm away	22.4	0.166	0.315	0.17

Table 25. SAR results for GPRS body-worn configurations

***** Note: If the power drift is ≤ – 0.200 dB, the extrapolated SAR is calculated using the formula:
Extrapolated SAR = (Measured SAR) * 10^(|Power Drift (dB)| / 10)

Mode	Freq. (MHz)	Cond. Power (dBm)	Holster type / device configuration	Liquid Temp. (°C)	SAR, averaged over 1 g		
					Measured (W/kg)	Power Drift (dBm)	*Extrapolated (W/kg)
802.11b/ WLAN 2450 MHz	2437	17.85	Horizontal Holster, back side facing	22.9	0.036	-0.058	0.04
	2412	18.18	Leather Swivel Holster, back side facing	22.5	0.095	0.320	0.10
	2437	17.85	Leather Swivel Holster, back side facing	23.0	0.041	-0.147	0.04
	2412	18.18	Leather Swivel Holster, front side facing	22.7	0.034	-0.577	0.04
	2412	18.18	Leather Swivel Holster, headset , back side facing	22.6	0.084	-0.033	0.08
	2412	18.18	No Holster, back side 25 mm away	22.4	0.063	0.092	0.06
Bluetooth	2441	8.50	Leather Swivel Holster, Back side facing	22.5	0.000554	-0.157	0.0006
	2441	8.50	Horizontal Holster, Back side facing	22.1	0.00126	0.242	0.0001
	2441	8.50	Horizontal Holster, Front side facing	22.4	0.000135	0.102	0.0001
	2441	8.50	Horizontal Holster, headset , back side facing	22.2	0.000308	-4.48	0.0009
	2441	8.50	25 mm spacing, Back side facing	22.1	0.000208	4.01	0.0002

Table 26. SAR results for RBZ41GW body-worn configurations

* Note: If the power drift is ≤ – 0.200 dB, the extrapolated SAR is calculated using the formula:
Extrapolated SAR = (Measured SAR) * 10^(|Power Drift (dB)| / 10)

12.0 REFERENCES

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