SAR Compliance Test Report

Testing Lab:

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Statement of Compliance:

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

(none)

Device Category:

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

RF exposure environment:

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

Approved by:	**Signatures**	**Date**
Paul G. Cardinal, Ph.D. Manager, Compliance & Certification	Paul G Cardinal	18 Sep., 2003

Tested and documented by:

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CONTENTS

1.0 OPERATING CONFIGURATIONS AND TEST CONDITIONS

1.1 Pictures of Handheld

Figure 1. BlackBerry Wireless Handheld

1.2 Antenna description

Type	External whip antenna
Location	Left side
Configuration	Helix

Table 1. Antenna description

1.3 Handheld description

Handheld Model	RAL10IN	
FCC ID	L6ARAL10IN	
Serial Number	N/A	
Prototype or Production Unit	Pre-production	
Mode(s) of Operation	PSTN (Phone) / Data-Mode	Push-To-Talk mode
Modulation Mode(s)	TDMA 16QAM	TDMA 16QAM
Maximum pulsed average conducted RF Output Power	28.50 dBm	28.50 dBm
Tolerance in Power Setting	±1.60 dB	±1.60 dB
Duty Cycle	2:6	1:6

Table 2. Test device description

1.4 Body worn accessories

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

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

Figure 2. Body-worn holster ASY-04465-001 and Leather Swivel Holster HDW-05402-002

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

1.5 Headsets

The RIM Blackberry Wireless handheld was tested with (for worst case scan) and without headset model number HDW-03458-001. It was found that the SAR values were lower while the headset was attached as shown in the Table 17 and 18.

1.6 Battery

The BlackBerry Wireless Handheld FCC ID L6ARAL10IN has been tested with two battery options:
BAT-03087-001- A 1000 mAh (Lower capacity)
BAT-06532-001- A 1425 mAh (Higher capacity)

1.7 Procedure used to establish the test signal

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

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

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

2.0 DESCRIPTION OF THE TEST EQUIPMENT

2.1 SAR measurement system

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

The DASY4 system for performing compliance tests consists of the following items:

· A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
· An arm extension for accommodating the data acquisition electronics (DAE).
· A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
· A DAE module which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the Electro-optical coupler (EOC).
· A unit to operate the optical surface detector which is connected to the EOC.
· The EOC performs the conversion from an optical signal into the digital electric signal of the DAE. The EOC is connected to the PC plug-in card.

· The functions of the PC plug-in card based on a DSP is to perform the time critical tasks such as signal filtering, surveillance of the robot operation fast movement interrupts.
· A computer operating Windows NT.
· DASY4 software version 3.1C.
· Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
· The generic twin phantom enabling testing left-hand and right-hand usage.
· The device holder for handheld mobile phones.
· Tissue simulating liquid mixed according to the given recipes (see Application Note).
· System validation dipoles allowing for the validation of proper functioning of the system.

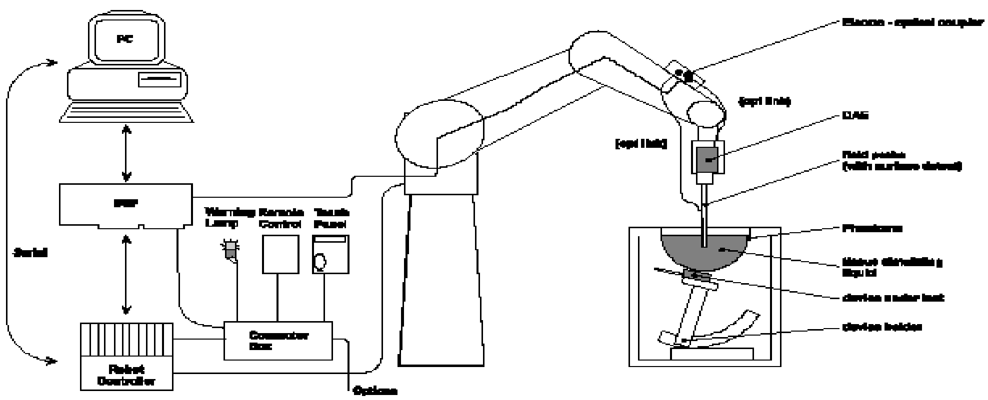

Figure 3: System Description

2.1.1 Equipment List

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
SCHMID & Partner Engineering AG	E-field probe	ET3DV6	1644	21/10/2003
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE3)	DAE3 V1	472	19/08/2004
SCHMID & Partner Engineering AG	Dipole Validation Kit	D835V2	446	21/08/2005
Agilent Technologies	Signal generator	HP 8648C	4037U03155	01/08/2005
Agilent Technologies	Power meter	E4419B	GB40202821	31/07/2004
Agilent Technologies	Power sensor	8482A	US37295126	07/08/2004
Amplifier Research	Amplifier	5S1G4M3	300986	CNR
Agilent Technologies	Network analyzer	8753ES	US39174857	31/07/2004
Giga-Tronics	Power meter	8541C	1837762	30/10/2003
Giga-Tronics	Power sensor	8482A	US37295126	30/10/2003

Table 3. Equipment list

2.2 Description of the test setup

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

2.2.1 Handheld and base station simulator setup

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

2.2.2 DASY setup

- Turn the computer on and log on to Windows NT.
- Start DASY4 software by clicking on the icon located on the Windows desktop. Once the software loads, click on the Change to Robot toolbar button to open the State and Robot Monitoring Windows.
- Once the DASY State dialog opens you can ignore all errors and click OK to open the Robot Monitoring window.
- Mount the DAE unit and the probe. Turn on the DAE unit.
- Turn the Robot Controller on by turning the main power switch to the horizontal position
- Align the probe and click the align probe in the light beam button to correct the probe offset.
- Open a program and configure it to the proper parameters
- Establish a connection between the Handheld and the communications test instrument. Place the Handheld on the stand and adjust it under the phantom.
- Start SAR measurements.

3.0 ELECTRIC FIELD PROBE CALIBRATION

3.1 Probe Specification

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

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

Table 4. Probe specification

3.2 Probe calibration and measurement errors

The probe was calibrated on 21/10/2002 with an accuracy better than ±10%. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe were tested. The probe calibration parameters are shown on Appendix D.

4.0 SAR MEASUREMENT SYSTEM VERIFICATION

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

4.1 System accuracy verification for head adjacent use

f (MHz)	Limits / Measured	SAR (W/kg) 1 g/ 10 g	Dielectric Parameters		Liquid Temp (°C)
			ε_r	σ [S/m]	
835	Measured 09/09/03	9.96 / 6.48	42.5	0.91	21.8
	Measured 09/11/03	10.30 / 6.62	42.7	0.91	20.6
	Measured 09/14/03	9.90 / 6.43	42.7	0.91	20.6
	Measured 09/15/03	10.10 / 6.55	42.2	0.91	21.2
	Recommended Limit	9.60 / 6.24	43.3	0.91	N/A

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

5.0 PHANTOM DESCRIPTION

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

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

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

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

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

Figure 4
SAM Twin Phantom

6.0 TISSUE DIELECTRIC PROPERTY

6.1 Composition of tissue simulant

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

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

Table 7. Tissue simulant recipe

6.1.1 Equipment

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
Pyrex, England	Graduated Cylinder	N/A	N/A	N/A
Pyrex, USA	Beaker	N/A	N/A	N/A
Acculab	Weight Scale	V1-1200	018WB2003	N/A
Hart Scientific	Digital Thermometer	61161-302	21352860	10/12/2003
IKA Works Inc.	Hot Plate	RC Basic	3.107433	N/A

Table 8. Tissue simulant preparation equipment

6.1.2 Preparation procedure

800-900 MHz liquids

• Fill the container with **water**. Begin heating and stirring.
• Add the **Cellulose,** the **preservative substance** and the **salt**. After several hours, the liquid will become more transparent again. The container must be covered to prevent evaporation.
• Add **Sugar**. Stir it well until the sugar is sufficiently dissolved.
• Keep the liquid hot but below the boiling point for at least an hour. The container must be covered to prevent evaporation.
• Remove the container from, and turn the hotplate off and allow the liquid to cool off to room temperature prior to performing dielectric measurements.

1800-1900 MHz liquid

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

6.2 Electrical parameters of the tissue simulating liquid

The tissue dielectric parameters shall be measured before a batch can be used for SAR measurements to ensure that the simulated tissue was properly made and will simulate the desired human characteristic. Limits and measured electrical parameters are show in the table below.
Recommended limits are adopted from IEEE P1528/D1.2: " 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 09/09/03	42.5	0.91	21.8
		Measured 09/11/03	42.7	0.91	21.2
		Measured 09/15/03	42.2	0.91	21.2
		Recommended Limits	55.2	0.97	N/A
	Muscle	Measured 09/15/03	53.8	0.98	21.2
		Recommended Limits	55.2	0.97	N/A

Table 9. Electrical parameters of tissue simulating liquid

6.2.1 Equipment

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
Agilent Technologies	Network Analyzer	8753ES	US39174857	31/07/2004
Agilent Technologies	Dielectric probe kit	HP 85070C	US9936135	CNR
Dell	PC using GPIB card	GX110	347	N/A
Hart Scientific	Digital Thermometer	61161-302	21352860	10/12/2003

Table 10. Equipment required for electrical parameter measurements

Test Configuration

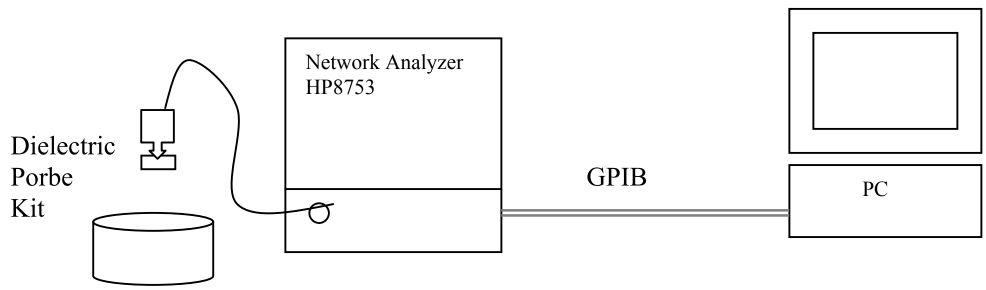

Figure 6: Test configuration

6.2.3 Procedure

1. Turn NWA on and allow at least 30 minutes for warm up.
2. Mount dielectric probe kit so that interconnecting cable to NWA will not be moved during measurements or calibration.
3. Pour de-ionized water and measure water temperature (±1°).
4. Set water temperature in HP-Software (Calibration Setup).
5. Perform calibration.
6. Validate calibration with dielectric material of known properties (e.g. polished ceramic slab with >8mm thickness ε'=10.0, ε''=0.0). If measured parameters do not fit within tolerance, repeat calibration (±0.2 for ε': ±0.1 for ε'').
7. Relative permittivity $\varepsilon r = \varepsilon'$ and conductivity can be calculated from ε''
   $\sigma = \omega \, \varepsilon_0 \, \varepsilon''$
8. Measure liquid shortly after calibration.
9. Stir the liquid to be measured. Take a sample (~50ml) with a syringe from the center of the liquid container.
10. Pour the liquid into a small glass flask. Hold the syringe at the bottom of the flask to avoid air bubbles.
11. Put the dielectric probe in the glass flask. Check that there are no air bubbles in front of the opening in the dielectric probe kit.
12. Perform measurements.
13. Adjust medium parameters in DASY4 for the frequencies necessary for the measurements (‘Setup Config’, select medium (e.g. Brain 900 MHz) and press ‘Option’-button.
14. Select the current medium for the frequency of the validation (e.g. Setup Medium Brain 900 MHz).

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

Relative permittivity $\varepsilon r = \varepsilon'$ = 42.51
Conductivity $\sigma = \omega \, \varepsilon_0 \, \varepsilon''$ = 2 x 3.1416 x 835 e+6 x 8.854e-12 x 19.69 = 0.91 S/m

Title
SubTitle
September 09, 2003 09:35 AM

Frequency	e'	e"
800.000000 MHz	42.8180	19.8124
801.000000 MHz	42.8242	19.8257
802.000000 MHz	42.8090	19.8012
803.000000 MHz	42.8153	19.8144
804.000000 MHz	42.7776	19.8071
805.000000 MHz	42.7806	19.7885
806.000000 MHz	42.7608	19.8253
807.000000 MHz	42.7738	19.8039
808.000000 MHz	42.7524	19.7759
809.000000 MHz	42.7344	19.7795
810.000000 MHz	42.7151	19.7781
811.000000 MHz	42.7115	19.7940
812.000000 MHz	42.6788	19.7639
813.000000 MHz	42.7218	19.7721
814.000000 MHz	42.6812	19.7713
815.000000 MHz	42.7057	19.7523
816.000000 MHz	42.6645	19.7679
817.000000 MHz	42.6704	19.7595
818.000000 MHz	42.6530	19.7254
819.000000 MHz	42.6504	19.7248
820.000000 MHz	42.6321	19.7447
821.000000 MHz	42.6268	19.7341
822.000000 MHz	42.6264	19.7222
823.000000 MHz	42.6091	19.7257
824.000000 MHz	42.6010	19.7427
825.000000 MHz	42.5789	19.7103
826.000000 MHz	42.6131	19.7259
827.000000 MHz	42.5572	19.7244
828.000000 MHz	42.5830	19.7104
829.000000 MHz	42.5624	19.7203
830.000000 MHz	42.5728	19.6894
831.000000 MHz	42.5439	19.6698
832.000000 MHz	42.5430	19.6741
833.000000 MHz	42.5156	19.6965
834.000000 MHz	42.5064	19.6713
835.000000 MHz	42.5113	19.6951
836.000000 MHz	42.4826	19.6756
837.000000 MHz	42.4930	19.6449
838.000000 MHz	42.4854	19.6616
839.000000 MHz	42.4597	19.6519
840.000000 MHz	42.4675	19.6852
841.000000 MHz	42.4196	19.6714

Title
SubTitle
September 11, 2003 09:44 AM

Frequency	e'	e"
800.000000 MHz	43.1813	19.6624
801.000000 MHz	43.1772	19.6403
802.000000 MHz	43.1706	19.6679
803.000000 MHz	43.1536	19.6385
804.000000 MHz	43.1384	19.6739
805.000000 MHz	43.1422	19.6605
806.000000 MHz	43.1727	19.6450
807.000000 MHz	43.1240	19.6572
808.000000 MHz	43.1007	19.6243
809.000000 MHz	43.0880	19.6481
810.000000 MHz	43.0697	19.6518
811.000000 MHz	43.0671	19.6727
812.000000 MHz	43.0569	19.6092
813.000000 MHz	43.0580	19.6236
814.000000 MHz	43.0157	19.6180
815.000000 MHz	43.0176	19.6160
816.000000 MHz	43.0216	19.6403
817.000000 MHz	43.0086	19.6049
818.000000 MHz	43.0006	19.6434
819.000000 MHz	42.9543	19.6228
820.000000 MHz	42.9663	19.6180
821.000000 MHz	42.9287	19.6272
822.000000 MHz	42.9252	19.5679
823.000000 MHz	42.9174	19.6062
824.000000 MHz	42.8934	19.6063
825.000000 MHz	42.8991	19.5979
826.000000 MHz	42.8456	19.6064
827.000000 MHz	42.8528	19.5657
828.000000 MHz	42.8502	19.6024
829.000000 MHz	42.7956	19.5688
830.000000 MHz	42.8294	19.5842
831.000000 MHz	42.7821	19.6124
832.000000 MHz	42.7865	19.5620
833.000000 MHz	42.7966	19.6054
834.000000 MHz	42.7466	19.5497
835.000000 MHz	42.7707	19.5678
836.000000 MHz	42.7321	19.6251
837.000000 MHz	42.7310	19.5554
838.000000 MHz	42.7203	19.5625
839.000000 MHz	42.6971	19.5625
840.000000 MHz	42.6740	19.5626
841.000000 MHz	42.6538	19.5724

Title
SubTitle
September 15, 2003 10:10 AM

Frequency	e'	e"
800.000000 MHz	42.5688	19.5422
801.000000 MHz	42.5825	19.5429
802.000000 MHz	42.5473	19.5244
803.000000 MHz	42.5463	19.5509
804.000000 MHz	42.5048	19.5287
805.000000 MHz	42.5333	19.5633
806.000000 MHz	42.5121	19.5356
807.000000 MHz	42.4892	19.5409
808.000000 MHz	42.4801	19.5371
809.000000 MHz	42.4629	19.5625
810.000000 MHz	42.4739	19.5530
811.000000 MHz	42.4485	19.5483
812.000000 MHz	42.4445	19.5430
813.000000 MHz	42.4422	19.5049
814.000000 MHz	42.4267	19.5352
815.000000 MHz	42.3895	19.5069
816.000000 MHz	42.3890	19.5330
817.000000 MHz	42.3747	19.5092
818.000000 MHz	42.3999	19.5119
819.000000 MHz	42.3719	19.5348
820.000000 MHz	42.3590	19.5160
821.000000 MHz	42.3448	19.4923
822.000000 MHz	42.3382	19.5146
823.000000 MHz	42.3529	19.4988
824.000000 MHz	42.3026	19.5173
825.000000 MHz	42.3216	19.5163
826.000000 MHz	42.2857	19.5095
827.000000 MHz	42.2794	19.4944
828.000000 MHz	42.2968	19.5257
829.000000 MHz	42.2457	19.5020
830.000000 MHz	42.2745	19.4982
831.000000 MHz	42.2417	19.5013
832.000000 MHz	42.2397	19.4638
833.000000 MHz	42.2390	19.5424
834.000000 MHz	42.1925	19.4965
835.000000 MHz	42.2240	19.5024
836.000000 MHz	42.1887	19.4957
837.000000 MHz	42.1647	19.4542
838.000000 MHz	42.1920	19.4823
839.000000 MHz	42.1375	19.4812
840.000000 MHz	42.1842	19.5036
841.000000 MHz	42.1104	19.5080

Title
SubTitle
September 15, 2003 10:13 AM

Frequency	e'	e"
800.000000 MHz	54.2099	21.2447
801.000000 MHz	54.2105	21.2507
802.000000 MHz	54.2004	21.2265
803.000000 MHz	54.2100	21.2578
804.000000 MHz	54.1625	21.2240
805.000000 MHz	54.1863	21.1992
806.000000 MHz	54.1368	21.2230
807.000000 MHz	54.1455	21.2036
808.000000 MHz	54.1266	21.2335
809.000000 MHz	54.0946	21.1946
810.000000 MHz	54.0930	21.2409
811.000000 MHz	54.0608	21.1853
812.000000 MHz	54.1142	21.2119
813.000000 MHz	54.0510	21.1957
814.000000 MHz	54.0229	21.1670
815.000000 MHz	54.0258	21.1778
816.000000 MHz	54.0084	21.1790
817.000000 MHz	54.0132	21.1947
818.000000 MHz	53.9892	21.1927
819.000000 MHz	53.9790	21.1354
820.000000 MHz	53.9743	21.1713
821.000000 MHz	53.9236	21.1566
822.000000 MHz	53.9546	21.1516
823.000000 MHz	53.9228	21.1581
824.000000 MHz	53.9439	21.1566
825.000000 MHz	53.8989	21.1568
826.000000 MHz	53.8933	21.1428
827.000000 MHz	53.8975	21.1252
828.000000 MHz	53.8794	21.1379
829.000000 MHz	53.8445	21.1345
830.000000 MHz	53.8817	21.1160
831.000000 MHz	53.8407	21.1260
832.000000 MHz	53.8450	21.1084
833.000000 MHz	53.8272	21.1210
834.000000 MHz	53.8050	21.0911
835.000000 MHz	53.7909	21.1134
836.000000 MHz	53.7892	21.1091
837.000000 MHz	53.7645	21.1022
838.000000 MHz	53.7664	21.1076
839.000000 MHz	53.7295	21.1272
840.000000 MHz	53.7728	21.0954
841.000000 MHz	53.7132	21.1124

Table 11. 835 MHz head and muscle tissue dielectric parameter data

7.0 SAR SAFETY LIMITS

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

Table 12. SAR safety limits for Controlled / Uncontrolled environment

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

Table 13. SAR safety limits

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

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

8.0 DEVICE POSITIONING

8.1 Device holder for SAM Twin Phantom

The Handheld was positioned for all test configurations using the DASY4 holder. The device holder facilitates the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. The devices can be easily, accurately and with repeatability positioned according to FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

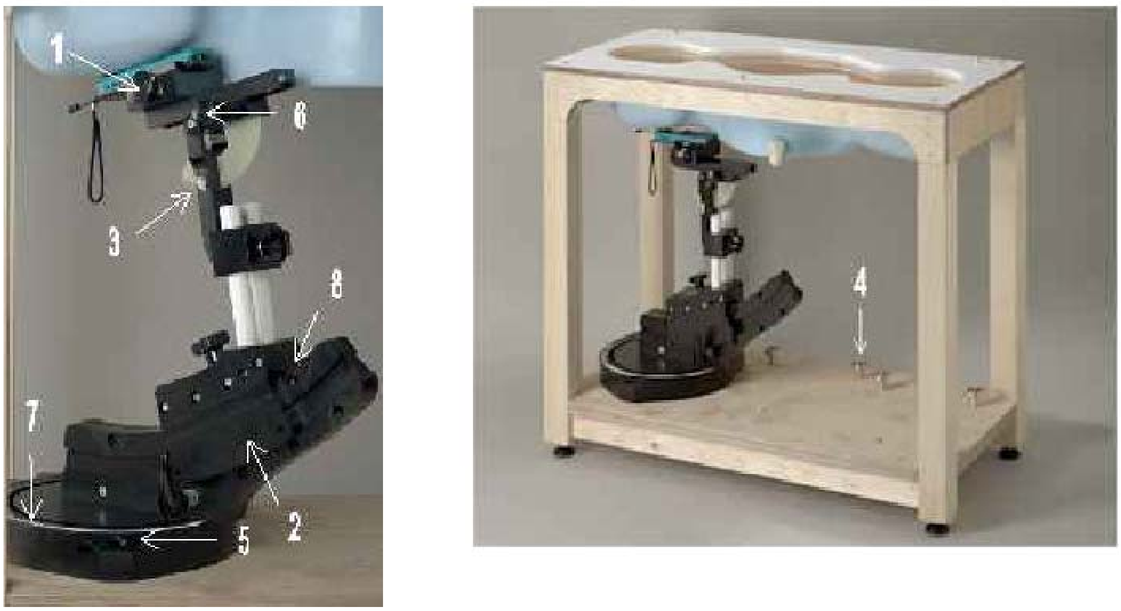

Figure 6
Device Holder

1. Put the phone in the clamp mechanism (1) and hold it straight while tightening. (Curved phones or phones with asymmetrical ear pieces should be positioned so that the ear piece is in the symmetry plane of the clamp).

2. Adjust the sliding carriage (2) to 90°. Then adjust the phone holder angle (3) until the reference line of the phone is horizontal (parallel to the flat phantom bottom). The phone reference line is defined as the front tangential line between the ear piece and the center of the device bottom (or the center of the flip hinge). For devices with parallel front and back sides, the phone holder angle (3) is 0°.

3. Place the device holder at the desired phantom section and move it securely against the positioning pins (4). The screw in front of the turning plate can be applied for correct positioning (5). (Do not tighten it too strongly).

4. Shift the phone clamp (6) so that the ear piece is exactly below the ear marking of the phantom. The phone is now correctly positioned in the holder for all standard phantom measurements, even after changing the phantom or phantom section.

5. Adjust the device position angles to the desired measurement position.

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

8.2 Description of the test positioning

8.2.1 Test Positions of Device Relative to Head

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

The handset was tested in the above positions according to IEEE P1528 /D1.2 : "Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques".

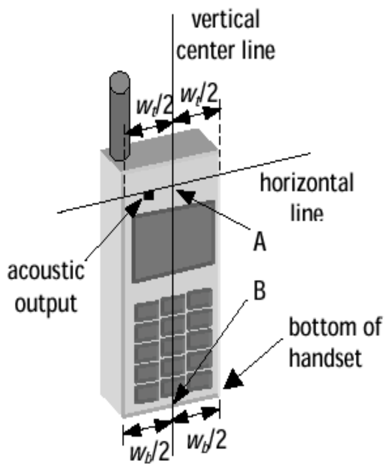

Figure 8a – Handset vertical and horizontal reference lines – fixed case

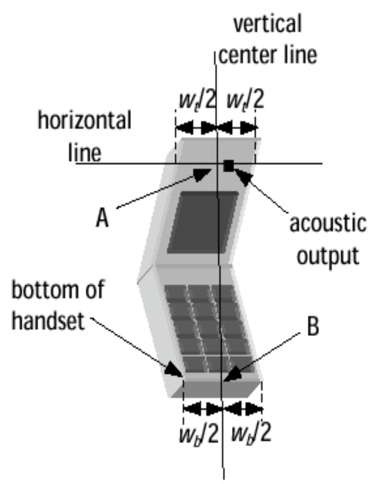

Figure 8b – Handset vertical and horizontal reference lines – "clam-shell"

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 8a and 8b), 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 8a). The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output. However, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset (see Figure 8b), especially for clamshell handsets, handsets with flip pieces, and other irregularly shaped handsets.
3) Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 8), such that the plane defined by the vertical center line and the horizontal center line is in a plane approximately parallel to the sagittal plane of the phantom.
4) Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear.
5) While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is the plane normal to MB ("*mouth-bac*k") - NF ("*neck-fron*t") including the line MB (reference plane).
6) Rotate the phone around the vertical centerline until the phone (horizontal line) is symmetrical with respect to the line NF.
7) While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the ear (cheek).

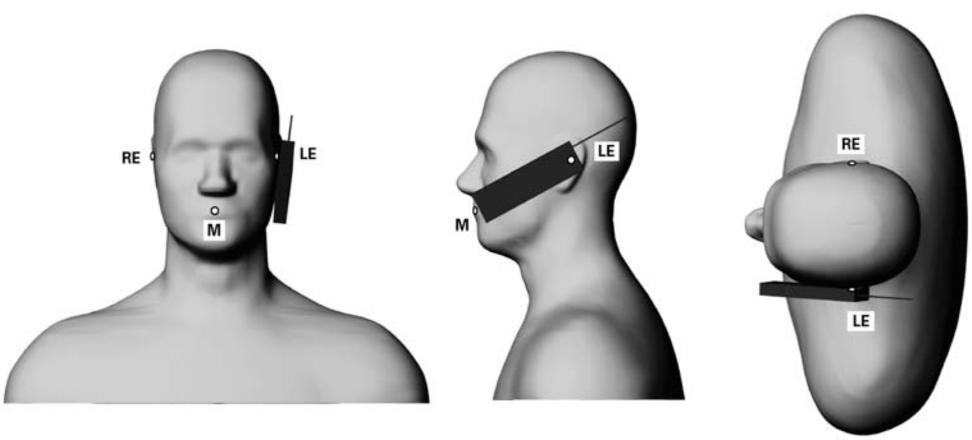

Figure 9 – Phone position 1, "cheek" or "touch" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

8.2.1.2 Definition of the "Tilted" Position

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

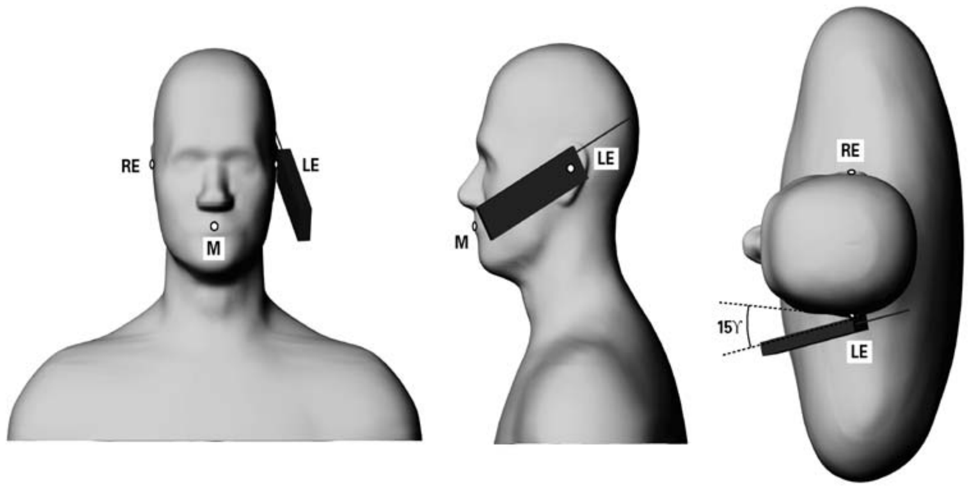

Figure 10 – Phone position 2, "tilted position." The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

8.2.2 Body Holster Configuration

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

9.0 High Level Evaluation

9.1 Maximum search

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

9.2 Extrapolation

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

9.3 Boundary correction

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

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

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

10.0 MEASUREMENT UNCERTAINTIES

DASY4 Uncertainty Budget **According to IEEE P1528 [1]**								
Error Description	Uncertainty value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±4.8 %	N	1	1	1	±4.8 %	±4.8 %	∞
Axial Isotropy	±4.7 %	R	$\sqrt{3}$	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	$\sqrt{3}$	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Linearity	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Readout Electronics	±1.0 %	N	1	1	1	±1.0 %	±1.0 %	∞
Response Time	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	$\sqrt{3}$	1	1	±1.5 %	±1.5 %	∞
RF Ambient Conditions	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.4 %	R	$\sqrt{3}$	1	1	±0.2 %	±0.2 %	∞
Probe Positioning	±2.9 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Max. SAR Eval.	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Test Sample Related								
Device Positioning	±2.9 %	N	1	1	1	±2.9 %	±2.9 %	145
Device Holder	±3.6 %	N	1	1	1	±3.6 %	±3.6 %	5
Power Drift	±5.0 %	R	$\sqrt{3}$	1	1	±2.9 %	±2.9 %	∞
Phantom and Setup								
Phantom Uncertainty	±4.0 %	R	$\sqrt{3}$	1	1	±2.3 %	±2.3 %	∞
Liquid Conductivity (target)	±5.0 %	R	$\sqrt{3}$	0.64	0.43	±1.8 %	±1.2 %	∞
Liquid Conductivity (meas.)	±2.5 %	N	1	0.64	0.43	±1.6 %	±1.1 %	∞
Liquid Permittivity (target)	±5.0 %	R	$\sqrt{3}$	0.6	0.49	±1.7 %	±1.4 %	∞
Liquid Permittivity (meas.)	±2.5 %	N	1	0.6	0.49	±1.5 %	±1.2 %	∞
Combined Std. Uncertainty						±10.3 %	±10.0 %	330
Expanded STD Uncertainty						**±20.6 %**	**±20.1 %**	

Table 14. Measurement uncertainty

11.0 TEST RESULTS

11.1 SAR measurement results at highest power measured against the head

Mode	f (MHz)	Conducted pulse average power (dBm)	Antenna Configuration	SAR, averaged over 1 g (W/Kg) Left-hand			SAR, averaged over 1 g (W/Kg) Right-hand		
				Liquid Temp (C) °	Cheek	Tilted	Liquid Temp (C) °	Cheek	Tilted
TDMA 835	806.0125	-	retracted	-	-	-	21.4	0.87	0.89
	806.0125	-	extended	-	-	-	-	-	-
	815.5000	28.39	retracted	21.2	* 0.73	0.72	21.6	0.89	**0.90**
	815.5000	28.39	extended	21.2	* 0.42	0.48	21.6	* 0.49	0.25
	824.9875	-	retracted	-	-	-	21.8	0.83	0.84
	824.9875	-	extended	-	-	-	-	-	-

Table 15. SAR results for head configuration with BAT-03087-001 battery attached

11.2 SAR measurement results at highest power measured against the head

Mode	f (MHz)	Conducted pulse average power (dBm)	Antenna Configuration	SAR, averaged over 1 g (W/Kg) Left-hand			SAR, averaged over 1 g (W/Kg) Right-hand		
				Liquid Temp (C) °	Cheek	Tilted	Liquid Temp (C) °	Cheek	Tilted
TDMA 835	806.0125	-	retracted	-	-	-	20.6	0.83	**0.91**
	806.0125	-	extended	-	-	-	-	-	-
	815.5000	28.30	retracted	21.4	* 0.68	0.70	20.8	0.89	0.90
	815.5000	28.30	extended	21.4	* 0.42	0.44	20.8	* 0.50	0.61
	824.9875	-	retracted	-	-	-	20.8	0.83	0.84
	824.9875	-	extended	-	-	-	-	-	-

Table 16. SAR results for head configuration with BAT-06532-001 battery attached

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

Mode	f (MHz)	Conducted pulse average power (dBm)	Antenna Config.	Liquid Temp. (C) °	Holster Type	SAR, averaged over 1 g without headset (W/kg)	SAR, averaged over 1 g with headset (W/kg)
TDMA 835	806.0125	-	Retracted	-	Plastic Holster	-	-
	806.0125	-	Extended	-	Plastic Holster	-	-
	815.5000	28.39	Retracted	21.5	Plastic Holster	* **0.50**	0.41
	815.5000	28.39	Extended	21.5	Plastic Holster	* 0.36	0.36
	824.9875	-	Retracted	-	Plastic Holster	-	-
	824.9875	-	Extended	-	Plastic Holster	-	-
	806.0125	-	Retracted	-	Leather Swivel Holster	-	-
	806.0125	-	Extended	-	Leather Swivel Holster	-	-
	815.5000	28.39	Retracted	21.2	Leather Swivel Holster	* 0.49	-
	815.5000	28.39	Extended	21.2	Leather Swivel Holster	* 0.36	-
	824.9875	-	Retracted	-	Leather Swivel Holster	-	-
	824.9875	-	Extended	-	Leather Swivel Holster	-	-

Table 17. SAR results with holster for body configuration with BAT-03087-001 battery attached

11.4 SAR measurement results at highest power measured against the body using holster

Mode	f (MHz)	Conducted pulse average power (dBm)	Antenna Config.	Liquid Temp. (C) °	Holster Type	SAR, averaged over 1 g without headset (W/kg)	SAR, averaged over 1 g with headset (W/kg)
TDMA 835	806.0125	-	Retracted	-	Plastic Holster	-	-
	806.0125	-	Extended	-	Plastic Holster	-	-
	815.5000	28.30	Retracted	21.0	Plastic Holster	* **0.50**	0.36
	815.5000	28.30	Extended	21.1	Plastic Holster	* 0.36	0.29
	824.9875	-	Retracted	-	Plastic Holster	-	-
	824.9875	-	Extended	-	Plastic Holster	-	-
	806.0125	-	Retracted	-	Leather Swivel Holster	-	-
	806.0125	-	Extended	-	Leather Swivel Holster	-	-
	815.5000	28.30	Retracted	21.3	Leather Swivel Holster	* 0.47	-
	815.5000	28.30	Extended	21.3	Leather Swivel Holster	* 0.49	-
	824.9875	-	Retracted	-	Leather Swivel Holster	-	-
	824.9875	-	Extended	-	Leather Swivel Holster	-	-

Table 18. SAR results with holster for body configuration with BAT-06532-001 battery attached

11.5 SAR measurement results at highest power measured for push-to-talk operation mode, front side of handheld 2.5 cm away from the flat phantom with muscle tissue

Mode	f (MHz)	Conducted pulse average power (dBm)	Antenna Config.	Liquid Temp. (C) °	SAR, averaged over 1 g (W/kg)
TDMA 835	806.0125	-	Retracted	-	-
	806.0125	-	Extended	-	-
	815.5000	28.39	Retracted	21.4	*** 0.15**
	815.5000	28.39	Extended	21.4	* 0.11
	824.9875	-	Retracted	-	-
	824.9875	-	Extended	-	-

Table 19. SAR results for push-to-talk operation mode with BAT-03087-001 battery attached

11.6 SAR measurement results at highest power measured for push-to-talk operation mode, front side of handheld 2.5 cm away from the flat phantom with muscle tissue

Mode	f (MHz)	Conducted pulse average power (dBm)	Antenna Config.	Liquid Temp. (C) °	SAR, averaged over 1 g (W/kg)
TDMA 835	806.0125	-	Retracted	-	-
	806.0125	-	Extended	-	-
	815.5000	28.30	Retracted	21.3	*** 0.15**
	815.5000	28.30	Extended	21.3	* 0.11
	824.9875	-	Retracted	-	-
	824.9875	-	Extended	-	-

Table 20. SAR results for push-to-talk operation mode with BAT-06532-001 battery attached

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

12.0 REFERENCES

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

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

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

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

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

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

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

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

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

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