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Test & Certification Center (TCC) - Dallas

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SAR Compliance Test Report

Test report no.:	WR88.001A	Date of report:	20-Jan-04
Template version:	-	Number of pages:	51
Testing laboratory:	Test & Certification Center (TCC) Dallas Nokia Mobile Phones 6021 Connection Drive Irving, TX 75039, USA Tel. +1 972 894 5000 Fax. +1 972 894 4988	Client:	Nokia Copenhagen Product Creation Center Frederikskaj 1790 Copenhagen V Copenhagen, Denmark Tel. +4540733772
Responsible test engineer:	N. Walton	Product contact person:	Ole Myrtue
Measurements made by:	J. Love		
Tested device:	RH-36		
FCC ID (USA):	QTKRH-36	Industry Canada ID:	-
Supplement reports:	-		

Testing has been carried out in accordance with:

47CFR §2.1093
Radiofrequency Radiation Exposure Evaluation: Portable Devices

FCC OET Bulletin 65 (Edition 97-01), Supplement C (Edition 01-01)
Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

RSS-102
Evaluation Procedure for Mobile and Portable Radio Transmitters with Respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields

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

Documentation: The documentation of the testing performed on the tested devices is archived for 15 years at TCC Dallas.

Test results: The tested device complies with the requirements in respect of all parameters subject to the test. The test results and statements relate only to the items tested. The test report shall not be reproduced except in full, without written approval of the laboratory.

Date and signatures: 20-Jan-04

For the contents:

Alan Ewing
TCC Line Manager

Nerina Walton
Test Engineer

CONTENTS

1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Period of test	6-Jan-04 to 7-Jan-04
SN, HW and SW numbers of tested device	IMEI: 01027400/325131/0 HW: 0574 SW: 4.11
Batteries used in testing	BL-5C
Headsets used in testing	HDC-5
Other accessories used in testing	-
State of sample	Prototype unit
Notes	-

1.2 Maximum Results

The maximum measured SAR values for Head configuration and Body Worn configuration are given in section 1.2.1 and 1.2.2 respectively. The device conforms to the requirements of the standard(s) when the maximum measured SAR value is less than or equal to the limit.

1.2.1 Head Configuration

Mode	Ch / *f* (MHz)	EDRP/EIRP	Position	SAR limit (1g avg)	Measured SAR value (1g avg)	Result
GSM 850	251 / 848.8	29.7 dBm	Left Cheek	1.6 W/kg	0.73 W/kg	PASSED
GSM 1900	512 / 1850.2	31.7 dBm	Right Tilt	1.6 W/kg	0.70 W/kg	PASSED

1.2.2 Body Worn Configuration

Mode	Ch / *f* (MHz)	EDRP/EIRP	Separation distance	SAR limit (1g avg)	Measured SAR value (1g avg)	Result
GSM 850	190 / 836.6	28.1 dBm	1.5 cm	1.6 W/kg	1.02 W/kg	PASSED
GSM 1900	661 / 1880.0	31.1 dBm	1.5 cm	1.6 W/kg	0.90 W/kg	PASSED

1.2.3 Maximum Drift

Maximum drift during measurements	-0.25 dB

1.2.4 Measurement Uncertainty

Extended Uncertainty (k=2) 95%	± 29.1 %

2. DESCRIPTION OF THE DEVICE UNDER TEST

Device category	Portable
Exposure environment	Uncontrolled Exposure

Modes and Bands of Operation	GSM 850	GSM 1900
Modulation Mode	GMSK	GMSK
Duty Cycle	1/8	1/8
Transmitter Frequency Range (MHz)	824.2 – 848.8	1850.2 - 1909.8

2.1 Picture of the Device

2.2 Description of the Antenna

The device has an internal patch antenna.

3. TEST CONDITIONS

3.1 Temperature and Humidity

Period of measurement:	6-Jan-04 to 7-Jan-04
Ambient temperature (°C):	21°C to 23°C
Ambient humidity (RH %):	24 % to 44 %

3.2 Test Signal, Frequencies, and Output Power

The device was put into operation by using an Anritsu MT8802A operating in GSM. Communication between the device and the call tester was established by air link.

The device output power was set to maximum power level for all tests; a fully charged battery was used for every test sequence.

In all operating bands the measurements were performed on lowest, middle and highest channels.

Power output was measured by a separate accredited test laboratory on the same unit as used for SAR testing.

4. DESCRIPTION OF THE TEST EQUIPMENT

4.1 Measurement System and Components

The measurements were performed using an automated near-field scanning system, DASY3 software version 3.1d, manufactured by Schmid & Partner Engineering AG (SPEAG) in Switzerland. The SAR extrapolation algorithm used in all measurements on the device was the 'worst-case extrapolation' algorithm.

The following table lists calibration dates of SPEAG components:

Test Equipment	Serial Number	Calibration interval	Calibration expiry
DASY3 DAE V1	389	12 months	10/2005
E-field Probe ET3DV6	1504	12 months	12/2005
Dipole Validation Kit, D835V2	486	24 months	05/2005
Dipole Validation Kit, D1900V2	504	24 months	07/2005

Additional test equipment used in testing:

Test Equipment	Model	Serial Number	Calibration interval	Calibration expiry
Signal Generator	HP 8648C	3836A04346	12 months	06/2004
Amplifier	AR 5S1G2	25583	-	-
Power Meter	Boonton 4232A	64701	12 months	07/2004
Power Sensor	Boonton 51015	32188	12 months	07/2004
Power Sensor	Boonton 51015	32188	12 months	07/2004
Call Tester	Anritsu MT8802A	MT26889	12 months	10/2004
Vector Network Analyzer	Agilent 8753ES	US39174932	12 months	01/2004
Dielectric Probe Kit	Agilent 85070D	US01440005	-	-
Power Sensor	Boonton 51015	32188	12 months	07/2004

4.1.1 Isotropic E-field Probe 1504

Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., butyl diglycol)
Calibration	Calibration certificate in Appendix C
Frequency	10 MHz to 3 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Optical Surface Detection	± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.4 dB in HSL (rotation normal to probe axis)
Dynamic Range	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm Tip length: 16 mm Body diameter: 12 mm Tip diameter: 6.8 mm Distance from probe tip to dipole centers: 2.7 mm
Application	General dosimetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms

4.2 Phantoms

The phantom used for all tests i.e. for both validation testing and device testing, was the twin-headed "SAM Phantom", manufactured by SPEAG. The phantom conforms to the requirements of IEEE P1528/D1.2, April 21, 2003 (as established by sub committee SCC-34/SC-2).

Validation tests were performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.

The SPEAG device holder (see Section 5.1) was used to position the device in all tests whilst a tripod was used to position the validation dipoles against the flat section of phantom.

4.3 Simulating Liquids

Recommended values for the dielectric parameters of the simulating liquids are given in IEEE P1528/D1.2, April 21, 2003 and FCC Supplement C to OET Bulletin 65. All tests were carried out using liquids whose dielectric parameters were within ± 5% of the recommended values. All tests were carried out within 24 hours of measuring the dielectric parameters.

The depth of the liquid was 15.0 ± 0.5 cm measured from the ear reference point during validation and device measurements.

4.3.1 Liquid Recipes

The following recipes were used for Head and Body liquids:

800MHz Band

Ingredient	Head (% by weight)	Body (% by weight)
Deionised Water	51.07	65.45
HEC	0.23	-
Sugar	47.31	34.31
Preservative	0.24	0.10
Salt	1.15	0.62

1900MHz Band

Ingredient	Head (% by weight)	Body (% by weight)
Deionised Water	54.88	69.02
Butyl Diglycol	44.91	30.76
Salt	0.21	0.22

4.3.2 Verification of the System

The manufacturer calibrates the probes annually. Dielectric parameters of the simulating liquids were measured every day using the dielectric probe kit and the network analyser. A SAR measurement was made following the determination of the dielectric parameters of the liquids, using the dipole validation kit. A power level of 250mW was supplied to the dipole antenna, which was placed under the flat section of the twin SAM phantom. The validation results (dielectric parameters and SAR values) are given in the table below.

System Verification, Head Tissue Simulant

f [MHz]	Description	SAR [W/kg], 1g	Dielectric Parameters		Temp [°C]
			εr	σ [S/m]	
835	Reference result ± 10% window	9.80 8.82 to 10.78	42.8	0.89	N/A
	6-Jan-04	10.20	43.0	0.93	21.1
	7-Jan-04	10.04	43.6	0.92	20.9
1900	Reference result ± 10% window	40.80 36.72 to 44.88	40.2	1.46	N/A
	7-Jan-04	40.40	38.6	1.45	19.7

System Verification, Body Tissue Simulant

f [MHz]	Description	SAR [W/kg], 1g	Dielectric Parameters		Temp [°C]
			εr	σ [S/m]	
835	Reference result ± 10% window	9.88 8.89 to 10.87	55.0	0.98	N/A
	6-Jan-04	9.56	52.4	0.94	21.5
1900	Reference result ± 10% window	42.00 37.80 to 46.20	50.9	1.60	N/A
	6-Jan-04	38.40	51.0	1.60	20.1

Plots of the Verification scans are given in Appendix A.

4.3.3 Tissue Simulants used in the Measurements

Head Tissue Simulant Measurements

f [MHz]	Description	Dielectric Parameters		Temp [°C]
		εr	σ [S/m]	
836.5	Recommended value ± 5% window	41.5 39.4 to 43.6	0.90 0.86 to 0.95	N/A
	6-Jan-04	43.0	0.93	21.1
	7-Jan-04	43.6	0.92	20.9
1880	Recommended value ± 5% window	40.0 38.0 to 42.0	1.40 1.33 to 1.47	N/A
	7-Jan-04	38.7	1.44	19.7

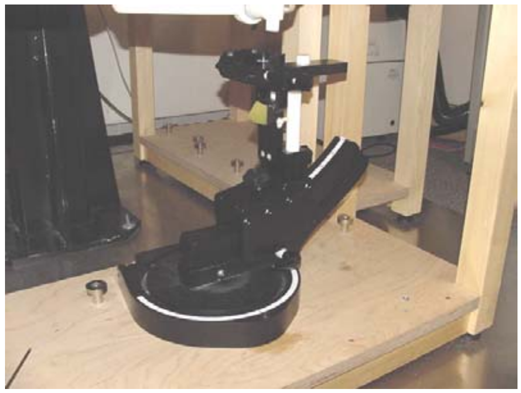
Body Tissue Simulant Measurements

f [MHz]	Description	Dielectric Parameters		Temp [°C]
		εr	σ [S/m]	
836.5	Recommended value ± 5% window	55.2 52.4 to 58.0	0.97 0.92 to 1.02	N/A
	6-Jan-04	52.4	0.94	21.5
1880	Recommended value ± 5% window	53.3 50.6 to 56.0	1.52 1.44 to 1.60	N/A
	6-Jan-04	51.1	1.58	20.1

5. DESCRIPTION OF THE TEST PROCEDURE

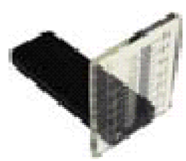
5.1 Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the Dasy system.



Device holder supplied by SPEAG

A Nokia designed spacer (illustrated below) was used to position the device within the SPEAG holder. The spacer positions the device so that the holder has minimal effect on the test results but still holds the device securely. The spacer was removed before the tests.



Nokia spacer

5.2 Test Positions

5.2.1 Against Phantom Head

Measurements were made in “cheek” and “tilt” positions on both the left hand and right hand sides of the phantom.

The positions used in the measurements were according to IEEE P1528/D1.2 April 21 2003 "Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”.

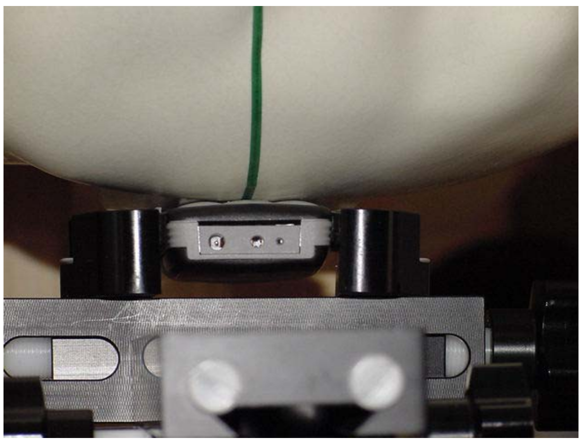


Photo of the device in “cheek” position

Photo of the device in “tilt” position

5.2.2 Body Worn Configuration

The device was placed in the SPEAG holder using the Nokia spacer and placed below the flat section of the phantom. The distance between the device and the phantom was kept at 1.5 cm using a separate flat spacer that was removed before the start of the measurements. The device was oriented with its antenna facing the phantom since this orientation gave higher results.

Photo of the device positioned for Body SAR measurement. The spacer was removed for the tests.

5.3 Scan Procedures

First coarse scans were used for determination of the field distribution. Next a cube scan, 5x5x7 was performed around the highest E-field value to determine the averaged SAR value. Drift was determined by measuring the same point at the start of the coarse scan and again at the end of the cube scan.

5.4 SAR Averaging Methods

The maximum SAR value was averaged over a cube of tissue using interpolation and extrapolation.

The interpolation of the points was done with a 3d-Spline. The 3d-Spline comprised three one-dimensional splines with the "Not a knot" -condition [W. Gander, Computermathematik, p. 141-150] (x, y and z -directions) [Numerical Recipes in C, Second Edition, p 123].

The extrapolation was based on least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 30 mm in all z-axis, a fourth order polynomial was calculated. This polynomial was then used to evaluate the points between the phantom surface and the probe tip. The points, calculated from the phantom surface, were at 1mm spacing.

6. MEASUREMENT UNCERTAINTY

Table 6.1 – Measurement uncertainty evaluation

Uncertainty Component	P1528 Sec	Tol. (%)	Prob Dist	Div	c_i	u_i (%)	v_i
Measurement System							
Probe Calibration	E2.1	±4.8	N	1	1	±4.8	∞
Axial Isotropy	E2.2	±4.7	R	√3	$(1-c_p)^{1/2}$	±1.9	∞
Hemispherical Isotropy	E2.2	±9.6	R	√3	$(c_p)^{1/2}$	±3.9	∞
Boundary Effect	E2.3	±8.3	R	√3	1	±4.8	∞
Linearity	E2.4	±4.7	R	√3	1	±2.7	∞
System Detection Limits	E2.5	±1.0	R	√3	1	±0.6	∞
Readout Electronics	E2.6	±1.0	N	1	1	±1.0	∞
Response Time	E2.7	±0.8	R	√3	1	±0.5	∞
Integration Time	E2.8	±2.6	R	√3	1	±1.5	∞
RF Ambient Conditions - Noise	E6.1	±3.0	R	√3	1	±1.7	∞
RF Ambient Conditions - Reflections	E6.1	±3.0	R	√3	1	±1.7	∞
Probe Positioner Mechanical Tolerance	E6.2	±0.4	R	√3	1	±0.2	∞
Probe Positioning with respect to Phantom Shell	E6.3	±2.9	R	√3	1	±1.7	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E5.2	±3.9	R	√3	1	±2.3	∞
Test sample Related							
Test Sample Positioning	E4.2.1	±6.0	N	1	1	±6.0	11
Device Holder Uncertainty	E4.1.1	±5.0	N	1	1	±5.0	7
Output Power Variation - SAR drift measurement	6.6.3	±10.0	R	√3	1	±5.8	∞
Phantom and Tissue Parameters							
Phantom Uncertainty (shape and thickness tolerances)	E3.1	±4.0	R	√3	1	±2.3	∞
Liquid Conductivity Target - tolerance	E3.2	±5.0	R	√3	0.64	±1.8	∞
Liquid Conductivity - measurement uncertainty	E3.3	±5.5	N	1	0.64	±3.5	5
Liquid Permittivity Target tolerance	E3.2	±5.0	R	√3	0.6	±1.7	∞
Liquid Permittivity - measurement uncertainty	E3.3	±2.9	N	1	0.6	±1.7	5
Combined Standard Uncertainty			RSS			±14.5	187
Coverage Factor for 95%			k=2				
Expanded Standard Uncertainty						±29.1	