TCC

Test & Certification Center (TCC) - Dallas

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Certificate Number: 1819-01

SAR Compliance Test Report

Test report no.:	WR116.001A	Date of report:	7-Apr-04
Template version:	-	Number of pages:	-
Testing laboratory:	Test & Certification Center (TCC) Dallas Nokia Mobile Phones 6021 Connection Drive Irving, TX 75039, USA Tel. +1 972 894 5000	Client:	Nokia Germany (GmbH) Product Creation Center Rensingstrasse 15 D-44807 Bochum Germany Tel. +49 234 984 0
Responsible test engineer:	N. Walton	Product contact person:	E. Edelmann
Measurements made by:	J. Torres, J. Love		
Tested device:	RH-47		
FCC ID (USA):	OW3RH-47	Industry Canada ID:	661AA-RH47
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 1528 - 2003
IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement 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: 7-Apr-04

For the contents:

Mark Swenson
On Behalf Of
Alan Ewing
TCC Line Manager

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Test Engineer

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Period of test	18-Feb-04 to 20-Feb-04
SN, HW and SW numbers of tested device	IMEI: 001004/00/124818/7 HW: 0413 SW: T 02.25
Batteries used in testing	BL-6C, 3.7V
Headsets used in testing	HS-7N
Other accessories used in testing	Multimedia Card (EMC/DCU)
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	128/824.2	29.6 dBm	Left Cheek	1.6 W/kg	0.56 W/kg	PASSED
GSM 1900	512/1850.2	29.8 dBm	Right Cheek	1.6 W/kg	0.45 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
GPRS 850 + BT	128/824.2	29.2 dBm	2.2 cm	1.6 W/kg	0.71 W/kg	PASSED
GPRS 1900 + BT	512/1850.2	29.2 dBm	2.2 cm	1.6 W/kg	0.78 W/kg	PASSED

1.2.3 Maximum Drift

Maximum drift during measurements	-0.34 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	GPRS 850	GPRS 1900	BT
Modulation Mode	GMSK	GMSK	GMSK	GMSK	GFSK
Duty Cycle	1/8	1/8	1/8 & 2/8	1/8 & 2/8	N/A
Transmitter Frequency Range (MHz)	824.2 – 848.8	1850.2 - 1909.8	824.2 – 848.8	1850.2 - 1909.8	2400.0 – 2483.5

2.1 Picture of the Device

Please refer to Section 1 of Appendix E.

2.2 Description of the Antenna

The device has an internal patch antenna.

3. TEST CONDITIONS

3.1 Temperature and Humidity

Period of measurement:	18-Feb-04 to 20-Feb-04
Ambient temperature (°C):	21.0 to 23.0
Ambient humidity (RH %):	32.0 to 46.0

3.2 Test Signal, Frequencies, and Output Power

The device was put into operation by using a call tester. 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 as considered appropriate.

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	377	12 months	12/2004
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	07/2004

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	26001	12 months	08/2004
Power Sensor	Boonton 51015	31143	12 months	08/2004
Power Sensor	Boonton 51015	31144	12 months	08/2004
Call Tester (GSM)	Anritsu MT8802A	MT26889	12 months	10/2004
Call Tester (GSM, BT, GPRS)	CMU 200	838115/047	12 months	09/2004
Vector Network Analyzer	Agilent 8720D	US38431353	12 months	07/2004
Dielectric Probe Kit	Agilent 85070D	US01440005	-	-

4.1.1 Isotropic E-field Probe, SN 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 1528 - 2003.

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 1528 - 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]
			ε_r	σ [S/m]	
835	Reference result for SN486	9.80	42.8	0.89	N/A
	± 10% window	8.82 to 10.78			
	18-Feb-04	9.48	41.2	0.89	21.1
1900	Reference result for SN504	40.8	40.2	1.46	N/A
	± 10% window	36.72 to 44.88			
	19-Feb-04	37.36	41.0	1.47	19.5

System Verification, Body Tissue Simulant

f [MHz]	Description	SAR [W/kg], 1g	Dielectric Parameters		Temp [°C]
			ε_r	σ [S/m]	
835	Reference result for SN486	9.88	55.0	0.98	N/A
	± 10% window	8.89 to 10.87			
	20-Feb-04	9.28	56.1	0.94	20.2
1900	Reference result for SN504	42.0	50.9	1.6	N/A
	± 10% window	37.8 to 46.2			
	20-Feb-04	38.36	51.2	1.6	19.1

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]
		ε_r	σ [S/m]	
836.5	Recommended value	41.5	0.90	N/A
	± 5% window	39.4 to 43.6	0.86 to 0.95	
	18-Feb-04	41.2	0.89	21.1
1880	Recommended value	40.0	1.40	N/A
	± 5% window	38.0 to 42.0	1.33 to 1.47	
	19-Feb-04	41.1	1.46	19.5

Body Tissue Simulant Measurements

f [MHz]	Description	Dielectric Parameters		Temp [°C]
		ε_r	σ [S/m]	
836.5	Recommended value	55.2	0.97	N/A
	± 5% window	52.4 to 58.0	0.92 to 1.02	
	20-Feb-04	56.1	0.94	20.2
1880	Recommended value	53.3	1.52	N/A
	± 5% window	50.6 to 56.0	1.44 to 1.60	
	20-Feb-04	51.3	1.58	19.1

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

For photos of the device in “cheek” and “tilt’ positions, please refer to Section 2.1 of Appendix E.

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 2.2 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.

For photos of the device positioned for Body SAR measurement, please refer to Section 2.2 of Appendix E.

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	Section in IEEE 1528	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**	

7. RESULTS

The measured Head SAR values for the test device are tabulated below:

GSM 850MHz Head SAR results

Mode and Band	Multimedia Card Option	Position		SAR, averaged over 1g (W/kg)		
				Ch 128 824.2 MHz	Ch 190 836.6 MHz	Ch 251 848.8 MHz
		Power level		29.6 dBm	29.6 dBm	30.2 dBm
GSM 850	N/A	Left	Cheek	-	0.50	-
			Tilt	-	0.39	-
		Right	Cheek	-	0.51	-
			Tilt	-	0.33	-
GSM 850	Installed	Left	Cheek	**0.56**	0.53	0.54
			Tilt	-	0.36	-
		Right	Cheek	-	0.52	-
			Tilt	-	0.34	-

GSM 1900MHz Head SAR results

Mode and Band	Multimedia Card Option	Position		SAR, averaged over 1g (W/kg)		
				Ch 512 1850.2 MHz	Ch 661 1880.0 MHz	Ch 810 1909.8 MHz
		Power level		29.8 dBm	29.2 dBm	28.2 dBm
GSM 1900	N/A	Left	Cheek	-	0.35	-
			Tilt	-	0.22	-
		Right	Cheek	-	0.37	-
			Tilt	-	0.20	-
GSM 1900	Installed	Left	Cheek	-	0.37	-
			Tilt	-	0.23	-
		Right	Cheek	**0.45**	0.37	0.30
			Tilt	-	0.20	-

The measured Body SAR values for the test device are tabulated below:

GPRS 850MHz Body SAR Results

Mode and Band	Multimedia Card Option	Body-worn location setup	SAR, averaged over 1g (W/kg)		
			Ch 128 824.2 MHz	Ch 190 836.6 MHz	Ch 251 848.8 MHz
		Power level	29.2 dBm	29.2 dBm	29.5 dBm
GPRS 850 + BT	N/A	Headset, HS-7N	**0.71**	0.70	0.67
GPRS 850 + BT	Installed	Headset, HS-7N	-	0.68	-

GSM 1900MHz Body SAR Results

Mode and Band	Multimedia Card Option	Body-worn location setup	SAR, averaged over 1g (W/kg)		
			Ch 512 1850.2 MHz	Ch 661 1880.0 MHz	Ch 810 1909.8 MHz
		Power level	29.2 dBm	28.6 dBm	28.0 dBm
GPRS 1900 + BT	N/A	Headset, HS-7N	**0.78**	0.71	0.53
GPRS 1900 + BT	Installed	Headset, HS-7N	0.74	0.65	0.51

Plots of the Measurement scans are given in Appendix B.