

Specific Absorption Rate (SAR) Test Report

for
Samsung Electronics Co., Ltd.
on the
PCS1900/GSM900 Cellular Phone
Model: SGH-Q105

Test Report: 30062621
Date of Report: August 18, 2001

Job Number: 3006262
Date of Test: August 10 to 11, 2001

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Tested by: <i>Xi-Ming Yang</i>	Xi-Ming Yang	Review Date: <i>8/20/01</i>
Reviewed by: <i>David Chernomordik</i>	David Chernomordik EMC Technical Manager	Review Date: <i>8/20/01</i>

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Intertek Testing Services NA, Inc.

1365 Adams Court, Menlo Park, CA 94025

Telephone 650-463-2900 Fax 650-463-2910 Home Page www.etlsemko.com



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TABLE OF CONTENTS

1.0	JOB DESCRIPTION	2
1.1	Client Information.....	2
1.2	Equipment under test (EUT)	2
1.3	Test Plan Reference	3
1.4	System test configuration.....	3
1.4.1	System block diagram & Support equipment	3
1.4.2	Test Position.....	4
1.4.3	Body SAR Position	5
1.4.4	Test Condition.....	6
1.5	Modifications required for compliance	6
1.6	Additions, deviations and exclusions from standards.....	6
2.0	SAR EVALUATION.....	7
2.1	SAR Limits.....	7
2.2	Configuration Photographs	8
2.3	System Verification	17
2.4	Evaluation Procedures	17
2.5	Test Results	18
3.0	EQUIPMENT	21
3.1	Equipment List	21
3.2	Tissue Simulating Liquid	22
3.3	E-Field Probe Calibration	24
3.4	Measurement Uncertainty	25
3.5	Measurement Traceability.....	25
4.0	WARNING LABEL INFORMATION - USA.....	26
5.0	REFERENCES.....	27
6.0	DOCUMENT HISTORY.....	28
	APPENDIX A - SAR Evaluation Data	29
	APPENDIX B - E-Field Probe Calibration Data	60

1.0 JOB DESCRIPTION**1.1 Client Information**

The EUT has been tested at the request of:

Company: Samsung Electronics Co., Ltd.
Address: #94-1, Imsoo Dong
Gumi-City, Kyung-Buk 730-350
Korea
Name of contact: Mr. S. H. An
Telephone: +82 54 479-5635
Fax: +82 54 479-5620

1.2 Equipment under test (EUT)**Product Descriptions:**

Equipment	PCS1900/GSM900 DUAL BAND Celular Phone		
Trade Name	Samsung Electronics Co., Ltd.	Model No	SGH-Q105
FCC ID	Not Labeled	S/N No.	Not Labeled
Category	Portable	RF Exposure	Uncontrolled Environment
Frequency Band	890 – 915 MHz 1850 - 1910 MHz	System	GSM 900 GSM 1900 (PCS)

EUT Antenna Description			
Type	Monopole	Configuration	Fixed
Dimensions	18mm (Length)	Gain	0 dBi
Location	Top, Right		

Use of Product : Voice Communication

Manufacturer: Samsung Electronics Co., Ltd.

Production Planned [X] Yes, [] No

EUT receive date: August 10, 2001

EUT received condition: Prototype in good condition.

Test start date: August 10, 2001

Test end date: August 11, 2001

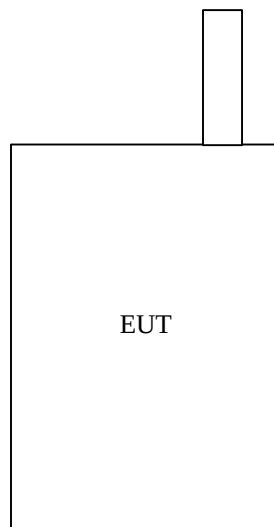
1.3 Test Plan Reference

FCC rule part 2.1093, FCC Docket 96-326 & Supplement C to OET Bulletin 65

1.4 System test configuration

1.4.1 System block diagram & Support equipment

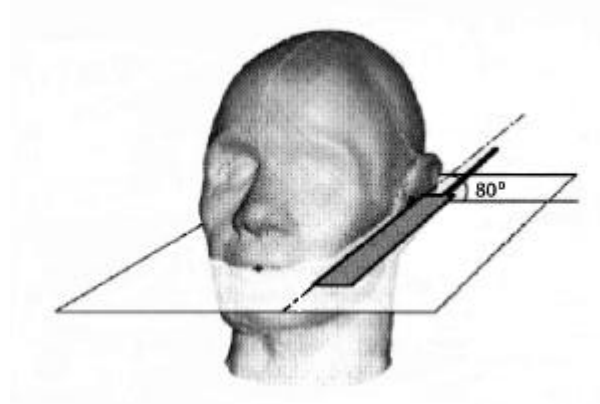
The EUT was tested without the need for support equipment.



1.4.2 Test Position

The SGH-Q105 was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in C95.1 (1992) and Supplement C of OET 65 (1998). The SGH-Q105 was placed in the intended use position, i.e. CENELEC 80° position. This position is defined by a reference plane and a line. The reference plane of the head is given by three points, the auditory canal opening of both ears and center of the closed mouth. The reference line of the SGH-Q105 is defined by the line, which connects the center of the earpiece with the center of the bottom of the case and lies on the surface of the case facing the phantom. The reference line of the SGH-Q105 lies in the reference plane of the head. The center of the earpiece of the SGH-Q105 is placed at the entry of the auditory canal. The angle between the reference line of the phone and the line connecting both auditory canal openings is 80°. Please refer to figure 1 below for the position details:

Figure 1: Intended use position



Additionally, the SGH-Q105 was tested in a second position from the normal 80° angle between the reference line of the phone and the line connecting both auditory canal openings. The center of the ear piece of the SGH-Q105 is placed at the entry of the auditory canal. The angle between the reference line of the phone and the line connecting both auditory canal openings was adjusted from 80° to the angle where two points of the phone were in contact with the phantom (ear hole and cheek).

The left hand and right hand sections of the phantom were used for measuring the low, middle, and high channels in the 80° and 2 point touch positions. The test data for the worst case positions is reported.

1.4.3 Body SAR Position

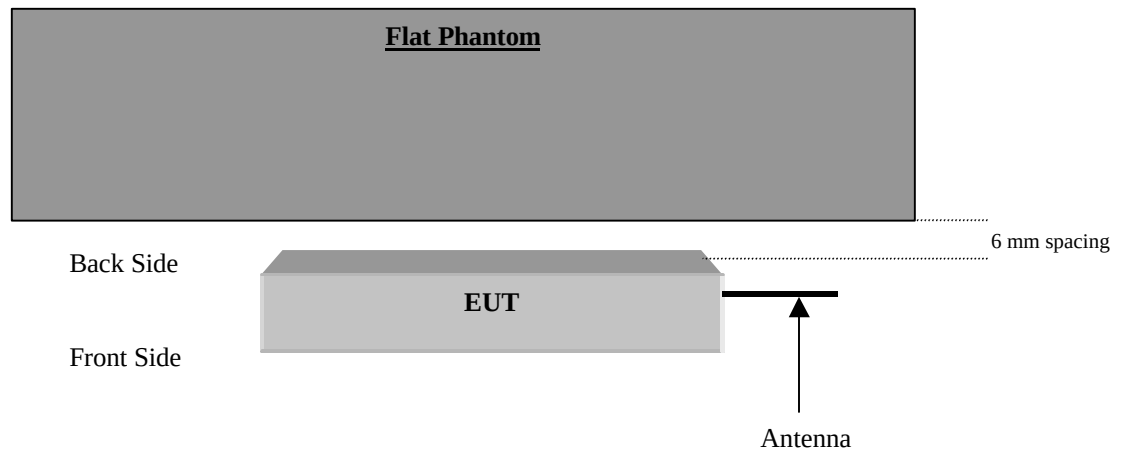


Figure 1: Intended use position for Body Worn operation, 6 mm from Phantom

1.4.4 Test Condition

During tests, the worst case data (max. RF coupling) was determined with following conditions:

EUT Antenna	Fixed	Orientation	Normal
Usage	Right Hand, Left Hand, Body Worn	Distance between antenna axis at the joint and the phantom:	21 mm, position: 2 point touch, right hand 18 mm, position: 80°, right hand 17 mm, position: 2 point touch, left hand 15 mm, position: 80°, left hand 6 mm, body SAR
Simulating human hand	Not Used	EUT Battery	Fully Charged
Power output (EIRP)	31.57 dBm, 890 MHz; 31.81 dBm, 902 MHz; 30.39 dBm, 915 MHz ;	25.30 dBm, 1850 MHz 25.88 dBm, 1880 MHz 24.61 dBm, 1910 MHz	

The spatial peak SAR values were accessed for lowest, middle and highest operating channels defined by the manufacturer. EIRP is specified by the customer. Tests were performed in GSM mode.

1.5 Modifications required for compliance

No modifications were implemented by Intertek Testing Services.

1.6 Additions, deviations and exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.0 SAR EVALUATION

2.1 SAR Limits

The following FCC limits for SAR apply to devices operate in General Population/Uncontrolled Exposure environment:

EXPOSURE (General Population/Uncontrolled Exposure environment)	SAR (W/kg)
Average over the whole body	0.08
Spatial Peak (1g)	1.60
Spatial Peak for hands, wrists, feet and ankles (10g)	4.00

2.2 Configuration Photographs

SAR measurement Test Setup



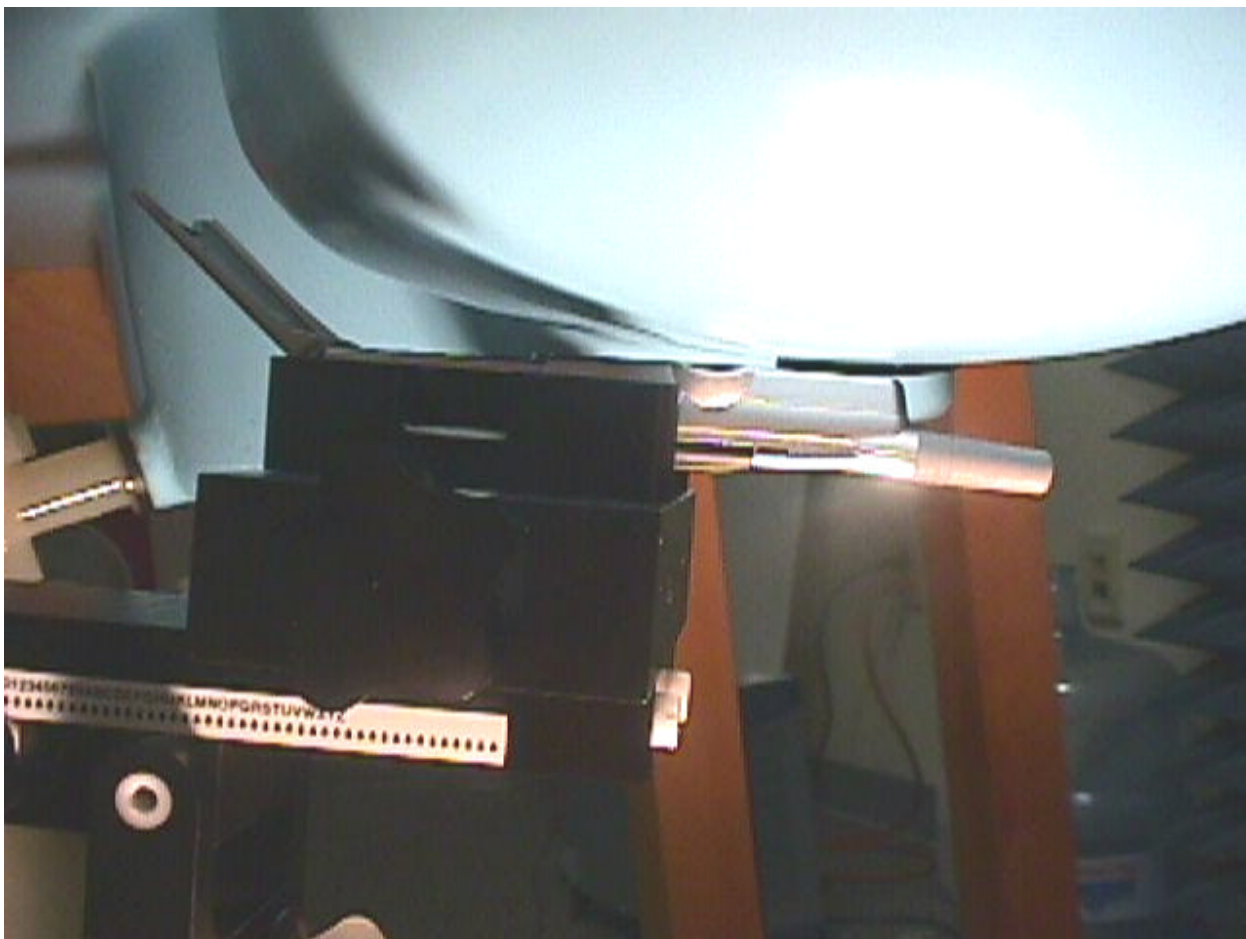
2.2 Configuration Photographs Continued

SAR Measurement Test Setup



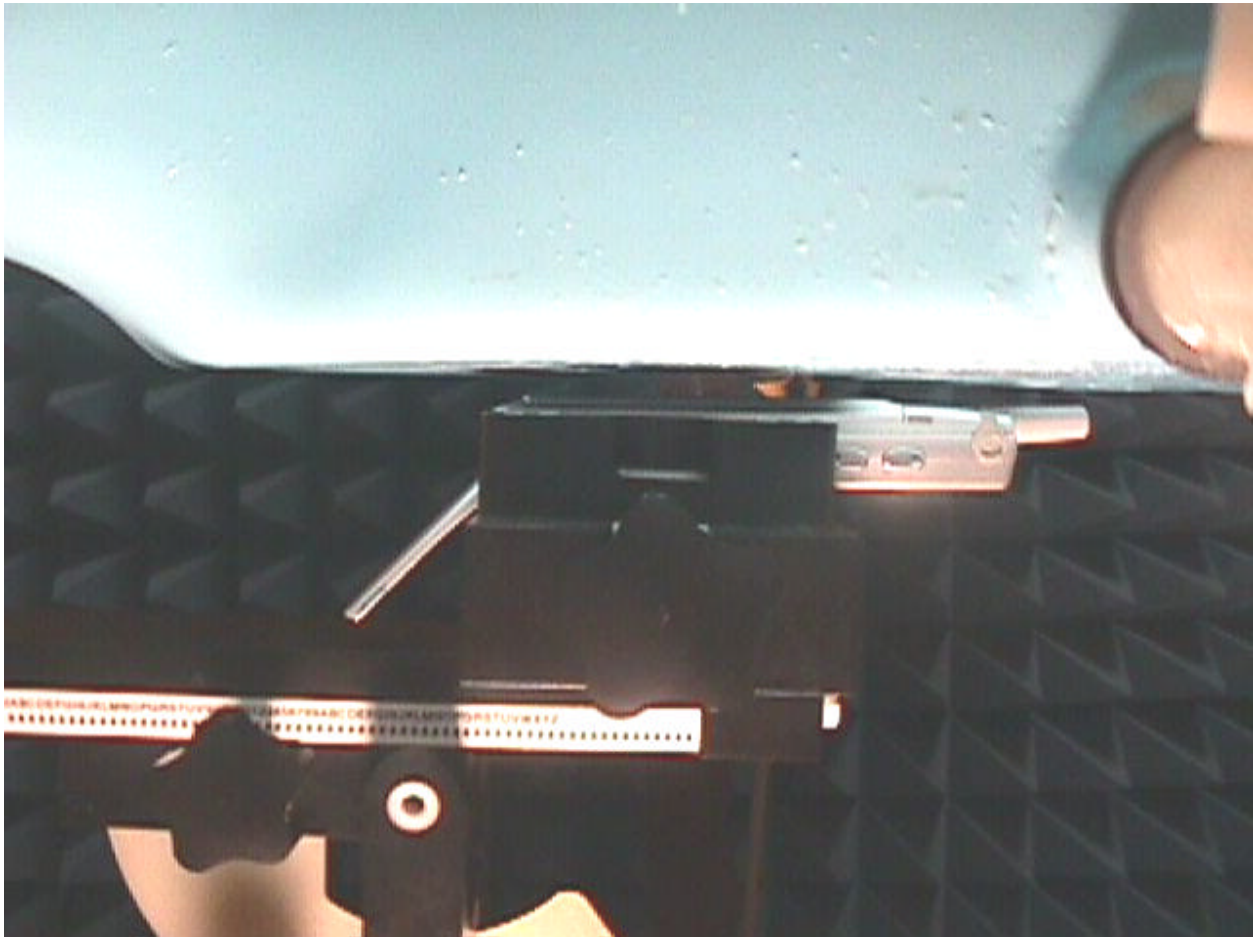
2.2 Configuration Photographs – Continued

SAR Measurement Test Setup



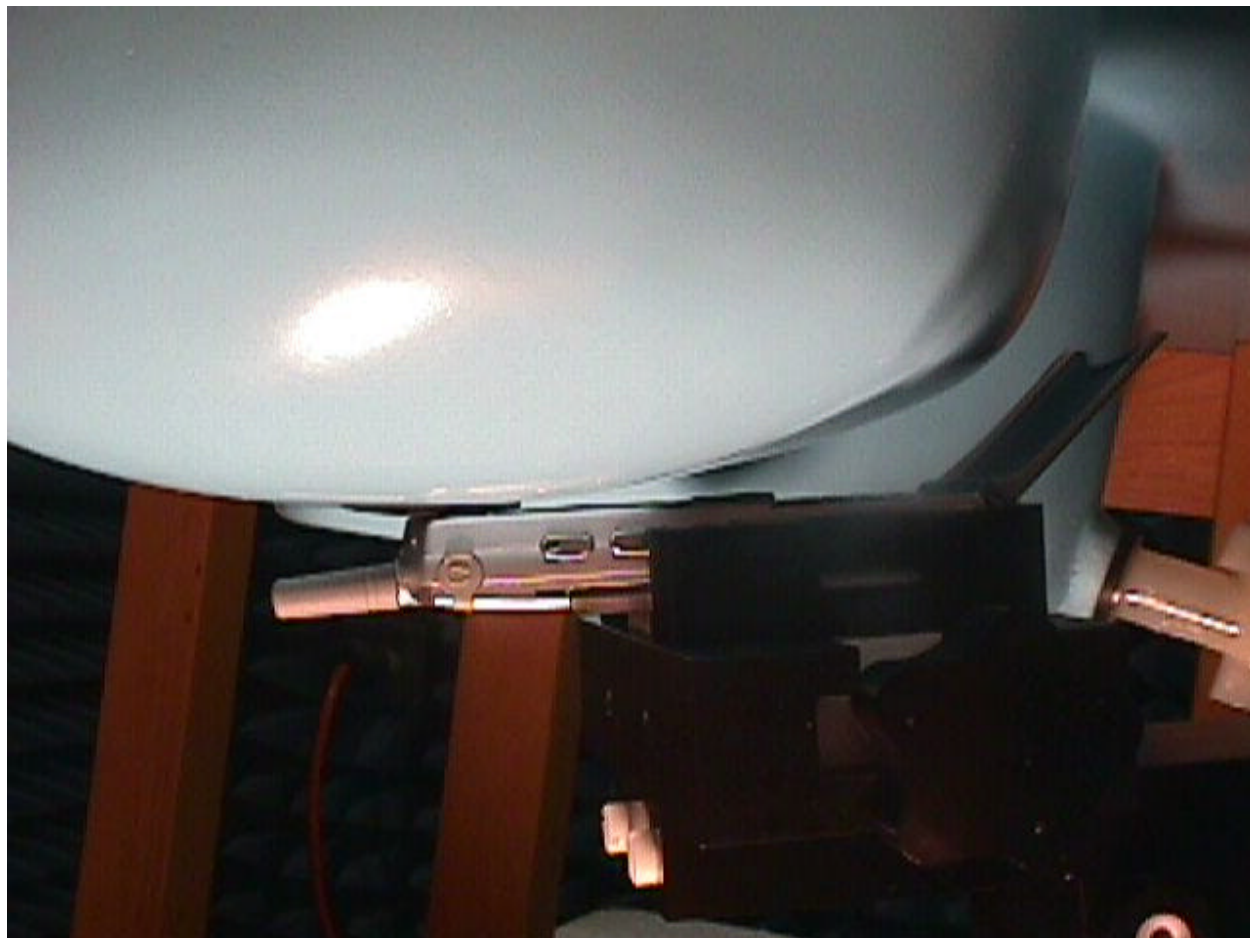
2.2 Configuration Photographs – Continued

SAR Measurement Test Setup



2.2 Configuration Photographs – Continued

SAR Measurement Test Setup



2.2 Configuration Photographs – Continued

SAR EUT PHOTO



2.2 Configuration Photographs – Continued

SAR EUT PHOTO



2.2 Configuration Photographs – Continued

SAR EUT PHOTO



2.2 Configuration Photographs – Continued

SAR EUT PHOTO



2.3 System Verification

Prior to the assessment, the system was verified to the $\pm 5\%$ of the specifications by using the system validation kit. The validation was performed at 900 MHz.

Validation kit	Targeted SAR _{1g} (mW/g)	Measured SAR _{1g} (mW/g)
D900V2, S/N #: 013	3.92	3.99

2.4 Evaluation Procedures

The SAR evaluation was performed with the following procedures:

- a. SAR was measured at a fixed location above the ear point and used as a reference value for the assessing the power drop.
- b. The SAR distribution at the exposed side of the head was measured at a distance of 4.0 mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 20 mm x 20 mm. Based on this data, the area of the maximum absorption was determined by spline interpolation.
- c. Around this point, a volume of 32 mm x 32 mm x 34 mm was assessed by measuring 5 x 5 x 7 points. Based on this data set, the spatial peak SAR value was evaluated with the following procedure:
 - i) The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measurement point is 1.6 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in Z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
 - ii) The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed using the 3-D spline interpolation algorithm. The 3-D spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y and z directions). The volume was integrated with the trapezoidal algorithm. 1000 points (10 x 10 x 10) were interpolated to calculate the average.
 - iii) All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
- d. Re-measurement of the SAR value at the same location as in step a. above. If the value changed by more than 5 %, the evaluation was repeated.

2.5 Test Results

The results on the following page(s) were obtained when the device was tested in the condition described in this report. Detail measurement data and plots, which reveal information about the location of the maximum SAR with respect to the device, are reported in Appendix A.

Trade Name:	Samsung Electronics Co., Ltd.	Model No.:	SGH-Q105
Serial No.:	Not Labeled	Test Engineer:	Xi-Ming Yang

TEST CONDITIONS			
Ambient Temperature	23 °C	Relative Humidity	55 %
Test Signal Source	Test Mode	Signal Modulation	GSM
Output Power Before SAR Test	31.57 dBm, 890 MHz 31.81 dBm, 902 MHz 30.39 dBm, 915 MHz	Output Power After SAR Test	31.57 dBm, 890 MHz 31.81 dBm, 902 MHz 30.39 dBm, 915 MHz
Output Power Before SAR Test	25.30 dBm, 1850 MHz 25.58 dBm, 1880 MHz 24.61 dBm, 1910 MHz	Output Power After SAR Test	25.30 dBm, 1850 MHz 25.58 dBm, 1880 MHz 24.61 dBm, 1910 MHz
Test Duration	23 Min.	Number of Battery Change	Every Scan

In the table below, the measured SAR averaged over 10 g is reported, according the requirements of EN50360.

Plot No	Channel MHz	Operating Mode	Crest Factor	Antenna Position	Measured SAR _{1g} (mW/g)	Measured SAR _{10g} (mW/g)
1	890	GSM	8	Left Hand, 80°		0.995
2	902	GSM	8	Left Hand, 80°		0.848
3	914	GSM	8	Left Hand, 80°		0.763
4	890	GSM	8	Left Hand, Two-touch		1.18
5	902	GSM	8	Left Hand, Two-touch		1.06
6	914	GSM	8	Left Hand, Two-touch		0.940
7	890	GSM	8	Right Hand, 80°		0.932
8	902	GSM	8	Right Hand, 80°		0.813
9	914	GSM	8	Right Hand, 80°		0.675
10	890	GSM	8	Right Hand, Two-touch		1.02
11	902	GSM	8	Right Hand, Two-touch		0.901
12	914	GSM	8	Right Hand, Two-touch		0.760
13	890	GSM	8	Body		1.07
14	902	GSM	8	Body		1.05
15	914	GSM	8	Body		0.912

In the table below, the measured SAR averaged over 1g is reported, according the FCC requirements.

Plot No	Channel MHz	Operating Mode	Crest Factor	EUT Position	Measured SAR _{1g} (mW/g)	Measured SAR _{10g} (mW/g)
16	1850	GSM	8	Body	1.21	
17	1880	GSM	8	Body	1.35	
18	1910	GSM	8	Body	1.28	
19	1850	GSM	8	Left Hand, 80°	1.47	
20	1880	GSM	8	Left Hand, 80°	1.50	
21	1910	GSM	8	Left Hand, 80°	1.53	
22	1850	GSM	8	Left Hand, Two-touch	0.948	
23	1880	GSM	8	Left Hand, Two-touch	1.16	
24	1910	GSM	8	Left Hand, Two-touch	1.07	
25	1850	GSM	8	Right Hand, 80°	1.25	
26	1880	GSM	8	Right Hand, 80°	1.43	
27	1910	GSM	8	Right Hand, 80°	1.51	
28	1850	GSM	8	Right Hand, Two-touch	0.922	
29	1880	GSM	8	Right Hand, Two-touch	1.15	
30	1910	GSM	8	Right Hand, Two-touch	1.05	

Note: a) Worst case data were reported
b) Duty cycle factor included in the measured SAR data
c) Uncertainty of the system is not included

3.0 EQUIPMENT

3.1 Equipment List

The Specific Absorption Rate (SAR) tests were performed with the SPEAG model DASY 3 automated near-field scanning system, which is a package, optimized for dosimetric evaluation of mobile radios [3].

The following major equipment/components were used for the SAR evaluations:

SAR Measurement System			
EQUIPMENT	SPECIFICATIONS	S/N #	LAST CAL. DATE
Robot	Stäubi RX60L	597412-01	N/A
	Repeatability: ± 0.025 mm Accuracy: 0.806×10^{-3} degree Number of Axes: 6		
E-Field Probe	ET3DV5	1333	04/23/01
	Frequency Range: 10 MHz to 6 GHz Linearity: ± 0.2 dB Directivity: ± 0.1 dB in brain tissue		
Data Acquisition	DAE3	317	N/A
	Measurement Range: 1 μ V to >200mV Input offset Voltage: < 1 μ V (with auto zero) Input Resistance: 200 M		
Phantom	Generic Twin V3.0	N/A	N/A
	Type: Generic Twin, Homogenous Shell Material: Fiberglass Thickness: 2 ± 0.1 mm Capacity: 20 liter Ear spacer: 4 mm (between EUT ear piece and tissue simulating liquid)		
Simulated Tissue	Mixture	N/A	8/10/01
	Please see section 6.2 for details		
Power Meter	HP 8900D w/ 84811A sensor	3607U00673	08/01/01
	Frequency Range: 100kHz to 18 GHz Power Range: 300 μ W to 3W		

3.2 Tissue Simulating Liquid

Brain	
Ingredient	Frequency (800 – 900 MHz)
Water	40.3 %
Sugar	56.0 %
Salt	2.5 %
HEC	1.0 %
Bactericide	0.2 %

The dielectric parameters were verified prior to assessment using the HP 85070A dielectric probe kit and the HP 8753C network Analyzer. The dielectric parameters were:

Frequency (MHz)	ϵ_r^*	σ^* (mho/m)	ρ^{**} (kg/m ³)
902	45.1 ± 5%	0.81 ± 10%	1000

* Worst case uncertainty of the HP 85070A dielectric probe kit

** Worst case assumption

Brain	
Ingredient	Frequency (1800 - 1900 MHz)
Water	53.93 %
Sugar	44.97 %
Salt	0 %
HEC	1.0 %
Bactericide	0.1 %

The dielectric parameters were verified prior to assessment using the HP 85070A dielectric probe kit and the HP 8753C network Analyzer. The dielectric parameters were:

Frequency (MHz)	ϵ_r^*	σ^* (mho/m)	ρ^{**} (kg/m ³)
1880	40.4 ± 5%	1.75 ± 10%	1000

* Worst case uncertainty of the HP 85070A dielectric probe kit

** Worst case assumption

Note: The amount of each ingredient specified in the tables is not the exact amounts of the final test solution. The final test solution was adjusted by adding small amounts of water, sugar, and/or salt to calibrate the solution to meet the proper dielectric parameters.

Muscle	
Ingredient	Frequency (800 – 900 MHz)
Water	54.05 %
Sugar	45.05 %
Salt	0.1 %
Bactericide	0.8%

The dielectric parameters were verified prior to assessment using the HP 85070A dielectric probe kit and the HP 8753C network Analyzer. The dielectric parameters were:

Frequency (MHz)	ϵ_r^*	$\sigma^*(\text{mho/m})$	$\rho^{**}(\text{kg/m}^3)$
902	$55.8 \pm 5\%$	$0.98 \pm 10\%$	1000

* Worst case uncertainty of the HP 85070A dielectric probe kit

** Worst case assumption

Muscle	
Ingredient	Frequency (1800 - 1900 MHz)
Water	55.5 %
Sugar	43.5 %
Salt	0 %
Cellulose	1.0 %

The dielectric parameters were verified prior to assessment using the HP 85070A dielectric probe kit and the HP 8753C network Analyzer. The dielectric parameters were:

Frequency (MHz)	ϵ_r^*	$\sigma^*(\text{mho/m})$	$\rho^{**}(\text{kg/m}^3)$
1880	$52.2 \pm 5\%$	$1.65 \pm 10\%$	1000

* Worst case uncertainty of the HP 85070A dielectric probe kit

** Worst case assumption

Note: The amount of each ingredient specified in the tables is not the exact amounts of the final test solution. The final test solution was adjusted by adding small amounts of water, sugar, and/or salt to calibrate the solution to meet the proper dielectric parameters.

3.3 E-Field Probe Calibration

Probes were calibrated by the manufacturer in an IFI Model 110 TEM Cell. To ensure consistency, a strict protocol was followed. The conversion factor (ConF) between this calibration and the measurement in the tissue simulation solution was performed by comparison with temperature measurement and computer simulations. Probe calibration factors are included in Appendix B.

3.4 Measurement Uncertainty

The uncertainty budget has been determined for the DASY3 measurement system according to the NIS81 [5] and the NIST 1297 [6] documents and is given in the following table. The extended uncertainty (K=2) was assessed to be 23.5 %

UNCERTAINTY BUDGET				
Uncertainty Description	Error	Distrib.	Weight	Std.Dev.
Probe Uncertainty				
Axial isotropy	±0.2 dB	U-shape	0.5	±2.4 %
Spherical isotropy	±0.4 dB	U-shape	0.5	±4.8 %
Isotropy from gradient	±0.5 dB	U-shape	0	
Spatial resolution	±0.5 %	Normal	1	±0.5 %
Linearity error	±0.2 dB	Rectang.	1	±2.7 %
Calibration error	±3.3 %	Normal	1	±3.3 %
SAR Evaluation Uncertainty				
Data acquisition error	±1 %	Rectang.	1	±0.6 %
ELF and RF disturbances	±0.25 %	Normal	1	±0.25 %
Conductivity assessment	±10 %	Rectang.	1	±5.8 %
Spatial Peak SAR Evaluation Uncertainty				
Extrapol boundary effect	±3 %	Normal	1	±3 %
Probe positioning error	±0.1 mm	Normal	1	±1 %
Integrat. And cube orient	±3 %	Normal	1	±3 %
Cube shape inaccuracies	±2 %	Rectang.	1	±1.2 %
Device positioning	±6 %	Normal	1	±6 %
Combined Uncertainties				±11.7 %

3.5 Measurement Traceability

All measurements described in this report are traceable to National Institute of Standards and Technology (NIST) standards or appropriate national standards.

4.0 WARNING LABEL INFORMATION - USA

See users manual.

5.0 REFERENCES

- [1] ANSI, ANSI/IEEE C95.1-1991: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 GHz, The Institute of electrical and Electronics Engineers, Inc., New York, NY 10017, 1992

- [2] Federal Communications Commission, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", OET Bulletin 65, FCC, Washington, D.C. 20554, 1997

- [3] Thomas Schmid, Oliver Egger, and Niels Kuster, "Automated E-field scanning system for dosimetric assessments", *IEEE Transaction on Microwave Theory and Techniques*, vol. 44, pp. 105-113, Jan. 1996.

- [4] Niels Kuster, Ralph Kastle, and Thomas Schmid, "Dosimetric evaluation of mobile communications equipment with know precision", *IEICE Transactions on Communications*, vol. E80-B, no. 5, pp.645-652, May 1997.

- [5] NIS81, NAMAS, "The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddinton, Middlesex, England, 1994.

- [6] Barry N. Taylor and Chris E. Kuyatt, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994.

6.0 DOCUMENT HISTORY

Revision/ Job Number	Writer Initials	Date	Change
1.0 / 20434451	SS	March 22, 2001	Original document
	SS	June 19, 2001	Amendment to RPT #20434451

APPENDIX A - SAR Evaluation Data

Please note that the graphical visualization of the phone position onto the SAR distribution gives only limited information on the current distribution of the device, since the curvature of the head results in graphical distortion. Full information can only be obtained either by H-field scans in free space or SAR evaluation with a flat phantom.

Power drift is the measurement of power drift of the device over one complete SAR scan.

