

Specific Absorption Rate (SAR) Test Report
for
Hyundai Electronics Industries Co., Ltd.
on the
SingleBand PCS
Model: HGP-230

Test Report: J99006681_sar
Date of Report: April 5, 1999



NVLAP Laboratory Code 200201-0
Accredited for testing to FCC Parts 15

Tested by:	C. K. Li	
Reviewer:	C. K. Li	

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1 JOB DESCRIPTION

1.1 Client Information

The EUT has been tested at the request of

Company: Hyundai Electronics Industrial Co., Ltd.
San 13601, Amiri, Bubal-Eub,
Ichon-Si
Kyungki-Do, Korea

Name of contact: M.K. Kim
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1.2 Equipment under test (EUT)

Product Descriptions:

Equipment	Single Band PCS		
Trade Name	Hyundai	Model No.	HGP-230
FCC ID	CKLHGP-230	S/N No.	NA
Category	Portable	RF Exposure	Uncontrolled Environment
Frequency Band (uplink)	1850 – 1909.95 MHz	System	CDMA

EUT Antenna Description			
Type	¼λ Helical over ¼λ Whip	Configuration	Fixed
Dimensions	55.4mm(L), 1.83 mm (φ)	Gain	0 dBi
Location	Left,Top		

Use of Product : Voice communications

Manufacturer: SAME as above.

Production is planned: [X] Yes, [] No

EUT receive date: 4/2/99

EUT received condition: Good condition prototype

Test start date: 4/2/99

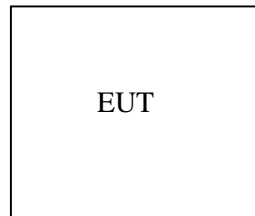
Test end date: 4/5/99

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 diagram shown below details test configuration of the equipment under test .



S:	Shielded	U:	Unshield	F:	With Ferrite Core
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Support equipment					
Equip. #	Equipment	Manufacturer	Model #	S/N #	FCC ID
None					

1.4.2 Test Position

The EUT 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 EUT 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 EUT is defined by the line which connects the center of the ear piece with the center of the microphone and lies on the surface of the case facing the phantom. The reference line of the EUT lies in the reference plane of the head. The center of the ear piece of the EUT 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:

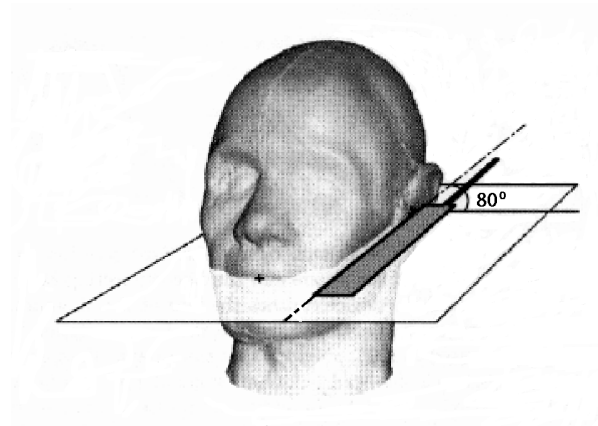


Figure 1: Intended use position

1.4.3 Test Condition

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

EUT Antenna	Extended and Retracted	Orientation	N/A
Usage	Left-Hand and Right -Hand	Distance between antenna axis at the joint and the liquid surface:	44 mm
Simulating human hand	Not Used	EUT Battery	Fully Charged
Power output	240 mW (Average reading)		

The spatial peak SAR values were accessed for lowest, middle and highest operating channels defined by the manufacturer.

Antenna port power measurement was performed, with the HP 435A power meter, before and after the SAR tests to ensure that the EUT operated at the highest power level.

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.

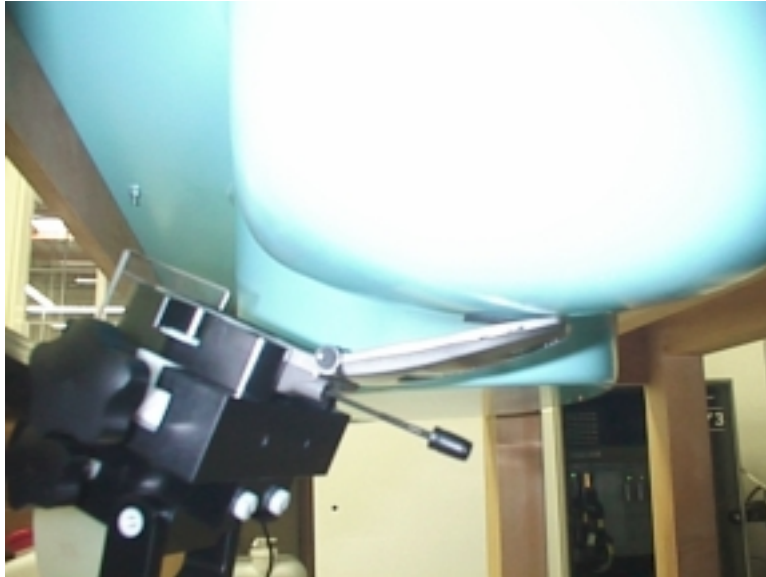
2 SAR EVALUATION**2.1 SAR Limits**

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

Worst-Case SAR measurement at 1851 MHz



Left-Hand Usage

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 1800 MHz.

Validation kit	Targeted SAR _{1g} (mW/g)	Measured SAR _{1g} (mW/g)
D1800V2, S/N #: 224	0.721	0.720

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 4.3 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. On the basis of 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 straight-forward 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 below 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:	Hyundai	Model No.:	HGP-230
Serial No.:	Not labelled	Test Engineer:	CK

TEST CONDITIONS			
Ambient Temperature	22.7 °C	Relative Humidity	52 %
Test Signal Source	Test Mode	Signal Modulation	CDMA
Output Power Before SAR Test	240 mW	Output Power After SAR Test	240 mW
Test Duration (each test)	25 Min.	Number of Battery Change	1

Left-Hand Usage				
Channel	Operating Mode	Duty Cycle ratio	Antenna Position	Measured SAR _{lg} (mW/g)
1851 MHz	CDMA	1	Fully Retracted	0.175
		1	Fully Extended	0.256
1880 MHz	CDMA	1	Fully Retracted	0.195
		1	Fully Extended	0.233
1908 MHz	CDMA	1	Fully Retracted	0.210
		1	Fully Extended	0.217

Right-Hand Usage ^{a)}				
Channel	Operating Mode	Duty Cycle ratio	Antenna Position	Measured SAR _{lg} (mW/g)
1851 MHz	CDMA	1	Fully Retracted	0.141
		1	Fully Extended	0.224

Note: a) Worst case data were reported
b) Duty cycle factor included in the measured SAR data

3.0 TEST 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 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 #	CAL. DATE
Robot	Stäubli RX60L Repeatability: ± 0.025 mm Accuracy: 0.806×10^{-3} degree Number of Axes: 6	597412-01	N/A
E-Field Probe	ET3DV5 Frequency Range: 10 MHz to 6 GHz Linearity: ± 0.2 dB Directivity: ± 0.1 dB in brain tissue	1333	03/18/99
Data Acquisition	DAE3 Measurement Range: $1\mu\text{V}$ to $>200\text{mV}$ Input offset Voltage: $< 1\mu\text{V}$ (with auto zero) Input Resistance: 200 M	358	2/99
Phantom	Generic Twin V3.0 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)	N/A	N/A
Simulated Tissue	Mixture Please see section 6.2 for details	N/A	03/25/99
Power Meter	HP 435A w/ 8481H sensor Frequency Range: 100kHz to 18 GHz Power Range: $300\mu\text{W}$ to 3W	1312A01255	02/01/99

3.2 Brain Tissue Simulating Liquid

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)
1800	39.25 \pm 5%	1.7 \pm 10%	1000
1900	38.58 \pm 5%	1.81 \pm 10%	1000

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

** worst case assumption

3.3 E-Field Probe Calibration

Probes were calibrated by the manufacturer in the TEM cell ifi 110. 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 C.

3.4 Measurement Uncertainty

The total uncertainty for the evaluation of the spatial peak SAR values averaged over a cube of 1 g tissue mass has been assessed for this system to be less than $\pm 20\%$ [4]. This uncertainty includes probe, calibration, positioning and evaluation errors as well as errors in assessing the correct dielectric parameters for the brain simulating liquid, etc.

UNCERTAINTY BUDGET	
Source of Uncertainty	Uncertainty ($\pm\%$)
<i>Field Measurement</i> Isotropy error in tissue-simulating liquid: $<\pm 0.2\text{dB}$ Frequency response: $<\pm 0.1\text{dB}$ Linearity: $<\pm 0.2\text{dB}$ Data acquisition and evaluation: $<\pm 0.05\text{dB}$ Probe calibration: $<\pm 10\%$ ELF and RF disturbance: $<\pm 10\mu\text{W/g}$	<i>13</i>
<i>Spatial Peak Evaluation</i> Extrapolation and interpolation error, and position error: $<\pm 0.1\text{dB}$ Integration and maximum search routine: $<\pm 0.1\text{dB}$ Inaccuracies in cube's shape: $<\pm 0.2\text{dB}$	<i>7</i>
<i>Tissue Calibration</i> HP85070 dielectric probe	<i>10</i>
<i>Total (rss)</i>	<i>17.8</i>

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

Not Applicable

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.

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.

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

APPENDIX B - E-FIELD PROBE CALIBRATION DATA

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