Specific Absorption Rate (SAR) Test Report
for
Symbol Technologies, Inc.
on the
NETVISION 2.4 GHZ DIRECT SEQUENCE SPREAD SPECTRUM RADIO
Model: DP-4046

Test Report: 2036369F1
Date of Report: March 27, 2001

Job #: J20036369F and J20036369H

Total number of pages in report: 31 + Data Sheets

NVLAP®

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

Tested by:	Suresh Kondapalli	Review Date: 3/30/01
Reviewed by:	David Chernomordik EMC Site Manager	Review Date: 3/30/01

Table of Contents

1.0 JOB DESCRIPTION

1.1 Client Information

The EUT has been tested at the request of:

Company: Symbol Technologies, Inc..
Address: 6480 Via Del Oro
San Jose, CA 95119-1208
USA
Name of contact: Mr. Norm Nelson
Telephone: (408) 528-2649
Fax: (408) 528-2740

1.2 Equipment under test (EUT)

Product Descriptions:

Equipment	NETVISION 2.4 GHZ DIRECT SEQUENCE SPREAD SPECTRUM RADIO. Unit is available with a main antenna and an auxiliary antenna.		
Trade Name	Symbol Technologies, Inc.	Model No:	DP-4046
FCC ID	H9PDP4046	S/N No.	Not Labeled
Category	Portable	RF Exposure	Uncontrolled Environment
Frequency Band (up link)	2402-2480 MHz	System	DSSS
EUT Antenna Descriptions			
Main Antenna Type	Name: Phone PCB Sanyo #: IRA4L90A15401 Symbol #: 50-21900-045 Gain: 2 dBi	Auxiliary Antenna Type	Name: Phone Stick On Sanyo #: IRA4L90A15401 Symbol #: 50-21900-044 Gain: 2 dBi
Location:	Main Antenna: Internal Auxiliary Antenna: Internal		

Note: For details on antennas see Appendix C

Use of Product : Wireless Voice/Data communications

Manufacturer: Symbol Technologies, Inc.

Production is planned [X] Yes, [ ] No

EUT receive date: March 19, 2001

EUT received condition: Prototype in good condition.

Test start date: March 20, 2001

Test end date: March 26, 2001

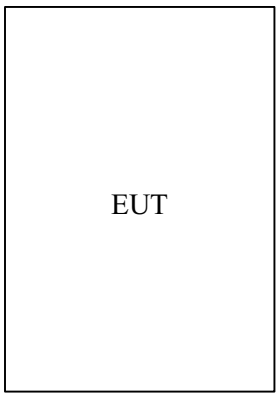
1.3 Test plan reference

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 for Brain

The DP-4046 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 DP-4046 was placed in the intended use position, i.e. CENELEC 80^{o} 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 DP-4046 is defined by the line, which connects the center of the ear piece 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 DP-4046 lies in the reference plane of the head. The center of the ear-piece of the DP-4046 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^{o}. Please refer to figure 1 below for the position details:

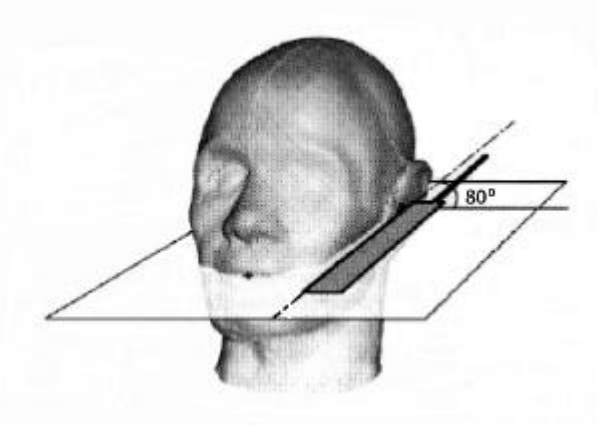


Figure 1: Intended use position for Brain

Additionally, the DP-4046 was tested in a second position from the normal 80^{o} angle between the reference line of the phone and the line connecting both auditory canal openings. The center of the ear piece of the DP-4046 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 ^{o} to the angle where two points of the phone were in contact with the phantom (ear hole and cheek). This position is called two touch.

Data pages indicate the position of the DP-4046 during testing. The 80 ^{o} test position has data pages labeled ‘one touch’. The two touch position has data pages labeled ‘two touch’.

1.4.3 Test Position for Muscle

The DP-4046 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). Please refer to figure 2 below for the position details:

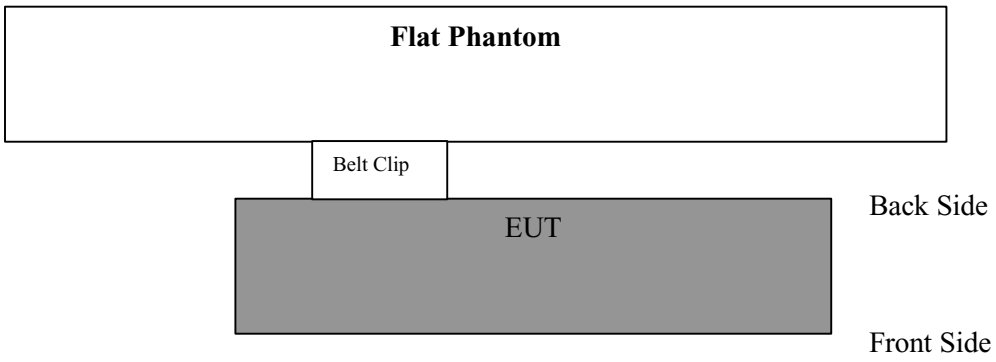


Figure 2: Intended use position for Muscle(Body Worn)

Data pages indicate the position of the DP-4046 during testing. The muscle test position has data pages labeled 'with Belt Clip'.

1.4.4 Test Condition

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

EUT Antenna	Internal	Orientation	80 Degrees (Brain) Two Point Touch (Brain) Flat (Muscle)
Usage	Right Hand Left Hand Body	Distance between antenna axis at the joint and the liquid surface:	Not able to measure due to the antenna being mounted internal to the phone
Simulating human hand	Not Used	EUT Battery	Fully Charged
Power output	21.6 dBm		

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

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

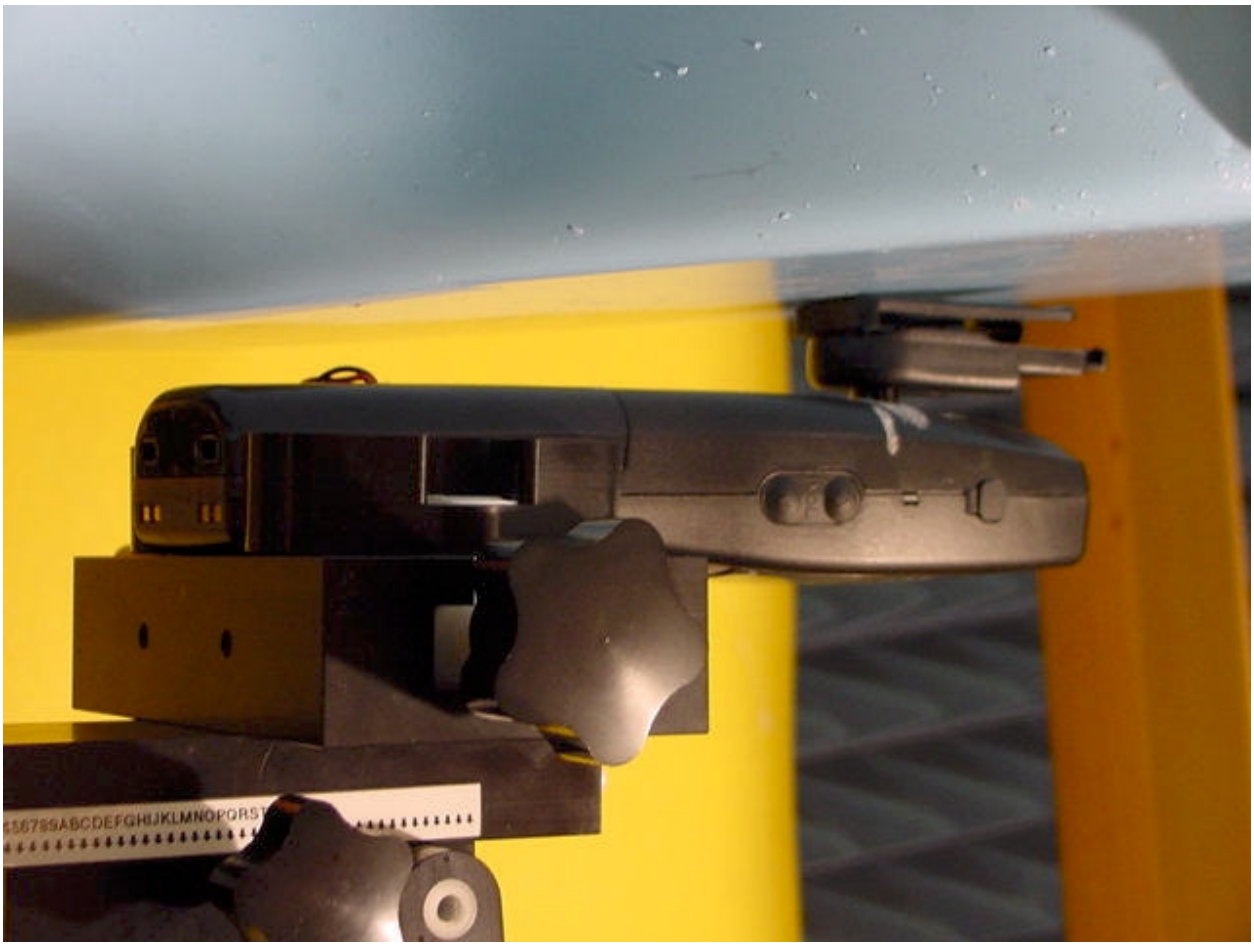
SAR Measurement Test Setup

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 Measurement Test Setup

2.2 Configuration Photographs – Continued

SAR Measurement Test Setup

2.2 Configuration Photographs – Continued

SAR Measurement Test Setup

2.3 System Verification

Prior to the assessment, the system was verified to the ±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	3.89

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 following pages contain data tables with the test results obtained when the device was tested in the condition described in this report. Detailed measurement plots, which reveal information about the location of the maximum SAR with respect to the device, are reported in Appendix A.

Trade Name:	Symbol Technologies Inc	**Model No.:**	DP-4046 Main Antenna
Serial No.:	Not Labeled	**Test Engineer:**	Suresh Kondapalli

TEST CONDITIONS			
Ambient Temperature	23 °C	Relative Humidity	55 %
Test Signal Source	Test Mode	Signal Modulation	CW
Output Power Before SAR Test	21.6 dBm	Output Power After SAR Test	21.6 dBm
Test Duration	23 Min.	Number of Battery Change	Every Scan

MAIN ANTENNA DATA TABLE

Brain EUT Position: Left Hand, 80 Deg				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2412	DSSS	1	0.628	1
2437	DSSS	1	0.632	2
2462	DSSS	1	0.706	3

Brain EUT Position: Left Hand, Two Points Touching Phantom				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2412	DSSS	1	0.527	4
2437	DSSS	1	0.492	5
2462	DSSS	1	0.525	6

Brain EUT Position: Right Hand, 80 Deg				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2412	DSSS	1	0.404	7
2437	DSSS	1	0.455	8
2462	DSSS	1	0.457	9

Brain EUT Position: Right Hand, Two Points Touching Phantom				
Channel	Operating	Duty	Measured SAR_{1g}	Plot Number

MHz	Mode	Cycle ratio	(mW/g)	
2412	DSSS	1	0.349	10
2437	DSSS	1	0.423	11
2462	DSSS	1	0.394	12

Muscle **EUT Position: Face down, with belt Clip Touching Phantom ***				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2412	DSSS	1	0.366	13
2437	DSSS	1	0.342	14
2462	DSSS	1	0.285	15

* Belt-clip is 18.3 mm thick

AUXILIARY ANTENNA DATA TABLE

Trade Name:	Symbol Technologies Inc	**Model No.:**	DP-4046 With Auxiliary Antenna
Serial No.:	Not Labeled	**Test Engineer:**	Suresh Kondapalli

TEST CONDITIONS			
Ambient Temperature	23 °C	Relative Humidity	55 %
Test Signal Source	Test Mode	Signal Modulation	CW
Output Power Before SAR Test	21.6 dBm	Output Power After SAR Test	21.6 dBm
Test Duration	23 Min.	Number of Battery Change	Every Scan

Brain **EUT Position: Left Hand, 80 Deg**				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2412	DSSS	1	0.168	16
2437	DSSS	1	0.087	17
2462	DSSS	1	0.083	18

Brain **EUT Position: Left Hand, Two Points Touching Phantom**				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number

2412	DSSS	1	0.081	19
2437	DSSS	1	0.085	20
2462	DSSS	1	0.062	21

Brain EUT Position: Right Hand, 80 Deg				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2412	DSSS	1	0.183	22
2437	DSSS	1	0.155	23
2462	DSSS	1	0.101	24

Brain EUT Position: Right Hand, Two Points Touching Phantom				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2412	DSSS	1	0.185	25
2437	DSSS	1	0.147	26
2462	DSSS	1	0.109	27

Muscle EUT Position: Face down, with belt Clip Touching Phantom *				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2412	DSSS	1	0.552	28
2437	DSSS	1	0.469	29
2462	DSSS	1	0.301	30

* Belt-clip is 18.3 mm thick

Notes: 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: ± 0.025mm Accuracy: 0.806x10^{-3} degree Number of Axes: 6		
E-Field Probe	**ET3DV5**	1333	04/10/00
	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: 1µV to >200mV Input offset Voltage: < 1µV (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	03/19/01
	Please see section 6.2 for details		
Power Meter	**HP 8900D** w/ 84811A sensor	3607U00673	08/01/00
	Frequency Range: 100kHz to 18 GHz Power Range: 300µW to 3W		

3.2 Tissue Simulating Liquid

Brain	
Ingredient	**Frequency** (2440 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$^{3)}$**
2440	50.6 ± 5%	2.24 ± 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 are not the exact amounts of the final test solution. The final test solution was adjusted by adding small amounts of either water, sugar, and/or salt to calibrate the solution to meet the proper dielectric parameters.

Muscle	
Ingredient	**Frequency** (2440 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***	**σ *(mho/m)**	**ρ **(kg/m$^{3)}$**
2440	51.2 ± 5%	2.36 ± 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 are not the exact amounts of the final test solution. The final test solution was adjusted by adding small amounts of either 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 Uncertanties				**±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 attached 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, "Dosimetic 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. Tayor and Chris E. Kuyatt, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institude of Standards and Technology, 1994.

6.0 Document History

Revision/ Job Number	Writer Initials	Date	Change
1.0 / 2036369F1	SS	March 27, 2001	Original document

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

See attached pages.

APPENDIX C – Antenna Specifications

See attached pages.