

SPECIFIC ABSORPTION RATE (SAR) TEST REPORT

**Symbol Technologies
One Symbol Plaza B-13
Holtsville NY 11742**

**Product: Mobile Computer
Model: MC9063
FCC ID: H9PMC9063B
IC ID: 1549D-MC9063B**

**Tested to the SAR Criteria in
FCC OET Bulletin 65, Supplement C (Edition 01-01)**

**Date: February 27, 2004
Project: 3054379**

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Jason Centers, Project Engineer

Approved By: Bryan C. Taylor **Date:** 3-29-2003
Bryan C. Taylor, Team Leader – Engineering



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1.0 Document History

Revision/ Job Number	Writer Initials	Date	Change
1.0 /3056760	BCT	February 27, 2004	Original document

2.0 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.

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3.0 Introduction

The Mobile Computer, Model: MC9063 (supporting numeric keypad) was evaluated for SAR in accordance with the requirements for RF Exposure compliance testing defined in FCC OET Bulletin 65, Supplement C (Edition 01-01). Testing was performed at the Intertek Testing Services facility in Lexington, Kentucky.

For the evaluation, the dosimetric assessment system DASY3 was used. The phantom employed was the "SAM Twin Phantom". The total uncertainty for the evaluation of the spatial peak SAR values averaged over a cube of 1g tissue mass had been assessed for this system to be $\pm 27.0\%$.

The device was tested at the maximum output power declared by Symbol Technologies.

The maximum spatial peak SAR value for the sample device averaged over 1g was found to be:

Phantom	Position	Worst Case Extrapolated SAR _{1g} mW/g
Head Section (Phone Mode)	NA	NA
Flat Section (Push To Talk)	NA	NA
Flat Section (Data Mode)	Belt Clip Flat Against Phantom; Screen Facing Out CDMA PCS Channel 600 - 1880.00 MHz	0.28

Based on the worst case data presented above, the sample tested was found to be in compliance with the requirements defined in OET Bulletin 65, Supplement C (Edition 01-01).

Modifications required for compliance

Intertek implemented no modifications.

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4.0 Test Site Description

The SAR test site located at 731 Enterprise Drive, Lexington KY 40510 is comprised of the SPEAG model DASY 3 automated near-field scanning system, which is a package, optimized for dosimetric evaluation of mobile radios [3]. This system is installed in an ambient-free shielded enclosure with RF absorbing material on the walls and ceiling. The Ambient temperature is controlled to $22.2 \pm 2^\circ\text{C}$. Because the HVAC operates as a closed system, the relative humidity remains constant at $50 \pm 5\%$. During the SAR evaluations, the RF ambient conditions are monitored continuously for signals that might interfere with the test results. The tissue simulating liquid is also stored and validated in this area in order to keep it at the same constant ambient temperature as the room.

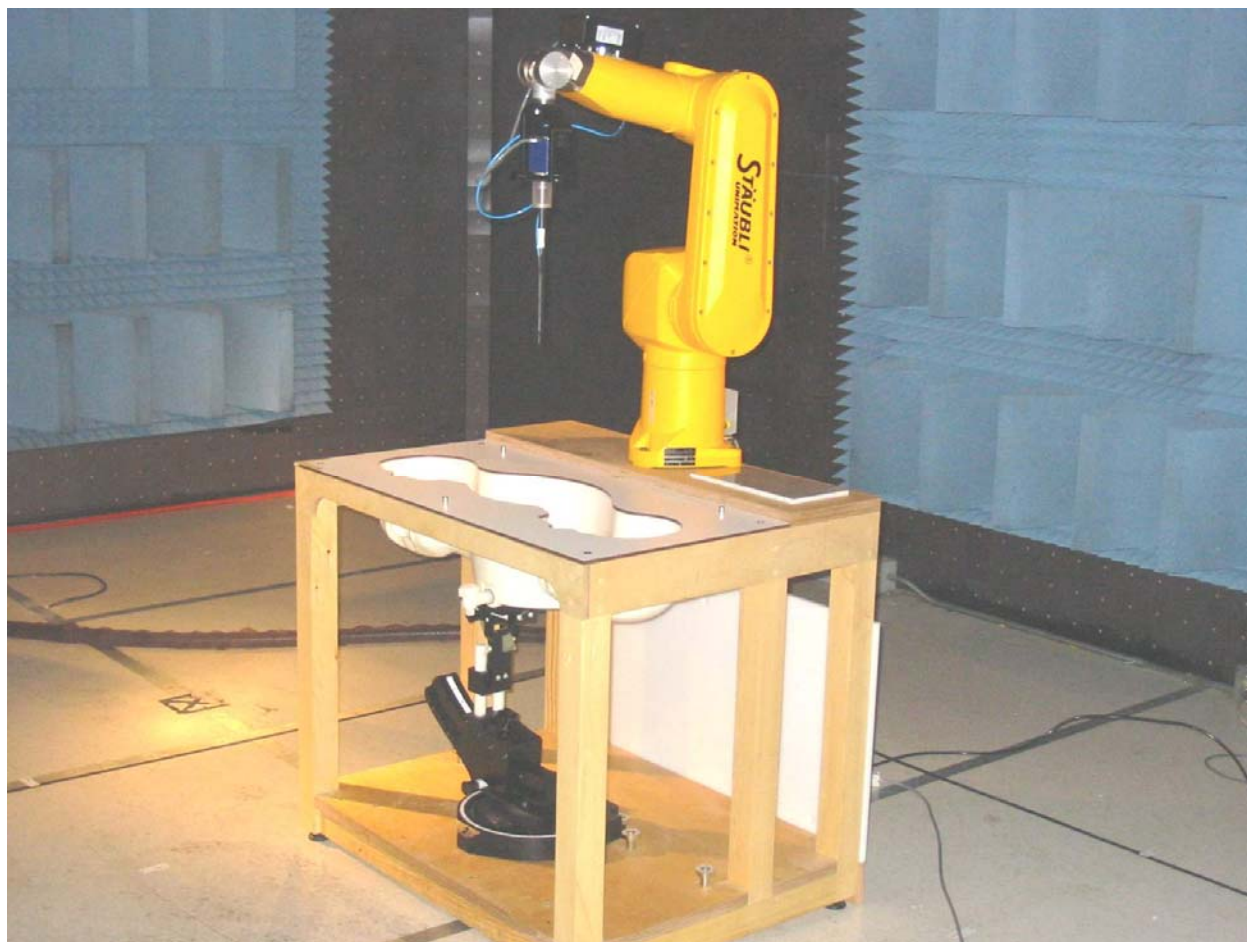


Figure 1 – SAR Test Site

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Measurement Equipment

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

SAR Measurement System			
EQUIPMENT	SPECIFICATIONS	S/N #	Last Cal. Data
Robot	Stäubli RX60L	597412-01	N/A
	Repeatability: ± 0.025 mm Accuracy: 0.806×10^{-3} degree Number of Axes: 6		
E-Field Probe	ER3DV6	1785	07/28/2003
	Dynamic Range: 5 μ W/g to >100 mW/g Tip diameter: 6.8 mm Probe Linearity: ± 0.2 dB (30 MHz to 3 GHz) Axial isotropy: ± 0.2 dB Spherical isotropy: ± 0.2 dB Length: 34.5 cm Distance between the probe tip and the dipole center: 2.7 mm Calibration: 450, 835/900, 1800/1900, 2450 MHz for head & body liquid		
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	SAM Twin V4.0	TP-1243	QD000P40CA
Complies with IEEE P1528-200x, draft 6.5 (See certificate in App. C)	Type SAM Twin, Homogenous Shell Material: Fiberglass Thickness: 2 ± 0.2 mm Capacity: 20 liter Size of the flat section: approx. 320 x 230 mm		
Device holder	Non-conductive holder supplied with DASY3, dielectric constant less than 5.0	N/A	N/A
Simulated Tissue	Mixture	N/A	2/23/2004 – 2/26/2004
	Please see Tissue Simulating Liquid Description (Percentage by Weight) and Validation on page 13 for details		
Spectrum Analyzer	HP 8566B	3014A07309	8/20/03
	100 Hz – 22 GHz		
Signal Generator	HP 83620 B	3614A00199	8/21/03
	Frequency Range: 10MHz – 20 GHz Amplitude Range: -110 dBm – 25 dBm		

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Measurement Uncertainty

The Table below includes the uncertainty budget suggested by the IEEE Std 1528-200X and determined by SPEAG for the DASY3 measurement System. The extended uncertainty (K=2) was assessed to be 27.0 %

Uncertainty Component	Tolerance (± %)	Probability Distribution	Divisor	c_i	Standard Uncertainty, (± %)	v_i^2 or v_{eff}
Measurement System						
Probe Calibration	4.8	Normal	1	1	4.8	Inf.
Axial Isotropy	4.7	Rectangular	$\sqrt{3}$	$(1-c_p)^{1/2}$	1.9	Inf.
Spherical Isotropy	9.6	Rectangular	$\sqrt{3}$	$\sqrt{c_p}$	3.9	Inf.
Boundary Effect	5.5	Rectangular	$\sqrt{3}$	1	3.2	Inf.
Linearity	4.7	Rectangular	$\sqrt{3}$	1	2.7	Inf.
System Detection Limits	1.0	Rectangular	$\sqrt{3}$	1	0.6	Inf.
Readout Electronics	1.0	Normal	1	1	1.0	Inf.
Response Time	0.8	Rectangular	$\sqrt{3}$	1	0.5	Inf.
Integration Time	1.4	Rectangular	$\sqrt{3}$	1	0.8	Inf.
RF Ambient Conditions	3.0	Rectangular	$\sqrt{3}$	1	1.7	Inf.
Probe Positioner Mechanical Tolerance	0.4	Rectangular	$\sqrt{3}$	1	0.2	Inf.
Probe Positioning with respect to Phantom Shell	2.9	Rectangular	$\sqrt{3}$	1	1.7	Inf.
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	3.9	Rectangular	$\sqrt{3}$	1	2.3	Inf.
Test sample Related						
Test Sample Positioning	6.0	Normal	0.89	1	6.7	12
Device Holder Uncertainty	5.0	Normal	0.84	1	5.9	8
Output Power Variation - SAR drift measurement	5.0	Rectangular	$\sqrt{3}$	1	2.9	Inf.
Phantom and Tissue Parameters						
Phantom Uncertainty (shape and thickness tolerances)	4.0	Rectangular	$\sqrt{3}$	1	2.3	Inf.
Liquid Conductivity Target tolerance	3.0	Rectangular	$\sqrt{3}$	0.6	1.0	Inf.
Liquid Conductivity - measurement uncertainty	10.0	Rectangular	$\sqrt{3}$	0.6	3.5	Inf.
Liquid Permittivity Target tolerance	4.0	Rectangular	$\sqrt{3}$	0.6	1.3	Inf.
Liquid Permittivity - measurement uncertainty	5.0	Rectangular	$\sqrt{3}$	0.6	1.7	Inf.
Combined Standard Uncertainty					13.5	
Expanded Uncertainty (95% CONFIDENCE INTERVAL)					27.0	

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Notes.

1. The Divisor is a function of the probability distribution and degrees of freedom (v_i and v_{eff}). See NIST Technical Note TN1297, NIS 81 and NIS 3003.
2. c_i is the sensitivity coefficient that should be applied to convert the variability of the uncertainty component into a variability of SAR.

Measurement Tractability

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

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5.0 Job Description

The MC9000-S has been tested to the requirements defined in OET Bulletin 65, Supplement C (Edition 01-01) at the request of the Applicant: Symbol Technologies Inc.

Name of contact: Marco Belli
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Model Number: MC9000-S
Serial Number ALP75427
Part Number MC9063-SKEJBAEA7WW

Manufacturer of the device: Symbol Technologies
One Symbol Plaza B-13
Holtsville NY 11742

Radio modules integrated	RLAN	Bluetooth	CDMA
Manufacturer of the radio	Symbol Technologies	Symbol Technologies	Sierra Wireless
Model Number of the radio	21-64436	21-64381	EM3420

Battery/Power Supply:

Manufacturer of the batteries: Symbol Technologies
Part Number of the batteries: 21-62960-01
Manufacturer of the Power Supply: Symbol Technologies
Model number of the Power Supply: SYM0-2
Part Number of the Power Supply: 50-14001-008 Rev.C

Headset:

Manufacturer: VXI Corporation
Type: VXI 61-SYB
Part Number: 50-11300-050

EUT receive date: 2/23/2004
EUT received condition: Good working condition production unit
Test start date: 3/1/2004
Test end date: 3/3/2004

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Test Sample Description

Test sample			
Model	MC9063		
FCC ID	H9PMC9063B		
IC ID:	1549D-MC9063B		
Device Category	Portable		
RF Exposure Category	General Population/Uncontrolled Environment		
Integrated Radio Modules	RLAN	Bluetooth	CDMA
Frequency Range, MHz	2412 –2462	2402 –2480	a) 824.7-848.31, b) 1851.25-1908.75
Type of transmission	DSSS	FHSS	CDMA
Maximum RF output power (on file with the FCC)	0.1 W	0.1 W	a) 0.26 W (ave.) b) 0.25 W (ave.)
Maximum measured ERP/EIRP	0.105 W	0.129 W	a) 0.107 W b) 0.446 W

Test sample Antenna			
Type	Folded dipole	Folded dipole	WWAN
Location	internal	internal	internal
Maximum Gain	1 dBi	1 dBi	0 dBi

Test sample Accessories	
Battery type	Part Number 21-62960-01 7.2V 22mAh Li-Ion Battery
Headset	VXI 61-SYB
Case with Belt Clip	Part Number 11-66061-01, provided the separation distance to a human body of 35 mm

Test Signal Mode	
Test Commands	x
Base Station Simulator	

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Test Sample Photographs



Figure 2 – MC9063 (Front) with headphones



Figure 3 – MC9063 (Back)

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Figure 4 – MC9063 with Battery Removed



Figure 5 – Battery

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6.0 System Verification

Dipole System Validation

Prior to the assessment, the system was verified to be within $\pm 10\%$ of the specifications by using the system validation kit. The validation was performed at each frequency range shown in the table below.

Reference Dipole Validation								
Frequency Measure (MHz)	Dipole Type	Dipole Serial Number	Fluid Type	Dipole Power Input	Cal. Lab SAR (1g)	Measured SAR (1g)	% Error SAR (1g)	Date
900	D900V2	13	900 MHz Head	250 mW	2.66	2.72	2.26	3/1/2004
1800	D1800V2	224	1800 MHz Head	250 mW	9.93	9.33	6.04	3/1/2004
2400	D2450V2	718	2450 MHz Body	250 mW	14.2	14.00	1.41	3/2/2004

Dipole dimensions: L=150.2 mm, D=3.6 mm

The following information, regarding the impedance of the D900V2, S/N #: 013 dipole was supplied by SPEAG:

Feed-point impedance at 900 MHz: $\text{Re}\{Z\} = 50.3 \text{ Ohm}$; $\text{Im}\{Z\} = 0.7 \text{ Ohm}$

Return Loss at 900 MHz -41.9 dB

For the SAR Dipole Validation plots see Appendix A

Tissue Simulating Liquid Description (Percentage by Weight) and Validation

	450 MHz		835 MHz		915 MHz		1900 MHz		2450 MHz	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
NaCl	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7

Note: The amounts 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 water, sugar, and/or salt to calibrate the solution to meet the proper dielectric parameters.

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The dielectric parameters were verified prior to assessment using the HP 85070A dielectric probe kit and the HP 8753C Network Analyzer. The dielectric parameters (ϵ_r , σ) on each day of testing were as follows:

Body Tissue Parameters								
Frequency Measure (MHz)	Dielectric Constant Target	Dielectric Constant Measure	Dielectric % Deviation	Imaginary Part	Conductivity Target	Conductivity Measure	Conductivity % Deviation	Date
810	55.3	55.6	0.54	21.8	0.95	0.98	3.34	3/1/2004
835	55.2	55.3	0.18	21.57	0.97	1.00	3.23	3/1/2004
899	55	54.7	0.55	21.69	1.05	1.08	3.25	3/1/2004

Body Tissue Parameters								
Frequency Measure (MHz)	Dielectric Constant Target	Dielectric Constant Measure	Dielectric % Deviation	Imaginary Part	Conductivity Target	Conductivity Measure	Conductivity % Deviation	Date
1851.25	53.4	52.89	0.96	14.6	1.52	1.50	1.14	3/2/2004
1880	53.3	52.42	1.65	14.5	1.52	1.52	0.29	3/2/2004
1908.75	53.3	51.92	2.59	14.53	1.52	1.54	1.44	3/2/2004

Body Tissue Parameters								
Frequency Measure (MHz)	Dielectric Constant Target	Dielectric Constant Measure	Dielectric % Deviation	Imaginary Part	Conductivity Target	Conductivity Measure	Conductivity % Deviation	Date
2437	52.7	51.5	2.28	15.3	1.95	2.07	6.30	3/2/2004
2443	52.7	51.5	2.28	15.3	1.95	2.08	6.57	3/2/2004
2000	53.3	52.3	1.88	13.5	1.52	1.50	1.24	3/2/2004
2450	52.7	51.4	2.47	15.4	1.95	2.10	7.57	3/2/2004

Maximum mass density $\rho = 1 \text{ g/cm}^3$

Maximum deviation of the dielectric parameters from the recommended values was 4.53%.

During the measurements, the liquid level was maintained to a level of 15 cm with a tolerance of $\pm 0.2 \text{ cm}$.

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7.0 Evaluation Procedures

Prior to any testing, the appropriate fluid was used to fill the phantom to a depth of 15 cm $\pm$ 0.2cm. The fluid parameters were verified and the dipole validation was performed as described in the previous sections.

Test Positions:

The Device was positioned against the SAM and flat phantoms using the exact procedure described in Supplement C Edition 01 – 01 of Federal Communications Commission, “Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields”, OET Bulletin 65, FCC, Washington, D.C. 20554, 1997.

Reference Power Measurement:

The measurement probe was positioned at a fixed location above the reference point. A power measurement was made with the probe above this reference position so it could be used for assessing the power drift later in the test procedure.

Coarse Scan:

A coarse area scan with a horizontal grid spacing of 20 x 20 mm was performed in order to find the approximate location of the peak SAR value. This scan was performed with the measurement probe at a constant height in the simulating fluid. A two dimensional spline interpolation algorithm was then used to determine the peaks and gradients within the scanned area.

Zoom Scan:

A zoom scan was performed around the approximate location of the peak SAR as determined from the coarse scan. The zoom scan was comprised of a measurement volume of 32 x 32 x 34 mm based on 5 x 5 x 7 points. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure:

Data Extrapolation:

Since the center of the dipoles in the measurement probe are 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 data at the surface was extrapolated. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in the Z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

The maximum interpolated value was searched with a straightforward sorting algorithm. Around this maximum, the SAR values averaged over the spatial volumes (1g or 10g) were computed using a 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 a trapezoidal

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algorithm. 1000 points (10 x 10 x 10) were interpolated to calculate the average.

All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

Reference Power Measurement:

The probe was positioned at precisely the same reference point and the reference power measurement was repeated. The difference between the initial reference power and the final one is referred to as the power drift. If the power drift exceeded 5% of the final peak SAR value, the measurement was repeated.

RF Ambient Activity:

During the entire SAR evaluation, the RF ambient activity was monitored using a spectrum analyzer with an antenna connected to it. The spectrum analyzer was tuned to the frequency of measurement and with one trace set to max hold mode. In this way, it was possible to determine if at any point during the SAR measurement there were an interfering ambient signal. If an ambient signal was detected, then the SAR measurement was repeated.

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8.0 Configuration / Test Photographs



Figure 6 – MC9063 Screen In



Figure 7 – MC9063 Screen In Extra Battery

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Figure 8 – MC9063 Screen Out



Figure 9 – MC9063 Screen Out Extra Battery

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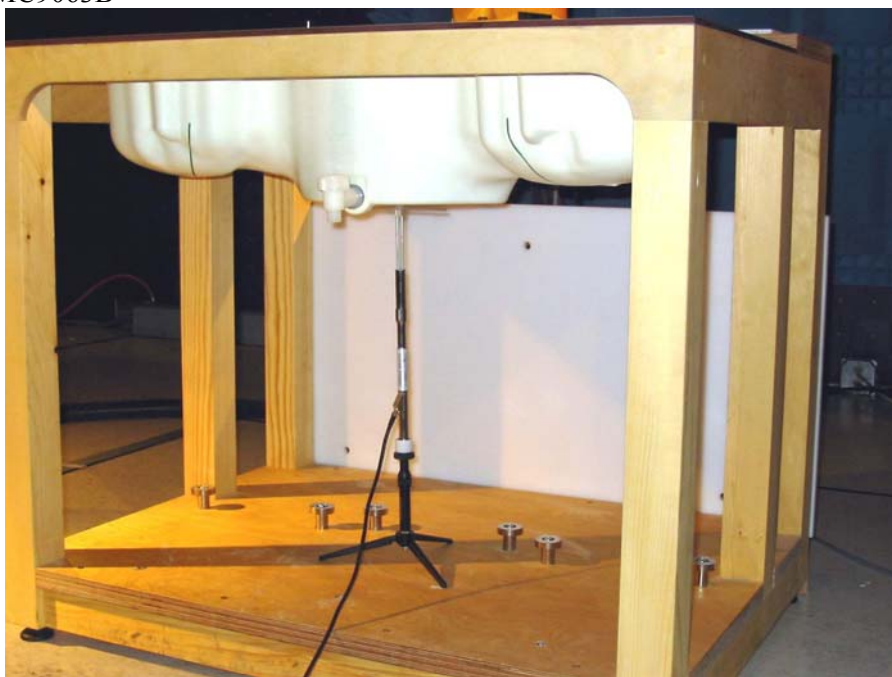


Figure 10 - System Verification Dipole

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9.0 Criteria

The following FCC limits for SAR apply to devices operating 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

10.0 Engineering Judgments

The EUT could be inserted into the holster with the screen facing in or out. In addition, the holster could be used with an extra battery installed and without. SAR scans were performed in using all of the above configurations in order to determine the worst case configuration.

The EUT had three transmitters installed (CDMA, RLAN, and Bluetooth). The CDMA transmitter operated in both the Cell and PCS bands. It was possible to turn on multiple transmitters at one time. This report only addresses each transmitter operating by itself with all other transmitters turned off. The results for multiple transmitters operating at the same time are included in a separate report.

The SAR was measured at the middle channel for each configuration. Per Supplement C (01-01), if the SAR at the middle channel was at least 3.0 dB lower than the SAR limit, testing at the high and low channels was optional.

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11.0 Tabular 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. The extrapolated SAR results account for the drift measurements using the following formula:

$$\text{Extrapolated SAR} = \text{Measured SAR} \times 10^{-(\text{Drift}/10)}$$

For positive drift values no extrapolation was performed. A dashed line will appear in the table for the extrapolation values in this case.

Data Mode Tabular Test Results

During the test, the RF output power of the test sample varied by a small amount due to heat and battery output power. To take into account this power drift a reference measurement was performed at a predefined position in the fluid just before and just after each SAR scan. The difference in these values is recorded in the table below as the SAR drift. The 1-g SAR was extrapolated for drift and is shown in the table below.

MC9063 - CDMA Cell and PCS									
Channel	Frequency (MHz)	Test Position	Battery in Case	Other Attachments	SAR Drift (dB)	Measured 1-g SAR (mW/g)	Meas. 10-g SAR (mw/g)	Extrapolated Worst Case 1-g SAR (mW/g)	Extrapolated Worst Case 10-g SAR (mW/g)
384	836.52	Screen Facing In	Yes	Headset	-0.100	0.037	0.027	0.038	0.028
384	836.52	Screen Facing Out	Yes	Headset	-0.160	0.093	0.066	0.096	0.068
384	836.52	Screen Facing Out	No	Headset	-0.110	0.098	0.069	0.100	0.070
384	836.52	Screen Facing In	No	Headset	-0.020	0.030	0.022	0.030	0.022
600	1880.00	Screen Facing In	Yes	Headset	0.000	0.006	0.003	---	---
600	1880.00	Screen Facing Out	Yes	Headset	0.340	0.280	0.154	---	---
600	1880.00	Screen Facing Out	No	Headset	-0.300	0.258	0.142	0.276	0.152
600	1880.00	Screen Facing In	No	Headset	0.000	0.005	0.002	---	---

Exhibit 1: Body Mode CDMA Cell and PCS Bands

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MC9063 - RLAN									
Channel	Frequency (MHz)	Test Position	Battery in Case	Other Attachments	SAR Drift (dB)	Measured 1-g SAR (mW/g)	Meas. 10g-SAR (mw/g)	Extrapolated Worst Case 1-g SAR (mW/g)	Extrapolated Worst Case 10-g SAR (mW/g)
6	2437.00	Screen Facing In	Yes	Headset	-0.700	0.014	0.008	0.016	0.009
6	2437.00	Screen Facing Out	Yes	Headset	0.000	0.005	0.003	---	---
6	2437.00	Screen Facing Out	No	Headset	0.000	0.003	0.002	---	---
6	2437.00	Screen Facing In	No	Headset	-0.690	0.013	0.008	0.016	0.009

Exhibit 2: Body Mode RLAN

MC9063 - Bluetooth									
Channel	Frequency (MHz)	Test Position	Battery in Case	Other Attachments	SAR Drift (dB)	Measured 1-g SAR (mW/g)	Meas. 10g-SAR (mw/g)	Extrapolated Worst Case 1-g SAR (mW/g)	Extrapolated Worst Case 10-g SAR (mW/g)
	2443.00	Screen Facing In	Yes	Headset	0.000	0.003	0.001	---	---
	2443.00	Screen Facing Out	Yes	Headset	0.000	0.003	0.001	---	---
	2443.00	Screen Facing Out	No	Headset	0.000	0.004	0.001	---	---
	2443.00	Screen Facing In	No	Headset	0.000	0.003	0.001	---	---

Exhibit 3: Body Mode Bluetooth