October 1, 1999
SAR Test Report for Motorola portable cellular phone (FCC ID IHDT6ZU1).

Prepared by:
Paul Moller, Principal Staff Engineer
Motorola Personal Communications Sector Product Safety Laboratory
Libertyville, Illinois

Contents

1. Introduction

The Motorola Personal Communications Sector Product Safety Laboratory has performed measurements of the maximum potential exposure to the user of portable cellular phone FCC ID IHDT6ZU1. The Specific Absorption Rate (SAR) of this product was measured. This report details the test setup and equipment as well as the results of those tests.

2. Applicable Regulations

Federal Communications Commission rule §2.1093(d)(2), the ANSI/IEEE C95.1 1992 and the NCRP Report Number 86 specify the maximum exposure limit of 1.6 W/kg as averaged over any 1 gram of tissue for portable devices being used within 20cm of the user in the uncontrolled environment.

3. Description of Test Sample

A prototype unit serial number 061899-1 was measured. This unit is identical in physical construction, maximum radiated power levels and antenna structure to units that will be in production. It transmits in the frequency range of 824 to 849 MHz using CDMA mode only. The maximum average transmit power for this test unit is 0.25 Watts. The unit is equipped with a telescoping antenna that serves as both a receive and transmit antenna. The antenna has a retracted and an extended operating position as shown in figures 1 and 2 respectively.

Figure 1. Front of Phone with Antenna Retracted.

Figure 2. Back of Phone with Antenna Extended.

Figures 3 and 4 show the test unit as it is placed onto the phantom head with the antenna in the retracted and extended positions respectively. For the purposes of the actual SAR tests the phantom head is tilted on its side by 90 degrees so that a vertically oriented measurement

probe can easily scan an area where the phone is in close contact with the phantom and the SAR will be the highest.

Figure 3. Phone against Phantom Head with Antenna Retracted

Figure 4. Phone against Phantom Head with Antenna Extended

4. SAR Test Facility

The Motorola test facility utilized for the SAR testing of this product is the Personal Communications Sector Product Safety Laboratory, in Libertyville Illinois. The laboratory utilizes a Dosimetric Assessment System (Dasy™) SAR measurement system manufactured by Schmid & Partner Engineering AG (SPEAG™), of Zurich Switzerland. This system utilizes a computer controlled six axis robot to move a measurement probe to measure the SAR. A photo of the Dasy™ system with the Motorola phantom is shown in figure 5 Probe serial number 1103 was used for the measurements. It was calibrated at SPEAG™, and has a calibration date April 20, 1999. A copy of the calibration certificate is included as appendix B. Dipole Validation Kit type D900V2, serial number 036 was used to validate the system accuracy at 900MHz. The validation SAR value is 9.56 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 9.40 mW/g normalized to 1 Watt. This is within the required accuracy, and thus the measured SAR values are considered correct for the 900 MHz frequency band. See appendix C for printout of the validation test from the Dasy™ measurement system.

The measurement methodology is described in IEEE Transactions on Vehicular Technology, vol. 44, no. 3, August 1995, titled Electromagnetic Energy Exposure of Simulated users of Portable Cellular Telephones. The Dasy™ system is operated per the instructions in the Dasy™ Users Manual. A copy of the title page of this manual is included as appendix D. The entire manual is available directly from SPEAG™.

Figure 5. Dasy™ system with the Motorola Phantom.

5. Test Sample Conditions

For the purposes of these tests the subject phone was positioned on the measurement phantom per the instructions in the Motorola users manual for the subject phone. The position used for the tests is the 3-point contact position. In this position the test sample contacts the phantom's ear and cheek and is positioned with a repeatability of better than ±6%. Since the antenna is not located on the center of the phone, the SAR was measured with the phone on both the left and right side talk positions (See figures 3 and 4). Due to the construction of the phone, the base of the antenna is 20 mm away from the phantom for the left side head, which is the closest.

The test sample is capable of operation in a test mode that allows control of the transmitter without the need to place actual phone calls. This guarantees that the unit does not change its transmitter power, and that the resultant SAR values will not be affected by external connections. For the purposes of this test the unit is commanded to test mode and manually set to the proper channel, transmitter power level and transmit mode of operation. The phone is then placed in the SAR measurement system with a fully charged extended capacity battery. At the end of each test the unit is measured for RF power out so as to ensure that the test was evaluating the maximum SAR level. For the purposes of these tests, the transmitter was operated at the highest transmitter output level in both the analog and digital modes (full vocoder rate for digital mode), with the antenna in both the extended and retracted positions, and with the phone on both left and right side talk positions.

6. Method of Measurement

The system is instructed to scan as much of the face of the phone as is in close proximity to the phantom. Using the information gained about the general region of highest SAR, the system then automatically scans a smaller area centered around the location of peak spatial SAR. During this scan the system automatically measures the fall off of electric field strength as the measurement probe is moved away from the inner surface of the phantom in the direction of the local normal to the phantom surface. Using appropriate probe calibration techniques, the SAR in 1 gram of phantom tissue is then calculated. The 800 MHz phantom head, shown in figures 3 and 4, was filled with a liquid having relative dielectric constant equal to 42.5 and conductivity equal to 0.85 S/m. This mixture is a good dielectric equivalent of the gray matter of the human brain. The composition of the liquid mixture is as follows: 42.5% water; 55.6.0% sugar; 0.8% salt, 1% HEC; and 0.1% bactericide.

7. Measurement Uncertainty

The overall RMS uncertainty of the measurement system is ±12.0%. The breakdown of the individual uncertainties is as follows:

Probe uncertainty	**±%**
Isotropy error	7.2
Calibration error	3.3
Spatial resolution	0.5

SAR Evaluation	±%
Conductivity measurement	5.0
Environmental errors	1.0

Peak SAR Evaluation	±%
Probe positioning	1.0
Volumetric averaging	4.2
Device positioning	6.0

8. SAR Test Results

Figure 6 shows the phone overlaid with a typical contour plot. The phone is placed on the phantom's head with the center of the speaker at the center of the ear, and the center line of the phone extends downward to the center of the phantom's mouth.

The maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT6ZU1), is 1.24 W/kg and was found to be with the antenna in the extended position on the right side head. A full data set output of the two test conditions with the highest SAR values from the Dasy™ measurement system is included as appendix A. The test conditions included are indicated as bold numbers in the following table. All other test conditions measured lower SAR values than those included.

	Left side head		Right side head		Conducted
Channel	Ant Ret	Ant Ext	Ant Ret	Ant Ext	Power (watts)
991	0.74	0.88	0.72	0.78	0.25
384	0.62	1.08	**0.84**	**1.24**	0.26
799	0.44	0.4	0.33	0.38	0.25

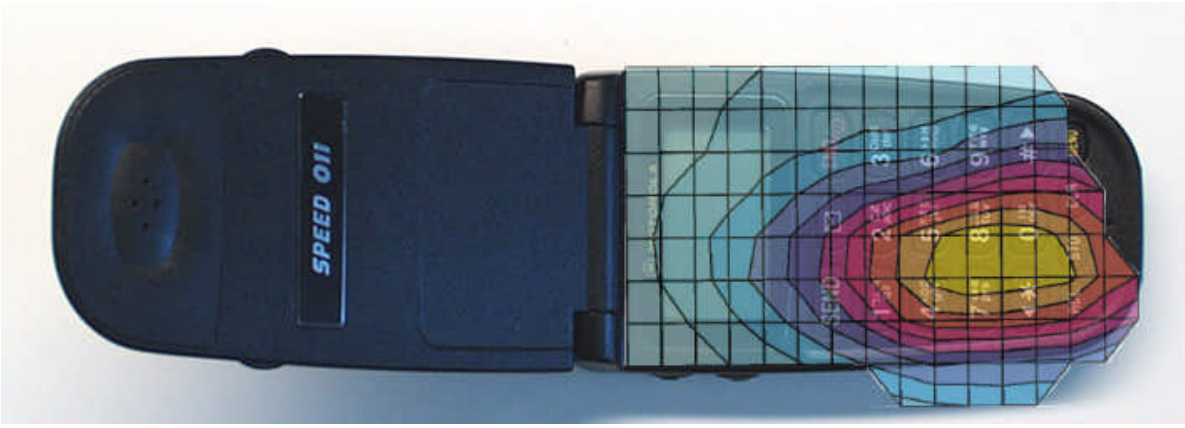


Figure 6. Contour Plot overlaid on face of Phone

9. Hand SAR

Portable cellular phone FCC ID IHDT6ZU1 was measured for total radiated power in the presence of a human phantom complete with a hand holding the phone. The phone was positioned on a full body measurement phantom per the instructions in the Motorola users manual for the subject phone. Total radiated power was measured without a hand holding the phone, and then as a second measurement with a phantom hand holding the phone in a normal position. One can see the placement of the phantom hand relative to the subject phone in figure 7. The phantom hand has the same dimensions as a real human hand, and is made of a pliable shell that is filled with tissue simulant. The tissue simulant is the same as is used in the head phantom. The dielectric constant is 42.5 and the conductivity is 0.85 S/m. The phantom is placed inside of an anechoic chamber capable of performing full spherical scans of the phones radiation characteristics, specifically total radiated power. The difference in total radiated with and without the phantom hand is then measured for both the antenna retracted and extended cases. This difference in total radiated power is then the maximum power that is deposited in the hand. The phone was set to transmit on maximum power (0.25 Watt).

For the subject phone, the maximum power deposited in the hand was found to be less than 16mW for both the antenna retracted and extended positions. Federal Communications Commission rule §2.1093(d)(2), the ANSI/IEEE C95.1 1992 and the NCRP Report Number 86 specify the maximum exposure limit in the hand of 4 W/kg as averaged over any 10 grams of tissue for portable devices being used within 20cm of the user in the uncontrolled environment. More than 40mW of total power deposited in the hand would be required for the limit of 4 W/kg averaged over 10 grams to be exceeded. Since the total power deposited in the hand for the test phone is less than 40 mW, the standard is not exceeded. Included are two pictures. Figure 7 shows the subject phone in the normal talk position with the phantom hand in the test position. Figure 8 shows the full body phantom in the anechoic chamber.

Figure 7. Phone in Hand against Phantom Head

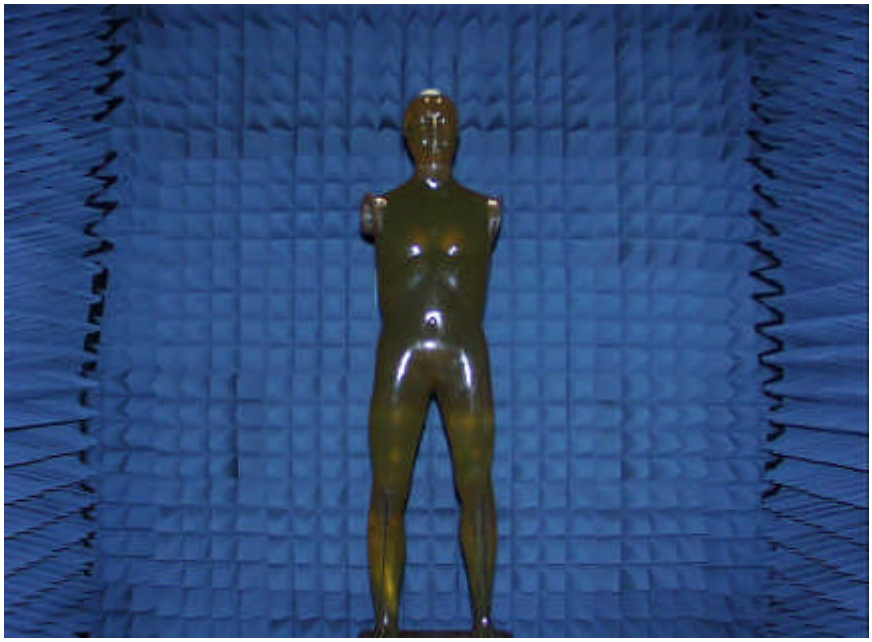


Figure 8. Full Body Phantom in the Anechoic Chamber.

10. Body Worn Configuration Evaluation

The portable cellular phone (FCC ID IHDT6ZU1) does not ship with a holster or belt clip. Thus body worn configuration testing does not apply.

10. External Antenna Option Evaluation

The portable cellular phone (FCC ID IHDT6ZU1) is not intended to be used with an external antenna option.

11. Battery Options

The portable cellular phone (FCC ID IHDT6ZU1) does have two battery options, “standard” and “thin“. For the purposes of head adjacent testing the battery chosen was the “standard” battery. The “thin” battery does not alter the proximity of the transceiver to the user in any way and should not change the SAR values .

12. Summary

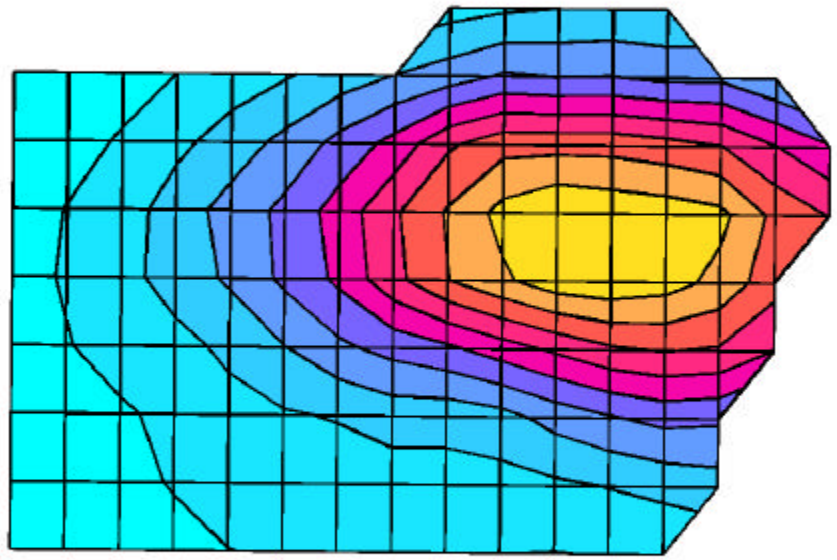
The SAR values found for the portable cellular phone (FCC ID IHDT6ZU1) are below the maximum recommended levels of 1.6 W/kg.

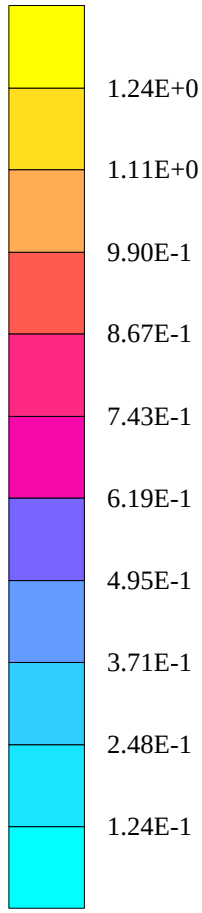
Appendix A

The following pages are printouts from the Dasy™ measurement system of the data against the phantom head.

s/n 061899-1

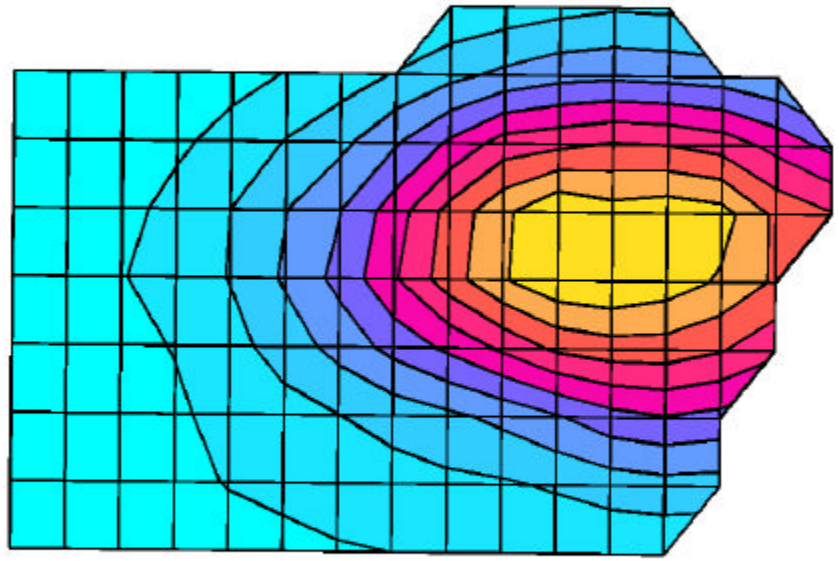
Chan:384/Pwr: 24dbm/Ant: out
Motorola right head phantom Phantom; right head Section; Position: (80°,251°); Frequency: 837 MHz
Probe: ET3DV4 - SN1103; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Brain 800 MHz: σ = 0.85 mho/m ε_r = 42.5 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.24 [mW/g], SAR (10g): 0.878 [mW/g] * Max outside, (Worst-case extrapolation)
Coarse: Dx = 8.0, Dy = 10.0, Dz = 10.0
Powerdrift: 0.17 dB

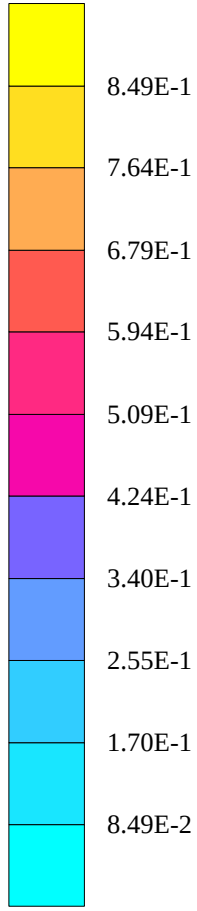




s/n 061899-1

Chan:384/Pwr: 24dbm/Ant: in
Motorola right head phantom Phantom; right head Section; Position: (80°,251°); Frequency: 837 MHz
Probe: ET3DV4 - SN1103; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Brain 800 MHz: σ = 0.85 mho/m ε_r = 42.5 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.842 [mW/g], SAR (10g): 0.592 [mW/g], (Worst-case extrapolation)
Coarse: Dx = 8.0, Dy = 10.0, Dz = 10.0
Powerdrift: 0.04 dB





Appendix B

The following page is a copy of the Calibration Certificate for Dasy™ probe serial number 1103.

Schmid & Partner
Engineering AG

Staffelstrasse 8, 8045 Zurich, Switzerland, Telefon +41 1 280 08 60, Fax +41 1 280 08 64

Calibration Certificate

Dosimetric E-Field Probe

Type:	ET3DV4
Serial Number:	1103
Place of Calibration:	Zurich
Date of Calibration:	April 20, 1999
Calibration Interval:	12 months

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The test results were within published specifications.

The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG. Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

Calibrated by: 

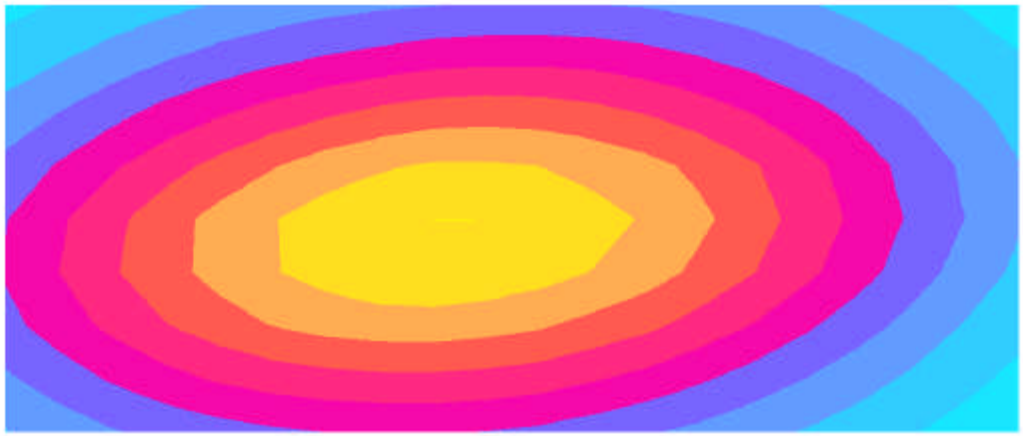
Approved by: 

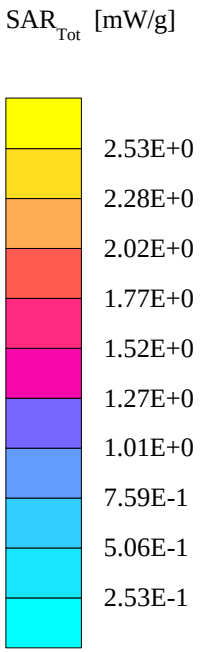
Appendix C

The following page is the printout from the Dasy™ measurement system validation tests.

Dipole 900 MHz

250 mW CW power
Free Space Phantom; Free Space Section; Position: (80°,180°); Frequency: 900 [MHz]
Probe: ET3DV4 - SN1103; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Brain 800 - 900 MHz: σ = 0.83 [mho/m] ε_r = 43.0 ρ = 1.00 [g/cm^3]
Cube 5x5x7: SAR (1g): 2.35 [mW/g], SAR (10g): 1.53 [mW/g], (Worst-case extrapolation)
Coarse: Dx = 5.0, Dy = 5.0, Dz = 0.0
Powerdrift: -0.02 dB





Appendix D

The following page is a copy of the first page of the Dasy™ Users Manual

Schmid & Partner
Engineering AG

Staffelstrasse 8, 8045 Zurich, Switzerland, Telefon +41 1 280 08 60, Fax +41 1 280 08 64

DASY3 - User Manual

Content