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SAR Test Report for Motorola portable cellular phone (FCC ID IHDT56ZF1).

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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 IHDT56ZF1. 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 EDF4082AZGJ 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 AMPS and TDMA modes, and 1850 to 1910 MHz using TDMA mode only. The unit was tested at its maximum transmitter power. The unit is equipped with a fixed antenna that serves as both a receive and transmit antenna. The antenna has a single operating position as shown in figure 1.

Figure 1. Back of Phone Showing Antenna

Figure 2 shows the test unit as it is placed onto the phantom. For the purposes of the actual SAR tests the Motorola 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 2. Phone Against Head in Normal Use Position

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 3. Probe serial number 1005 was used for the measurements. It was calibrated at SPEAG™, and has a calibration date June 12, 1998. 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 800MHz. The validation SAR value is 9.56 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 9.18

mW/g normalized to 1 Watt. This is within the required accuracy, and thus the measured SAR values are considered correct. See appendix C for printout of the validation test from the Dasy™ measurement system. Dipole Validation Kit type D1800V2, serial number 226 was used to validate the system accuracy at 1900MHz. The validation SAR value is 39.9 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 40.4 mW/g normalized to 1 Watt. This is within the required accuracy, and thus the measured SAR values are considered correct. See appendix D 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 3. Dasy™ System used for measurements

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 figure 2). Due to the construction of the phone, the base of the antenna is 23 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. Since the test sample uses the 1/3 duty cycle of the TDMA system while in digital mode, the crest factor (the ratio between peak and average power) is set to 3 for these tests. When the test sample was tested in analog mode the crest factor was set to 1. The phone is then placed in the SAR measurement system with a fully charged battery. At the end of each test the Dasy™ system measures the drift of the SAR at a fixed point in the phantom so as to ensure that the test sample has not changed in transmitter power. For the purposes of these tests, the transmitter was operated at the highest transmitter output 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 800MHZ phantom head, shown in figure 2, was filled with a liquid having relative dielectric constant equal to 44 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. The 1900MHZ phantom head, also shown in figure 2, was filled with a liquid having relative dielectric constant equal to 41 and conductivity equal to 1.71 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: 45.9% water; 53.0% sugar; 0% 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 4 shows the phone overlaid with a typical contour plot. The phone is placed on the phantom's head with the center of the phone's 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 same orientation and phone position are used for left and right side talk positions.

The maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT56ZF1) in the 800MHz band is 1.25 W/kg and was found on the left side head, and with the phone in analog mode. The highest SAR found in digital mode was 0.39 W/kg. A full data set output of three 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. Note that digital mode SAR data was measured only for the test condition that resulted in the highest analog SAR value. This is because the only difference between analog and digital modes that can impact SAR is the average transmitter power.

Analog 800 Channel	Right side head	Left side head	Conducted Power (Watts)
991	0.85	0.92	0.45
384	**1.07**	**1.25**	0.45
799	1.00	0.85	0.45

Digital 800 Channel	Right side head	Left side head	Avg. Conducted Power (Watts)
384		**0.39**	0.56

Figure 4. Phone with 800MHz Analog Contour Plot Overlay

The maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT56ZF1) in the 1900MHz band is 0.66 W/kg and was found on the left side head. A full data set output of 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. Figure 5 shows the contour plot of the highest test condition overlaid onto a picture of the phone.

Digital 1900 Channel	Right side head	Left side head	Conducted Power (Watts)
1	0.50	0.61	0.57
1000	0.48	**0.66**	0.56
999	**0.52**	0.64	0.57

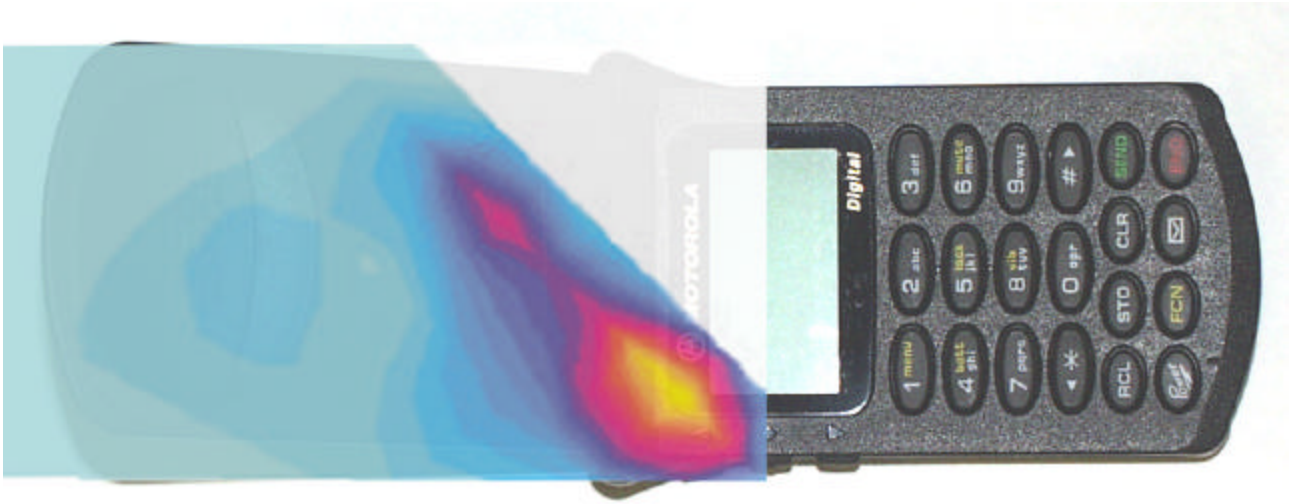


Figure 5. Phone with 1900MHz TDMA Contour Plot Overlay

9. Summary

The SAR values found for the portable cellular phone (FCC ID IHDT56ZF1) are below the maximum recommended levels of 1.6 W/kg.

Appendix A

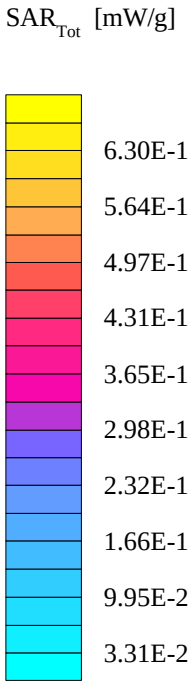
The following pages are printouts from the Dasy™ measurement system of the data as indicated.

800 MHz ANALOG SN# EDF4082AZGJ CH384

TILT LEFT Phantom; TILT LEFT Section; Position: (80°,220°); Frequency: 837 [MHz]
Probe: ET3DV4 - SN1005 (DAE2); ConvF(5.90,5.90,5.90); Crest factor: 1.0; Brain 800 MHz: σ = 0.85 [mho/m] ε_r = 44.0 ρ = 1.00 [g/cm^3]
Cube 5x5x7: SAR (1g): 1.25 [mW/g], SAR (10g): 0.729 [mW/g] * Max outside, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0

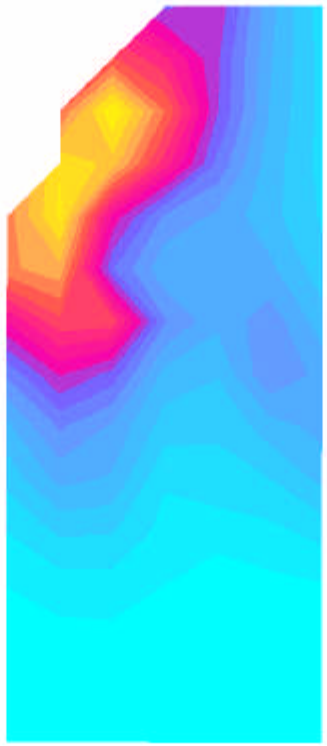
800 Mhz Amps SN# EDF4082AZGJ CH384

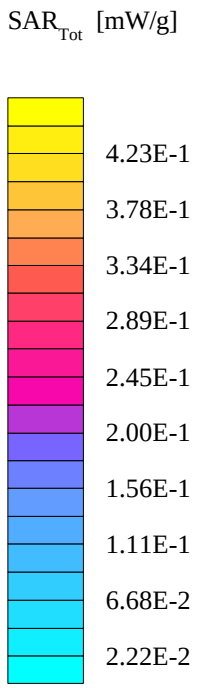
TILT RIGHT Phantom; TILT RIGHT Section; Position: (80°,220°); Frequency: 837 [MHz]
Probe: ET3DV4 - SN1005 (DAE2); ConvF(5.90,5.90,5.90); Crest factor: 1.0; Brain 800 MHz: σ = 0.85 [mho/m] ε_r = 44.0 ρ = 1.00 [g/cm^3]
Cube 5x5x7: SAR (1g): 1.07 [mW/g], SAR (10g): 0.763 [mW/g], (Worst-case extrapolation)
Coarse: Dx = 9.0, Dy = 9.0, Dz = 10.0



800 MHz TDMA SN# EDF4082AZGJ CH384

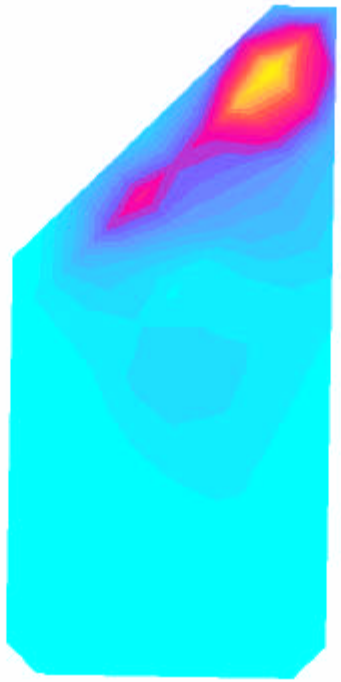
TILT LEFT Phantom; TILT LEFT Section; Position: (80°,220°); Frequency: 837 [MHz]
Probe: ET3DV4 - SN1005 (DAE2); ConvF(5.90,5.90,5.90); Crest factor: 3.0; Brain 800 MHz: σ = 0.85 [mho/m] ε_r = 44.0 ρ = 1.00 [g/cm^3]
Cube 5x5x7: SAR (1g): 0.390 [mW/g], SAR (10g): 0.230 [mW/g], (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0

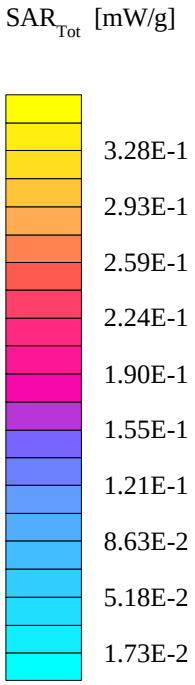




1900Mhz TDMA SN# EDF4082AZGJ CH1000

TILT LEFT Phantom; Section; Position: ; Frequency: 1880 [MHz]
Probe: ET3DV4 - SN1005 (DAE2); ConvF(5.10,5.10,5.10); Crest factor: 3.0; Brain 1900 MHz: σ = 1.71 [mho/m] ε_r = 41.0 ρ = 1.00 [g/cm^3]
Cube 5x5x7: SAR (1g): 0.664 [mW/g], SAR (10g): 0.307 [mW/g], (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0





1900MHz TDMA SN# EDF4082AZGJ CH 1999

TILT RIGHT Phantom; Section; Position: ; Frequency: 1910 [MHz]
Probe: ET3DV4 - SN1005 (DAE2); ConvF(5.10,5.10,5.10); Crest factor: 3.0; Brain 1900 MHz: σ = 1.71 [mho/m] ε_r = 41.0 ρ = 1.00 [g/cm^3]
Cube 5x5x7: SAR (1g): 0.516 [mW/g], SAR (10g): 0.281 [mW/g] * Max outside, (Worst-case extrapolation)
Coarse: Dx = 9.0, Dy = 9.0, Dz = 10.0

Appendix B

The following page is a copy of the Calibration Certificate for Dasy™ probe serial number 1005.

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:	**1005**
Place of Calibration:	**Zurich**
Date of Calibration:	**June 12, 1998**
Calibration Interval:	**12 months**

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. 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: Thomas Schmid

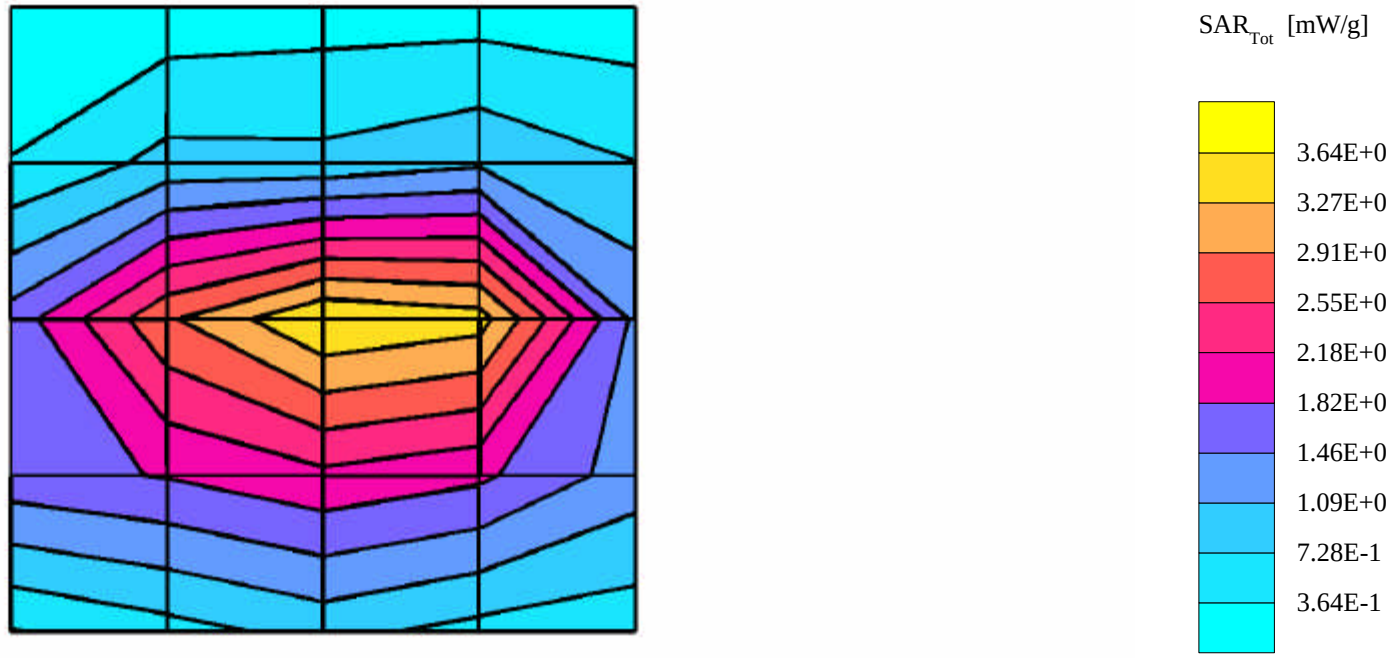
Approved by: N. Kes

Appendix C

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

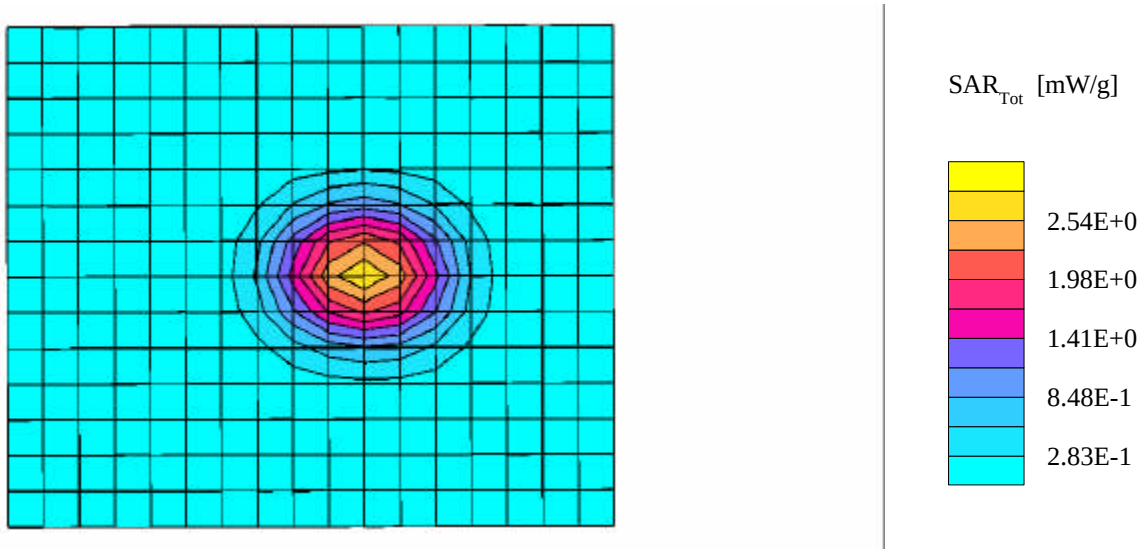
Dipole 900 MHz

Input Power= 0.5W
Generic Twin; Flat
Probe: ET3DV4 - SN1008 (DAE2); ConvF(6.00,6.00,6.00); Crest factor: 1.0; Brain 900 MHz: σ = 0.85 [mho/m] ε_r = 42.5 ρ = 1.00 [g/cm^3]
Cube 5x5x7: Peak: 7.96 [mW/g], SAR (1g): 4.59 [mW/g], SAR (10g): 2.68 [mW/g] * Max outside, (Worst-case extrapolation)
Penetration depth: 13.0 (11.2, 15.2) [mm]
Powerdrift: 0.03 dB



1800 MHz Validation Dipole

250 mW CW input power
MOT FLAT; MOTO FLAT
Probe: ET3DV4 - SN1005 (DAE2); ConvF(5.10,5.10,5.10); Crest factor: 1.0; Brain 1800 MHz: σ = 1.71 [mho/m] ε_r = 41.0 ρ = 1.00 [g/cm^3]
Cube 5x5x7: Peak: 19.5 [mW/g], SAR (1g): 10.1 [mW/g], SAR (10g): 5.09 [mW/g], (Worst-case extrapolation)
Penetration depth: 7.3 (7.1, 8.0) [mm]



Appendix D

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

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Preliminary Manual

DASY3 V1.0b

for Windows 95

March 98 Edition
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