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SAR Test Report for Motorola portable cellular phone (FCC ID IHDT56ZJ1).

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Contents

- 1) Introduction
- 2) Applicable Regulations
- 3) Description of Test Sample
- 4) Description of Motorola SAR Test Facility
- 5) Test Sample Conditions
- 6) Method of Measurement
- 7) Measurement Uncertainty
- 8) SAR Test Results
- 9) SAR in the Hand Measurements
- 10) Summary

Appendix A: Included data

Appendix B: Measurement Probe Calibration Certificate

Appendix C: Printout from the DasyTM measurement system validation test

Appendix D: DasyTM Users Manual (first page)

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 IHDT56ZJ1. 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 EDDDF8F7 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 mode, and 1850 to 1910 MHz using CDMA mode. 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.



Figure 2.

Figure 3 shows the test unit as it is placed onto the Motorola 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 3. Phone against side of Phantom Head.

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 4. 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 800MHz. The validation SAR value is

9.56 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 9.40 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 36.4 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.

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 4. Dasy™ System

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 $\pm 6\%$. 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 3). 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. 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 and module 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 3, was filled with a liquid having relative dielectric constant equal to 43 and conductivity equal to 0.83 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 3, 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 $\pm 12.0\%$. The breakdown of the individual uncertainties is as follows:

Probe Uncertainty	$\pm\%$
Isotropy error	7.2
Calibration error	3.3
Spatial resolution	0.5
SAR Evaluation	
$\pm\%$	
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 5 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 IHDT56ZJ1) in the 800MHz band is 1.34 W/kg and was found on the right 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.

Analog 800 Channel	Right Side head		Left Side head		Conducted Power (Watts)
	Ant In	Ant Out	Ant In	Ant Out	
991	1.34	0.19	0.93	0.15	0.331
384	0.69	0.21	0.47	0.20	0.331
799	0.72	0.21	0.50	0.22	0.331



Figure 5. 800MHz Contour Plot Overlaid on Face of Phone.

The maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT56ZJ1) in the 1900MHz band is 1.38 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 6 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)
	Ant In	Ant Out	Ant In	Ant Out	
25	0.72	1.12	0.99	1.38	0.326
600	1.00	1.20	0.93	1.20	0.326
1175	1.08	1.25	0.71	1.37	0.326



Figure 6. 1900MHz Contour Plot Overlaid on Face of Phone.

9. SAR in the Hand Measurements

Portable cellular phone FCC ID IHDT56ZJ1 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 43.0 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 (0.45 Watt) in analog mode. Since digital mode average transmit power (0.45 Watt) is equal to that of the analog power, total radiated power was not measured in digital mode.

For the subject phone, the maximum power deposited in the hand was found to be less than 27mW for both the antenna retracted and extended positions in the both the 800MHz analog mode and 1900MHz CDMA mode. 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. Simulated Hand Against Phantom Head.



Figure 8. Phantom in Anechoic Chamber.

10. Summary

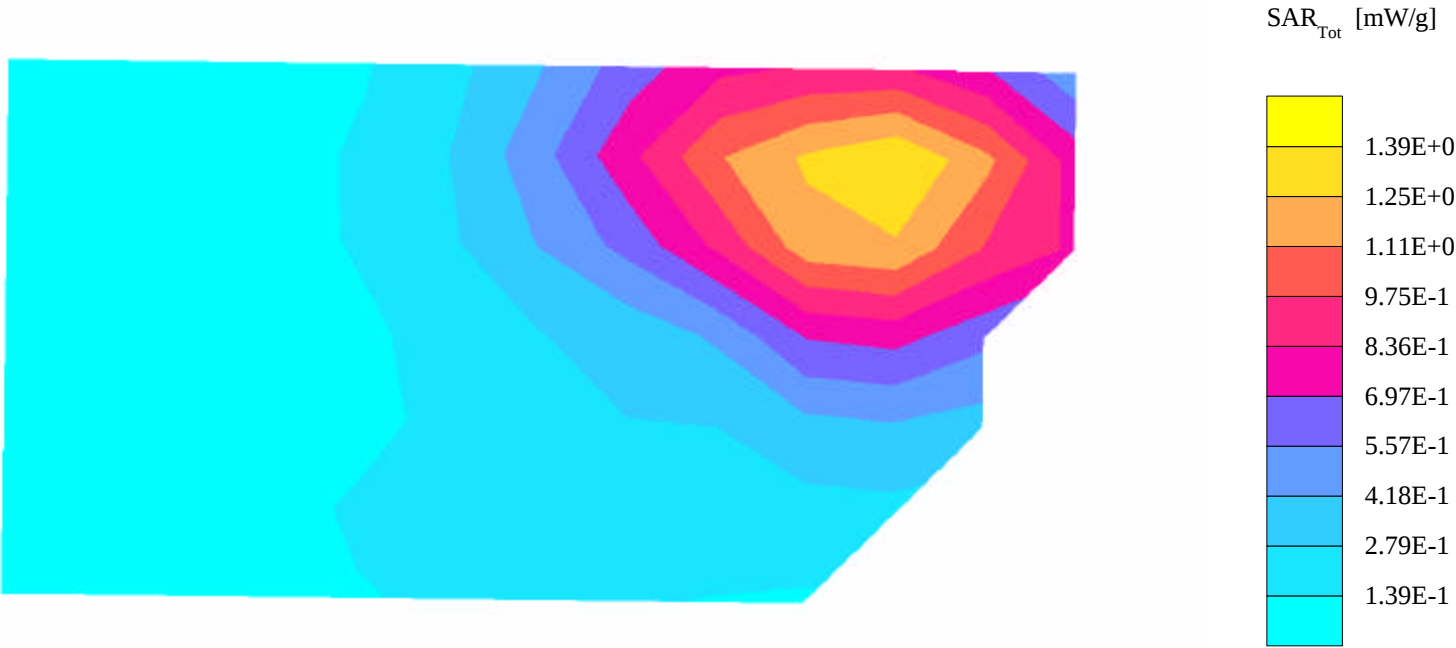
The SAR values found for the portable cellular phone (FCC ID IHDT56ZJ1) are below the maximum recommended levels of 1.6 W/kg.

Appendix A

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

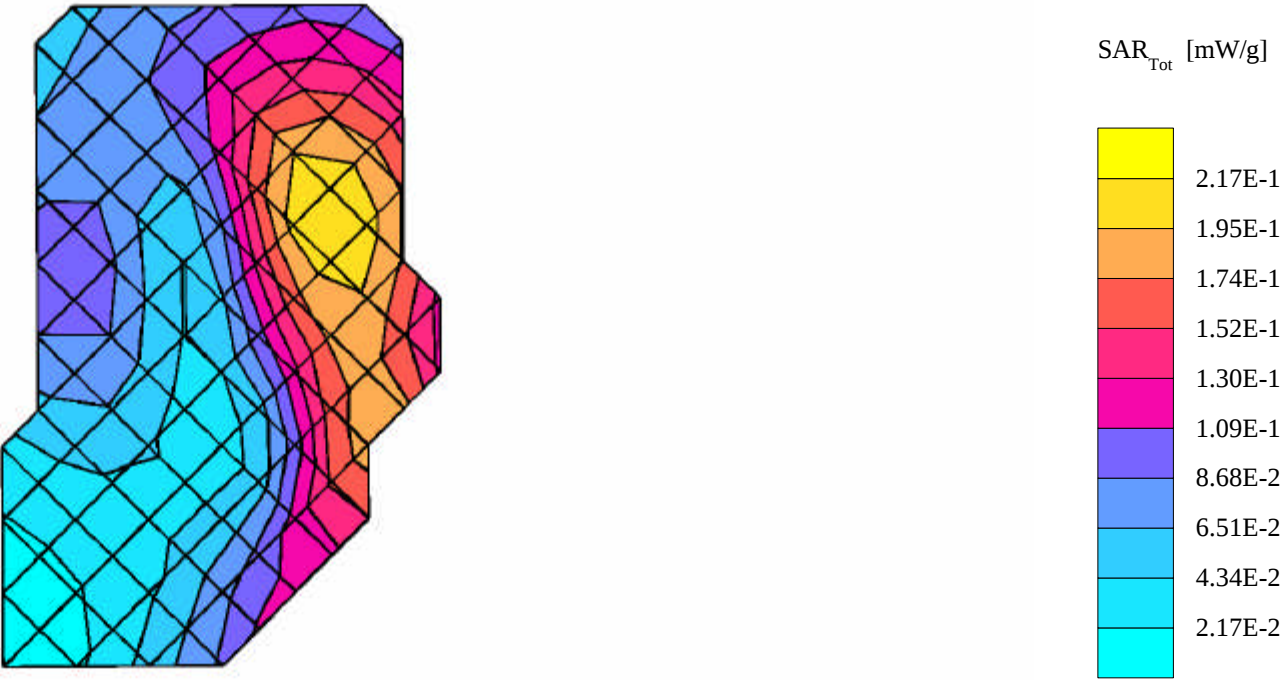
S/N: EDDDF8F7

chan 991/pwr 02/Ant In/et
Motorola right head phantom Phantom; Right Side Section; Position: (80°,251°); Frequency: 824 [MHz]
Probe: ET3DV4 - SN1103; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Brain 800 - 900 MHz: $\sigma = 0.83$ [mho/m] $\epsilon_r = 43.0$ $\rho = 1.00$ [g/cm³]
Cube 5x5x7: SAR (1g): 1.34 [mW/g], SAR (10g): 0.842 [mW/g], (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0
Powerdrift: -0.18 dB



S/N: EDDDF8F7

chan 799/pwr 02/ant out/et
Motorola Left Head Tilted Phantom; Left Head Section; Position: (80°,251°); Frequency: 848 [MHz]
Probe: ET3DV4 - SN1103; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Brain 800 - 900 MHz: $\sigma = 0.83$ [mho/m] $\epsilon_r = 43.0$ $\rho = 1.00$ [g/cm³]
Cube 5x5x7: SAR (1g): 0.221 [mW/g], SAR (10g): 0.155 [mW/g], (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Powerdrift: -0.41 dB



06/29/99

SN# EDDDF8F7

Chan:1175/Pwr: 25.2dbm/Ant: out

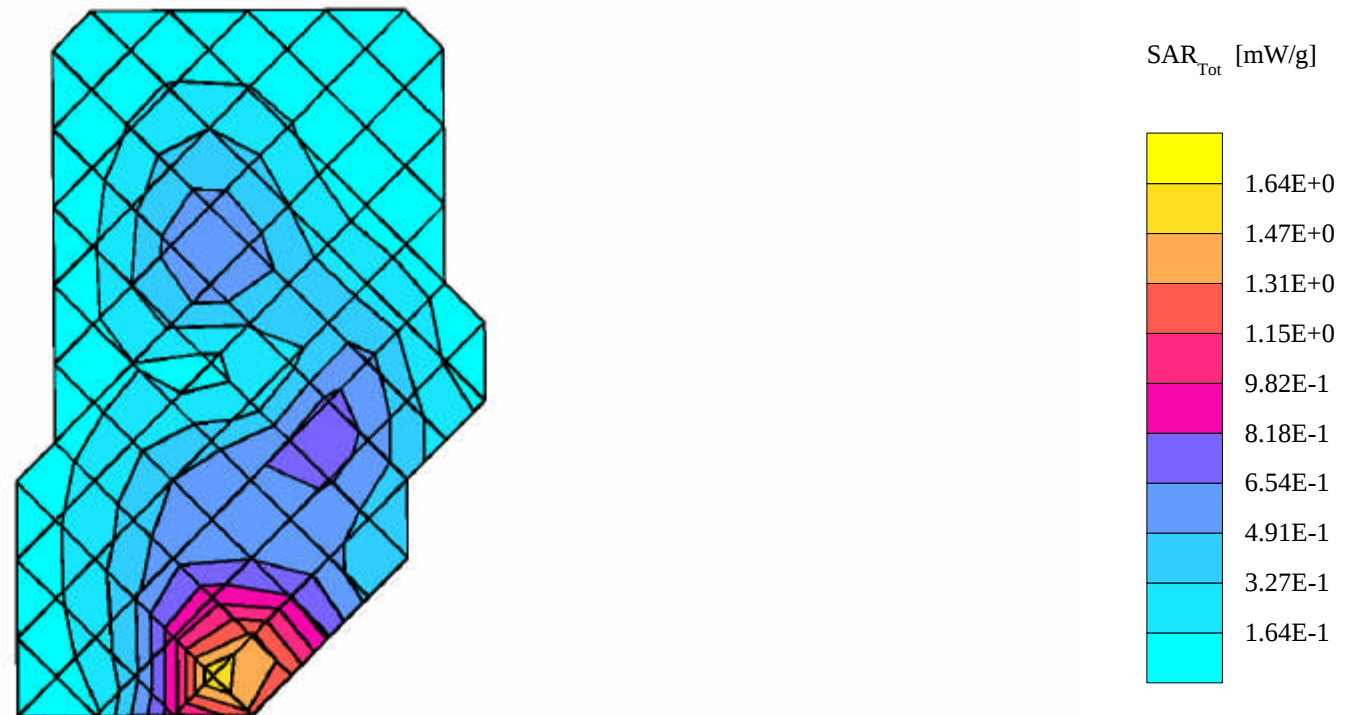
Motorola Left Head Tilted Phantom; Left Head Section; Position: (80°,251°); Frequency: 1851 [MHz]

Probe: ET3DV4 - SN1103 ; ConvF(4.90,4.90,4.90); Crest factor: 1.0; Brain 1800 -1910 MHz: $\sigma = 1.71$ [mho/m] $\epsilon_r = 41.0$ $\rho = 1.00$ [g/cm³]

Cube 5x5x7: SAR (1g): 1.38 [mW/g], SAR (10g): 0.689 [mW/g], (Worst-case extrapolation)

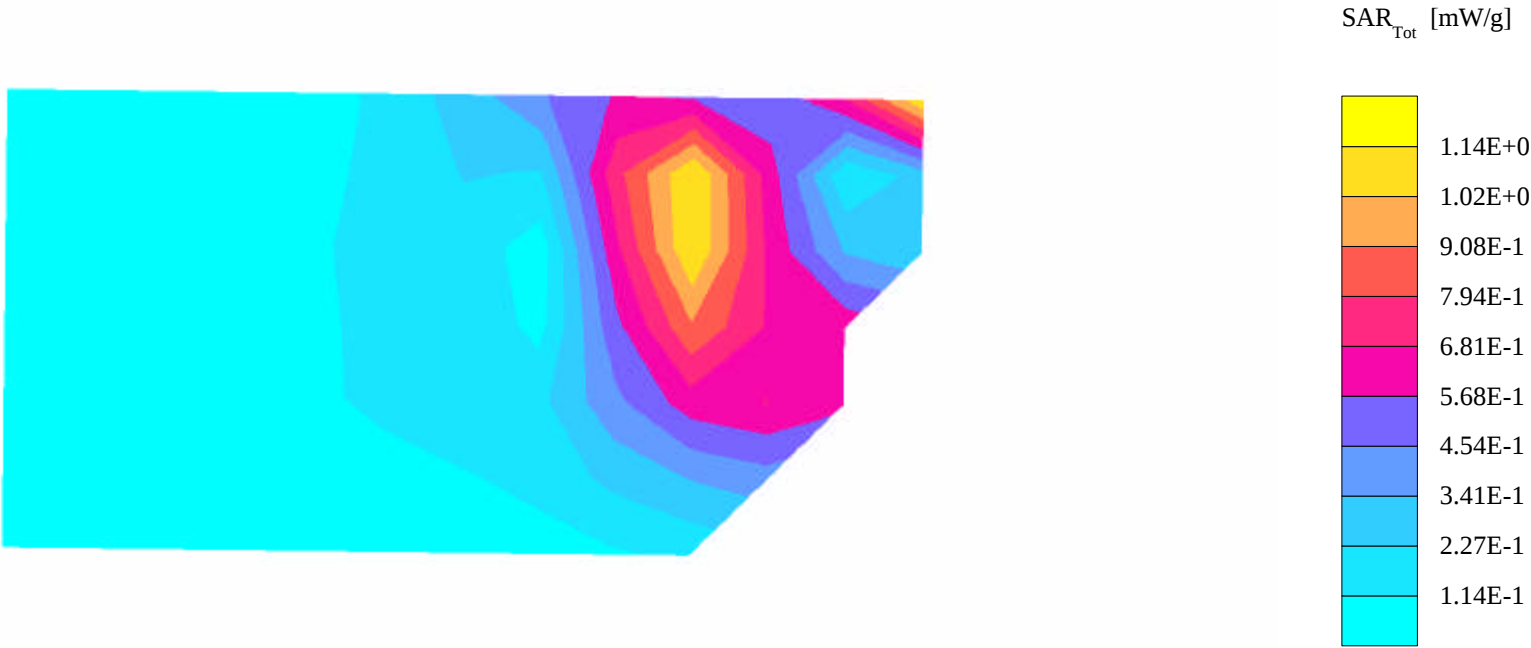
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0

Powerdrift: 0.03 dB



SN# EDDDF8F7

Chan:1175/Pwr: 25dbm/Ant: in
Motorola right head phantom Phantom; Right Side Section; Position: (80°,251°); Frequency: 1900 [MHz]
Probe: ET3DV4 - SN1103; ConvF(4.90,4.90,4.90); Crest factor: 1.0; Brain 1800 -1910 MHz: $\sigma = 1.71$ [mho/m] $\epsilon_r = 41.0$ $\rho = 1.00$ [g/cm³]
Cube 5x5x7: SAR (1g): 1.08 [mW/g], SAR (10g): 0.530 [mW/g], (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0
Powerdrift: -0.01 dB



Appendix B

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

Calibration Certificate

Dosimetric E-Field Probe

Type:

ET3DV4

Serial Number:

1103

Place of Calibration:

Zurich

Date of Calibration:

April 20, 1999

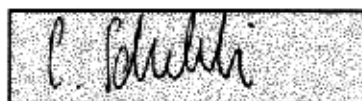
Calibration Interval:

12 months

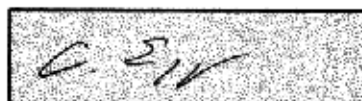
Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The test results were within published specifications.

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 800 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: $\sigma = 0.83$ [mho/m] $\epsilon_r = 43.0$ $\rho = 1.00$ [g/cm³]
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



Dipole 1900 MHz

250 mW CW power

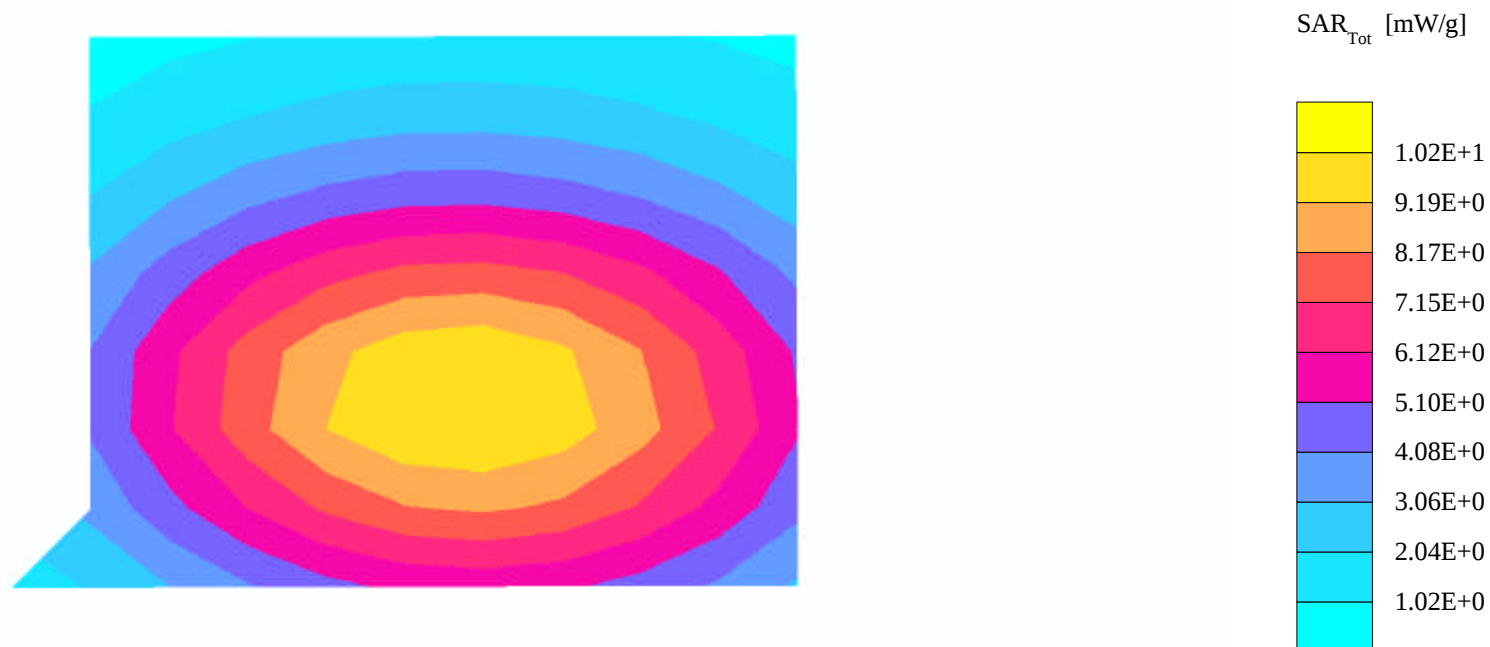
Free Space Phantom; Free Space Section; Position: (80°,180°); Frequency: 1800 [MHz]

Probe: ET3DV4 - SN1103; ConvF(4.90,4.90,4.90); Crest factor: 1.0; Brain 1800 -1900 MHz: $\sigma = 1.71$ [mho/m] $\epsilon_r = 41.0$ $\rho = 1.00$ [g/cm³]

Cube 5x5x7: SAR (1g): 9.10 [mW/g], SAR (10g): 4.67 [mW/g], (Worst-case extrapolation)

Coarse: Dx = 5.0, Dy = 5.0, Dz = 0.0

Powerdrift: 0.04 dB



Appendix D

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

Preliminary Manual

DASY3 V1.0b

for Windows 95