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SAR Test Report for Motorola portable cellular phone (FCC ID IHDT5ZP1).

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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 IHDT5ZP1. 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 FC846049 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. 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. Front 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 1502 was used for the measurements. It was calibrated at SPEAG™, and has a calibration date October 28, 1999. Dipole Validation Kit type D900V2, serial number 055 was used to validate the system accuracy. The validation SAR value is 9.08 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 9.56 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 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  $\pm 6\%$ . 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 2). 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. 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 phantom head, shown in figure 2, was filled with a liquid having relative dielectric constant equal to 43.5 and conductivity equal to 0.84 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 RSS uncertainty of the measurement system is  $\pm 12.0\%$  ( $K=1$ ). The breakdown of the individual uncertainties is as follows:

| <b>Probe Uncertainty</b> | <b><math>\pm\%</math></b> |
|--------------------------|---------------------------|
| 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 IHDT5ZP1) is 1.16 W/kg and was found on the right side head, and with the phone in analog mode. The highest SAR found in digital mode was 0.60 W/kg. 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. Note that digital mode SAR data was measured only for the test conditions 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.

| Analogue<br>Channel | Left Head   | Right Head  | Conducted Power<br>Output (mW) |
|---------------------|-------------|-------------|--------------------------------|
| 991                 | 0.95        | 1.00        | 398                            |
| 384                 | 0.93        | 0.98        | 398                            |
| 799                 | <b>1.05</b> | <b>1.16</b> | 398                            |

| TDMA<br>Channel | Left side head | Right side head | Conducted Power<br>Output (mW) |
|-----------------|----------------|-----------------|--------------------------------|
| 786             | <b>0.541</b>   | 0.598           | 210                            |



Figure 4. Phone with Analog Contour Plot Overlay

#### 9. Body Worn Configuration Evaluation

The cellular phone (FCC ID IHDT5ZP1) can be used in a body-worn configuration using the supplied belt clip. We have performed an evaluation to show RF exposure compliance when used with the belt clip. The test sample was tested only in the mode that resulted in the highest SAR value when held against the phantom head. Figure 5 shows the test unit as it is placed onto the phantom.

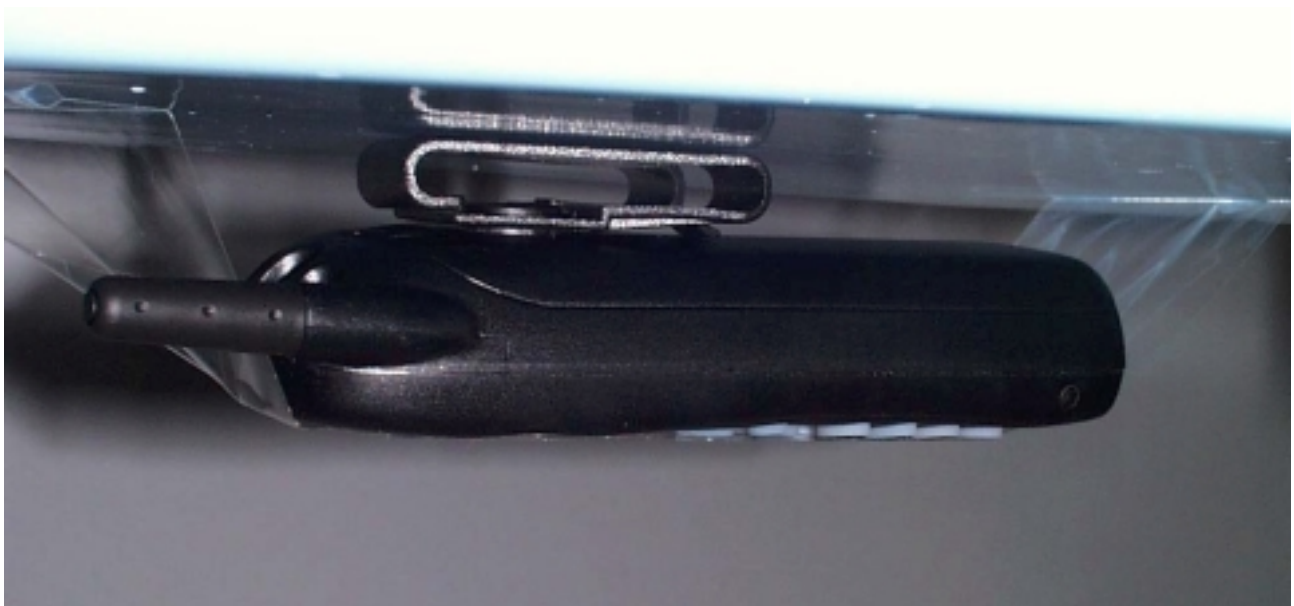


Figure 5. Phone In Supplied Belt Clip Against Phantom

The maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT5ZP1) when used in the body worn configuration is 1.21 W/kg. A full data set output of the test condition with the highest SAR values from the Dasy™ measurement system is included as Appendix B.

The test condition included is indicated as a bold number in the following table. All other test conditions measured lower SAR values than those included. The location of highest SAR was the area on the phone near the antenna.

| Channel | Analog Mode<br>SAR | Digital Mode<br>SAR |
|---------|--------------------|---------------------|
| 991     | 1.05               |                     |
| 384     | 0.98               |                     |
| 799     | <b>1.21</b>        | <b>0.47</b>         |

#### 10. Battery Options

The cellular phone (FCC ID IHDT5ZP1) does have two battery options., “slim” and “high capacity”. These battery options do not affect the attachment to the belt clip, and thus do not change the distance from the antenna or phone to the body in the body worn configuration. For the purposes of head adjacent testing the battery chosen was the battery that gave the highest SAR values, in this case a “high capacity” battery was used for the head adjacent testing.

#### 11. Summary

The SAR values found for the portable cellular phone (FCC ID IHDT5ZP1) 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 FC846049**

Ch# 799/ Pwr02 / Modulation: ANALOG

Betty Phantom; Right Head Section; Position: (80°,180°); Frequency: 849 MHz

Probe: ET3DV6 - SN1502; ConvF(6.69,6.69,6.69); Crest factor: 1.0; Brain 800 MHz:  $\sigma = 0.84$  mho/m  $\epsilon_r = 43.5$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 1.16 mW/g, SAR (10g): 0.830 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 15.0, Dz = 0.0

Penetration depth: 19.2 (17.5, 20.7) [mm]

Powerdrift: -0.08 dB



s/n FC846049

Ch# 799/ Pwr02 / Modulation: ANALOG

Barney Phantom; Left Head Section; Position: (80°,180°); Frequency: 849 MHz

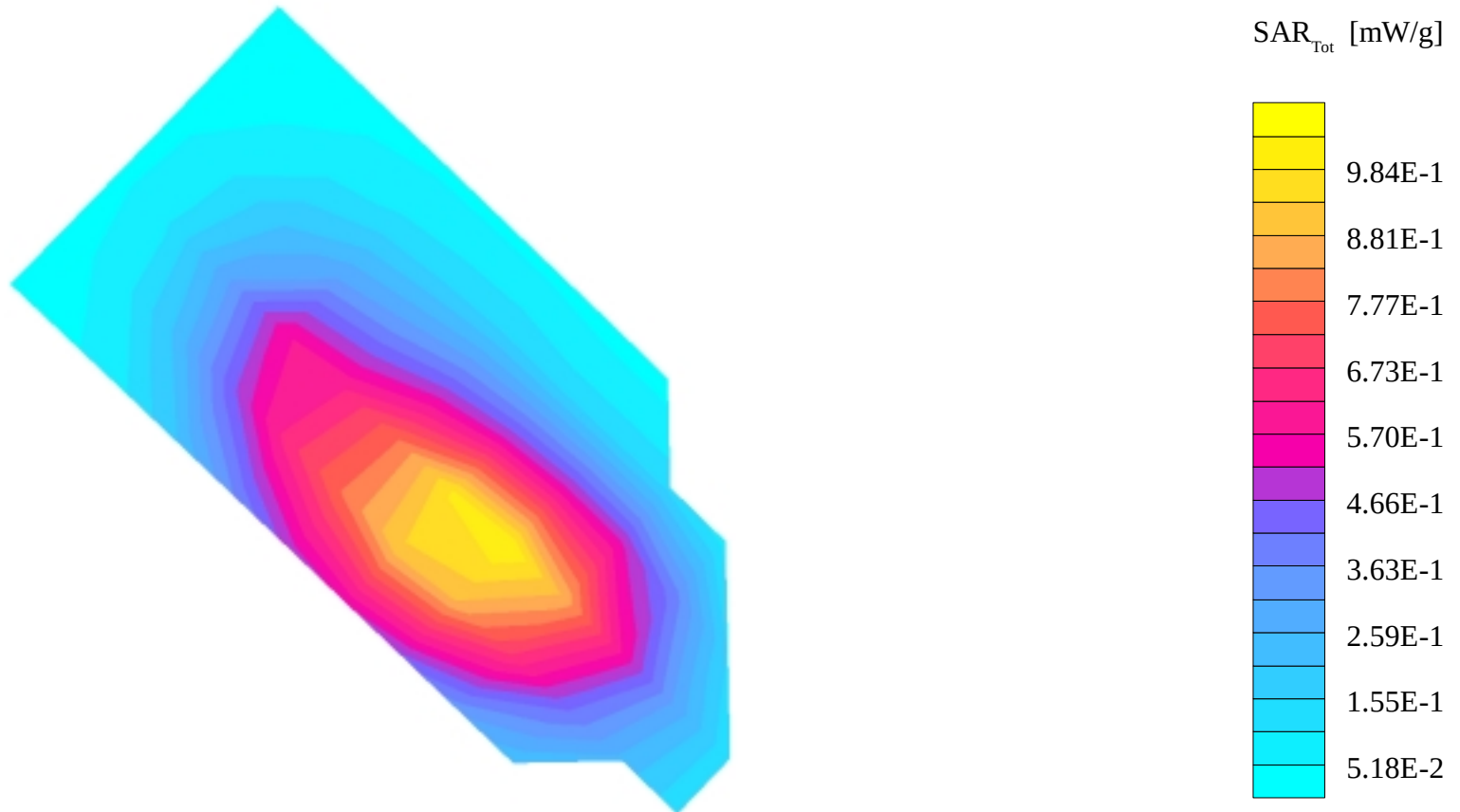
Probe: ET3DV6 - SN1502; ConvF(6.69,6.69,6.69); Crest factor: 1.0; Brain 800 MHz:  $\sigma = 0.83$  mho/m  $\epsilon_r = 44.1$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 1.05 mW/g, SAR (10g): 0.766 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 15.0, Dz = 0.0

Penetration depth: 19.9 (17.8, 21.5) [mm]

Powerdrift: 0.03 dB



s/n FC846049

Ch# 786/ Pwr02 / Modulation:TDMA

Betty Phantom; Right Head Section; Position: (80°,180°); Frequency: 849 MHz

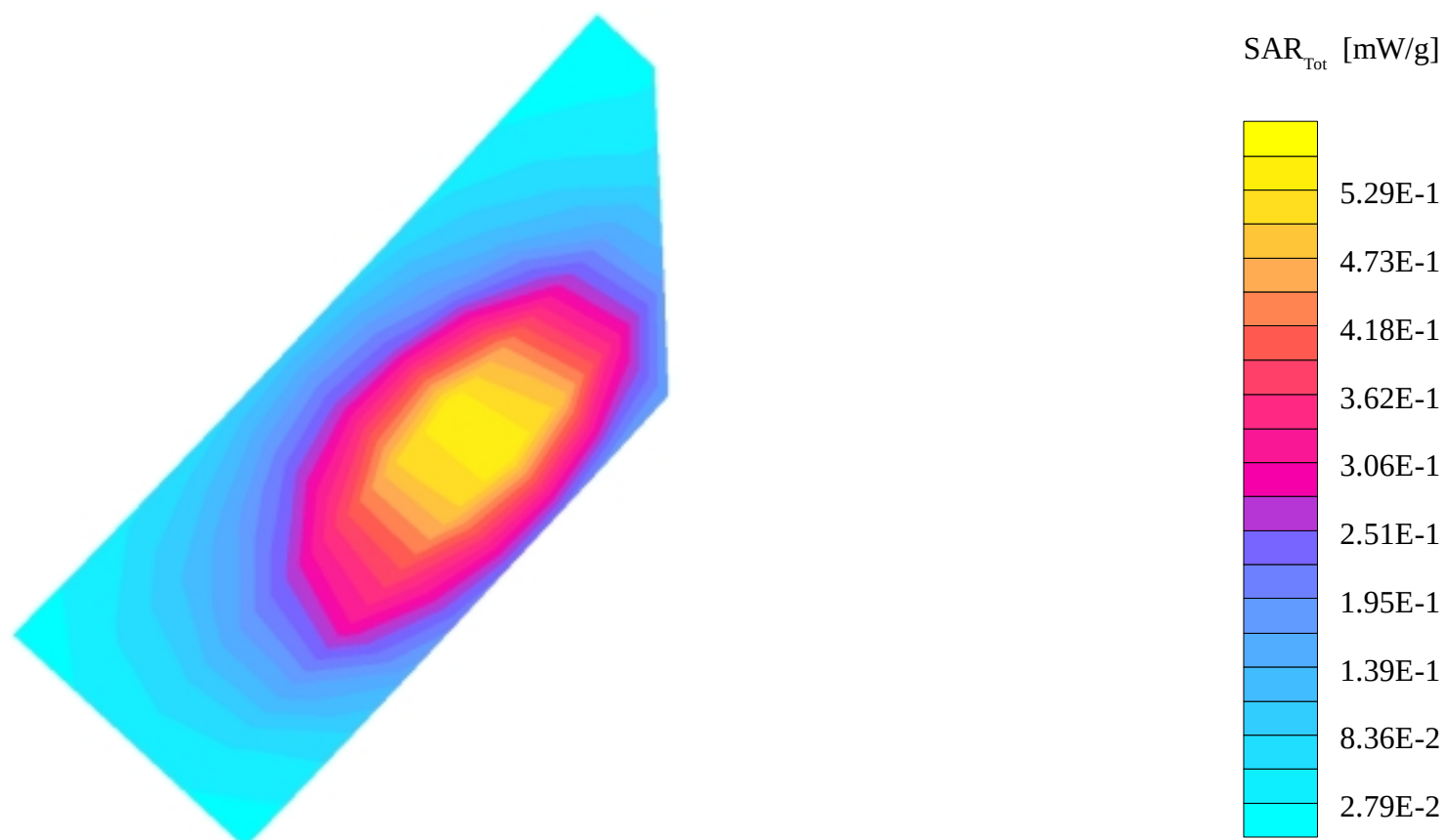
Probe: ET3DV6 - SN1502; ConvF(6.69,6.69,6.69); Crest factor: 3.0; Brain 800 MHz:  $\sigma = 0.87$  mho/m  $\epsilon_r = 48.2$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.598 mW/g, SAR (10g): 0.423 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 15.0, Dz = 0.0

Penetration depth: 17.9 (16.7, 19.2) [mm]

Powerdrift: 0.01 dB



s/n FC846049

Ch# 786/ Pwr02 / Modulation: TDMA

Barney Phantom; Left Head Section; Position: (80°,180°); Frequency: 839 MHz

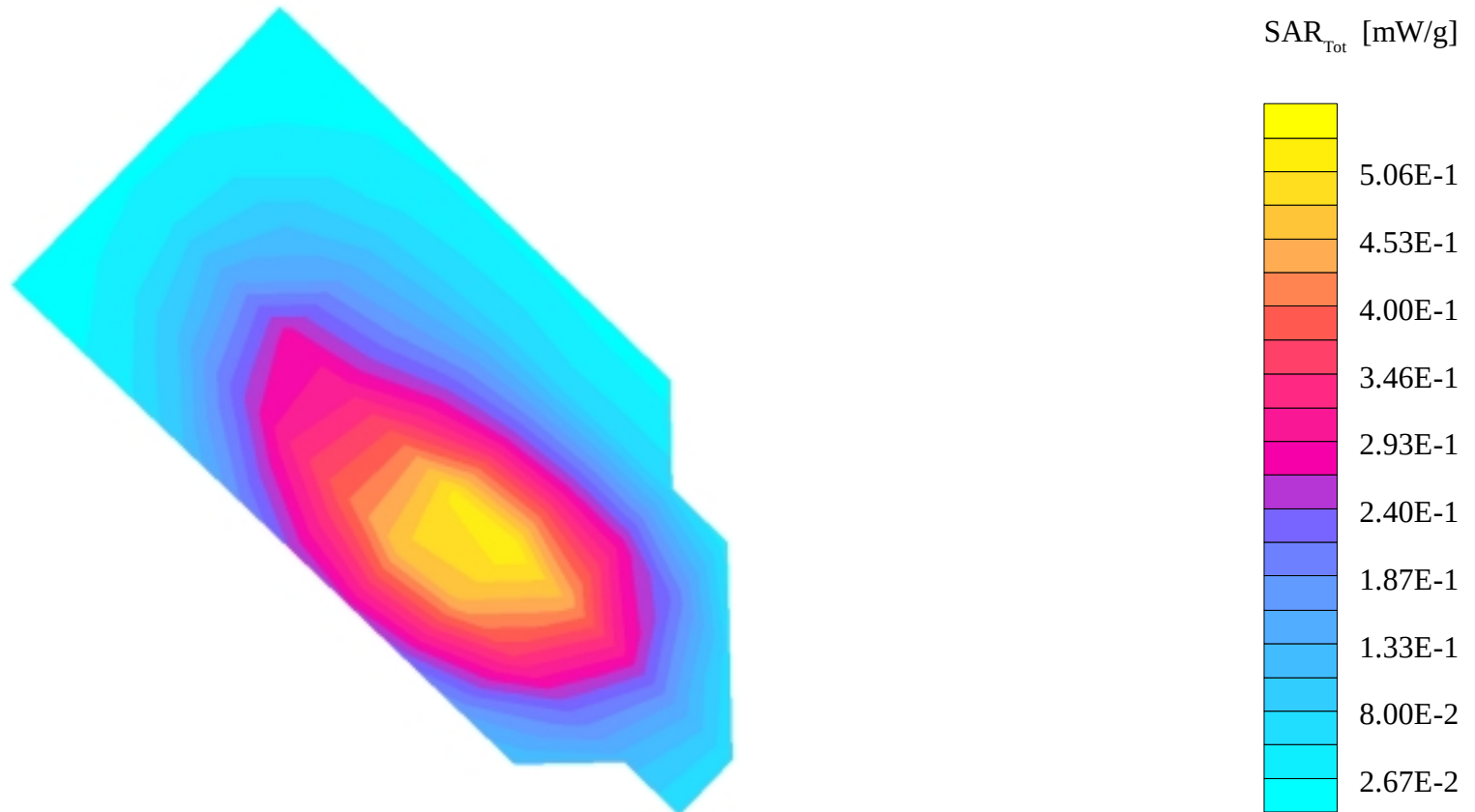
Probe: ET3DV6 - SN1502; ConvF(6.69,6.69,6.69); Crest factor: 3.0; Brain 800 MHz:  $\sigma = 0.83$  mho/m  $\epsilon_r = 44.1$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.541 mW/g, SAR (10g): 0.395 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 15.0, Dz = 0.0

Penetration depth: 19.5 (17.9, 20.8) [mm]

Powerdrift: -0.02 dB



## Appendix B

The following pages are printouts from the Dasy™ measurement system of the data in a Body Worn Configuration.

s/n FC846049

Ch# 799/ Pwr02 / Modulation:Analog

Amy Twin Phantom Phantom; Section 1 Section; Position: (0°,0°); Frequency: 849 MHz

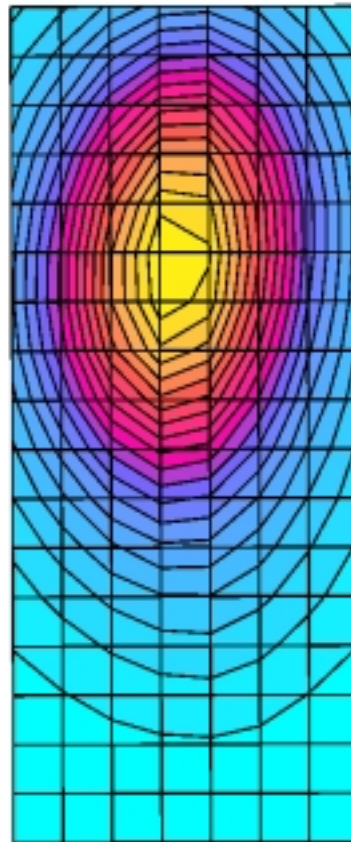
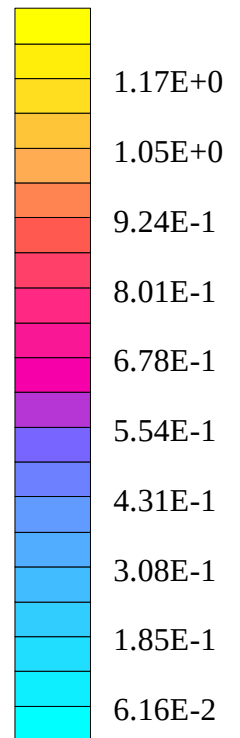
Probe: ET3DV6 - SN1502; ConvF(6.69,6.69,6.69); Crest factor: 1.0; Muscle 900 MHz:  $\sigma = 1.23$  mho/m  $\epsilon_r = 57.5$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 1.21 mW/g, SAR (10g): 0.815 mW/g, (Worst-case extrapolation)

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

Penetration depth: 13.6 (12.5, 14.9) [mm]

Powerdrift: 0.01 dB

SAR<sub>Tot</sub> [mW/g]

## s/n FC84408D

Ch# 799/ Pwr02 / Modulation:TDMA

Amy Twin Phantom Phantom; Section 1 Section; Position: (0°,0°); Frequency: 837 MHz

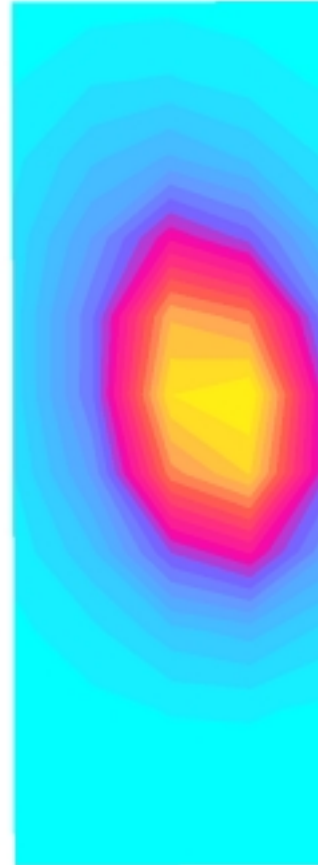
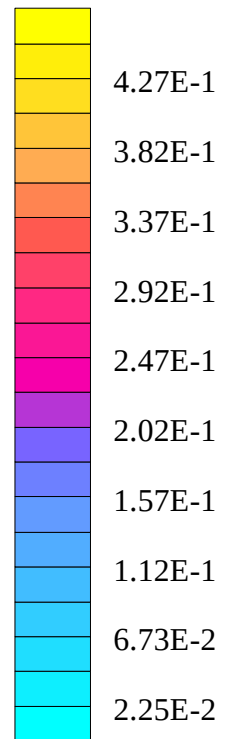
Probe: ET3DV6 - SN1502; ConvF(6.69,6.69,6.69); Crest factor: 1.0; Muscle 900 MHz:  $\sigma = 1.07$  mho/m  $\epsilon_r = 56.1$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.474 mW/g, SAR (10g): 0.331 mW/g, (Worst-case extrapolation)

Coarse: Dx = 20.0, Dy = 20.0, Dz = 0.0

Penetration depth: 15.4 (14.1, 16.5) [mm]

Powerdrift: 0.01 dB

SAR<sub>Tot</sub> [mW/g]

## Appendix C

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

## Dipole 900MHz

900MHz Dipole Validation Dipole Sn# 055 / forward Power = 248 mW

Amy Twin Phantom; Section 1

Probe: ET3DV6 - SN1502; ConvF(6.69,6.69,6.69); Crest factor: 1.0; Brain 900 MHz:  $\sigma = 0.85$  mho/m  $\epsilon_r = 41.3$   $\rho = 1.00$  g/cm<sup>3</sup>

Cubes (2): Peak: 3.73 mW/g  $\pm 0.02$  dB, SAR (1g): 2.39 mW/g  $\pm 0.04$  dB, SAR (10g): 1.57 mW/g  $\pm 0.05$  dB, (Worst-case extrapolation)

Penetration depth: 13.1 (11.7, 14.8) [mm]

Powerdrift: 0.17 dB

