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SAR Test Report for Motorola portable cellular phone (FCC ID IHDT56AA1).

Prepared by:

Paul Moller

Motorola Personal Communications Sector Product Safety Laboratory

Libertyville, Illinois

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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 IHDT56AA1. 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 A01307 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 CDMA modes, 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. Showing Retracted Antenna



Figure 2. Showing Extended Antenna

Figures 3 and 4 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 with Antenna Retracted



Figure 4. Phone against side of 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 1398 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 57 was used to validate the system accuracy at 800MHz. The validation SAR value is 9.6 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 9.24 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. Dipole Validation Kit type D1800V2, serial number 255 was used to validate the system accuracy at 1900MHz. The validation SAR value is 39.0 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 39.4 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. The manual is available directly from SPEAG™.



Figure 5. 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 figures 3 and 4). Due to the construction of the phone, the base of the antenna is 17 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 Analog mode tests the unit is commanded to test mode and manually set to the proper channel, transmitter power level and transmit mode of operation. For the purposes of the CDMA mode tests, the unit is placed in a phone call using an HP8924 and is commanded to the highest possible power by means of the "always up" command. 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 figures 3 and 4, was filled with a liquid having relative dielectric constant equal to 44.75 and conductivity equal to 0.92 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 figures 3 and 4, was filled with a liquid having relative dielectric constant equal to 38.56 and conductivity equal to 1.46 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: 54.99% water; 44.92% Glycol; and 0.18% salt.

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:

Probe Uncertainty	$\pm\%$
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 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 IHDT56AA1) in the 800MHz band is 1.50 W/kg and was found on the left side head. A full data set output of the 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	Left side head		Right side head		Conducted Power (Watts)
	Ant Ret	Ant Ext	Ant Ret	Ant Ext	
991	1.03	1.06	0.98	0.90	0.412
384	1.50	0.88	1.33	1.47	0.548
799	1.43	1.49	1.27	0.80	0.485
CDMA 800 Channel	Left side head		Right side head		Conducted Power (Watts)
	Ant Ret	Ant Ext	Ant Ret	Ant Ext	
1013	1.27	0.59	1.11	0.46	0.263
384	1.32	0.51	1.17	0.70	0.264
779	1.31	0.44	1.17	0.74	0.249

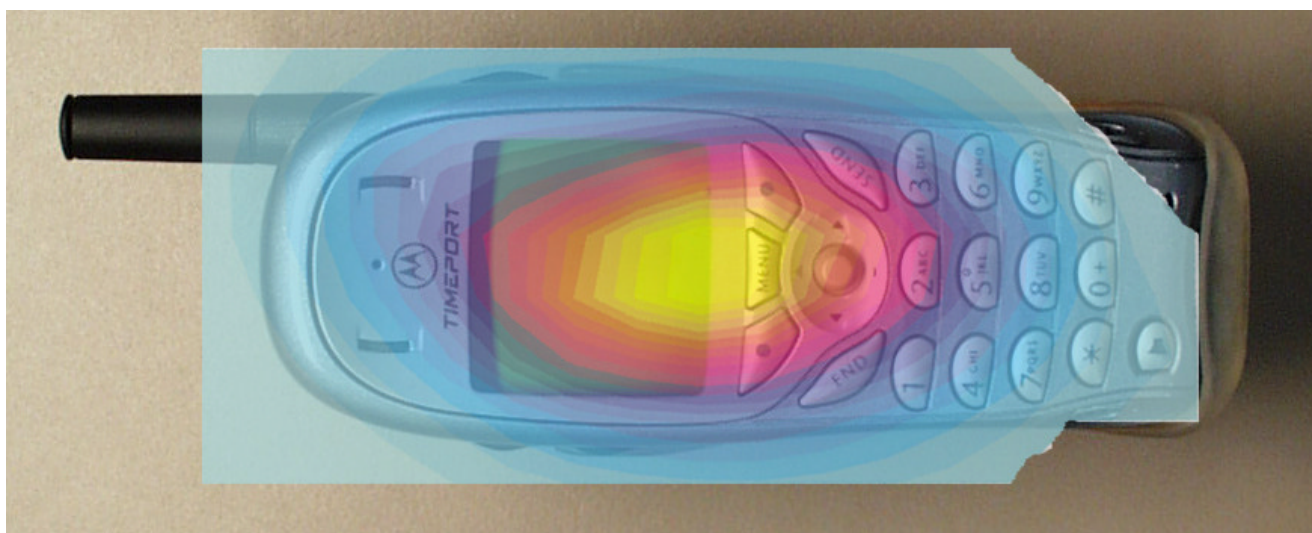


Figure 6. 800MHz Contour Plot Overlaid on Face of Phone.

The maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT56AA1) in the 1900MHz band is 0.94 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 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. Figure 7 shows the contour plot of the highest test condition overlaid onto a picture of the phone.

CDMA 1900 Channel	Left side head		Right side head		Conducted Power (Watts)
	Ant Ret	Ant Ext	Ant Ret	Ant Ext	
25	0.22	0.77	0.20	0.68	0.252
600	0.40	0.94	0.15	0.82	0.252
1175	0.21	0.88	0.11	0.72	0.249



Figure 7. 1900MHz Contour Plot Overlaid on Face of Phone.

9. Body Worn Configuration

The cellular phone (FCC ID IHDT56AA1) 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 either of the belt clips. Figure 8 shows the test unit as it is placed onto the phantom. The 800MHz phantom was filled with a liquid having relative dielectric constant equal to 52.51 and conductivity equal to 1.06 S/m. The composition of the liquid mixture is as follows: 52.5% water; 45.0% sugar; 1.3% salt, 1% HEC; and 0.2% bactericide. The 1900MHz phantom was filled with a liquid having relative dielectric constant equal to 49.78 and conductivity equal to 1.69 S/m. The composition of the liquid mixture is as follows: 66.1% water; 33.4% Glycol; and 0.5 salt.

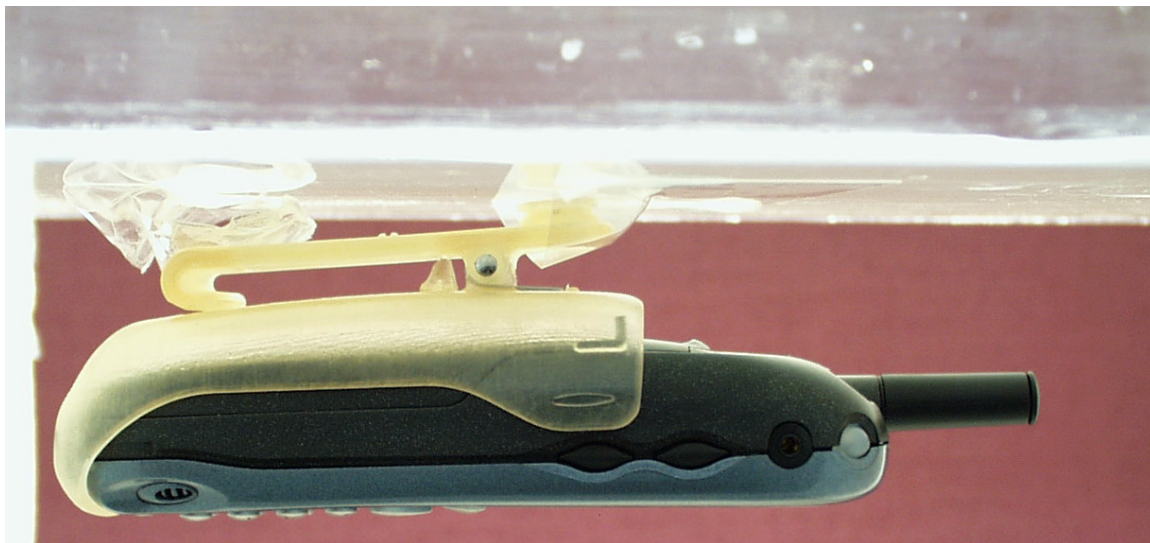


Figure 8. Phone In Belt Clip Against Phantom

The following table shows the SAR values for the body worn condition for 800MHz and 1900MHz. A full data set output of two test conditions with the highest SAR values from the Dasy™ measurement system in each frequency band is included as appendix C. The test conditions included are indicated as a bold number in the following table. All other test conditions measured lower SAR values than those included.

Analog 800 Channel	Ant Ret	Ant Ext	CDMA 1900 Channel	Ant Ret	Ant Ext
991	0.40	0.65	25	0.08	0.215
384	0.61	0.91	600	0.07	0.278
799	0.52	0.82	1175	0.08	0.214

10. Battery Options

The cellular phone (FCC ID IHDT56AA1) uses only one battery model. This model used for all testing. There are no other battery options for this cellular phone.

11. Summary

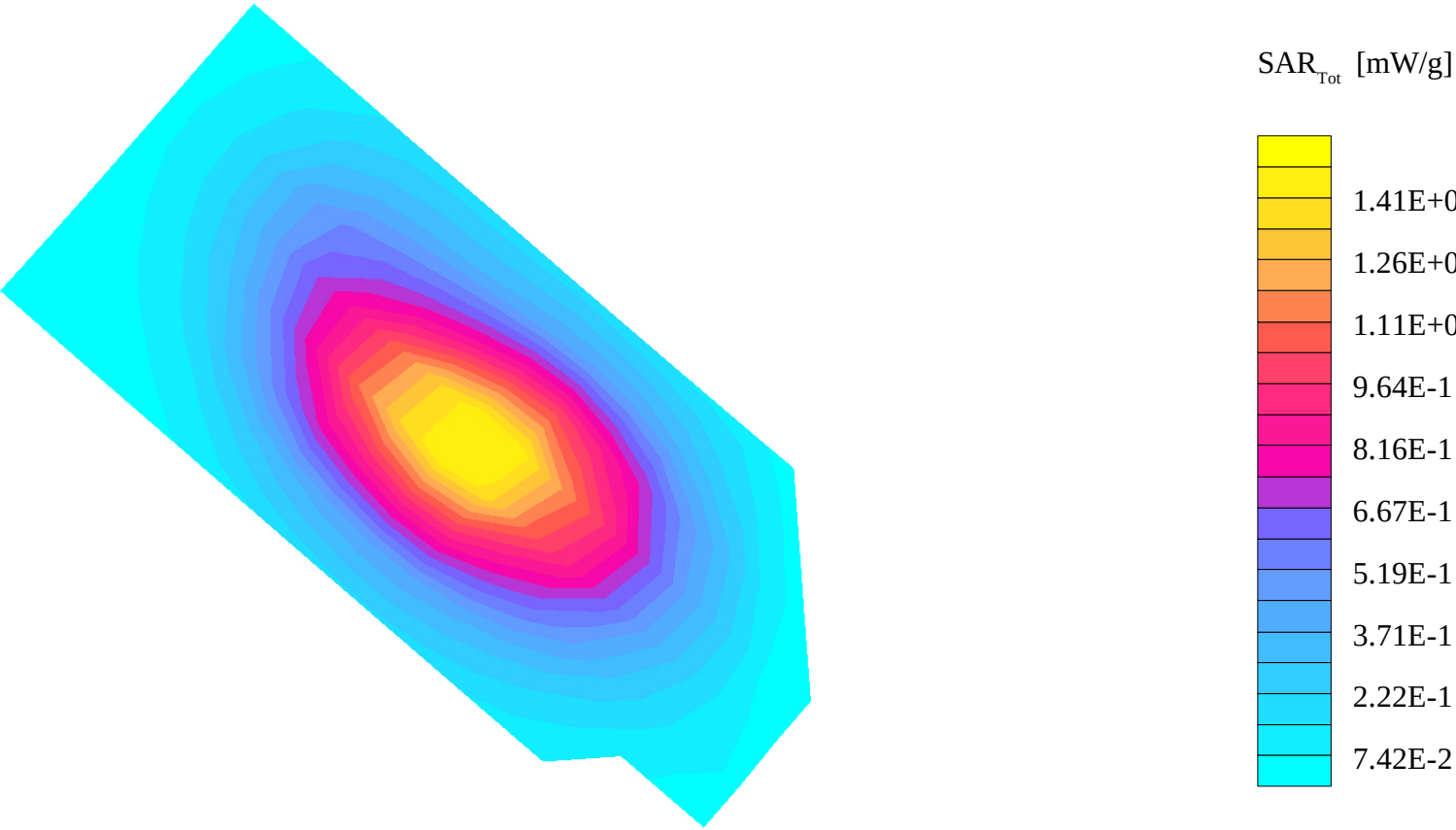
The SAR values found for the portable cellular phone (FCC ID IHDT56AA1) are below the maximum recommended levels of 1.6 W/kg.

Appendix A

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

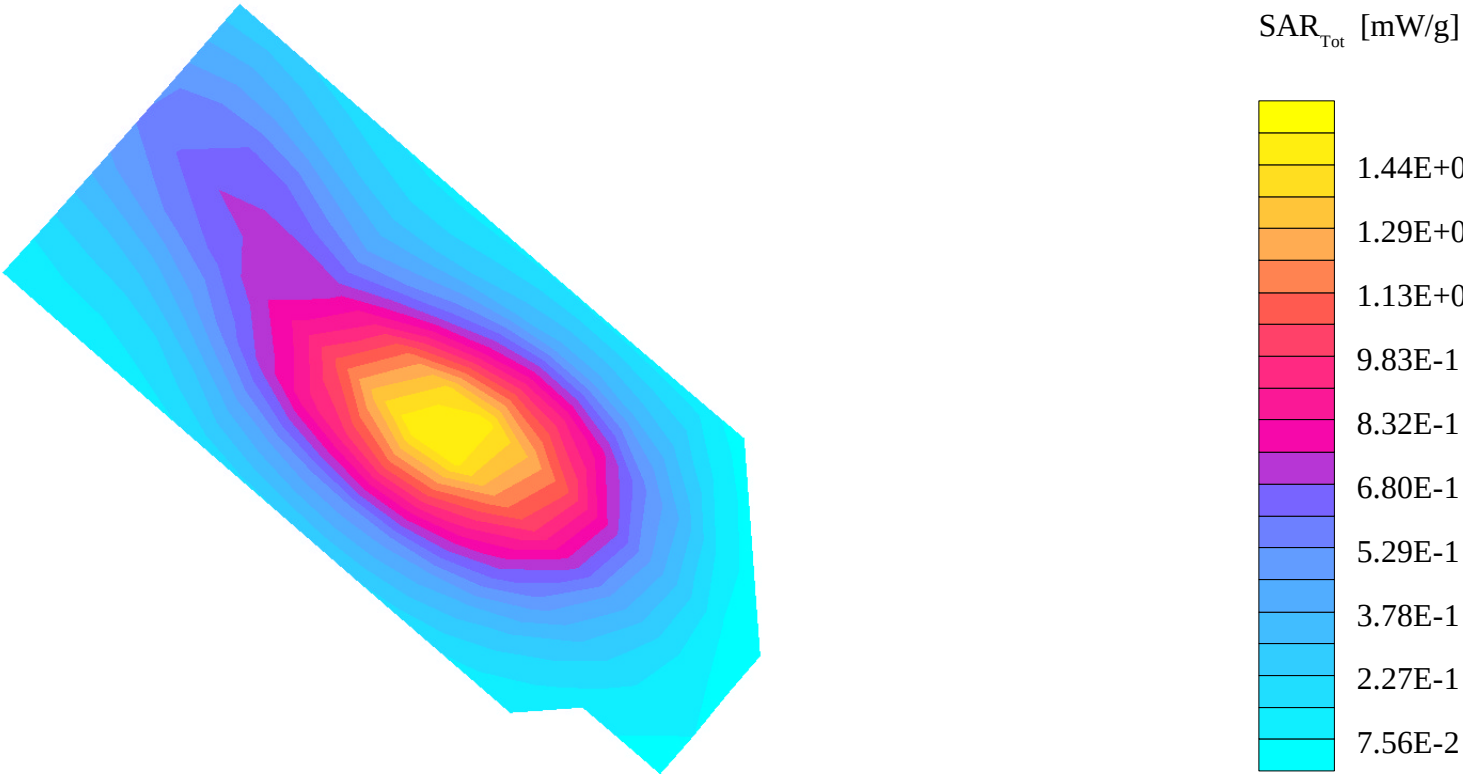
s/n AO1307

Ch#384 / Pwr Step:02 / Antenna Position:RETRACTED
Barney(left) Phantom; Left Head Section; Position: (80°,180°); Frequency: 837 MHz
Probe: ET3DV6 - SN1398 - Sugar Water Head; ConvF(6.61,6.61,6.61); Crest factor: 1.0; Head 835 MHz: $\sigma = 0.92$ mho/m $\epsilon_r = 44.8$ $\rho = 1.00$ g/cm³
Cube 5x5x7: SAR (1g): 1.50 mW/g, SAR (10g): 1.01 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0
Penetration depth: 15.3 (13.5, 17.2) [mm]
Powerdrift: -0.02 dB



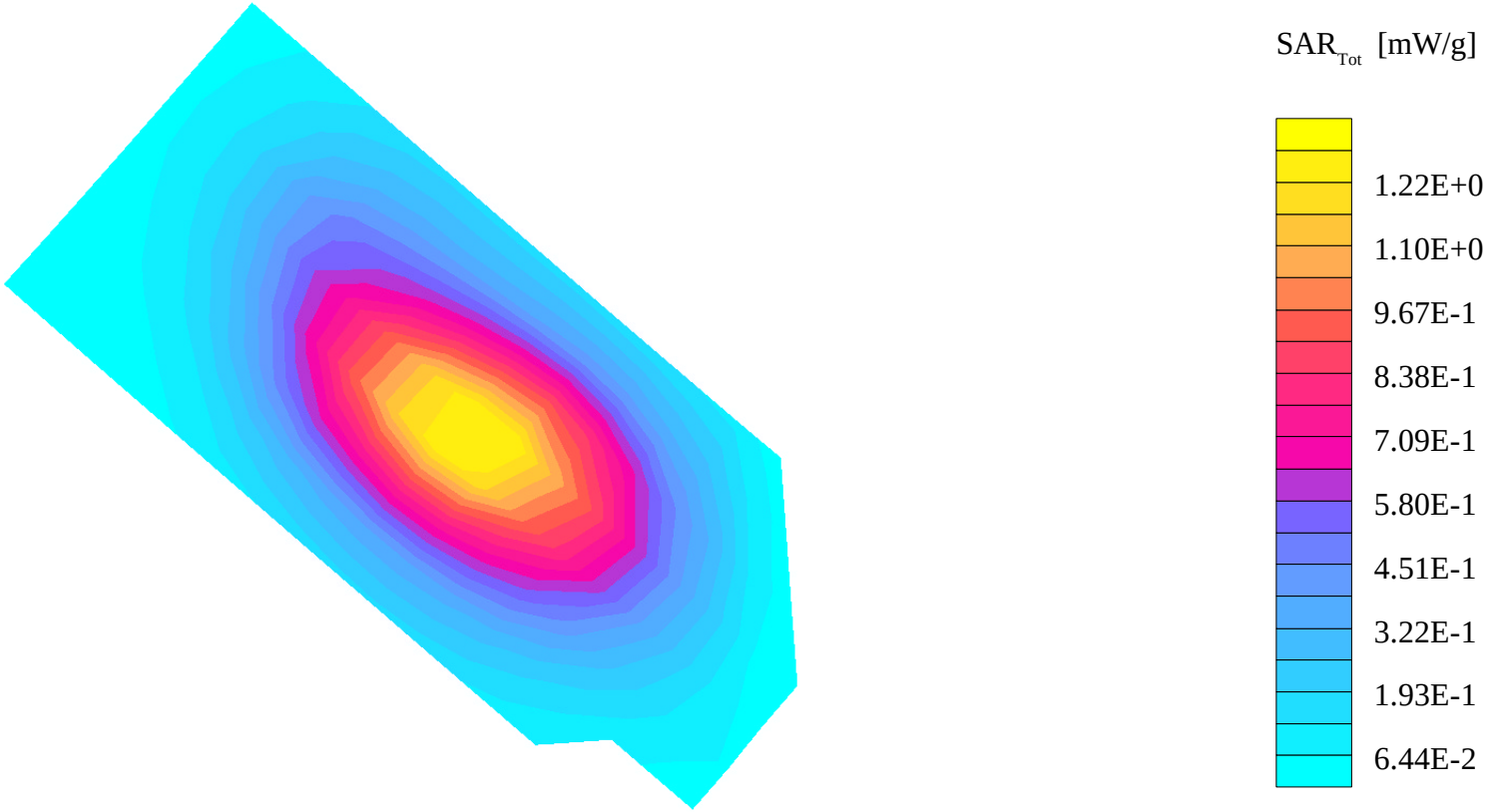
s/n AO1307

Ch#799 / Pwr Step:02 / Antenna Position:EXTENDED
Barney(left) Phantom; Left Head Section; Position: (80°,180°); Frequency: 849 MHz
Probe: ET3DV6 - SN1398 - Sugar Water Head; ConvF(6.61,6.61,6.61); Crest factor: 1.0; Head 835 MHz: $\sigma = 0.92 \text{ mho/m}$ $\epsilon_r = 44.8$ $\rho = 1.00 \text{ g/cm}^3$
Cube 5x5x7: SAR (1g): 1.49 mW/g, SAR (10g): 0.999 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0
Penetration depth: 15.2 (13.3, 17.3) [mm]
Powerdrift: -0.21 dB



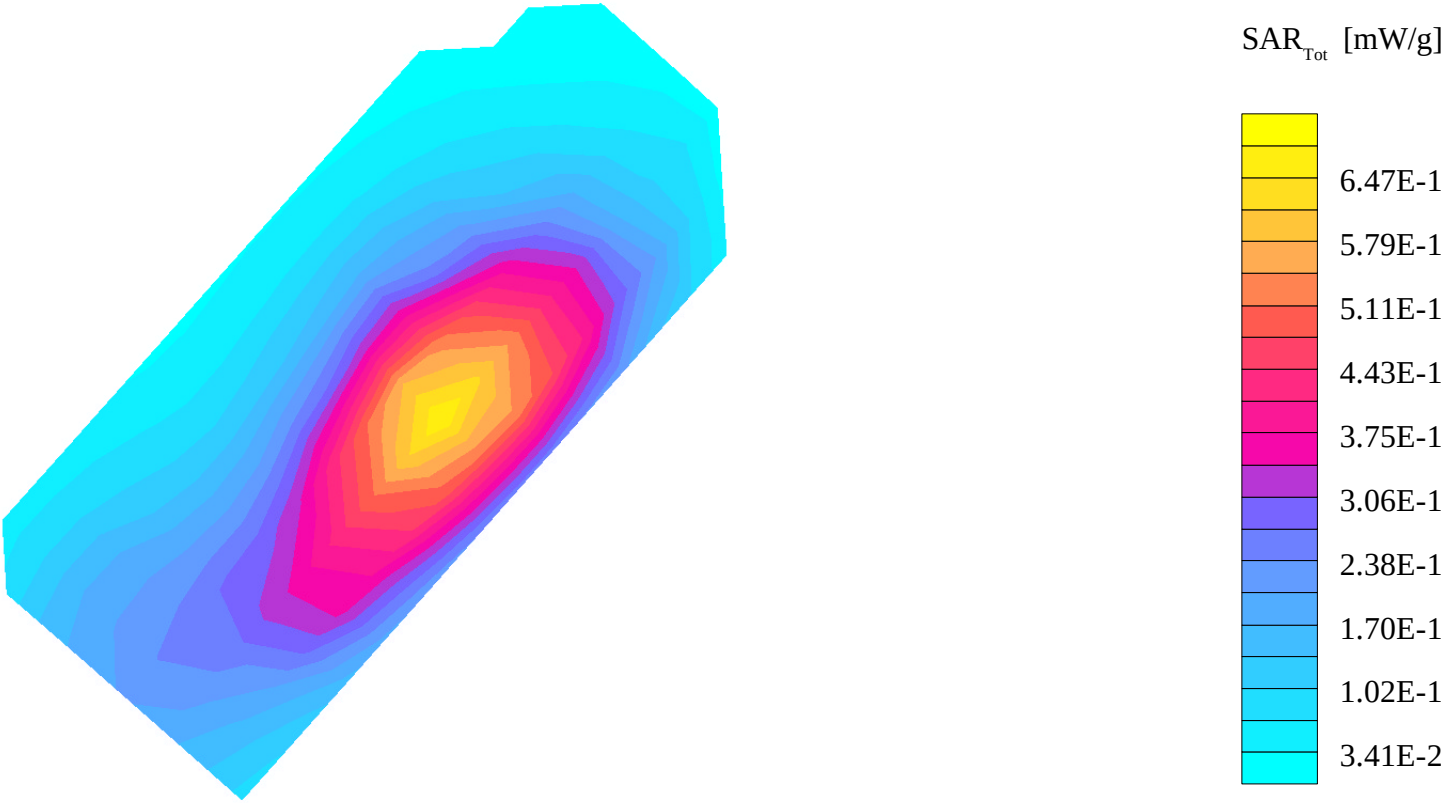
s/n AO1307

Ch#384 / Antenna Position:RETRACTED / Type of Modulation:CDMA
Barney(left) Phantom; Left Head Section; Position: (80°,180°); Frequency: 837 MHz
Probe: ET3DV6 - SN1398 - Sugar Water Head; ConvF(6.61,6.61,6.61); Crest factor: 1.0; Head 835 MHz: $\sigma = 0.92 \text{ mho/m}$ $\epsilon_r = 44.8$ $\rho = 1.00 \text{ g/cm}^3$
Cube 5x5x7: SAR (1g): 1.32 mW/g, SAR (10g): 0.889 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0
Penetration depth: 15.3 (13.3, 17.5) [mm]
Powerdrift: -0.08 dB



s/n AO1307

Ch#779 / Antenna Position:EXTENDED / Type of Modulation:CDMA
Thelma Lou(right) Phantom; Right Head Section; Position: (80°,180°); Frequency: 848 MHz
Probe: ET3DV6 - SN1398 - Sugar Water Head; ConvF(6.61,6.61,6.61); Crest factor: 1.0; Head 835 MHz: $\sigma = 0.88$ mho/m $\epsilon_r = 44.6$ $\rho = 1.00$ g/cm³
Cube 5x5x7: SAR (1g): 0.742 mW/g, SAR (10g): 0.491 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0
Penetration depth: 15.2 (13.4, 17.1) [mm]
Powerdrift: -0.37 dB

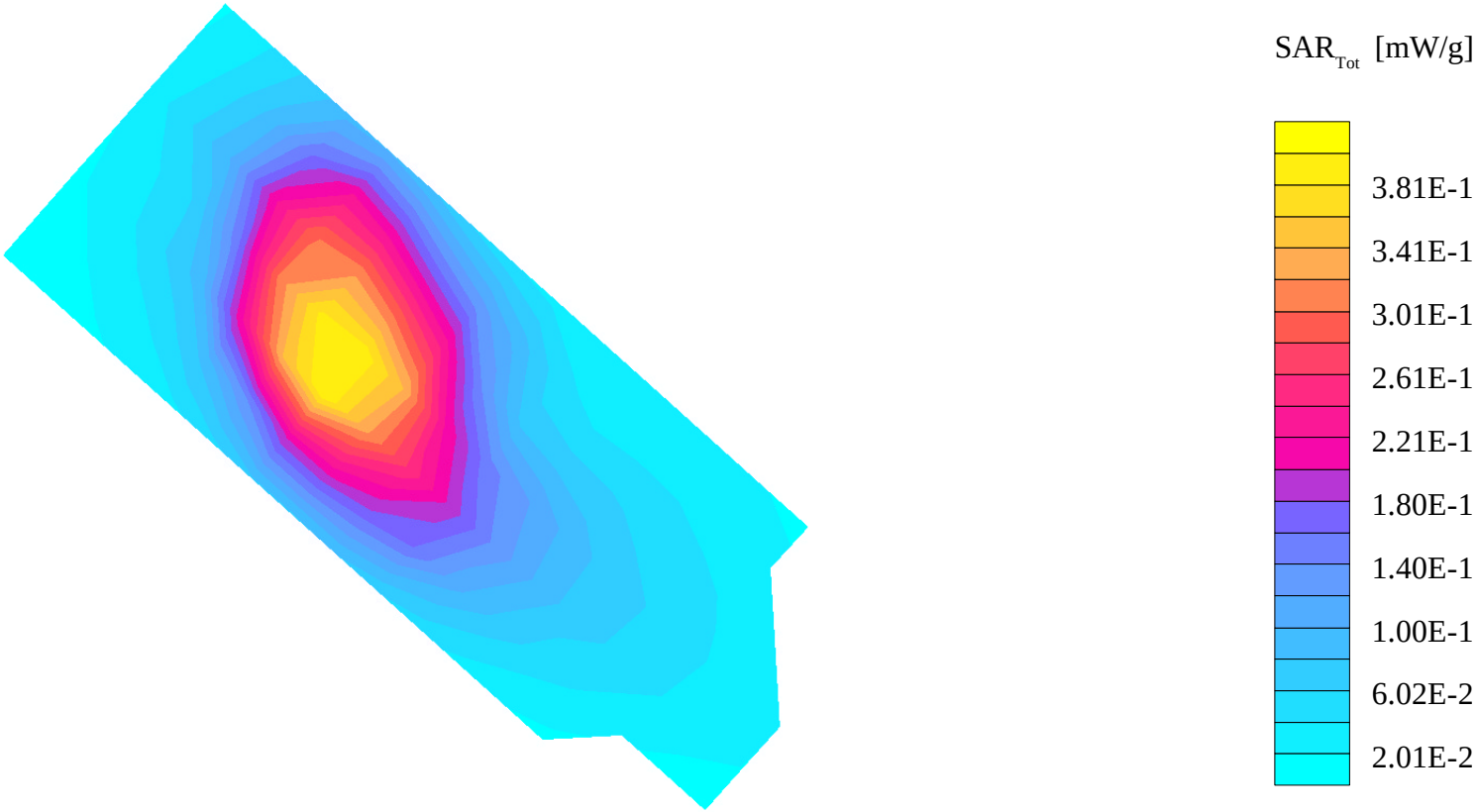


Appendix B

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

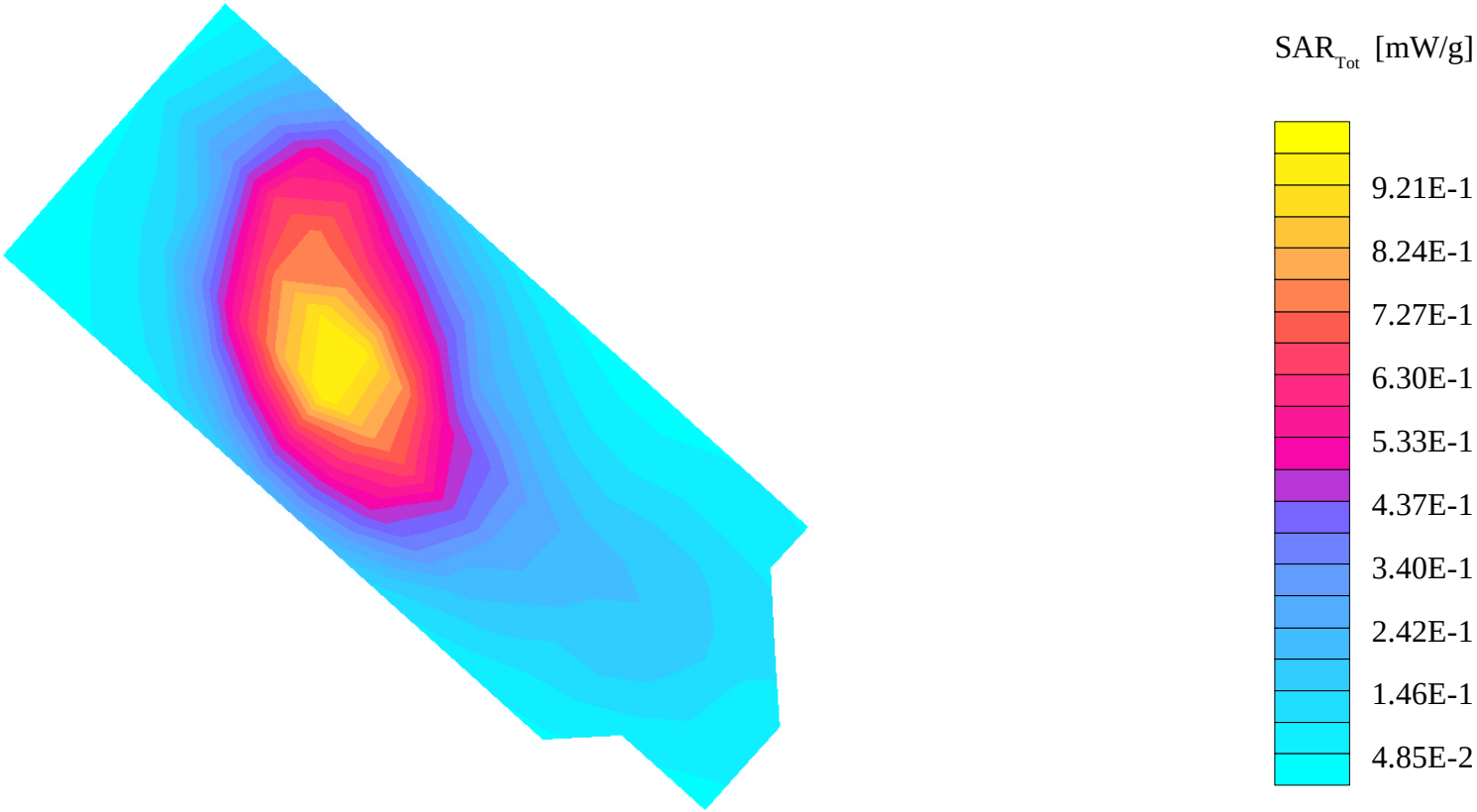
s/n AO1307

Ch#600 / Antenna Position:RETRACTED / Type of Modulation:CDMA
Desi (glycol Left) Phantom; Left Head Section; Position: (80°,180°); Frequency: 1880 MHz
Probe: ET3DV6 - SN1398 - Glycol Head; ConvF(5.51,5.51,5.51); Crest factor: 1.0; Head Glycol 1900 MHz: $\sigma = 1.46$ mho/m $\epsilon_r = 38.6$ $\rho = 1.00$ g/cm³
Cube 5x5x7: SAR (1g): 0.396 mW/g, SAR (10g): 0.235 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Penetration depth: 10.0 (9.8, 10.4) [mm]
Powerdrift: 0.09 dB



s/n AO1307

Ch#600 / Antenna Position:EXTENDED / Type of Modulation:CDMA
Desi (glycol Left) Phantom; Left Head Section; Position: (80°,180°); Frequency: 1880 MHz
Probe: ET3DV6 - SN1398 - Glycol Head; ConvF(5.51,5.51,5.51); Crest factor: 1.0; Head Glycol 1900 MHz: $\sigma = 1.46 \text{ mho/m}$ $\epsilon_r = 38.6$ $\rho = 1.00 \text{ g/cm}^3$
Cube 5x5x7: SAR (1g): 0.942 mW/g, SAR (10g): 0.564 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Penetration depth: 10.7 (10.4, 11.0) [mm]
Powerdrift: -0.06 dB



Appendix C

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

s/n AO1307

Ch#384 / Pwr Step:02 / Antenna Position:EXTENDED
Amy Twin Phantom Phantom; Section2 Section; Position: (0°,0°); Frequency: 837 MHz
Probe: ET3DV6 - SN1398 - Sugar Water Muscle; ConvF(6.70,6.70,6.70); Crest factor: 1.0; Muscle 800 MHz: $\sigma = 1.06$ mho/m $\epsilon_r = 52.5$ $\rho = 1.00$ g/cm³
Cube 5x5x7: SAR (1g): 0.907 mW/g, SAR (10g): 0.612 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Penetration depth: 14.0 (12.4, 15.7) [mm]
Powerdrift: -0.05 dB



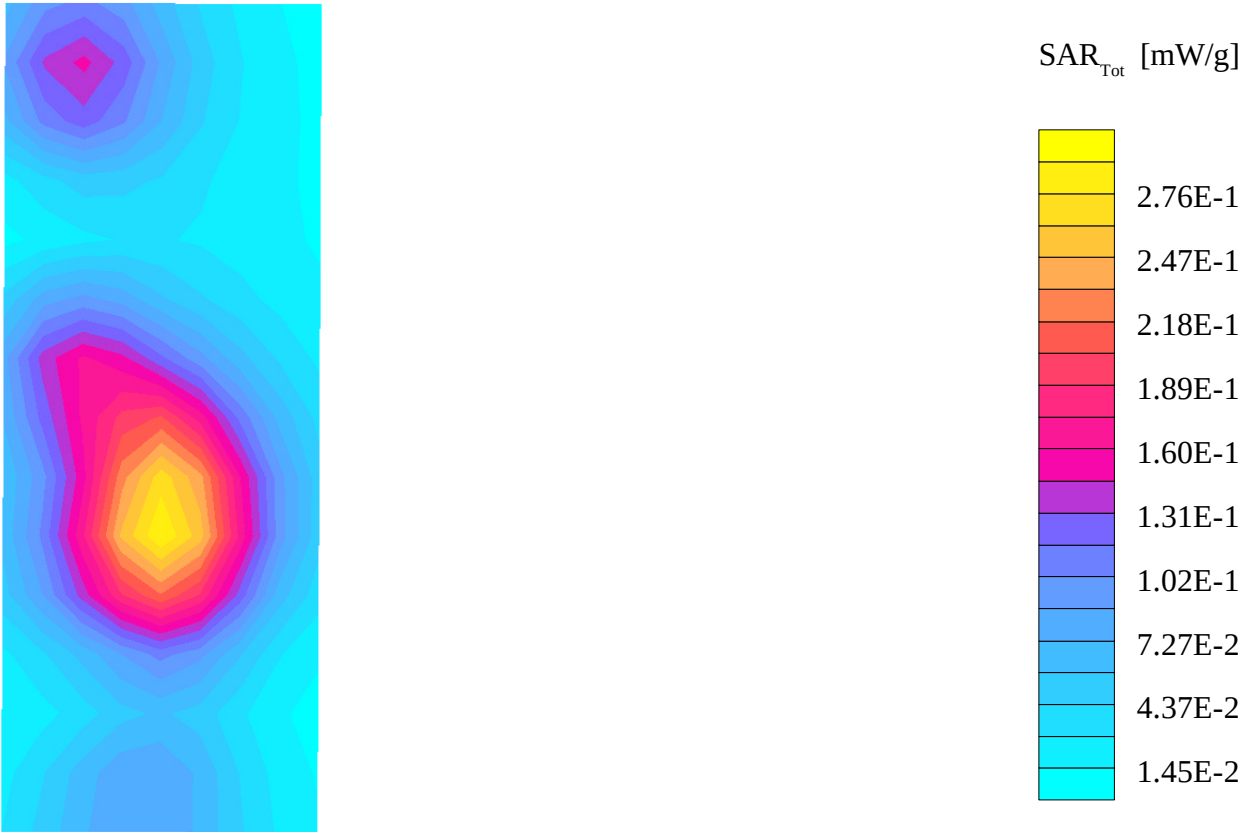
S/N AO1307

Ch#384 / Pwr Step:02 / Antenna Position:RETRACTED
Amy Twin Phantom Phantom; Section2 Section; Position: (0°,0°); Frequency: 837 MHz
Probe: ET3DV6 - SN1398 - Sugar Water Muscle; ConvF(6.70,6.70,6.70); Crest factor: 1.0; Muscle 800 MHz: $\sigma = 1.06 \text{ mho/m}$ $\epsilon_r = 52.5$ $\rho = 1.00 \text{ g/cm}^3$
Cube 5x5x7: SAR (1g): 0.608 mW/g, SAR (10g): 0.409 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Penetration depth: 14.0 (12.5, 15.6) [mm]
Powerdrift: -0.07 dB



s/n A01307

Ch# 600 / Antenna Position: Extended / Type of Modulation: 1900 CDMA
Amy Twin Phantom Phantom; Section2 Section; Position: (0°,0°); Frequency: 1883 MHz
Probe: ET3DV6 - SN1391 - Muscle; ConvF(5.07,5.07,5.07); Crest factor: 1.0; Muscle Glycol 1900 MHz: $\sigma = 1.69 \text{ mho/m}$ $\epsilon_r = 49.8$ $\rho = 1.00 \text{ g/cm}^3$
Cube 5x5x7: SAR (1g): 0.278 mW/g, SAR (10g): 0.167 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 10.0, Dz = 10.0
Penetration depth: 9.6 (8.4, 11.4) [mm]
Powerdrift: -0.06 dB



s/n A01307

Ch# 25 / Antenna Position: Retracted / Type of Modulation: 1900 CDMA
Amy Twin Phantom Phantom; Section2 Section; Position: (0°,0°); Frequency: 1851 MHz
Probe: ET3DV6 - SN1391 - Muscle; ConvF(5.07,5.07,5.07); Crest factor: 1.0; Muscle Glycol 1900 MHz: $\sigma = 1.64 \text{ mho/m}$ $\epsilon_r = 50.5$ $\rho = 1.00 \text{ g/cm}^3$
Cube 5x5x7: SAR (1g): 0.0803 mW/g, SAR (10g): 0.0490 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Penetration depth: 9.3 (8.2, 10.9) [mm]
Powerdrift: -0.03 dB



Appendix D

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

Dipole 900 Mhz

900 MHz Dipole Validation / Dipole Sn# 57 / Input Power = 252mW

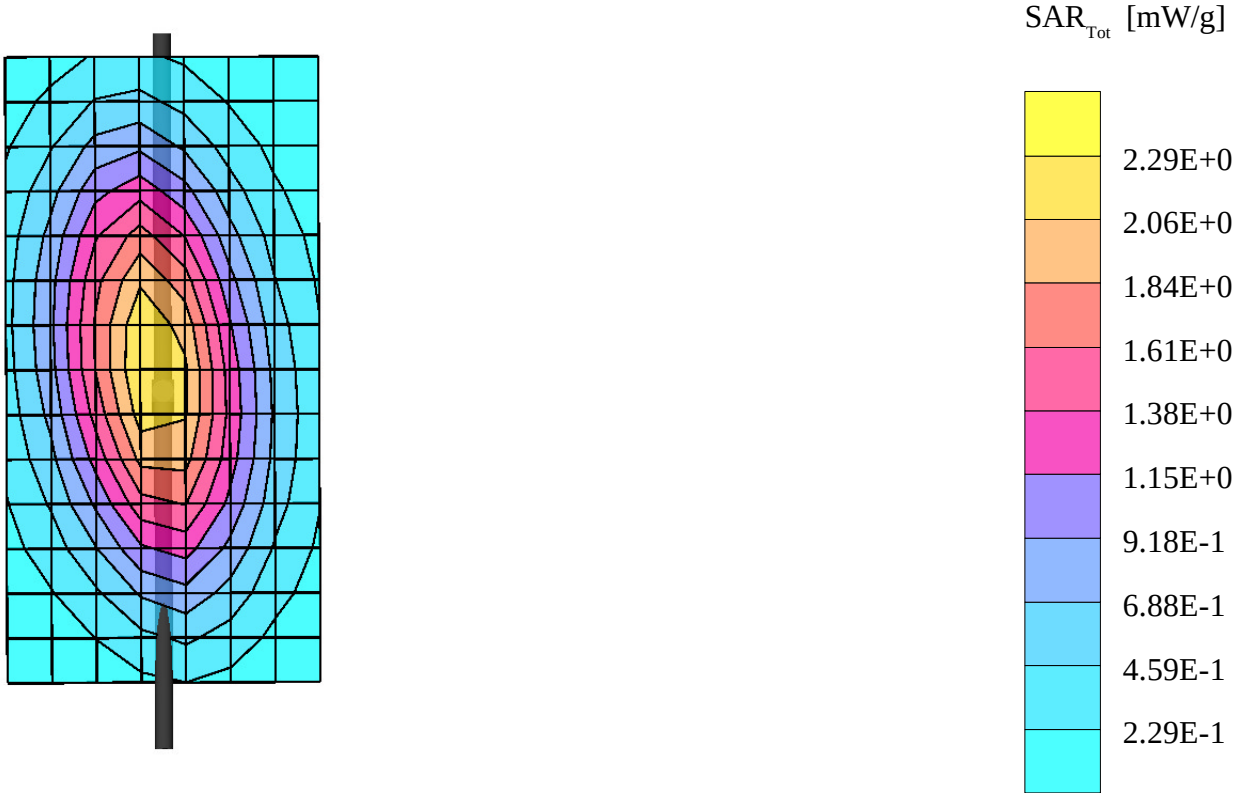
Amy Twin Phantom; Section 1

Probe: ET3DV6 - SN1398 - Validation; ConvF(6.61,6.61,6.61); Crest factor: 1.0; Validation 900 MHz: $\sigma = 0.87 \text{ mho/m}$ $\epsilon_r = 41.1$ $\rho = 1.00 \text{ g/cm}^3$

Cubes (2): Peak: $3.59 \text{ mW/g} \pm 0.12 \text{ dB}$, SAR (1g): $2.31 \text{ mW/g} \pm 0.13 \text{ dB}$, SAR (10g): $1.49 \text{ mW/g} \pm 0.14 \text{ dB}$, (Worst-case extrapolation)

Penetration depth: 12.3 (11.2, 13.8) [mm]

Powerdrift: -0.00 dB



Dipole 1800 MHz

1800 MHz Dipole Validation / Dipole Sn# 255 / Input Power = 248mW

Amy Twin Phantom; Section 1

Probe: ET3DV6 - SN1398 - Validation; ConvF(5.78,5.78,5.78); Crest factor: 1.0; Validation 1800 MHz: $\sigma = 1.73$ mho/m $\epsilon_r = 40.8$ $\rho = 1.00$ g/cm³

Cubes (2): Peak: 19.2 mW/g ± 0.10 dB, SAR (1g): 9.86 mW/g ± 0.07 dB, SAR (10g): 4.94 mW/g ± 0.04 dB, (Worst-case extrapolation)

Penetration depth: 7.4 (7.1, 8.2) [mm]

Powerdrift: -0.34 dB

