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SAR Test Report for Motorola portable cellular phone (FCC ID IHDT56ZF1), Class II Permissive Change.

Prepared by:

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 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 FC90ECED 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 figures 1 and 2.



Figure 1. Side of Phone
Showing Antenna



Figure 2. Back of Phone
Showing Antenna

Figure 3 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. Probe serial number 1398 was used for the measurements. It was calibrated at SPEAG™, and has a calibration date October 28, 1998. Dipole Validation Kit type D835V2, serial number 414 was used to validate the system accuracy. The validation SAR value is 8.56 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 8.8 mW/g normalized to 1 Watt. This is within the

required and thus the measured SAR values are considered correct. Dipole Validation Kit type D1800V2, serial number 251 was used to validate the system accuracy. The validation SAR value is 37.1 mW/g normalized to 1 Watt with a conductivity of 1.68 S/m, and the Dasy™ system used for the test phone measured 41.6 mW/g normalized to 1 Watt with a conductivity of 1.86 S/m. This is within the required accuracy when you account for the difference between the dielectric parameters, and thus the measured SAR values are considered correct. See appendix C for printout of the validation test from the Dasy™ measurement 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 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 43.6 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 2, was filled with a liquid having relative dielectric constant equal to 45.5 and conductivity equal to 1.84 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: 45.9% water; 53.0% sugar; 0% salt, 1% HEC; and 0.1% bactericide.

7. SAR Test Results

Figure 3 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 SAR level for the Motorola portable cellular phone (FCC ID IHDT56ZF1) in analog and digital modes in the 800MHz band did not degrade the margin for SAR and thus is not part of this class II permissive change.

The previous maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT56ZF1) in the 1900MHz band was 0.66 W/kg and was found on the left side head. The new maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT56ZF1) in the 1900MHz band is 1.31 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 3 shows the contour plot of the highest test condition overlaid onto a picture of the phone.

Digital 1900 Channel	Left side head	Right side head	Conducted Power (Watts)
1	1.31	0.92	0.40
1000	1.14	0.92	0.40
1999	0.79	0.97	0.40



Figure 3. Phone with 1900MHz TDMA Contour Plot Overlay

8. SAR in the Hand Measurements

Portable cellular phone FCC ID IHDT56ZF1, serial number FC801970 was measured. This unit is identical in physical construction, maximum radiated power levels and antenna structure to units that will be in production. This unit has the same output power, within 0.1dBm, as the unit used to measure SAR against the phantom head. This unit 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 4. 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 for 800MHz is the simulated muscle simulant. The dielectric constant is 52.0 and the conductivity is 1.1 S/m. The tissue simulant for 1900MHz is the same as is used in the head phantom. The dielectric constant is 46.0 and the conductivity is 1.8 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 in analog mode, which is higher average power than digital mode.

For the subject phone, the maximum power deposited in the hand was found to be less than 40 mW for both the antenna retracted and extended. 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 21 mW, the standard is not exceeded. Included are two pictures. Figure 4 shows the subject phone in the normal talk position with the phantom hand in the test position. Figure 5 shows the full body phantom in the anechoic chamber.



Figure 4. Simulated Hand Against Phantom Head.



Figure 5. Phantom in Anechoic Chamber.

9. Body Worn Configuration

The cellular phone (FCC ID IHDT56ZF1) 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. Figure 4 shows the test unit as it is placed onto the phantom. The phantom was filled with a liquid having relative dielectric constant equal to 52.7 and

conductivity equal to 1.11 S/m. FCC's OET Bulletin 65 Supplement C recommends muscle tissue simulant with a relative dielectric constant of 56.1 +/-5%, and a conductivity of 0.95 +/-5%. Thus the simulant actually used for the SAR tests was 5.8% low on relative dielectric constant, and 16.3% high on conductivity. This results in an over estimation of the SAR in the 800MHz band. The 1900MHz phantom was filled with a liquid having relative dielectric constant equal to 45.5 and conductivity equal to 1.84 S/m.



Figure 4. Phone In Supplied Belt Clip Against Phantom

The previous maximum SAR level for the Motorola portable cellular phone (FCC ID IHDT56ZF1) for the body worn condition was 0.89 W/kg and was found on channel 384. The following table shows the new SAR values for the body worn condition for 800MHz analog mode. 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 conditions included are indicated as a bold number in the following table. All other test conditions measured lower SAR values than those included. The area of highest SAR was the area near the antenna on the top of the phone.

Analog 800 Channel	Belt Clip
991	1.32
384	1.58
799	1.09

The following table shows the SAR values for the body worn condition in the 1900MHz band. 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 conditions included are indicated as a bold number in the following table. All other test conditions measured lower SAR values than those included.

Digital 1900 Channel	Belt Clip
1	0.50
1000	0.46
1999	0.54

10. 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.

s/n FC90ECED

Ch1999/ Pwr2 / Modulation: Digital

Lucy(right) Phantom; Right Head Section; Position: (80°,180°); Frequency: 1909 MHz

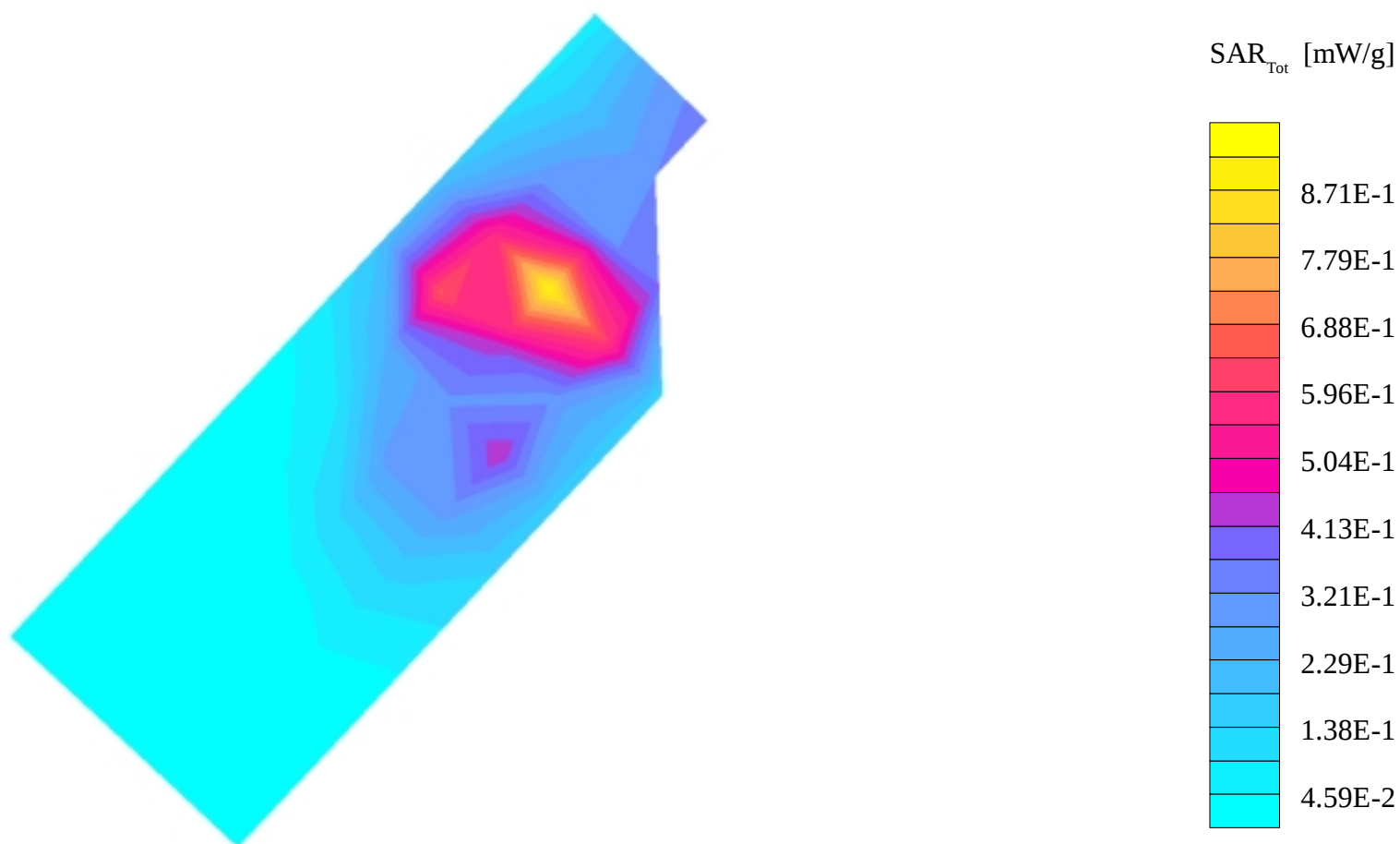
Probe: ET3DV6 - SN1398; ConvF(5.78,5.78,5.78); Crest factor: 1.0; Brain 1900 MHz: $\sigma = 1.83$ mho/m $\epsilon_r = 44.8$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 0.917 mW/g, SAR (10g): 0.489 mW/g, (Worst-case extrapolation)

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

Penetration depth: 10.0 (9.4, 10.9) [mm]

Powerdrift: 0.06 dB



s/n FC90ECED

Ch 1 / Pwr2 / Modulation: Digital

Desi(left) Phantom; Left Head Section; Position: (80°,180°); Frequency: 1850 MHz

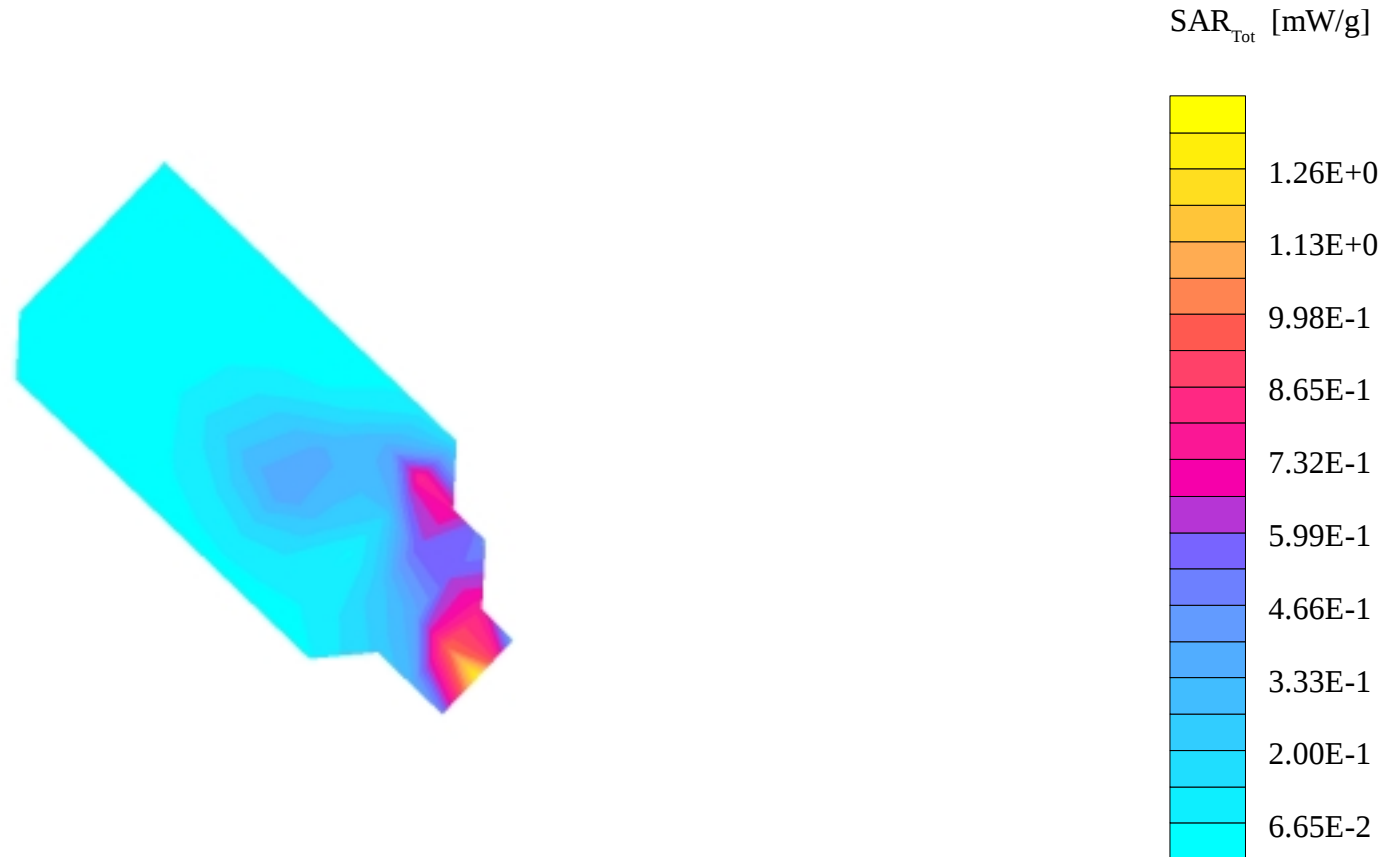
Probe: ET3DV6 - SN1398; ConvF(5.78,5.78,5.78); Crest factor: 1.0; Brain 1900 MHz: $\sigma = 1.84$ mho/m $\epsilon_r = 45.5$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 1.31 mW/g, SAR (10g): 0.652 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 13.0, Dz = 0.0

Penetration depth: 14.1 (13.5, 14.4) [mm]

Powerdrift: -0.06 dB



Appendix B

The following pages are printouts from the Dasy™ measurement system of the data for body-worn configuration as indicated.

s/n FC90ECED

Ch384 / Pwr2 / Modulation: Analog / body worn

Amy Twin Phantom Phantom; Section2 Section; Position: (0°,0°); Frequency: 837 MHz

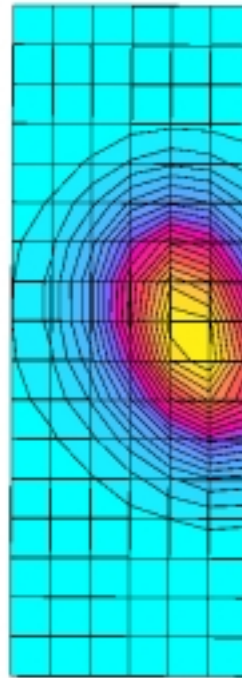
Probe: ET3DV6 - SN1398; ConvF(6.61,6.61,6.61); Crest factor: 1.0; Muscle - 835MHz: $\sigma = 1.11$ mho/m $\epsilon_r = 52.7$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 1.58 mW/g, SAR (10g): 1.08 mW/g, (Worst-case extrapolation)

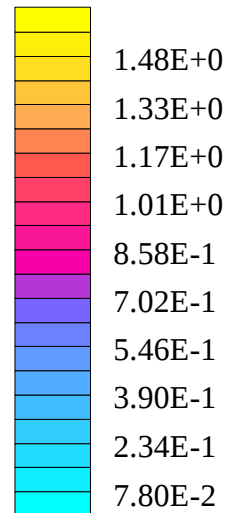
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0

Penetration depth: 14.1 (12.9, 15.3) [mm]

Powerdrift: -0.03 dB



SAR_{Tot} [mW/g]



s/n FC90ECED

Ch 1 / Pwr 2 / Modulation: Digital 1900 / body worn

Amy Twin Phantom Phantom; Section 1 Section; Position: (0°,0°); Frequency: 1909 MHz

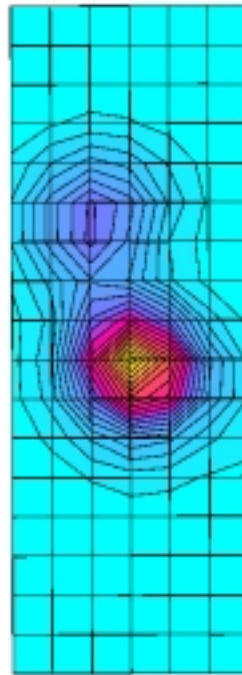
Probe: ET3DV6 - SN1398; ConvF(5.78,5.78,5.78); Crest factor: 1.0; Brain 1900 MHz: $\sigma = 1.84$ mho/m $\epsilon_r = 45.5$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 0.544 mW/g, SAR (10g): 0.297 mW/g, (Worst-case extrapolation)

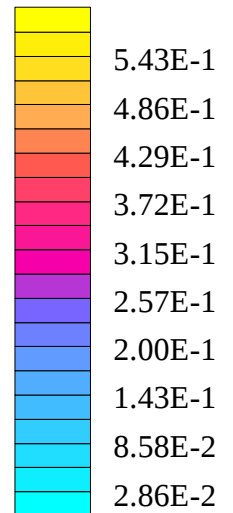
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0

Penetration depth: 8.0 (7.7, 8.7) [mm]

Powerdrift: 0.01 dB



SAR_{Tot} [mW/g]



Appendix C

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

Dipole 835MHz

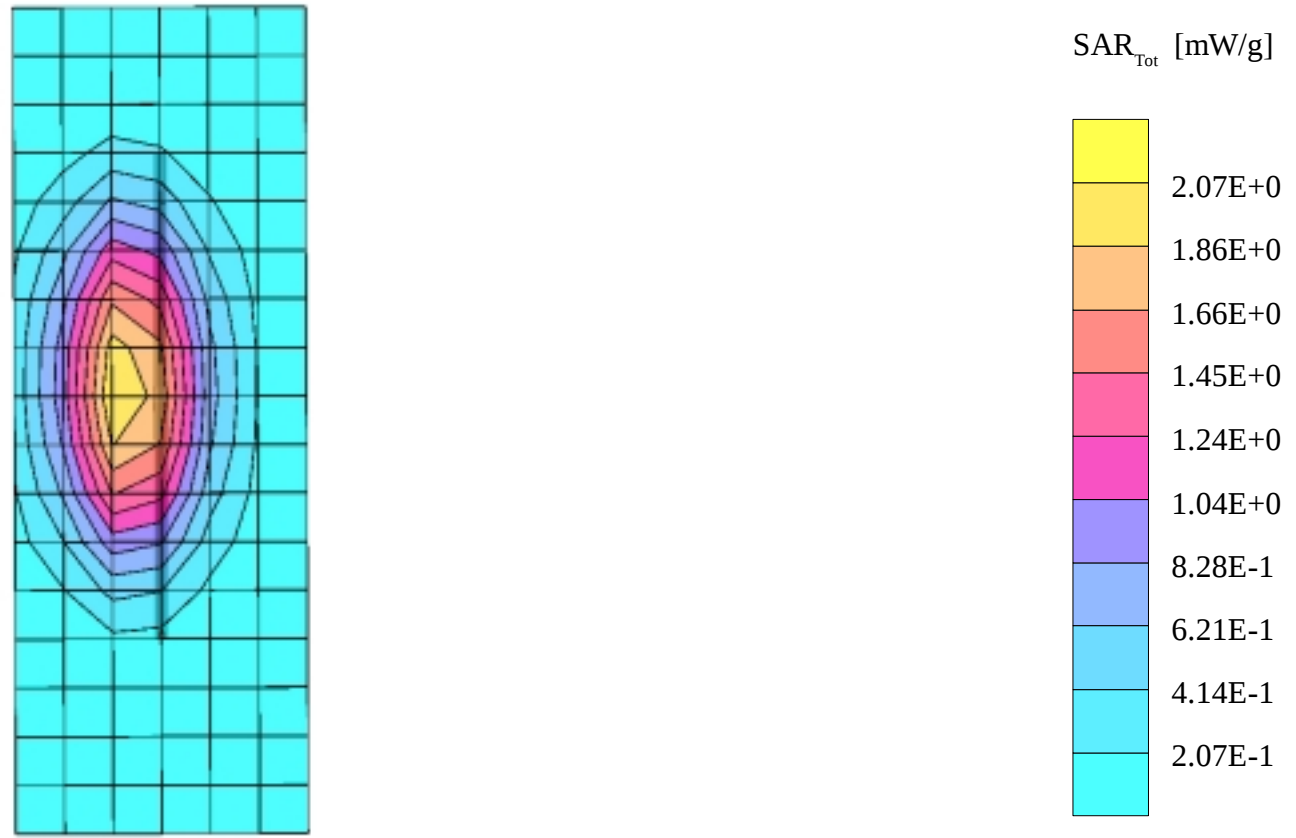
Amy Twin Phantom; Section 1

Probe: ET3DV6 - SN1398; ConvF(6.61,6.61,6.61); Crest factor: 1.0; Brain 835MHz: $\sigma = 0.81$ mho/m $\epsilon_r = 47.1$ $\rho = 1.00$ g/cm³

Cubes (2): Peak: 3.24 mW/g ± 0.06 dB, SAR (1g): 2.12 mW/g ± 0.03 dB, SAR (10g): 1.39 mW/g ± 0.02 dB, (Worst-case extrapolation)

Penetration depth: 12.9 (11.8, 14.5) [mm]

Powerdrift: 0.05 dB



Dipole 1800 MHz

1800Hz Dipole Validation Dipole Sn# 251

Amy Twin Phantom; Section 1

Probe: ET3DV6 - SN1398; ConvF(5.78,5.78,5.78); Crest factor: 1.0; Brain 1800 MHz: $\sigma = 1.86$ mho/m $\epsilon_r = 45.8$ $\rho = 1.00$ g/cm³

Cubes (2): Peak: 20.1 mW/g ± 0.02 dB, SAR (1g): 10.4 mW/g ± 0.01 dB, SAR (10g): 5.29 mW/g ± 0.01 dB, (Worst-case extrapolation)

Penetration depth: 7.6 (7.3, 8.5) [mm]

Powerdrift: -0.19 dB

