



August 26, 1999

SAR Test Report for Motorola portable satellite transceiver (FCC ID IHDT6NF1).

Prepared by:

Paul Moller, Principal Staff Engineer

Motorola Personal Communications Sector Product Safety Laboratory

Libertyville, Illinois

## 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) Body Worn Configuration Evaluation
- 10) External Antenna Option Evaluation
- 11) Battery Options
- 12) Summary

Appendix A: Included Data from Measurements Against Phantom Head

Appendix B: Measurement Probe Calibration Certificate

Appendix C: Printout from the Dasy™ measurement system validation test

Appendix D: Dasy™ 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 satellite transceiver FCC ID IHDT6NF1. 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 081099-2 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 1616 to 1626 MHz. The unit was tested at its maximum transmitter power.

The unit is equipped with a telescoping quadrifilar helix antenna that serves as both a receive and transmit antenna. The operation of the Iridium™ system is such that the subscriber unit must be in communication with satellites in low earth orbit. This means that the subscriber units antenna must have a clear view of the sky above the users head at all times. Thus the antenna is designed so as to have three positions. The first position is the “stowed” position where the antenna is rotated behind the subscriber unit. In this position the user would not be able to place or receive a phone call. This position is available for convenience of storage. The second position is the “retracted” position where the antenna is pointed towards the zenith, but is kept in its shortened telescoping dimension. The third position is where the antenna is also pointed towards the zenith, but is in its long telescoping dimension referred to as the “extended position”. Furthermore, the antenna can rotate to either of two detented positions which are roughly 30 degrees to the left and roughly 30 degrees to the right. These are intended to keep the antenna pointed to the zenith in both the left and right handed talk positions. Figures 1 and 2 show the front and back of the unit respectively.



Figure 1. Front of Transceiver



Figure 2. Back of Transceiver Showing Stowed Antenna

Figures 3 and 4 show the test unit as it is placed onto the phantom with the antenna in the extended and retracted positions respectively. 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. Transceiver Against Head with Antenna Extended



Figure 4. Transceiver Against Head with Antenna Retracted

#### 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 1375 was used for the measurements. It was calibrated at SPEAG™, and has a calibration date July 1, 1999. A copy of the calibration certificate is included as appendix B. Dipole Validation Kit type D1800V2, serial number 226 was used to validate the system accuracy at 1800MHz. The validation SAR value is 39.9 mW/g normalized to 1 Watt, and the Dasy™ system used for the test phone measured 40.8 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 5. 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 (See figures 3 and 4). 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  $\pm 6\%$ . SAR was measured in both the retracted and extended antenna positions. Due to the construction of the phone, the base of the antenna is 65 mm away from the phantom for the phantom head.

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 and transmitter power level. Since the test sample uses the 1/11 duty cycle of the Iridium™ system, the crest factor (the ratio between peak and average power) is set to 11 for these tests. 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, also shown in figures 3 and 4, was filled with a liquid having relative dielectric constant equal to 41 and conductivity equal to 1.32 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:

<b>Probe Uncertainty</b>	<b><math>\pm\%</math></b>
Isotropy error	7.2
Calibration error	3.3
Spatial resolution	0.5

<b>SAR Evaluation</b>	<b>±%</b>
Conductivity measurement	5.0
Environmental errors	1.0

<b>Peak SAR Evaluation</b>	<b>±%</b>
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 satellite transceiver (FCC ID IHDT6NF1) is 0.24 W/kg and was found on the left side head with the antenna retracted. 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.

Channel	Left side head		Right side head		Peak Conducted Power (Watts)
	Ant Ret.	Ant Ext.	Ant Ret.	Ant Ext.	
1	0.17	0.09	0.19	0.06	7.24
120	<b>0.24</b>	<b>0.11</b>	0.15	0.09	7.24
240	0.18	0.07	0.18	0.09	7.24



Figure 6. Transceiver with Contour Plot Overlay

## 9. Body Worn Configuration Evaluation

The portable satellite transceiver (FCC ID IHDT6NF1) can be placed in a body-worn configuration using the supplied holster. However due to the operation of the Iridium™ satellite system, it is not possible for the portable satellite transceiver to transmit while in the body worn configuration with the antenna stowed. Also, use of the portable satellite transceiver is not recommended when in the body worn configuration.

The portable satellite transceiver (FCC ID IHDT6NF1) can not be used with a PCMCIA card connection while in a body worn configuration.

## 10. External Antenna Option Evaluation

The Motorola Personal Communications Sector Product Safety Laboratory has evaluated the portable satellite transceiver (FCC ID IHDT6NF1) external antenna option for the need to conduct SAR evaluation. Given the design, recommended installation and how the phone operates with this option; when properly installed and used with this option, the phone/option combination satisfies the criteria to be considered a 'mobile device' as defined in Federal Communications Commission section 47 CFR § 2.1091 titled "Radio frequency radiation exposure evaluation: mobile devices."

In section § 2.1091, paragraph (b) defines a mobile device as "a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons." The portable satellite transceiver (FCC ID IHDT6NF1) is intended to be installed into a vehicle such that the phone is physically secured at one location. The installation guide describes the recommended installation of both the phone and the external antenna. The antenna is to be located outside of the vehicle and its location should be such that at least 20 cm of conductive horizontal surface extends in all directions from the center of the antenna. Based on the installation of the transceiver and the antenna, the transmitters radiating structure is more than 20 centimeters from the user. Thus, the portable satellite transceiver (FCC ID IHDT6NF1) is a "mobile device" as defined in section § 2.1091 paragraph (b).

Paragraph (c) of section § 2.1091 gives the descriptions of types of mobile devices that are subject to routine environmental evaluation for RF exposure based on frequencies of operation and transmit ERP. The portable satellite transceiver (FCC ID IHDT6NF1) operates at transmit frequencies of 1616 to 1626 MHz. Accounting for the cable loss and antenna gain of the external antenna option, the phone has an ERP of less than 3.0 Watts at 1600 MHz. Thus the portable satellite transceiver (FCC ID IHDT6NF1) is "categorically excluded from routine environmental evaluation" per paragraph (c), and thus SAR evaluation is not required.

## 11. Battery Options

The portable satellite transceiver (FCC ID IHDT6NF1) does have three battery options, "standard", "high capacity" and "ultra high capacity". For the purposes of head adjacent testing the battery chosen was the "standard" battery. The "high capacity" battery is the same physical size as the "standard" battery and will not change the SAR values. Additionally, the "ultra high capacity" battery is slightly larger than the "standard" battery, but does not alter the proximity of the transceiver to the user in any way.

## 12. Summary

The SAR values found for the portable cellular phone (FCC ID IHDT6NF1) 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 081099-2

Ch 120/Pwr 00/Ant Retracted/JK

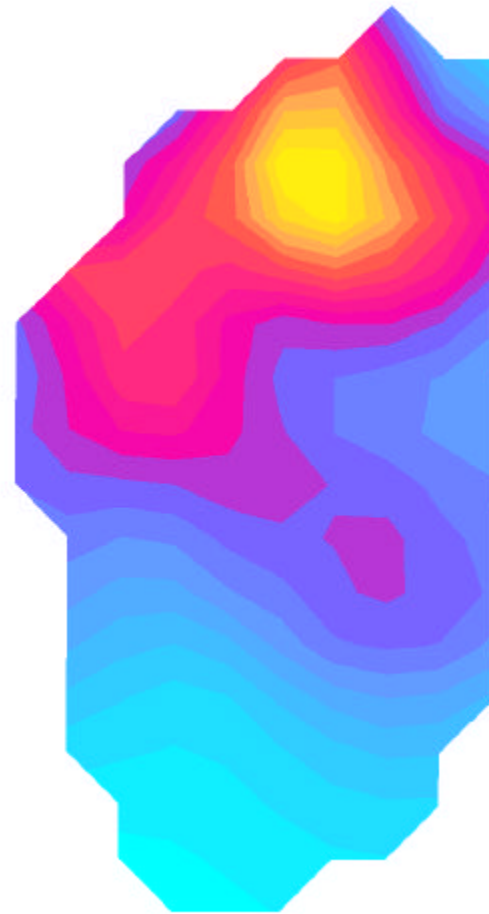
TILT LEFT Phantom; Section; Position: ; Frequency: 1621 MHz

Probe: ET3DV6 - SN1375; ConvF(6.06,6.06,6.06); Crest factor: 11.0; Head 1500 MHz:  $\sigma = 1.32$  mho/m  $\epsilon_r = 41.0$   $\rho = 1.00$  g/cm<sup>3</sup>

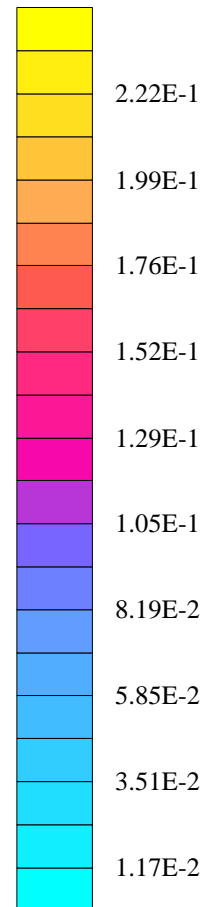
Cube 5x5x7: SAR (1g): 0.239 [mW/g], SAR (10g): 0.151 [mW/g], (Worst-case extrapolation)

Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0

Powerdrift: 0.42 dB



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



08/11/99

## S/N 081099-2

Ch 120/Pwr 00/Ant Extended/JK

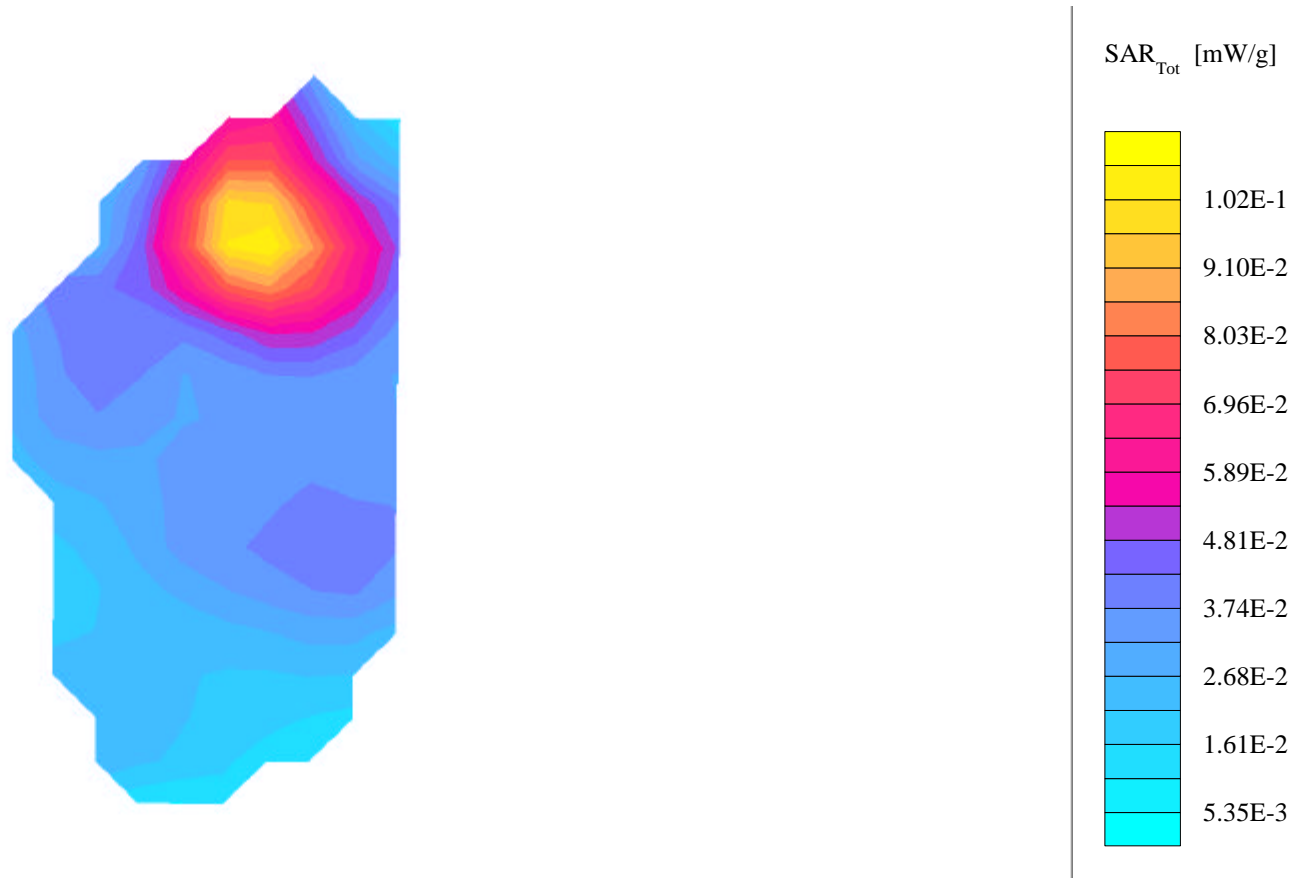
TILT LEFT Phantom; Section; Position: ; Frequency: 1621 MHz

Probe: ET3DV6 - SN1375; ConvF(6.06,6.06,6.06); Crest factor: 11.0; Head 1500 MHz:  $\sigma = 1.32$  mho/m  $\epsilon_r = 41.0$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7; SAR (1g): 0.107 [mW/g], SAR (10g): 0.0653 [mW/g], (Worst-case extrapolation)

Coarse: Dx = 10.0, Dy = 10.0, Dz = 0.0

Powerdrift: 0.50 dB



Appendix B

The following page is a copy of the Calibration Certificate for Dasy™ probe serial number 1375.

## Calibration Certificate

### Dosimetric E-Field Probe

Type:

**ET3DV6**

Serial Number:

**1375**

Place of Calibration:

**Zurich**

Date of Calibration:

**July 1, 1999**

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:

*C. Schilli*

Approved by:

*C. Schilli*

## Appendix C

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

# Dipole 1800 MHz

Forward Power : 258mW

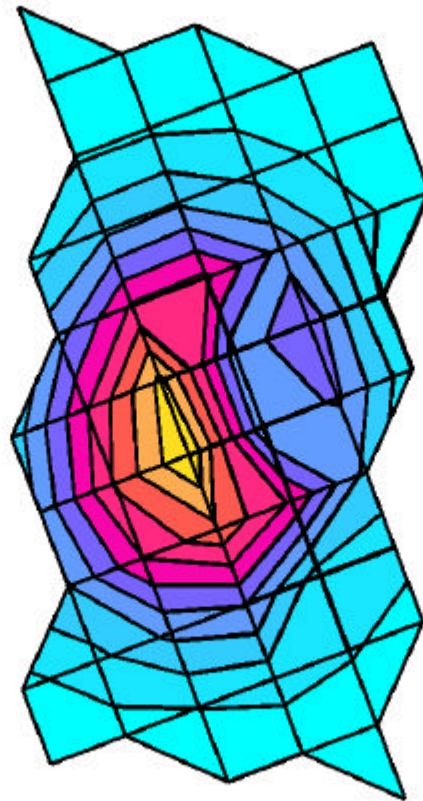
MOT FLAT Phantom; MOTO FLAT Section; Position: (0°,0°); Frequency: 1800 MHz

Probe: ET3DV6 - SN1375; ConvF(5.79,5.79,5.79); Crest factor: 1.0; Brain 1800 MHz:  $\sigma = 1.71$  mho/m  $\epsilon_r = 41.0$   $\rho = 1.00$  g/cm<sup>3</sup>

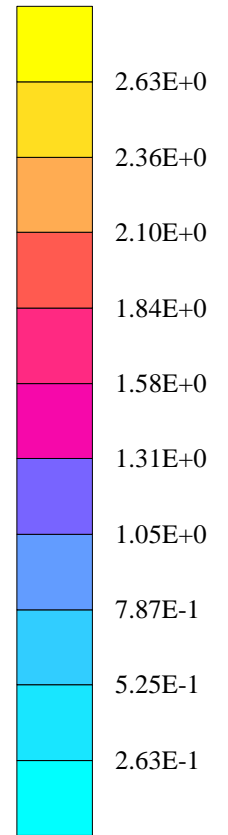
Cubes (2): SAR (1g): 10.2 mW/g  $\pm$  0.03 dB, SAR (10g): 4.99 mW/g  $\pm$  0.24 dB, (Worst-case extrapolation)

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

Powerdrift: -0.02 dB



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



## Appendix D

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

# Schmid & Partner Engineering AG

Staffelstrasse 8, 8045 Zurich, Switzerland, Telefon +41 1 280 08 60, Fax +41 1 280 08 64

---

## **Preliminary Manual**

***DASY3 V1.0b***

***for Windows 95***

March 98 Edition  
Schmid & Partner Engineering AG  
Staffelstrasse 8  
8045 Zurich  
Switzerland  
Tel +41 1 280 08 60  
Fax +41 1 280 08 64  
Email: [speag@access.ch](mailto:speag@access.ch)  
WWW: [www.access.ch/speag](http://www.access.ch/speag)