Engineering and Testing for EMC and Safety Compliance

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# RF Maximum Permissible Exposure (MPE) Report
# for
# Controlled and Uncontrolled Environments

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## Model: M7100 800 MHz Mobile Radio

**FCC ID: OWDTR-0022-E**
**IC: 3636B-0022**

**August 15, 2007**

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*Document Number: 2007225-004*



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## Table of Contents

## 1 MPE Measurements and Applicable Regulations

This test report presents the results of Maximum Permissible Exposure (MPE)[1] measurements performed on the M/A-COM, Inc. M7100 mobile radio, which is capable of operating in the frequency ranges 806–824 and 851–869 MHz. The tests were performed in accordance with TCB training material and the following parts of the FCC Rules and Regulations and Industry Canada Radio Standard Specifications:

- IEEE Std C95.1: 1999: "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz"
- IEEE Std C95.3: 2002: "IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields with Respect to Human Exposure to Such Fields, 100 kHz – 300 GHz"
- FCC OET Bulletin 65, Edition 97-01: "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields"
- FCC Supplement C to OET Bulletin 65, Edition 01-01: "Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emission"
- Subpart I, Part 1 of 47 CFR FCC Rules and Regulations, Edition 10-1-06: "Procedures Implementing the National Environmental Policy Act of 1969." Specifically, Paragraph 1.1310: "Radiofrequency Radiation Exposure Limits"
- Subpart J, Part 2 of 47 CFR FCC Rules and Regulations, Edition 10-1-06: "Equipment Authorization Procedures." Specifically, Paragraph 2.1091: "Radiofrequency Radiation Exposure Evaluation: Mobile Devices"
- RSS-102, Issue 2, November 2005: "Spectrum Management and Telecommunications Radio Standards Specification. Radiofrequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands.)"

[1] By definition, maximum permissible exposure (MPE) is rms or peak electric (or magnetic) field strength, or the plane-wave equivalent power densities associated with these fields to which a person may be exposed without harmful effect and with an acceptable safety factor.

## 2 Identification of the EUT

The EUT is a mobile radio and antenna assembled onto a mounting plate. This mounting plate acts as a determinable ground plane for the antenna. This MPE report and Class 2 Permissive Change covers the addition of a higher gain antenna which incorporates a GPS receiver antenna and LNA (AN-025167-015 5 dBd). General information about the EUT is shown below.

| | |
|---|---|
| **Manufacturer's Name** | M/A-COM, Inc. |
| **Manufacturer's Address** | 221 Jefferson Ridge Parkway<br>Lynchburg, VA 24501, USA |
| **Device Type** | Mobile radio with listed antenna |
| **Model of the EUT** | M7100 |
| **Serial Number of the Radio** | 9133415 |
| **FCC ID of the EUT** | OWDTR-0022-E |
| **IC ID of the EUT** | 3636B-0022 |
| **Operating Frequency Ranges (for the specific configuration in this report)** | 806–824 MHz, 851–869 MHz |
| **RF Max Power, Rated** | 36.4 W |
| **TX Duty Cycle** | 50% |
| **Antenna Tested** | M/A-COM, Inc. part number AN-025167-015 |
| **Year of Manufacture** | 2007 |

## 3 Modifications

No modifications were made to the EUT during testing.

## 4 Test Laboratory

Test personnel of Rhein Tech Laboratories, Inc. (RTL) performed testing for which the company is accredited by NVLAP. Testing was performed at the RTL test facility located at 360 Herndon Parkway, Suite 1400, Herndon, VA, 20170. Various regulatory bodies, including the FCC and IC, approved this facility for conducting tests and measurements on a contractual basis.

## 5 Turnaround Time

The EUT was ready for the MPE investigation on 08/12/07. The investigation was finished on 08/15/07.

## 6 Test Equipment, Accessories and Test Setup

Test equipment used for the measurements is shown in Table 6-1.

**Table 6-1: Test Equipment**

| RTL Barcode | Manufacturer | Model | Equipment Type | Serial Number | Calibration Due Date |
|---|---|---|---|---|---|
| 901182 | Wandel & Goltermann | TYPE-8 | E- Field Probe, 10 kHz to 3 GHz | AH-0021 | 01/06/08 |
| 901183 | Wandel & Goltermann | EMR 200[2] | Radiation Meter | AE-0024 | 01/06/08 |
| 901420 | Sper Scientific | 800016 | Humidity/Temperature Monitor | 044432 | 12/19/07 |
| 901366 | Control Company | PTB210 Class A | Barometer | W2940009 | 01/23/08 |
| 901184 | Agilent Technologies | E4416A | EPM-P Power Meter, Single Channel | GB41050573 | 10/3/07 |
| 901356 | Agilent Technologies | E9323A | Power Sensor | 31764-264 | 10/3/07 |
| 901291 | Pasternack | PE7031-20 | 300W Attenuator, DC - 1 GHz | NA | 1/11/08 |
| 901396 | MCE Weinschel | 48-40-34 | Attenuator, 40 dB, DC-18 GHz, 100 W | 93453 | 1/13/09 |
| 901381 | Weischel | 1 | Attenuator, 3 dB, 0-12.4 GHz | AL9483 | 12/5/08 |

Table 6-2 shows detailed information about the EUT and accessories.

[2] Per Operating Manual for the EMR 200 radiation meter, the device with the Type 8 probe might measure electromagnetic power in the range of 0.00027 - 170 mW/cm$^2$. The recommended environment is the following: Ambient temperature: (23 $\pm$ 3) °C, ambient relative humidity: 25% - 75%.

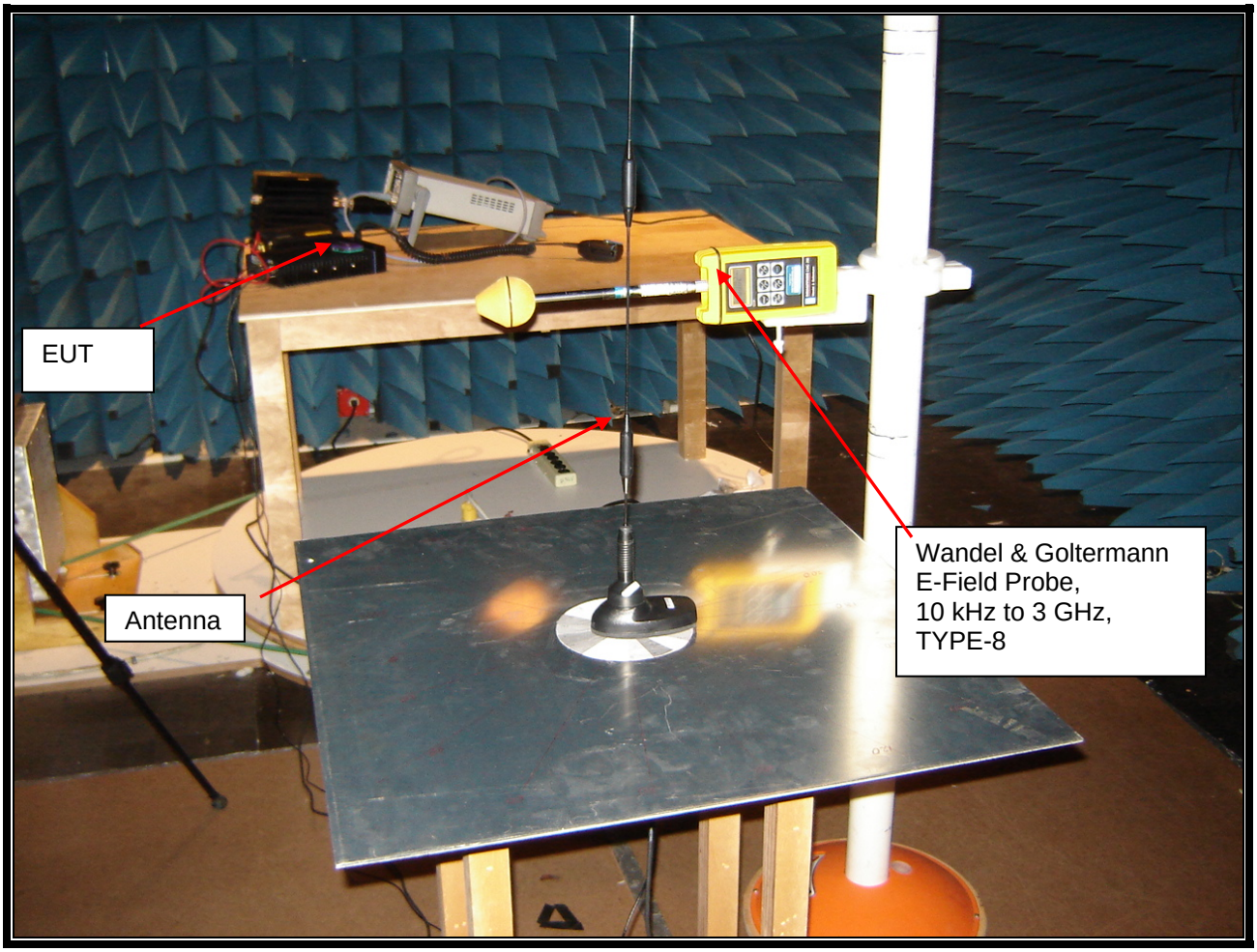
**Table 6-2: EUT and Accessories**

| Part | Manufacturer | Model | SN | FCC ID | IC ID |
|---|---|---|---|---|---|
| M7100 Radio | M/A-COM, Inc. | M7100 | 9133415 | OWDTR-0022-E | 3636B-0022 |
| Antenna | M/A-COM, Inc. | AN-025167-015 | N/A | N/A | N/A |
| DC Power Supply | Alinco | DM-330MVT | 0008661 | N/A | N/A |

To avoid influence of ambient radiation, RTL conducted the MPE measurements in a semi-anechoic chamber. Details of the test setup are as follows:

- The EUT was mounted on the 80 cm tall wood table in such a way that its antenna was located in the middle of the table. Under the antenna, we placed a drawing with 18 azimuth angles (every 20°) such that the antenna was in the center of the drawing.
- The control unit and a power supply were located at a distance of about 2 meters from the radiating EUT's antenna to minimize interference.
- The test probe was solidly connected to the radiation meter attached to the plastic mast in front of the EUT's antenna.
- During the MPE measurements, the EUT was set to transmit at maximum RF power.

The typical test setup is shown in Photograph 6-1.




**Photograph 6-1: MPE Test Setup for the EUT**

## 7 Justification of the Chosen Transmitting Mode and Frequency

The EUT is able to transmit with a non-modulated carrier and with various types of modulations. The original grant shows the power at 36.4 W. The highest reading of 36.4 W was at 806 MHz and FM modulation, which was chosen for the MPE measurements.

## 8 MPE Limits for the EUT

The FCC and IC have the same MPE limits for the EUT's frequency range, which are shown below for uncontrolled and controlled environments in Tables 8-1 and 8-2 respectively. The limits are based on the recommended MPE Guidelines published by the National Council on Radiation Protection and Measurements in "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields."

**Table 8-1: FCC/IC MPE Limit and Averaging Time in an Uncontrolled Environment**

| Frequency Range, MHz | Power Density (S), $mW/cm^2$ | Averaging Time, min |
|---|---|---|
| 300-1500 | f/1500 | 30 |
| Note that "f" in the column for power density is the frequency in MHz | | |

**Table 8-2: FCC/IC MPE Limit and Averaging Time in a Controlled Environment**

| Frequency Range, MHz | Power Density (S), $mW/cm^2$ | Averaging Time, min |
|---|---|---|
| 300-1500 | f/300 | 6 |
| Note that "f" in the column for power density is the frequency in MHz | | |

The MPE limits for the EUT transmitting at 806 MHz are shown in Table 8-3.

**Table 8-3: MPE Limits for the Frequency Transmitted by the EUT**

| Frequency, MHz | MPE Limit (S) for Controlled Environment, $mW/cm^2$ | MPE Limit (S) for Uncontrolled Environment, $mW/cm^2$ |
|---|---|---|
| 806 | 2.687 | 0.537 |

## 9 Calculating the Safe Distance from the EUT's Antenna

Before starting MPE measurements, we calculated the safe distance, $R_{safe}$ using a common formula for a far-field region:

$$\text{Rsafe} = \sqrt{\frac{P\max \cdot Gn \cdot \eta}{4\pi \cdot S}}$$

In this equation, $G_n$ is numerical antenna gain, $P_{max}$ and $S$ are the maximum power input to the antenna and the MPE limit for power density, respectively; $\eta$ is the duty cycle listed as a decimal number; $\eta$ = 0.5 in our case.

Cable loss of the RF cable connecting the EUT and the antenna under test decreases the RF power delivered to the antenna and influences the value of the safe distance. Based on the specification of the 4.6 m cable used in the EUT (Belden 8259 RG-58 A/U), total cable loss is about 2.9 dB; therefore, we adjusted the power delivered to the antenna from 36.4 W to 18.67 W.

The antenna manufacturer specified the antenna gain as the following: 5 dBd (7.15 dBi) if the antenna is attached to a reflective metallic surface. The antenna, as installed in this application, is mounted to a reflective metallic surface.

**Table 9-1: Calculated $R_{safe}$ for Different Environments**

| Antenna Gain, dBi | $R_{safe}$ for Controlled Environment, cm | $R_{safe}$ for Uncontrolled Environment, cm |
|---|---|---|
| 7.15 | 38 | 85 |

## 10 Standard Test Conditions and Engineering Practices

Except as noted herein, the following conditions and procedures were fulfilled during the testing:

1. ANSI C63.4 requires the ambient temperature and relative humidity to be within the ranges of 10°C to 40°C and 10% to 90%, respectively. With respect to the narrower ranges recommended for the power meter used for the measurements, ambient conditions shall be in line with the power meter ranges. Actual values of ambient temperature and relative humidity are shown in Section 12 of this test report.

2. Measurement results presented in Section 12, Test Results, unless otherwise noted, show the highest measured level of MPE.

## 11 Measurement Procedure

1. The test setup was as described in Section 6 of this test report.
2. Polarization of the EUT's antenna was vertical, which is its polarization in actual use.
3. The EUT at the chosen modulation was set to transmit at the chosen frequency at maximum RF power and at 50% duty cycle. During preliminary measurements, we set the distance between the power density probe and the EUT's antenna equal to the average calculated $R_{safe}$ (Table 9-1) applicable either for controlled or uncontrolled environments.
4. Power density measurements were taken at different heights of the probe from the ground (0.2 to 2 meters) while rotating versus azimuth (from 0° to 360°) the antenna.
5. The azimuth between the probe and the antenna position corresponding to the highest MPE level was chosen as the "worst case" position for the final measurements.
6. For the final measurements we adjusted the distance between the test probe and the tested antenna to the real safe distance, $R_{real}$, such that the measured highest power density in the "worst case" position was the same or slightly less than the test limit.
7. Final measurements were conducted at the chosen azimuth and different heights of the probe above the ground. The measurement results are shown in Section 12.
8. Average values of power density were calculated for the imaginary whole human body (0.2–2.0 m), for the lower part of the body (0.2–0.9 m) and for the upper part of the body (1.0–2.0 m). The results of calculations are shown in Section 12.

## 12 Test Results

The MPE measurements were conducted between 08/12/07 and 08/15/07 by Dan Baltzell.

Ambient conditions during the MPE investigation were as follows:

- Temperature 24.3°C
- Relative humidity 41%
- Atmospheric pressure 100.5 kPa

The MPE measurement procedure was in line with the description in Section 11. Tables 12-1 through 12-4 demonstrate the test results.

**Table 12-1: MPE for Controlled Environment**

| MPE, mW/cm$^2$, measured at the distance of **38 cm** between the probe and the antenna at the height (cm) shown below | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| 1.09 | 0.208 | 0.082 | 0.043 | 0.017 | 0.105 | 0.0078 | 0.0058 | 0.0054 | 0.0034 |

**Table 12-2: MPE for Body Parts in Controlled Environment**

| **Part of the body / averaging points** | **Averaged Power Density at $R_{real}$ = 38 cm, mW/cm$^2$** |
|---|---|
| Whole body (0.2 m to 2.0 m) | 0.157 |
| Lower body (0.2 m to 1.0 m) | 0.288 |
| Upper body (1.0 m to 2.0 m) | 0.026 |

**Table 12-3: MPE for Uncontrolled Environment**

| MPE, mW/cm$^2$, measured at the distance of **85 cm** between the probe and the antenna at the height (cm) shown below | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| 0.262 | 0.378 | 0.120 | 0.092 | 0.039 | 0.0322 | 0.024 | 0.015 | 0.011 | 0.074 |

**Table 12-4: MPE for Body Parts in Uncontrolled Environment**

| **Part of the body / averaging points** | **Averaged Power Density at the $R_{real}$ = 85 cm, mW/cm$^2$** |
|---|---|
| Whole body (0.2 m to 2.0 m) | 0.105 |
| Lower body (0.2 m to 1.0 m) | 0.178 |
| Upper body (1.0 m to 2.0 m) | 0.031 |

## 13 Conclusion

1. The MPE measurements for controlled and uncontrolled environments shown in this report were conducted per the applicable FCC/IC Rules, Regulations and Guidance, and determined the minimum safe distance between the EUT antenna and a user.

2. As is shown in Section 12, the measured MPE are below the maximum allowed limits.

3. The User Manual shall have a statement regarding the safe distance similar to the one shown below:

Based on the highest radiated RF power, the following distances are considered as safe distances for controlled and uncontrolled environments for the EUT antenna with the EUT transmitting at a maximum 50% duty cycle:

| **Safe Distance, $R_{safe}$, cm, for Different Environments** | |
|---|---|
| **Controlled Environment** | **Uncontrolled Environment** |
| 38 | 85 |