



Engineering and Testing for EMC and Safety Compliance



Accredited Under NVLAP Lab Code 200061-0

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

M/A-COM, Inc.
221 Jefferson Ridge Parkway
Lynchburg, VA 24501
Daryl Popowitch
Phone: (434) 455-9527
E-Mail: popowitda@tycoelectronics.com

Model: M7200 700/800 MHz Mobile Radio

**FCC ID: BV8M7200
IC: 3670A-M7200**

August 16, 2007

Report Prepared by Test Engineer: Dan Baltzell

Document Number: 2007226-004

This report may not be reproduced, except in full, without the written approval of Rhein Tech Laboratories, Inc. and M/A-COM, Inc. Test results relate only to the item tested.

This report must not be used by M/A-COM, Inc. to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

Table of Contents

1	MPE Measurements and Applicable Regulations	3
2	Identification of the EUT	4
3	Modifications	5
4	Test Laboratory	5
5	Turnaround Time	5
6	Test Equipment, Accessories and Test Setup	6
7	Justification of the Chosen Transmitting Mode and Frequency	9
8	MPE Limits for the EUT	9
9	Calculating the Safe Distance from the EUT's Antenna	10
10	Standard Test Conditions and Engineering Practices	10
11	Measurement Procedure	11
12	Test Results	12
13	Conclusion	13

1 MPE Measurements and Applicable Regulations

This test report presents the results of Maximum Permissible Exposure (MPE)¹ measurements performed on the M/A-CO764-776, 794-806, 806-824, 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 Specification:

- 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 Lynchburg, VA 24501, USA
Device Type	Mobile radio with listed antenna
Model of the EUT	M7200
Serial Number of the Radio	A40074001EF1
FCC ID of the EUT	BV8M7200
IC ID of the EUT	3670A-M7200
Operating Frequency Ranges (for the specific configuration in this report)	764–776, 794–806, 806–824, 851–869 MHz
RF Max Power, Rated	15 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. Different 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 08/16/07.

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
901396	MCE Weinschel	48-40-34	Attenuator, 40 dB, DC-18 GHz, 100 W	93453	1/13/09
901355	JFW Industries	50FH-003-300	300W 3DB DC1000 MHz Attenuator	N/A	1/11/08

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/cm². The recommended environment is the following: Ambient temperature: (23 ± 3) °C, ambient relative humidity: 25% - 75%.

Table 6-2: EUT and Accessories

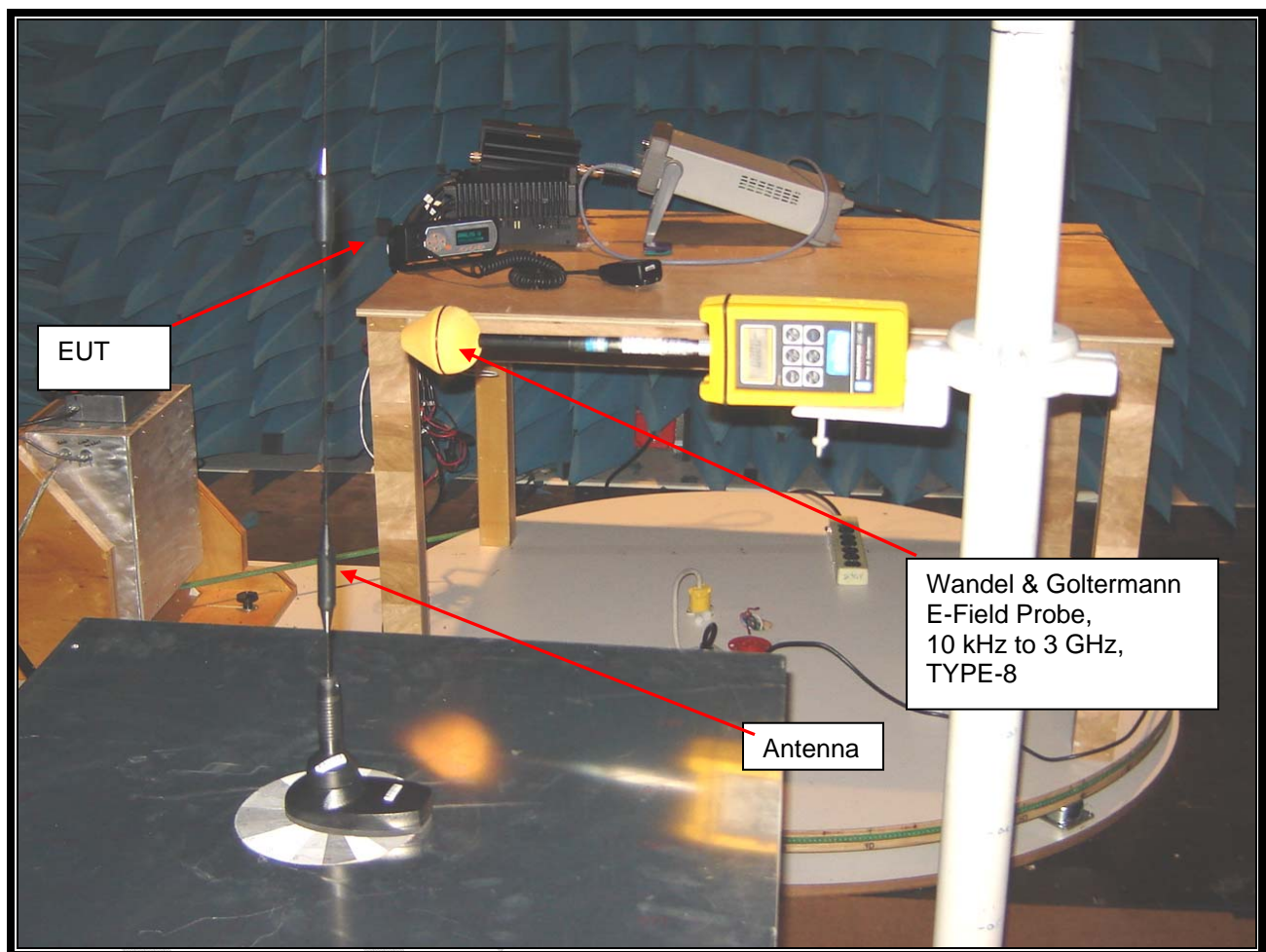
Part	Manufacturer	Model	SN	FCC ID	IC ID
M7200 Radio	M/A-COM, Inc.	M7200	A40074001EF1	BV8M7200	3670A-M7200
Power Supply	Samlex America	SEC 1212	03051-2K07-00197	N/A	N/A
Antenna	M/A-COM, Inc.	AN-025167-015	N/A	N/A	N/A
Control Head	M/A-COM, Inc.	CH-103 MACDOS0003	A4000A16FF9A	N/A	N/A
Handset/ Microphone	M/A-COM, Inc.	N/A	N/A	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 15.4 W over various frequencies and modulation modes. The highest reading of 15.4 W was at 868.9875 MHz and FM modulation, which were 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 868.9875 MHz and 803.00625 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
868.9875	2.897	0.579
803.00625	2.677	0.535

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:

$$R_{\text{safe}} = \sqrt{\frac{P_{\text{max}} \cdot G_N \cdot \eta}{4\pi \cdot S}}$$

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; η 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 15.4 W to 7.72 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:

Frequency (MHz)	Antenna Gain (dBi)	R_{safe} for Controlled Environment (cm)	R_{safe} for Uncontrolled Environment (cm)
803.00625	7.15	67	13
868.98750	7.15	62	12

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 08/15/07 by Dan Baltzell.

Ambient conditions during the MPE investigation were as follows:

- Temperature 24.5°C
- Relative humidity 42%
- 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 for 803.00625 MHz Wideband Analog FM

MPE, mW/cm ² , measured at the distance of 13 cm between the probe and the antenna at the height (cm) shown below									
20	40	60	80	100	120	140	160	180	200
.245	.034	.057	.006	.004	.003	.002	.002	.002	.001

Table 12-2: MPE for Body Parts in Controlled Environment for 803.00625 MHz Wideband Analog FM

Part of the body / averaging points	Averaged Power Density at $R_{real} = 13 \text{ cm}$, mW/cm ²
Whole body (0.2 m to 2.0 m)	0.036
Lower body (0.2 m to 1.0 m)	0.069
Upper body (1.0 m to 2.0 m)	0.002

Table 12-3: MPE for Uncontrolled Environment for 803.00625 MHz Wideband Analog FM

MPE, mW/cm ² , measured at the distance of 67 cm between the probe and the antenna at the height (cm) shown below									
20	40	60	80	100	120	140	160	180	200
.094	.034	.024	.026	.013	.007	.003	.002	.002	.001

Table 12-4: MPE for Body Parts in Uncontrolled Environment for 803.00625 MHz Wideband Analog FM

Part of the body / averaging points	Averaged Power Density at the $R_{real} = 67 \text{ cm}$, mW/cm ²
Whole body (0.2 m to 2.0 m)	0.021
Lower body (0.2 m to 1.0 m)	0.038
Upper body (1.0 m to 2.0 m)	0.003

Table 12-5: MPE for Controlled Environment for 868.9875 MHz Wideband Analog FM

MPE, mW/cm ² , measured at the distance of 12 cm between the probe and the antenna at the height (cm) shown below									
20	40	60	80	100	120	140	160	180	200
0.202	0.049	0.024	0.014	0.009	0.007	0.005	0.003	0.003	0.002

Table 12-6: MPE for Body Parts in Controlled Environment for 868.9875 MHz Wideband Analog FM

Part of the body / averaging points	Averaged Power Density at $R_{\text{real}} = 12 \text{ cm}$, mW/cm ²
Whole body (0.2 m to 2.0 m)	0.032
Lower body (0.2 m to 1.0 m)	0.060
Upper body (1.0 m to 2.0 m)	0.004

Table 12-7: MPE for Uncontrolled Environment for 868.9875 MHz Wideband Analog FM

MPE, mW/cm ² , measured at the distance of 62 cm between the probe and the antenna at the height (cm) shown below									
20	40	60	80	100	120	140	160	180	200
0.153	0.040	0.023	0.010	0.006	0.004	0.004	0.003	0.002	0.002

Table 12-8: MPE for Body Parts in Uncontrolled Environment for 868.9875 MHz Wideband Analog FM

Part of the body / averaging points	Averaged Power Density at the $R_{\text{real}} = 62 \text{ cm}$, mW/cm ²
Whole body (0.2 m to 2.0 m)	0.025
Lower body (0.2 m to 1.0 m)	0.046
Upper body (1.0 m to 2.0 m)	0.003

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 antennas 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
20*	67

* Though the actual measured safe distance was 13 cm, per FCC guidance the minimum separation for a mobile device is 20 cm.