CHOMERICS

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TEST SERVICES

EMC EVALUATION OF THE
M/A-COM
OPEN SKY ISM RADIO
IN ACCORDANCE WITH THE
FCC PART 15 SUBPART C
AND
FCC PART 15 SUBPART B

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Test Technician or Engineer: _____
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CTS Approved Signatory: _____

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LIST OF DEFINITIONS/ABBREVIATIONS

AC	Alternating Current
BB	Broadband
BW	Bandwidth
cm	Centimeter
C.P.U.	Calibrate Prior to Use
dB	Decibel
DC	Direct Current
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ER	Electric Radiation
EUT	Equipment Under Test
GHz	Gigahertz
Hz	Hertz
I-face	Interface
kHz	Kilohertz
m	Meter
MHz	Megahertz
mm	Millimeter
mS	Millisecond
mV	Millivolt
MR	Magnetic Radiation
NB	Narrowband
N.C.R.	No Calibration Required
PLC	Power Line Conduction
PPS	Pulses Per Second
uF	Microfarad
uH	Microhenry
uS	Microsecond
uV	Microvolt
U.W.C.	Use With Calibrated Equipment

1.0 GENERAL

1.1 Introduction

1.1.1 Purpose

The purpose of this report is to document the performance of the M/A-Com OpenSky ISM Radio during a variety of radio-performance tests and record the test requirements and procedures used. At the request of M/A-Com, the tests were performed by Chomerics Test Service (CTS) of Woburn, Massachusetts. The assessment will determine the compliance or non-compliance to the requirements set by FCC Part 15 Subpart B and C.

Testing was performed during the period of June 5 through 7 and June 18 through 19, 2001 under purchase order number 35610.

1.1.2 Requirements

The requirements for the sequence of tests performed on the M/A-Com OpenSky ISM Radio are as follows:

FCC Part 15 Subpart B Class B

The transceiver and system shall meet the FCC Part 15 Subpart B Class B radiated and conducted emissions limits as stated in 15.107 and 15.109.

Radiated Emissions Limits		
Frequency (MHz)	Field Strength (uV/meter)	Measurement Distance (meters)
30-88	100	3
88-216	150	3
216-960	200	3
960-2500	500	3

Note: Conducted emissions are not applicable do to the fact that the M/A-Com ISM Radio is powered by 48VDC.

FCC Part 15 Subpart C 15.247 Bandwidth

For Direct Sequence systems, the minimum 6dB bandwidth shall be at least 500kHz

FCC Part 15 Subpart C 15.247 Output Power

For Direct Sequence systems, the maximum output power is 1 Watt.

FCC Part 15 Subpart C 15.247 Spurious

In any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

FCC Part 15 Subpart C 15.247 Power Spectral Density

For direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any interval of continuous transmission.

FCC Part 15 Subpart C 15.247 Processing Gain

The processing gain of a direct sequence system, shall be at least 10 dB. The processing gain represents the improvement to the received signal-to-noise ratio, after filtering to the information bandwidth, from the spreading/despreading function. The processing gain may be determined by the following methods:

1. As measured at the demodulated output of the receiver.
2. A measured using the CW jamming margin method.

FCC Part 15 Subpart C 15.249 Field strength of the Fundamental and Harmonics

Field Strength of Fundamental and Harmonics		
Frequency (MHz)	Fundamental (mV/meter)	Harmonics (uV/meter)
2400-2483.5	50	500

FCC Part 15 Subpart C Band-Edge

In any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power, based on either an RF conducted or a radiated measurement.

1.2 Administrative Data

1.2.1 Test Facility

Chomerics test facility is recognized under the National Voluntary Laboratory Accreditation Program (NVLAP) for NVLAP Codes 12F01; FCC test methods – 47 CFR Part 15 – Digital Devices, 12F01a; Conducted Emissions, and 12F01b; Radiated Emissions under NVLAP Accreditation Number 100296-0. Tests within this report not conforming to these NVLAP Codes are not covered under Chomerics NVLAP accreditation. Chomerics NVLAP accreditation covers test method 12/CIS22 for IEC/CISPR 22:1993, 12/CIS22a for IEC/CISPR 22 Amendment 1:1995 and Amendment 2:1996. Chomerics NVLAP accreditation code 12/CIS22b covers Chinese National Standard CNS 13438:1997.

Chomerics Radiated and Conducted Emissions testing to AS/NZS3548 is accredited to the Australian Telecommunications Authority (AUSTEL) under file number A92/TH/0048.

Chomerics' Open Area Test Sites A and B are accredited for Radiated and Conducted Emissions through Industry Canada under file numbers IC2959A and IC2959B respectively.

Chomerics' Open Area Test Site A is accredited to the Voluntary Control Council for Interference (VCCI) in Japan for Radiated and Conducted Emissions testing under file R-749 and C-770 respectively.

Chomerics test facility operates under the current revision of Chomerics Quality Assurance (QA) Manual Document Number QA002.

The QA Manual has been constructed to reflect a quality program in accordance with the requirements of the National Institute of Standards and Technology (NIST), ISO 9002, ISO Guide 25, NIST Handbook 150, EN 45001, MIL-I-45208A, MIL-STD-461D, 462D and Chomerics Quality Assurance Program (QAP).

The QA Manual outlines and describes the procedures for establishing and maintaining the quality of analysis, research, inspection, and testing within Chomerics Test Service (CTS).

This test report does not represent an endorsement by the U.S. Government.

The results and/or conclusions within this test report refer and/or apply only to the unit(s) tested as defined by this report.

Measurements performed for this test are traceable to the National Institute of Standards and Technology (NIST) based on the fact that all test equipment used for the measurements were previously calibrated using standards traceable to NIST.

No deviations, additions to, or exclusions from the test specification(s) were made.

The system amplitude accuracy for the measurements made during the radiated emission tests was ±3dB. Chomerics Test Services measurement uncertainty calculations are available for review upon request.

1.2.2 Equipment Calibration

The calibration of Chomerics test facility equipment is controlled under the current edition of Chomerics Laboratory Test Equipment Calibration Manual Document Number QA001.

The test equipment used throughout this test sequence conforms to laboratory calibration standards, MIL-STD-45662, traceable to the National Institute of Standards and Technology. The date of the next due scheduled calibration is listed in each test section for the applicable equipment.

All test equipment is calibrated in one year intervals

1.2.3 Personnel

The test personnel used to perform or supervise the tests are accredited by the National Association of Radio and Telecommunications Engineers, Inc. (NARTE) as Certified Electromagnetic Compatibility Engineers (N.C.E.) and Technicians (N.C.T.).

1.3 Test Set-up

1.3.1 Test Site Matrix

The test locations used for the emissions and immunity tests are as follows: (Refer to Section 1.3.2 for test site descriptions).

Test Performed	**Test Site**
Radiated Emission Subpart B	Open Area Test Site A
Bandwidth 15.247	Open Area Test Site A
Power Output 15.247	Open Area Test Site A
Field Strength Fundamental	Open Area Test Site A
Spurious Emission 15.247	Open Area Test Site A
Band Edge	Open Area Test Site A
Power Spectral Density	Open Area Test Site A
Strength Harmonics	Open Area Test Site A

1.3.2 Test Site Descriptions

The following is a list of the test sites and descriptions of each. Refer to Section 1.3.1 for specific test sites used for testing.

Open Area Test Site A: Chomerics Open Area Test Site "A" if used for this test program is located in the lower parking lot attached to the Seeger Building at Chomerics, 84 Dragon Court, Woburn, Massachusetts (see Figure 1). Parking is permitted on one side of test site "A" at a discrete distance from the imaginary ellipse.

The Open Area Test Site A enclosure is a wooden structure measuring 56 x 30 x 25 feet in size with galvanized steel sheet metal used as the ground plane. The structure is sized to allow 3 meter measurements and is heated and/or air conditioned.

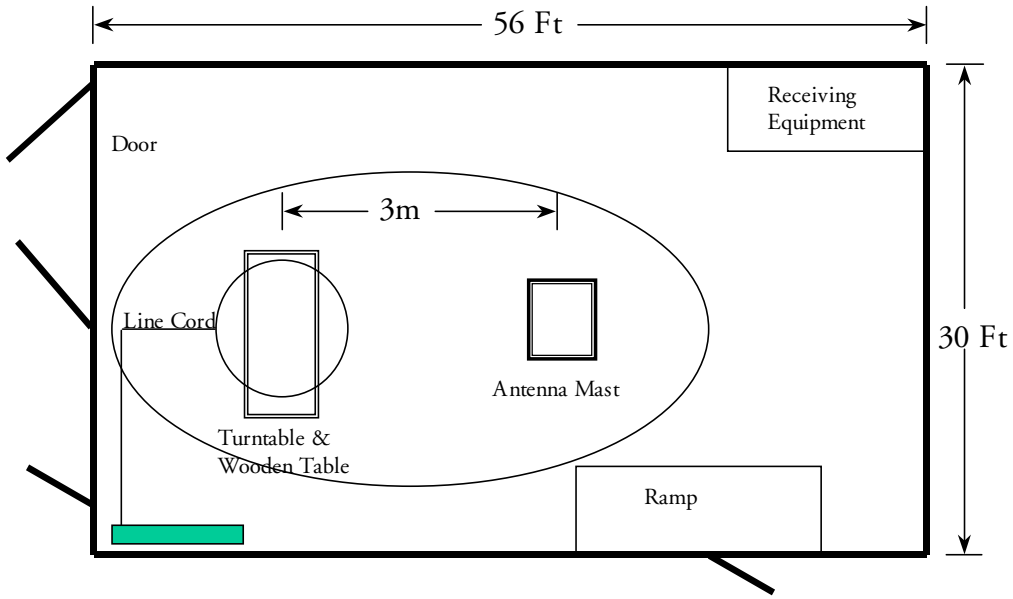
The structure used to support equipment under test is an EMCO 4 foot diameter motorized turntable. For tabletop equipment, a wooden table measuring 1.5 x 1 meter in size is positioned at the center of the turntable, at the proper height above the ground plane.

The area at the end of the Open Area Test Site “A” is the location for the test personnel and equipment to ensure they are outside the imaginary ellipse.

The available AC power within Open Area Test Site “A” is 120V 60Hz Single Phase 60Amps; 208V 60Hz Three Phase 60Amps; 208V 60Hz Single Phase 60Amps; 230V 50Hz Single Phase 50Amps.

This Site is listed with the Federal Communications Commissions (FCC).

OPEN AREA TEST SITE A
Figure 1



Key: = Power board

1.3.3 Equipment Under Test

The ISM radio is a Direct Sequence Spread Spectrum (DSSS) radio compliant with the Federal Communications Commission (FCC) Part 15.247 regulations operating in the ISM frequency band between 2.400 – 2.4835 GHz. The ISM frequency bands are unlicensed and available for public use. The ISM radio operates within the OpenSky® network to provide a point to multi-point communication link between tower sites and cell sites. The ISM radio is a low cost link used to extend the coverage area associated with a tower site. The coverage area serviced using a cell site may be necessary due to geographic constraints such as range (remote locations) or blocking.

An ISM radio has two primary modes of operation. The first mode is master mode. An ISM radio in Master mode controls the RF communications path with one or more ISM radios configured in slave mode. All RF communications are initiated by a master. A slave ISM radio can only transmit to a master in response to a request from the master. The master ISM radio communicates with each of the slaves in a round robin (time division multiplexed) order.

The tower site is equipped with a single ISM radio acting as a hub. This radio communicates with up to four cell site (or repeater) ISM radios. Each ISM radio operates at 2.4GHz and burst transfers the data using a 1 Mbps half-duplex air link. The master radio manages a Time Division Duplex (TDD) protocol to service each slave device.

The Tower Site equipment functions as a relay. IP packets, destined for a cell site OpenSky Base Station, are routed to the appropriate tower site using the T1 Point to Point Microwave link, in a manner identical to the OpenSky Base Stations at that tower site. The Access Router located at the tower site routes the ISM IP streams to the Backhaul Router for protocol conversion and forwarding to the Master ISM radio via the ISM network interface port. The ISM radio, in turn, routes the IP packets to the appropriate cell site slave ISM radio. The cell site ISM radio then passes the IP stream to its associated OpenSky Base Station unit that is co-located at the cell site via an EIA-232 SLIP interface. The time division multiplexed system has the capacity deliver bi-directional 38.4 kbps SLIP data to each slave radio.

The ISM radios have the ability to operate as a stand-alone repeater or as part of a cell drop and repeat. Two ISM radios are used in a repeater configuration, whether in a repeater or drop and repeat configuration. Note that the ISM radios are always configured with a master-slave relationship. A master can be configured to be a multi-point radio whether it is at a primary tower site, repeater or cell drop and repeat.

A repeater or cell drop and repeat has one radio that operates as a standard slave radio in communications with the primary tower site. The second ISM radio at a repeater site or cell drop and repeat is configured as a master ISM radio similar to a tower site. The interface between the repeater ISM radios uses the fiber optic network port for data communications.

2.0 SUMMARY

The terms "Passed" or "Failed" in this section are intended to guide the reader as to whether or not the EUT met the minimum Performance Criteria that can be interpreted from the FCC Parts 2, 15 and 90. The "Results" paragraph in each test section to follow, and the test data sheets, will outline specifically how the EUT performed during each test.

Radiated Emission Subpart B	Passed
Bandwidth 15.247	Passed
Power Output 15.247	Passed
Field Strength Fundamental	Passed
Spurious Emission 15.247	Passed
Band Edge	Passed
Power Spectral Density	Passed
Field Strength Harmonics	Passed

2.1 Summary of Recommendations

The M/A-Com OpenSky ISM Radio will not require modifications in order to insure compliance with CFR 47 FCC Part 15 Subparts B and C.