



Elliott Laboratories Inc.
www.elliottlabs.com

684 West Maude Avenue
Sunnyvale, CA 94086-3518

408-245-7800 Phone
408-245-3499 Fax

***Electromagnetic Emissions Test Report
In Accordance With
FCC Part 22 Subpart H
on the
Cellular Module
Model: CRM4200***

GRANTEE: Standard Communications Corp.
1111 Knox St.
Torrance, CA 90502

TEST SITE: Elliott Laboratories, Inc.
684 W. Maude Ave
Sunnyvale, CA 94086

REPORT DATE: April 9, 2001

FINAL TEST DATE: April 9, 2001

A handwritten signature in black ink that reads "David W. Bare".

AUTHORIZED SIGNATORY: _____

David Bare
Chief Technical Officer

This report shall not be reproduced, except in its entirety, without the written approval of Elliott Laboratories, Inc.

TABLE OF CONTENTS

COVER PAGE	1
TABLE OF CONTENTS.....	2
FCC CERTIFICATION INFORMATION	3
SCOPE.....	7
OBJECTIVE.....	7
EMISSION TEST RESULTS.....	8
SECTION 2.1046: RF POWER OUTPUT	8
SECTION 2.1047: MODULATION CHARACTERISTICS	8
Section 2.1047(a): Voice Modulated Communication Equipment (300 – 3000 Hz).....	8
Section 22.915(d)(i)(ii)(iii): Audio Filter Characteristics	8
Section 2.1047(b): Equipment which employs modulation limiting.....	8
SECTION 2.1049: OCCUPIED BANDWIDTH.....	9
SECTION 2.1051: SPURIOUS EMISSION AT ANTENNA TERMINAL.....	9
SECTION 2.1053: FIELD STRENGTH OF SPURIOUS RADIATION.....	10
SECTION 2.1055: FREQUENCY STABILITY	10
TEST SITE.....	11
GENERAL INFORMATION	11
CONDUCTED EMISSIONS CONSIDERATIONS	11
RADIATED EMISSIONS CONSIDERATIONS.....	11
MEASUREMENT INSTRUMENTATION.....	12
RECEIVER SYSTEM	12
INSTRUMENT CONTROL COMPUTER.....	12
POWER METER.....	12
FILTERS/ATTENUATORS.....	12
ANTENNAS	12
ANTENNA MAST AND EQUIPMENT TURNTABLE.....	13
INSTRUMENT CALIBRATION.....	13
TEST PROCEDURES	14
Section 2.1047, 2.1049, and 2.1051: CONDUCTED EMISSIONS AT THE ANTENNA PORT.....	14
Section 2.1046: RF OUTPUT POWER.....	14
Section 2.1047: MODULATION CHARACTERISTICS	14
Section 2.1055: FREQUENCY STABILITY.....	15
EUT AND CABLE PLACEMENT.....	15
Section 2.1053: RADIATED EMISSIONS	16
SPECIFICATION LIMITS AND SAMPLE CALCULATIONS	17
FREQUENCY STABILITY REQUIREMENTS, SECTION 22.917(E)	17
RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 22.917(E).....	17
CALCULATIONS – EFFECTIVE RADIATED POWER	17
EXHIBIT 1: Test Equipment Calibration Data	1
EXHIBIT 2: Test Measurement Data	2
EXHIBIT 3: Photographs of Test Configuration.....	3
EXHIBIT 4: FCC ID Label and Location.....	6
EXHIBIT 5: Internal and External Photos	7
EXHIBIT 6: Schematics, Block Diagram, and Parts list.....	8
EXHIBIT 7: User Manual, Theory of Operation, and Tune-Up procedure	9

FCC CERTIFICATION INFORMATION

The following information is in accordance with FCC Rules, 47CFR Part2, Subpart J, Section 2.1033(C).

2.1033(c)(1) Applicant: Standard Communication Corp.
1111 Knox St.
Torrance, CA 90502

2.1033(c)(2) FCC ID: **APV09002**

Technical Description

The CRM4200 is a 600 mW of maximum output power. The CRM4200 Cellular Radio Module is an OEM radio module for use in embedded wireless data and other applications. It is part of a series of modules providing solutions for customers with limited levels of RF expertise. The CRM4200 will be used with the highest gain antenna of 2.5 dBi Centurion's (Model: EXE-821-SM).

Standard Communication will use the Centurion dipole antenna with their developer kits. Only, the Centurion (Model: EXE-821-SM) 2.5 dBi gain antenna will be sold in the kit.

* Centurion Antenna: Model: EXE-821-SM 2.5dBi gain

2.1033(c)(3) Instructions/Installation Manual

Please refer to Exhibit 7: User Manual, Theory of Operation

2.1033(c)(4) Type of emissions

AMPS: 40K0F8W
Wideband: 36K0F1D

2.1033(c)(5) Frequency Range

Transmitter: 824.01 – 848.97 MHz
Receiver: 869.01 – 893.97 MHz

2.1033(c)(6) Range of Operation Power

Maximum power: 600 mW (ERP) conducted at antenna terminal

	<u>ERP (Watts)</u>	<u>EIPR(Watts)</u>
Centurion Antenna: 2.5dBi gain	1.07	1.75

2.1033(c)(7) Maximum Power Rating

Section 22.913: limited to 7 Watts ERP

2.1033(c)(8) Applied voltage and currents into the final transistor elements

CRM4200: 5Vdc, Current 100 mA

2.1033(c)(9) Tune-up Procedure

The Tune-Up procedure is located in pg. 20 of the Theory of Operations and in Specification manuals. Refer to Exhibit 7: User Manual, Theory of Operation, and Tune-up Procedure.

2.1033(c)(10) Schematic Diagram of the Transmitter

Refer to Exhibit 6. The schematic diagram

2.1033(c)(10) Means for Frequency Stabilization

TCXO (QL03), main VCO (QP01). For more information refer to Exhibit 7: Theory of Operation page 5.

2.1033(c)(10) Means for Suppression of Spurious radiation

A bandpass filter (FT01) is located before the final power amplifier stage to eliminate harmonic and spurious signals.

2.1033(c)(10) Means for Limiting Modulation

The signal is passed through a Soft limit circuit, BPF, LPF, Compressor circuit, Pre-emphasis circuit, and Hard limit circuit. For more information refer to Exhibit 7: Theory of Operation page 10.

2.1033(c)(10) Means for Limiting Power

Power Detector (QT04), Radio interface IC (QL01), APC circuit (QT05). For more information refer to Exhibit 7: Theory of Operation page 14.

2.1033(c)(11) Photographs or Drawing of the Equipment Identification Plate or Label

Refer to Exhibit 4

2.1033(c)(12) Photographs of equipment

Refer to Exhibit 5

2.1033(c)(13) Equipment Employing Digital Modulation

N/A

2.1033(c)(14) Data taken per Section 2.1046 to 2.1057

Refer to Exhibit 2

Section 22.919: Electronic Serial Number

The EUT meets the requirements of part 22.919 as follows:

- The ESN Serial number is used by factory for trace control.
- A Unique ESN Serial number is programmed at the factory for each Radio.
- The Unique ESN Serial number programmed in the Radio is not removable part.
- The ESN is stored by Multiplication by a polynomial
- The ESN is spread over various non-sequential memory.
- Customers do not have access to change the ESN value.

SECTION 22.921: 911 call processing procedure; 911-only calling mode

The E911 requirement does not apply in any way to the CMM products as they have no ability to place actual calls to any number, and they have no voice capability. The CRM products (4200) are exempt from the E911 requirement due to the fact that they are principally embedded data transceivers only. The current implementations of the CRM4250 and CRM4200 application interfaces do not support use of the transceiver on a stand-alone basis where internal E911 capability is required. In the event that the customer's final application has voice calling capability, that application will be required to comply with the E911 requirement.

At this time, the G2 CRM products (CRM4200) do not include any special handling provisions for 911 calling. The CRM does provide the application with access to the necessary radio control functions for use in implementing any of the 3 approved call-handling scenarios.

We do plan to implement and offer internal E911 call processing features in the future to simplify customer applications where this capability is required. The timeframe is within 2001 (target mid-year). The specific scenario(s) to be implemented have not yet been determined although it is anticipated that it will be a fully self-contained process, given the embedded nature of our products.

SCOPE

FCC Part 22 Subpart H testing was performed for the equipment mentioned in this report. The equipment was tested using Sections 2.1046 to 2.1057. TIA-603 was used as a test procedure guideline to perform the required test.

The intentional radiator above was tested in a simulated typical installation to demonstrate compliance with the relevant FCC performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

OBJECTIVE

The primary objective of the manufacturer is compliance with FCC part 22 Subpart H. Certification of these devices is required as a prerequisite to marketing as defined in Section 2.1033.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to FCC. FCC issues a grant of equipment authorization and a certification number upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product that may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

EMISSION TEST RESULTS**Section 2.1046: RF Power Output**

The EUT tested complied with the limits detailed in Section 22.213(a) with the EUT set to transmit continuously at maximum power. Refer to Setup Photo# 3 in Exhibit 3 and the test data in Exhibit 2: Test Measurement Data for full details.

SECTION 2.1047: MODULATION CHARACTERISTICS**Section 2.1047(a): Voice Modulated Communication Equipment (300 – 3000 Hz)**

The constant input test method was used to measure the frequency response from 300 to 3000 Hz. Device complies with 22.915(d)(1).

Please refer to Setup Photo# 2 under Exhibit 3.

Please, refer to data included under **Exhibit 2**: Test Measurement Data.

Section 22.915(d)(i)(ii)(iii): Audio Filter Characteristics

Measure the Low Pass Filter frequency response from 3000 to 30,000 Hz. Device complies with 22.915(d)(1)(i)(ii)

Please refer to Setup Photo# 2 under Exhibit 3.

Please, refer to data included under **Exhibit 2**: Test Measurement Data.

Section 2.1047(b): Equipment which employs modulation limiting

No deviation, in excess of +/- 12 kHz, was produced from 300 Hz to 15 kHz. Device complies with 22.915(b)(1).

The transmitter maximum rated deviation must not exceed +/- 12 kHz (+/- 10%).

Please refer to Setup Photo# 2 under Exhibit 3.

Please, refer to data included under **Exhibit 2**: Test Measurement Data.

SECTION 2.1049: OCCUPIED BANDWIDTH

Since EUT transmits AMPS and Wideband data Sections 22.917(b) and (d) were used to show compliance for the emission mask.

AMPS modulation: (+/- 12kHz audio and +/- 2kHz SAT)

The signal was modulated with a 2.5 kHz tone and input voltage adjusted to 16 dB greater than that required to produce 50% deviation.

Input Voltage: .5 Vp-p

The following Resolution and Video bandwidth was used per Section 22.917(h)(1)(i) to show compliance for the above requirement: 300 Hz.

Wideband Data modulation: (+/- 8kHz)

The following Resolution and Video bandwidth was used per Section 22.917(h)(2)(i) to show compliance for the above requirement: 300 Hz.

Please refer to Setup Photo# 3 under Exhibit 3.

Refer to data included under **Exhibit 2:** Test Measurement Data.

SECTION 2.1051: SPURIOUS EMISSION AT ANTENNA TERMINAL.

The Out-of-Band emissions from 1MHz to the 10th harmonic of the fundamental were tested per Section 22.917(e) using the 30kHz resolution and video bandwidth instrumentation settings per 22.917(h)(2)(ii).

Mobile emissions in the base frequency band were also measured per Section 22.917(f) with the transmitter operating at full power on 849 MHz.

Both AMPS and Wideband were tested.

Please refer to Setup Photo# 3 under Exhibit 3.

Refer to data included under **Exhibit 2:** Test Measurement Data.

SECTION 2.1053: FIELD STRENGTH OF SPURIOUS RADIATION.

The following measurements were extracted from the data recorded during the radiated electric field emissions scan and represent the highest amplitude peaks relative to the specification limit. The actual test data is contained in the appendices of this report. The field reading includes the correction factors that were applied on the Test equipment by software means.

Maximized Radiated Unwanted Emissions

Frequency	Level	Pol	FCC 90.210(d)(3)		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	V/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1669.880	81.7	H	84.4	-2.7	Pk	145	1.1	

Please refer to Setup Photo# 1 under Exhibit 3.

Please, refer to data included under **Exhibit 2**: Test Measurement Data.

SECTION 2.1055: FREQUENCY STABILITY

The EUT tested complies with Section 22.355.

Limit:

821 - 869 MHz: 2.5 ppm

The frequency of the transmitter varied by 467 Hz over the temperature range of -30 to +50 degrees Celsius.

For voltage stability, the EUT's is battery operated using a +5 or +12 Vdc variable power supply. The battery end point was determined to be at **4.7Vdc** CRM4200, this will be stated in the manufacturers manual. The frequency of the transmitter varied by 0 Hz.

Please, refer to data included under **Exhibit 2**: Test Measurement Data

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on April 9, 2001 at the Elliott Laboratories Open Area Test Site #1 & 2 located at 684 West Maude Avenue, Sunnyvale, California. Pursuant to Section 2.948 of the FCC Rules, construction, calibration, and equipment data has been filed with the Commission.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing are performed in conformance with Section 2 of FCC Rules. Measurements are made with the EUT connected to a spectrum analyzer through an attenuator to prevent overloading the analyzer.

RADIATED EMISSIONS CONSIDERATIONS

Radiated measurements are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR 16-1 defined elliptical area.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers are capable of measuring over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the particular detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. If average measurements above 1000MHz are performed, the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz is used.

INSTRUMENT CONTROL COMPUTER

A personal computer is utilized to record the receiver measurements of the field strength at the antenna, which is then compared directly with the appropriate specification limit. The receiver is programmed with appropriate factors to convert the received voltage into field strength at the antenna. Results are printed in a graphic and/or tabular format, as appropriate.

The test receiver also provides a visual display of the signal being measured.

POWER METER

A power meter and thermister mount may be used for output power measurements from transmitters as they provide a broadband indication of the power output.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or EUT and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transmitters and transient events.

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors programmed into the test receivers

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor drive to vary the antenna height.

The requirements of ANSI C63.4 were used for configuration of the equipment turntable. It specifies that the test height above ground for table-mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An appendix of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES**Section 2.1047, 2.1049, and 2.1051: CONDUCTED EMISSIONS AT THE ANTENNA PORT**

Direct measurements for output power, modulation characterization and frequency stability are performed with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded or for input protection by the fundamental transmission. The EUT was set at the middle of the frequency band and operating at maximum output power.

Section 2.1046: RF OUTPUT POWER

The EUT is configured to operate in the middle of the EUT frequency range at full power. A spectrum analyzer with resolution and video bandwidths of 30 kHz are used to measure the fundamental output power.

Section 2.1047: MODULATION CHARACTERISTICS***Voice Modulated Communication Equipment (300 – 3000 Hz)***

Used TIA/EIA-603 section 2.2.6.2.2 procedure. The constant input test method was used to measure the frequency response from 300 to 3000 Hz. The following steps were done.

1. Adjusted the transmitter per the manufacture's procedure for full rated system deviation.
2. Apply a 1000 Hz tone and adjusted the audio frequency generator to produce 20% of the rated system deviation.
3. Set the test receiver to measure rms deviation and record the deviation reading as DEVref.
4. Set the audio frequency generator to the desired test frequency between 300 and 3000 Hz.
5. Recorded the test receiver deviation reading as DEVfreq.
6. Calculated the audio frequency response at the present frequency as:
$$\text{Audio Frequency response} = 20 * \log_{10} (\text{DEVfreq} / \text{DEVref})$$
7. Repeated steps 4 through 6 for all other test frequencies.

Section 22.915(d)(i)(ii)(iii): Audio Filter Characteristics

The following test method was used to measure the Low Pass Filter frequency response from 3000 to 30,000 Hz.

To test the band limiting condition: adjusted the audio input frequency to 1000 Hz, and adjusted the input level to 20 dB greater than that required to produce ± 8 kHz deviation. Noted the output level on the frequency deviation meter or the calibrated test receiver. Using this output level as reference (0 dB), vary the modulating frequency from 3000 Hz to 30,000 Hz, and record the change in output while maintaining a constant audio input level.

Section 2.1047(b): Equipment which employs modulation limiting

The following procedure was used to test the modulation limiting circuit.

The transmitter was connected to the test receiver. An attenuator was placed in between to protect the test receiver's input port. The audio generator was set to 300, 1000, 2500, 3000, and 15,000 Hz and varied the test voltage for each audio frequency. Recorded the input voltage level that will produce 10 to 100% deviation. To further assure the limiting capability of the transmitter the voltage was increased beyond 100%. No deviation, in excess of +/- 12 kHz, was produced.

Section 2.1055: FREQUENCY STABILITY

The EUT is placed inside a temperature chamber with all support and test equipment located outside of the chamber. The spectrum analyzer is configured to give a 6-digit display for the marker-frequency function. The spectrum analyzer's built-in frequency counter is used to measure the maximum deviation of the fundamental frequency at each temperature.

For battery-powered devices the voltage battery end-point is determined by reducing the dc voltage until the unit ceases to function.

EUT AND CABLE PLACEMENT

The FCC requires that for Radiated Emissions interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst-case orientation is used for final measurements.

Section 2.1053: RADIATED EMISSIONS

A .5 meter cable was connected to the EUT antenna port and a 50-ohm load was placed at the end of the cable. The EUT was set to transmit continuously at maximum power. The frequency was set to the middle of the EUT frequency range.

The EUT was set on the turntable and the search antenna position 3 meters away. The output antenna terminal was terminated with a 50-ohm terminator. The EUT was set at the middle of the frequency band and set at maximum output power.

Radiated emissions measurements are performed in two phases. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from the lowest frequency generated in the device up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these are with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth that results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions that have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS**FREQUENCY STABILITY REQUIREMENTS, SECTION 22.917(e)**

Frequency Range Stability

821 – 869 MHz: 2.5 ppm over the temperature range –30 to +50 degrees Celsius

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 22.917(e)

The limits for radiated emissions are based on the power of the transmitter at the operating frequency. Data is measured in the logarithmic form of decibels relative to one milliwatt (dBm) or one microvolt/meter (dBuV/m.). The field strength of the emissions from the EUT is measured on a test site with a receiver.

For an operating power range of 3 watts the radiated emissions limit for spurious signals outside of the assigned frequency block is $43 + 10 \log_{10}$ (mean output power in watts) dB below the measured amplitude at the operating power.

CALCULATIONS – EFFECTIVE RADIATED POWER

$$E(\text{V/m}) = \frac{\sqrt{30 * P * G}}{d}$$

E= Field Strength in V/m

P= Power in Watts

G= Gain of antenna in numeric gain (Assume 1.64 for ERP)

d= distance in meters

$$E(\text{V/m}) = \frac{\sqrt{30 * .6 \text{ watts} * 1.64 \text{ dB}}}{3 \text{ meters}}$$

$$20 * \log (1.81 \text{ V/m} * 1,000,000) = 125.16 \text{ dBuV/m @ 3 meters}$$

Section 22.917(e): Request an attenuation of $43 + 10 \log (.6)$ or 40.78 dB for all emissions outside the assigned block, the limit for spurious and harmonic emissions is:

$$125.16 \text{ dBuV/m} - 40.78 \text{ dB} = 84.3 \text{ dBuV/m @ 3 meter.}$$

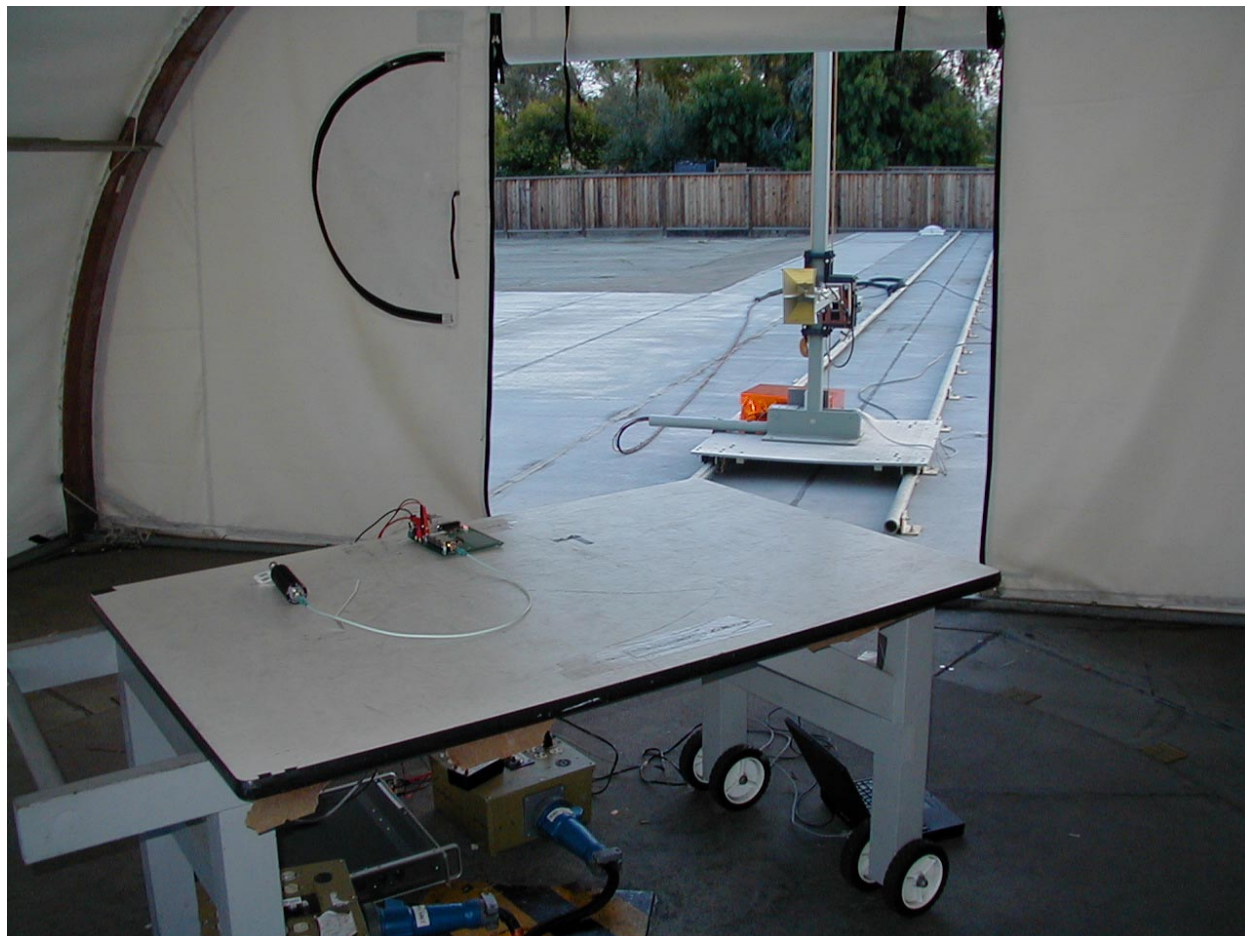
EXHIBIT 1: Test Equipment Calibration Data

EXHIBIT 2: Test Measurement Data

The following data includes conducted and radiated emission measurements of the Standard Communication, model CRM4200.

25 Pages

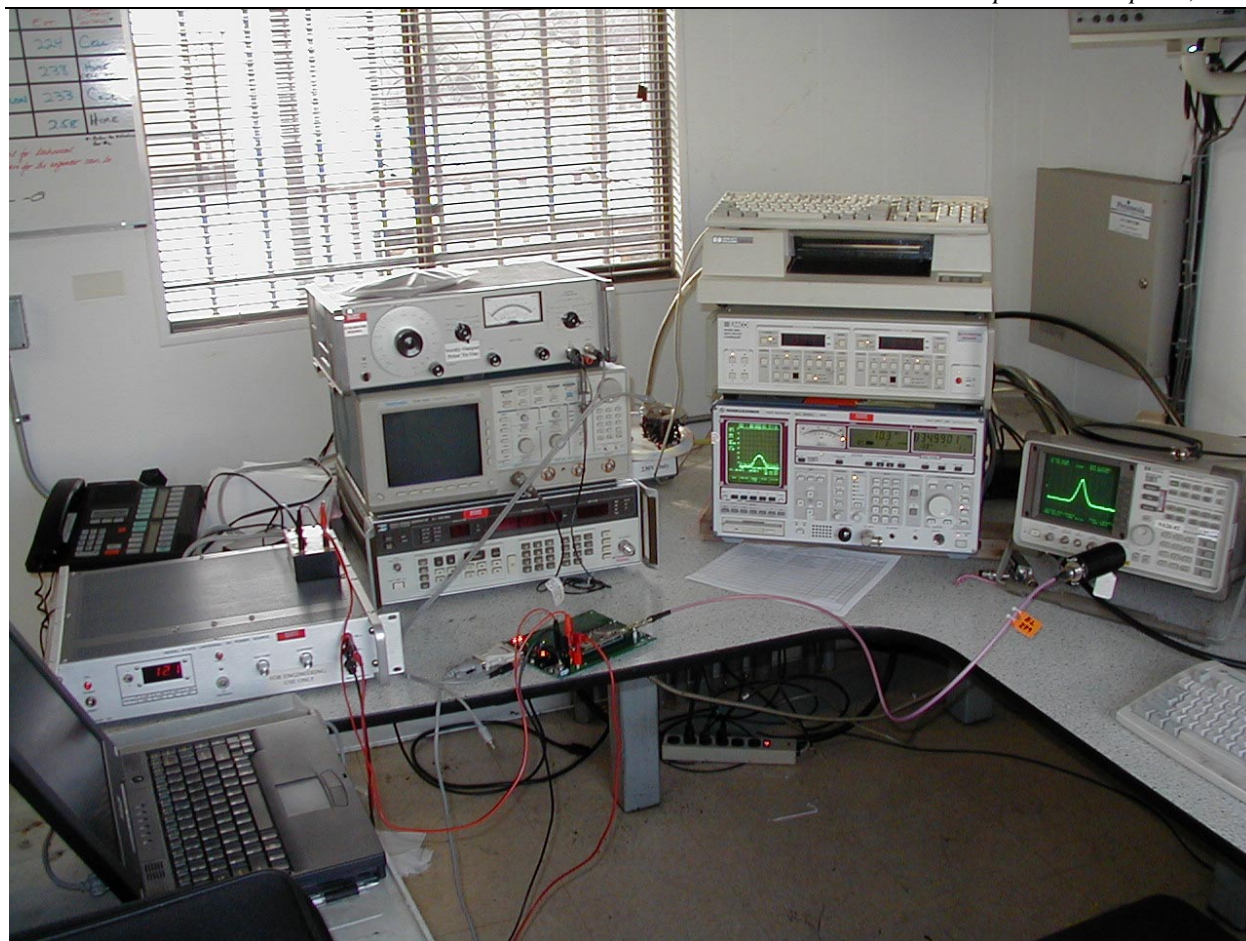
EXHIBIT 3: Photographs of Test Configuration



Setup Photo# 1



Setup Photo# 2



Setup Photo# 3

EXHIBIT 4: FCC ID Label and Location

1 page

EXHIBIT 5: Internal and External Photos

EXHIBIT 6: Schematics, Block Diagram, and Parts list

EXHIBIT 7: User Manual, Theory of Operation, and Tune-Up procedure