NVLAP Lab Code 200087-0

SUBMITTAL APPLICATION REPORT

FOR GRANT OF CERTIFICATION

FOR

Models: LT4424-200 and LT3124-200
2402-2478.2 MHz
FHSS Transceiver Module
FCC ID: KQL-4424200
IC: 2268C-4424200

FOR

Laird Technologies

11160 Thompson Avenue
Lenexa KS 66219

Test Report Number: 090427

Authorized Signatory: Scot D Rogers
Scot D. Rogers

NVLAP Lab Code 200087-0

ROGERS LABS, INC.
4405 West 259th Terrace
Louisburg, KS 66053
Phone / Fax (913) 837-3214

Engineering Test Report For Grant of Certification Application

FOR

CFR47, Part 15C - Intentional Radiator, Paragraph 15.247 and
Industry Canada RSS-210
License Exempt Intentional Radiator

For

Laird Technologies
11160 Thompson Avenue
Lenexa KS 66219

Ralph Hollis
Engineering Manager

Frequency Hopping Spread Spectrum Transceiver Module
Models: LT4424-200 AND LT3124-200
Frequency Range 2402-2478.2 MHz
FCC ID#: KQL-4424200
IC: 2268C-4424200

Test Date: April 27, 2009

Certifying Engineer: Scot D Rogers

Scot D. Rogers
Rogers Labs, Inc.
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Table Of Contents

TABLE OF CONTENTS 3

FORWARD 5

OPINION / INTERPRETATION OF RESULTS 5

ENVIRONMENTAL CONDITIONS 5

EQUIPMENT TESTED 6

2.1033(B) APPLICATION FOR CERTIFICATION 6

APPLICABLE STANDARDS & TEST PROCEDURES 7

EQUIPMENT FUNCTION AND TESTING PROCEDURES 7

EQUIPMENT AND CABLE CONFIGURATIONS 8

AC Line Conducted Emission Test Procedure 8

Radiated Emission Test Procedure 8

UNITS OF MEASUREMENTS 8

TEST SITE LOCATIONS 9

LIST OF TEST EQUIPMENT 9

SUBPART C - INTENTIONAL RADIATORS 10

15.203 Antenna Requirements 10

15.205 Restricted Bands of Operation 10

Radiated Emissions in Restricted Bands Data (1 dBi MicroStrip) 15.205 11
Radiated Emissions in Restricted Bands Data (5 dBi Dipole) 15.205 11
Radiated Emissions in Restricted Bands Data (8 dBi Omni) 15.205 12
Radiated Emissions in Restricted Bands Data (9 dBi Panel) 15.205 12

Summary of Results for Radiated Emissions in Restricted Bands 15.205 13

Statement of Modifications and Deviations 13

15.207 AC line Conducted Emissions Procedure 13

Figure One AC Line Conducted Emissions Line 1 14
Figure Two AC Line Conducted Emissions Line 2 14
AC Line Conducted Emissions Data (7 Highest Emissions) 15.207 15

Summary of Results for AC Line Conducted Emissions 15.207 15

15.209 Radiated Emissions Procedure 15

Figure Three General Radiated Emissions taken at 1 meter in screen room 16
Figure Four General Radiated Emissions taken at 1 meter in screen room 17
Figure Five General Radiated Emissions taken at 1 meter in screen room 17
Figure Six General Radiated Emissions taken at 1 meter in screen room 18

Figure Seven General Radiated Emissions taken at 1 meter in screen room....18
Figure Eight General Radiated Emissions taken at 1 meter in screen room....19
Figure Nine General Radiated Emissions taken at 1 meter in screen room....19
Radiated Emissions from EUT Data (Highest Emissions) 15.209 20

Summary of Results for General Radiated Emissions 15.209....20

Statement of Modifications and Deviations 21

15.247 Operation in the Band 2400-2483.5 MHz 21

Figure Ten Plot of Antenna Port Conducted Emissions....22
Figure Eleven Plot of Antenna Port Conducted Emissions 22
Figure Twelve Plot of Antenna Port Conducted Emissions 23
Figure Thirteen Plot of Antenna Port Conducted Emissions....23
Figure Fourteen Plot of Antenna Port Conducted Emissions 24
Figure Fifteen Plot of Antenna Port Conducted Emissions....24
Figure Sixteen Plot of Power Output Across Operational Band 25
Figure Seventeen Plot of 20 dB Occupied Bandwidth 25
Figure Eighteen Plot of 20 dB Occupied Bandwidth 26
Figure Nineteen Plot of 20 dB Occupied Bandwidth 26
Figure Twenty Plot of Channel Spacing....27
Figure Twenty-one Plot of Dwell time on Channel (LT4424-200)....27
Figure Twenty-two Plot of Channel Occupancy (LT4424-200) 28
Figure Twenty-three Plot of Dwell time on Channel (LT3124-200)....28
Figure Twenty-four Plot of Channel Occupancy (LT3124-200)....29
Figure Twenty-five Plot of Low Band Edge 29
Figure Twenty-six Plot of High Band Edge 30

Transmitter Antenna Conducted Emissions Data 30

Transmitter Radiated Emissions Data (1 dBi MicroStrip) 31

Transmitter Radiated Emissions Data (5 dBi Dipole) 32

Transmitter Radiated Emissions Data (8 dBi Omni)....33

Transmitter Radiated Emissions Data (9 dBi Panel)....34

Summary of Results for Radiated Emissions of Intentional Radiator 15.247 35

Statement of Modifications and Deviations 35

ANNEX....36

Annex A Measurement Uncertainty Calculations....37

Annex B Test Equipment List For Rogers Labs, Inc.....39

Annex C Rogers Qualifications....40

Annex D FCC Site Registration Letter 41

Annex E Industry Canada Site Registration Letter....42

Forward

The following information is submitted for consideration in obtaining Grant of Certification for a License Exempt Intentional Radiator operating under CFR47 Paragraph 15.247 and RSS-210. The frequency hopping spread spectrum transceiver is designed for incorporation into OEM equipment offering low cost solution for remote wireless communications.

Name of Applicant:
Laird Technologies
11160 Thompson Avenue
Lenexa KS 66219

Models: LT4424-200 AND LT3124-200

FCC I.D.: KQL-4424200 FRN: 0006 3090 82 IC: 2268C-4424200
Frequency Range: 2402-2478.2 MHz

Operating Power: 0.383 Watt antenna port conducted, 129.1 dBµV/m @ 3-meters (3- meter radiated measurement 9 dBi Panel), Occupied Bandwidth 985 kHz

Opinion / Interpretation of Results

Tests Performed	Results
Emissions Tests	
Emissions as per CFR47 paragraphs 2 and 15.205	Complies
Emissions as per CFR47 paragraphs 2 and 15.207	Complies
Emissions as per CFR47 paragraphs 2 and 15.209	Complies
Emissions as per CFR47 paragraphs 2 and 15.247	Complies
Emissions as per RSS-210 Issue 7, Dated June 2007	Complies

Environmental Conditions

Ambient Temperature	25.0° C
Relative Humidity	42%
Atmospheric Pressure	1012.9 mb

Equipment Tested

Equipment	Model	FCC I.D.#
EUT	LT4424-200 AND LT3124-200	KQL-4424200
CPU	Presario 2100	CRVSA-02T1-75
Antenna	MFB24008 Maxrad (Omni 8dBi)	
Antenna	NZH2400-MMCX Laird Technologies (Microstrip 1 dBi)	
Antenna	ID2450-RS362 Laird Technologies (Panel 9 dBi)	
Antenna	S151FC-L-(132)PX-2450S Nearson (Dipole 5 dBi)	

2.1033(b) Application for Certification

(1) Manufacturer: Laird Technologies
11160 Thompson Avenue
Lenexa KS 66219

(2) Identification: Model: LT4424-200 AND LT3124-200

FCC I.D.: KQL-4424200 IC: 2268C-4424200

(3) Instruction Book:

Refer to Exhibit for Instruction Manual.

(4) Description of Circuit Functions:

Refer to Exhibit of Operational Description.

(5) Block Diagram with Frequencies:

Refer to Exhibit of Operational Description.

(6) Report of Measurements:

Report of measurements follows in this Report.

(7) Photographs: Construction, Component Placement, etc.:

Refer to Exhibit for photographs of equipment.

(8) List of Peripheral Equipment Necessary for operation. The equipment operates from power received from the support circuitry. The module was placed on the support development board and communications to CPU through the RS-232 interface of the laptop computer during testing.

(9) Transition Provisions of 15.37 are not being requested.

(10) Not Applicable. The unit is not a scanning receiver.

(11) Not Applicable. The EUT does not operate in the 59 – 64 GHz frequency band.

(12) The equipment is not software defined and this section is not applicable.

Applicable Standards & Test Procedures

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2008, Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057, and applicable parts of paragraph 15, Part 15C Paragraph 15.247, and Industry Canada RSS-210 the following information is submitted.

Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in the ANSI 63.4-2003 Document FCC, documents DA00-1407 and DA00-705 and/or TIA/EIA 603-1. Testing for the AC line-conducted emissions were performed as defined in sections 7 and 13.1.3, testing of the radiated emissions was performed as defined in sections 8 and 13.1.4 of ANSI C63.4.

Equipment Function and Testing Procedures

The EUT is a 2402-2478.2 MHz frequency hopping spread spectrum transceiver used to transmit data in applications offering remote wireless connectivity. The transmitter portion of the design is received as a module and placed on support interface board incorporated into OEM system design. The unit is marketed for use to incorporate a wireless link to exchange data information from one point to another. For testing purposes the LT4424-200 was connected to the support development board and communicating to the laptop computer allowing for operational control of the transmitter and communications. The LT4424-200 and LT3124-200 receive power form the support circuitry and offers no provision to connect to utility AC power systems. No other interfacing options are provided on the design. For testing purposes the LT4424-200 and support equipment were powered from the AC power adapter supply of the support development board and set to transmit in all maximum data modes available. The device is marketed for modular solution for incorporation into OEM designed systems and used with approved antennas only. The design complies with the unique antenna connection requirements.

Equipment and Cable Configurations

AC Line Conducted Emission Test Procedure

The LT4424-200 operates from DC power only and must be connected to the support system for operation. For testing purposes, the manufacturer supplied AC power adapter for the support development board was used to power the system. Testing for the AC line-conducted emissions testing was performed as defined in sections 7 and 13.1.3 of ANSI C63.4. The test setup including the EUT was arranged in a typical equipment configuration and placed on a 1 x 1.5-meter wooden bench, 0.8 meters high located in a screen room. The power lines of the system were isolated from the power source using a standard LISN with a 50 µHy choke. EMI was coupled to the spectrum analyzer through a 0.1 µF capacitor internal to the LISN. The LISN was positioned on the floor beneath the wooden bench supporting the EUT. The power lines and cables were draped over the back edge of the table.

Radiated Emission Test Procedure

The EUT was placed on a rotating 1 x 1.5-meter wooden platform, 0.8 meters above the ground plane at a distance of 3 meters from the FSM antenna. Testing for the radiated emissions was performed as defined in sections 8 and 13.1.4 of ANSI C63.4. EMI energy was maximized by equipment placement, raising and lowering the FSM antenna, changing the antenna polarization, and by rotating the turntable. Each emission was maximized before data was taken using a spectrum analyzer. Refer to photographs in the test setup exhibits for EUT placement during testing.

Units of Measurements

Conducted EMI Data is in dBµV; dB referenced to one microvolt

Radiated EMI Data is in dBµV/m; dB/m referenced to one microvolt per meter

Test Site Locations

Conducted EMI — The AC power line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS

Radiated EMI — The radiated emissions tests were performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS

Site Approval — Refer to Annex for FCC and Industry Canada Site Registration Letters

NVLAP — Lab code 200087-0

List of Test Equipment

A Hewlett Packard 8591EM Spectrum Analyzer was used as the measuring device for the emissions testing of frequencies below 1 GHz. A Hewlett Packard 8562A Spectrum Analyzer was used as the measuring device for testing the emissions at frequencies above 1 GHz. The analyzer settings used are described in the following table. Refer to the appendix for a complete list of test equipment.

HP 8591 EM Analyzer Settings		
Conducted Emissions		
RBW	AVG. BW	Detector Function
9 kHz	30 kHz	Peak / Quasi Peak
Radiated Emissions		
RBW	AVG. BW	Detector Function
120 kHz	300 kHz	Peak / Quasi Peak
HP 8562A Analyzer Settings		
RBW	Video BW	Detector Function
100 kHz	100 kHz	Peak
1 MHz	1 MHz	Peak / Average

Equipment	Manufacturer	Model	Calibration Date	Due
LISN	Comp. Design	FCC-LISN-2-MOD.CD	10/08	10/09
Antenna	ARA	BCD-235-B	10/08	10/09
Antenna	EMCO	3147	10/08	10/09
Antenna	EMCO	3143	5/08	5/09
Analyzer	HP	8591EM	5/08	5/09
Analyzer	HP	8562A	5/08	5/09

Subpart C - Intentional Radiators

As per CFR47, Subpart C, paragraph 15.247 the following information is submitted.

15.203 Antenna Requirements

The product is produced with a MMCX antenna connector to be used with approved antenna structures. The antenna connection point complies with the unique antenna connection requirements. The requirements of 15.203 are fulfilled and there are no deviations or exceptions to the specification.

15.205 Restricted Bands of Operation

Spurious emissions falling in the restricted frequency bands of operation were measured at a distance of three meters at the OATS. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were checked at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. No other significant emission was observed which fell into the restricted bands of operation.

Sample Calculations:

$$\text{RFS (dB}\mu\text{V/m @ 3m)} = \text{FSM(dB}\mu\text{V)} + \text{A.F.(dB)} - \text{Gain(dB)}$$

$$= 15.7 + 28.1 - 200$$

$$= 23.8$$

Radiated Emissions in Restricted Bands Data (1 dBi MicroStrip) 15.205

Frequency in MHz	FSM Horz. (dBμV)	FSM Vert. (dBμV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBμV/m)	RFS Vert. @ 3m (dBμV/m)	FCC Class B Limit @ 3m (dBμV/m)
2390.0	15.7	18.0	28.1	20	23.8	26.1	54.0
2400.0	14.8	16.1	28.1	20	22.9	24.2	54.0
2483.5	17.3	17.6	28.1	20	25.4	25.7	54.0
4804.0	15.7	16.5	32.9	20	28.6	29.4	54.0
4880.2	16.4	17.3	32.9	20	29.3	30.2	54.0
4956.3	18.3	17.5	32.9	20	31.2	30.4	54.0
7206.0	18.3	18.1	36.4	20	34.7	34.5	54.0
7320.3	18.8	17.5	36.4	20	35.2	33.9	54.0
7434.5	18.8	18.6	36.4	20	35.2	35.0	54.0
12010.0	16.5	17.6	40.0	20	36.5	37.6	54.0
12200.5	16.3	17.5	40.4	20	36.7	37.9	54.0
12390.8	18.3	18.4	40.5	20	38.8	38.9	54.0

Other emissions present had amplitudes at least 20 dB below the limit.

Radiated Emissions in Restricted Bands Data (5 dBi Dipole) 15.205

Frequency in MHz	FSM Horz. (dBμV)	FSM Vert. (dBμV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBμV/m)	RFS Vert. @ 3m (dBμV/m)	FCC Class B Limit @ 3m (dBμV/m)
2390.0	15.1	21.6	28.1	20	23.2	29.7	54.0
2400.0	14.2	16.3	28.1	20	22.3	24.4	54.0
2483.5	16.0	17.8	28.1	20	24.1	25.9	54.0
4804.0	18.2	16.5	32.9	20	31.1	29.4	54.0
4880.2	17.8	17.0	32.9	20	30.7	29.9	54.0
4956.3	18.3	16.3	32.9	20	31.2	29.2	54.0
7206.0	18.3	18.1	36.4	20	34.7	34.5	54.0
7320.3	18.8	17.0	36.4	20	35.2	33.4	54.0
7434.5	19.8	19.6	36.4	20	36.2	36.0	54.0
12010.0	17.0	17.8	40.0	20	37.0	37.8	54.0
12200.5	18.0	17.5	40.4	20	38.4	37.9	54.0
12390.8	19.8	17.3	40.5	20	40.3	37.8	54.0

Other emissions present had amplitudes at least 20 dB below the limit.

Radiated Emissions in Restricted Bands Data (8 dBi Omni) 15.205

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	FCC Class B Limit @ 3m (dBµV/m)
2390.0	15.1	21.6	28.1	20	23.2	29.7	54.0
2400.0	18.5	15.5	28.1	20	26.6	23.6	54.0
2483.5	18.3	18.6	28.1	20	26.4	26.7	54.0
4804.0	17.8	17.7	32.9	20	30.7	30.6	54.0
4880.2	17.0	17.8	32.9	20	29.9	30.7	54.0
4956.3	17.5	18.0	32.9	20	30.4	30.9	54.0
7206.0	19.5	19.8	36.4	20	35.9	36.2	54.0
7320.3	18.5	19.0	36.4	20	34.9	35.4	54.0
7434.5	18.6	19.0	36.4	20	35.0	35.4	54.0
12010.0	18.1	19.3	40.0	20	38.1	39.3	54.0
12200.5	19.6	19.5	40.4	20	40.0	39.9	54.0
12390.8	19.1	18.5	40.5	20	39.6	39.0	54.0

Other emissions present had amplitudes at least 20 dB below the limit.

Radiated Emissions in Restricted Bands Data (9 dBi Panel) 15.205

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	FCC Class B Limit @ 3m (dBµV/m)
2390.0	15.7	18.0	28.1	20	23.8	26.1	54.0
2400.0	15.8	17.1	28.1	20	23.9	25.2	54.0
2483.5	16.3	15.1	28.1	20	24.4	23.2	54.0
4804.0	17.3	17.8	32.9	20	30.2	30.7	54.0
4880.2	17.3	17.0	32.9	20	30.2	29.9	54.0
4956.3	17.5	18.6	32.9	20	30.4	31.5	54.0
7206.0	18.3	19.3	36.4	20	34.7	35.7	54.0
7320.3	17.2	19.5	36.4	20	33.6	35.9	54.0
7434.5	18.5	19.7	36.4	20	34.9	36.1	54.0
12010.0	19.8	19.0	40.0	20	39.8	39.0	54.0
12200.5	18.0	19.0	40.4	20	38.4	39.4	54.0
12390.8	18.1	19.3	40.5	20	38.6	39.8	54.0

Other emissions present had amplitudes at least 20 dB below the limit.

Summary of Results for Radiated Emissions in Restricted Bands 15.205

The EUT demonstrated compliance with the radiated emissions requirements for FCC Part 15C Intentional Radiators. The EUT demonstrated a minimum margin of 13.7 dB below the requirements. Peak, Quasi-peak, and average amplitudes were checked for compliance with the regulations. Worst-case emissions are reported with other emissions found in the restricted frequency bands at least 20 dB below the requirements.

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to demonstrate compliance with the FCC Part 15C paragraph 15.205 emissions requirements. There were no deviations or exceptions to the specifications.

15.207 AC line Conducted Emissions Procedure

The EUT was arranged in the test setup configuration emulating typical equipment configuration and placed on a 1 x 1.5-meter wooden bench 80 cm above the conducting ground plane, floor of a screen room. The bench was positioned 40 cm away from the wall of the screen room. The LISN was positioned on the floor of the screen room 80-cm from the rear of the EUT. The manufacturer supplied AC power adapter for the support development board was connected to the LISN. A second LISN was positioned on the floor of the screen room 80-cm from the rear of the supporting equipment of the EUT. All power cords except the EUT were then powered from the second LISN. EMI was coupled to the spectrum analyzer through a 0.1 μF capacitor, internal to the LISN. Power line conducted emissions testing were carried out individually for each current carrying conductor of the EUT. The excess length of lead between the system and the LISN receptacle was folded back and forth to form a bundle not exceeding 40 cm in length. The screen room, conducting ground plane, analyzer, and LISN were bonded together to the protective earth ground. Preliminary testing was performed to identify the frequency of each radio frequency emission displaying the highest amplitude. The cables were repositioned to obtain maximum amplitude of measured EMI level. Once the worst-case configuration was identified, plots were made of the EMI from 0.15 MHz to 30 MHz then the data was recorded with maximum conducted emissions levels. Refer to figures one and two for plots of the AC Line conducted emissions.

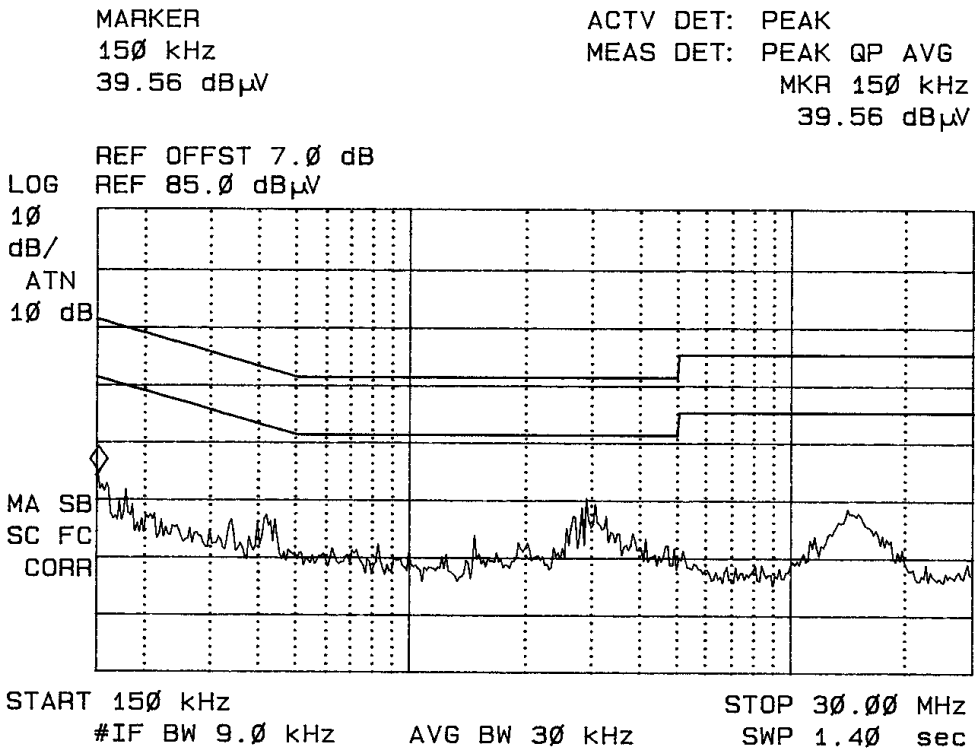

Figure One AC Line Conducted Emissions Line 1

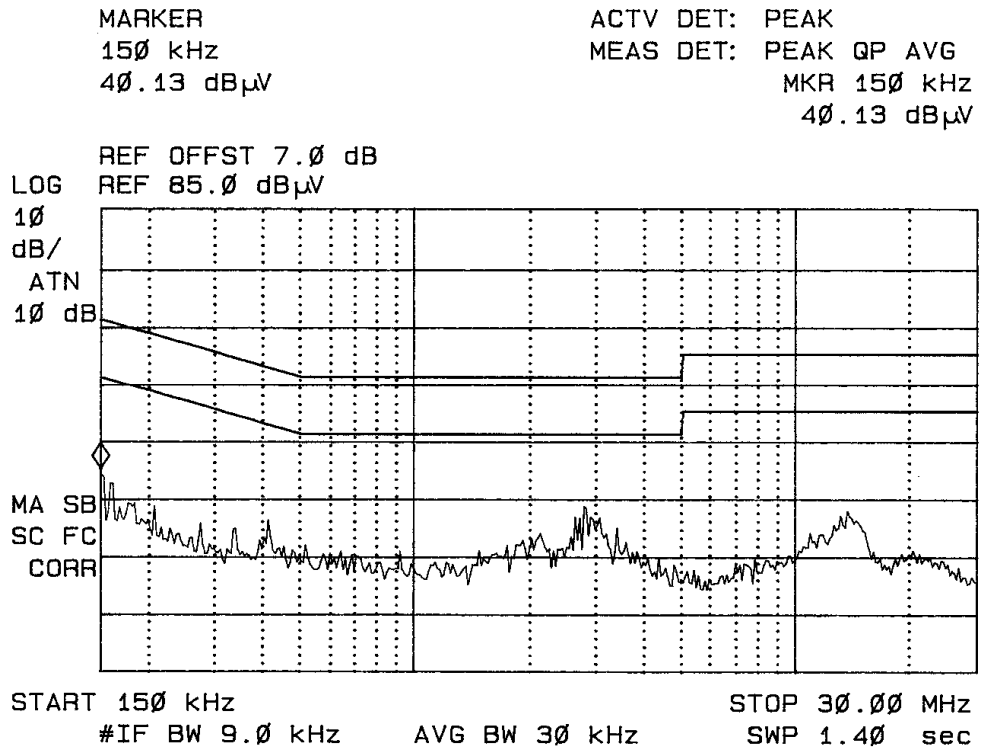

Figure Two AC Line Conducted Emissions Line 2

AC Line Conducted Emissions Data (7 Highest Emissions) 15.207

Frequency band (MHz)	L1 Level (dBµV)			L2 Level (dBµV)			CISPR 22 Limit Q.P. Ave(dBµV)
	Peak	Q.P.	AVE	Peak	Q.P.	AVE	
0.15 – 0.5	39.6	35.8	26.2	40.1	36.5	27.7	66 / 56
0.5 – 5	35.5	29.1	22.3	34.7	30.8	25.6	56 / 46
5 – 10	26.0	22.3	16.8	27.5	23.8	18.3	60 / 50
10 – 15	34.2	31.5	28.4	33.2	30.6	27.1	60 / 50
15 – 20	33.9	31.5	29.0	26.8	22.0	17.2	60 / 50
20 – 25	23.9	18.7	12.2	26.5	19.5	13.0	60 / 50
25 – 30	24.8	17.4	11.2	23.1	17.5	11.2	60 / 50

Other emissions present had amplitudes at least 10 dB below the limit.

Summary of Results for AC Line Conducted Emissions 15.207

The EUT demonstrated compliance with the conducted emissions requirements for CISPR 22 and CFR47 Part 15C equipment. The EUT demonstrated minimum margin of 25.2 dB below the Quasi-Peak limit, and 20.4 dB below the CISPR average limit. Measurements were taken using the peak, quasi peak, and average, measurement function for each emissions amplitude and were below the limits stated in the specification. Other emissions were present with recorded data representing worst-case amplitudes.

15.209 Radiated Emissions Procedure

The EUT was arranged in a typical equipment configuration and operated through all available modes with worst-case data recorded. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. Plots were made of the radiated frequency spectrum from 30 MHz to 22,000 MHz for the preliminary testing. Refer to figures three through nine for plots of the general radiated emissions spectrum taken in a screen room. The highest radiated emission was then re-maximized at the OATS location before final radiated emissions measurements were performed. Final data was taken with the EUT located at the OATS at a distance of 3 meters between the EUT and the receiving antenna. The frequency spectrum from 30 MHz to 30,000 MHz was searched for general radiated emissions. Measured emission levels were maximized by EUT placement on the table, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and

changing antenna position between horizontal and vertical polarization. Antennas used were Broadband Biconical from 30 to 200 MHz, Biconilog from 30 to 1000 MHz, Log Periodic from 200 MHz to 5 GHz and or, pyramidal horns and mixers from 4 GHz to 30 GHz, notch filters and appropriate amplifiers were utilized.

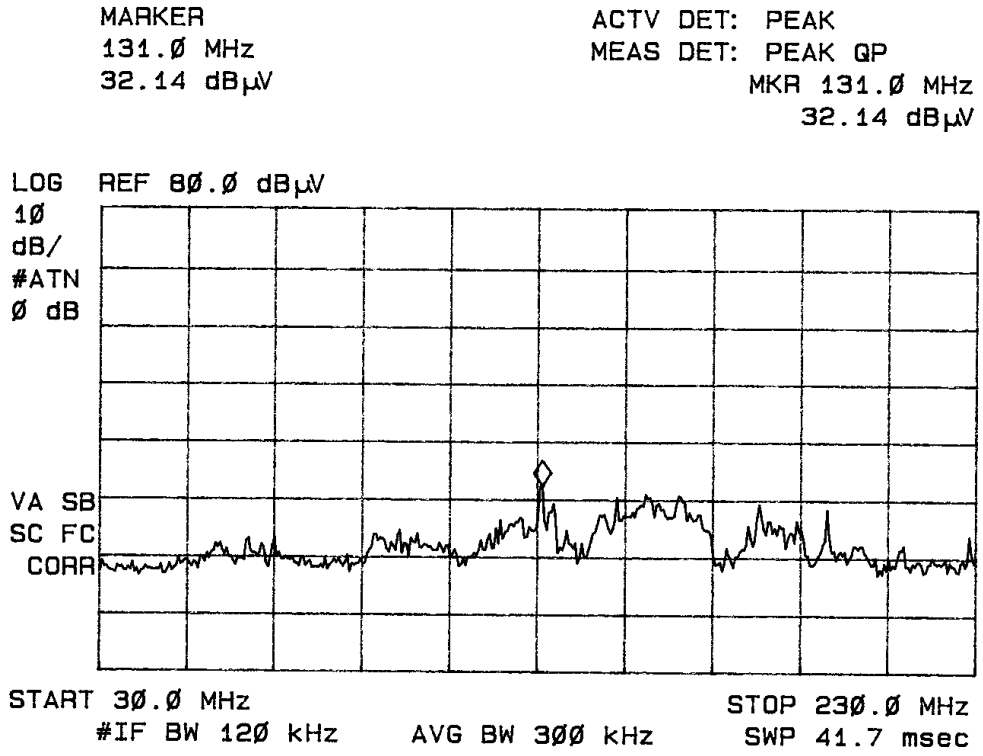

Figure Three General Radiated Emissions taken at 1 meter in screen room

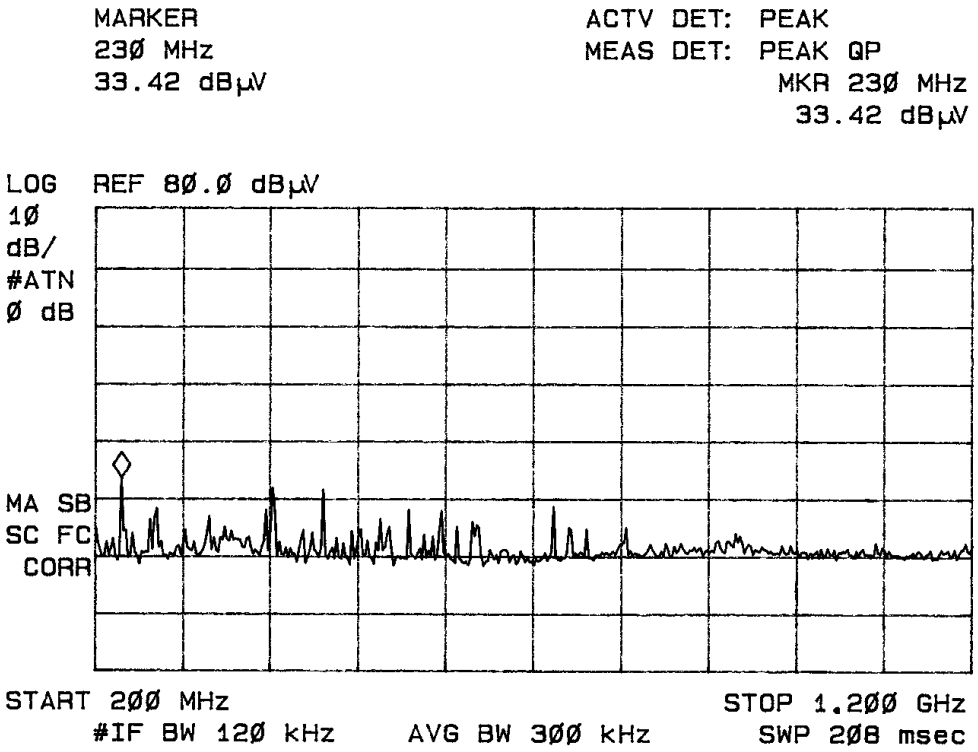

Figure Four General Radiated Emissions taken at 1 meter in screen room

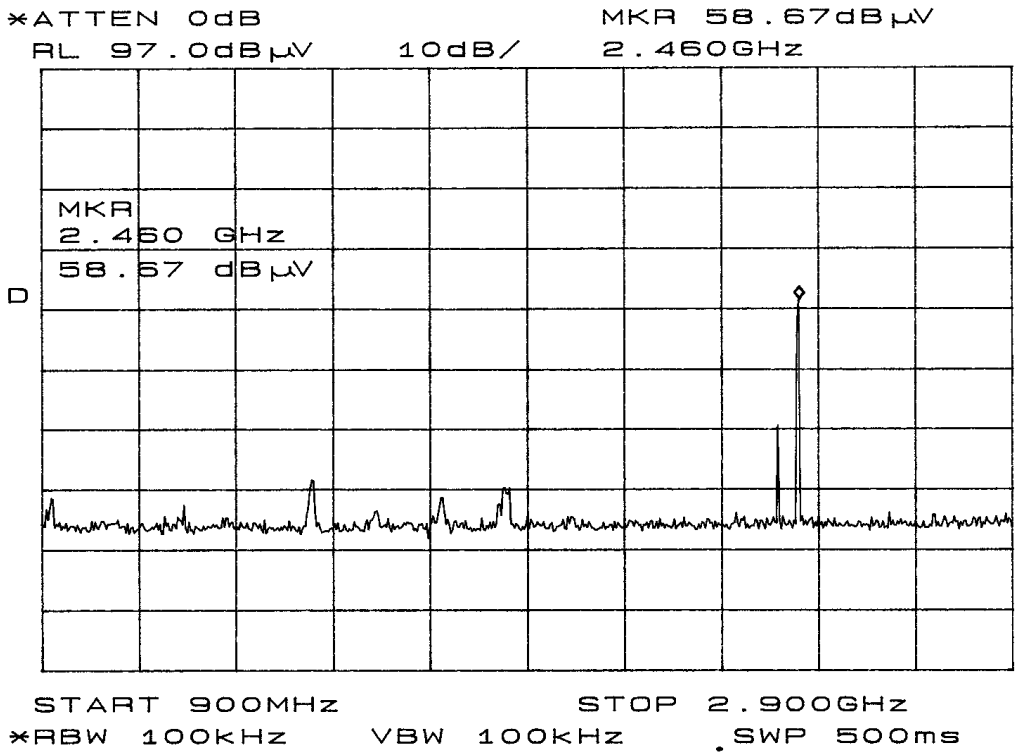

Figure Five General Radiated Emissions taken at 1 meter in screen room

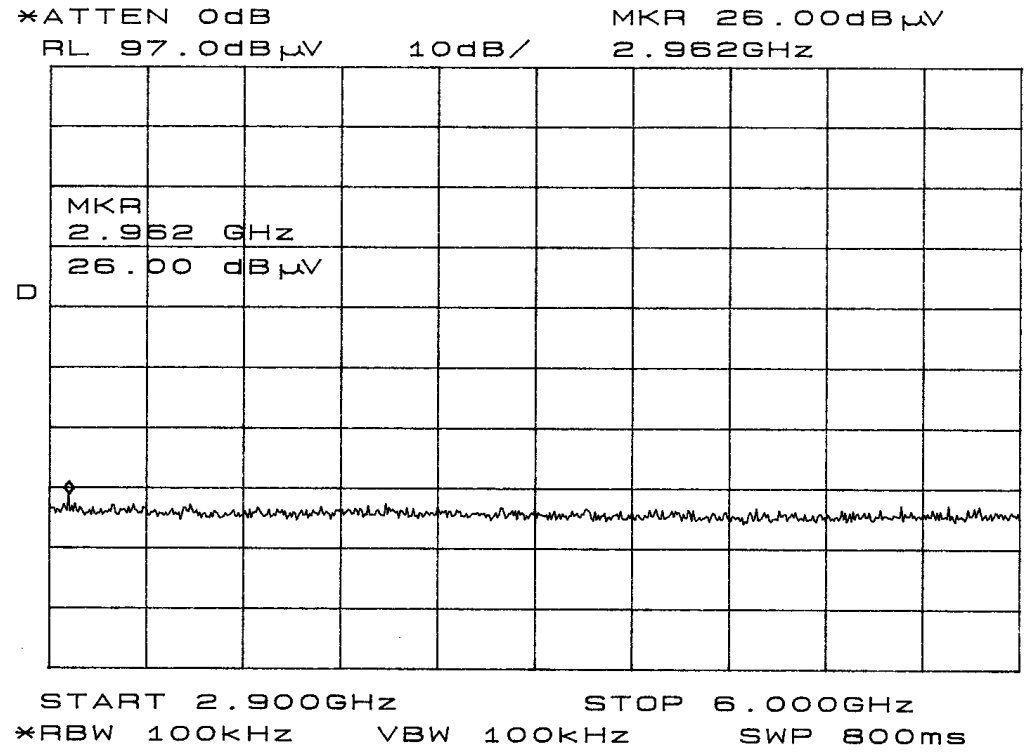

Figure Six General Radiated Emissions taken at 1 meter in screen room

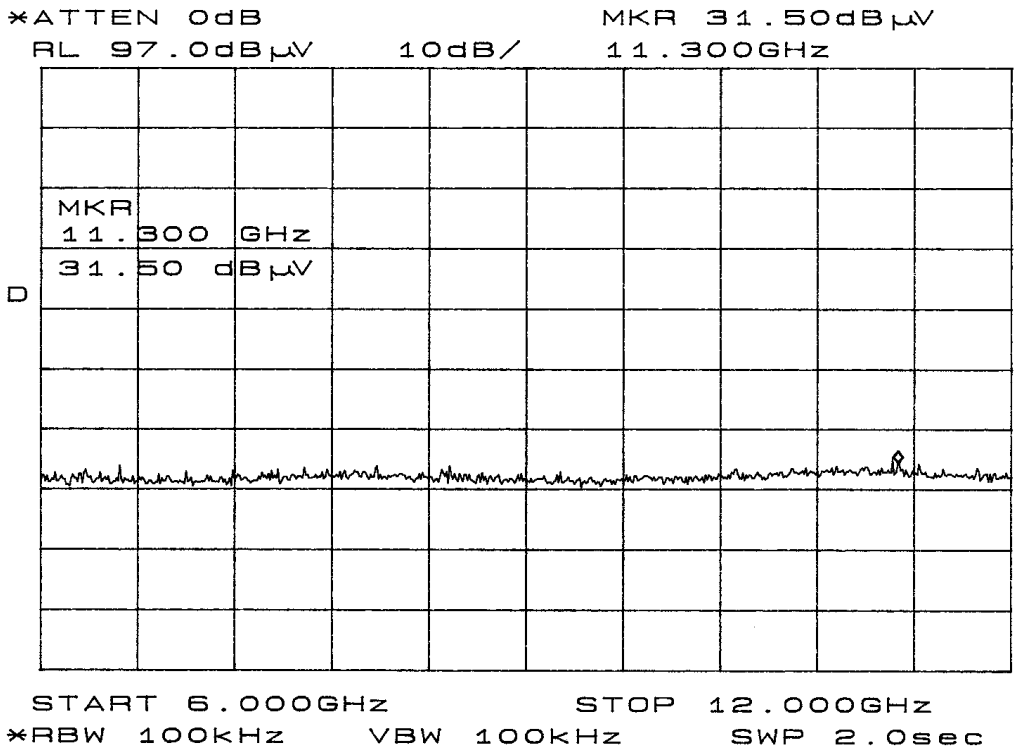

Figure Seven General Radiated Emissions taken at 1 meter in screen room

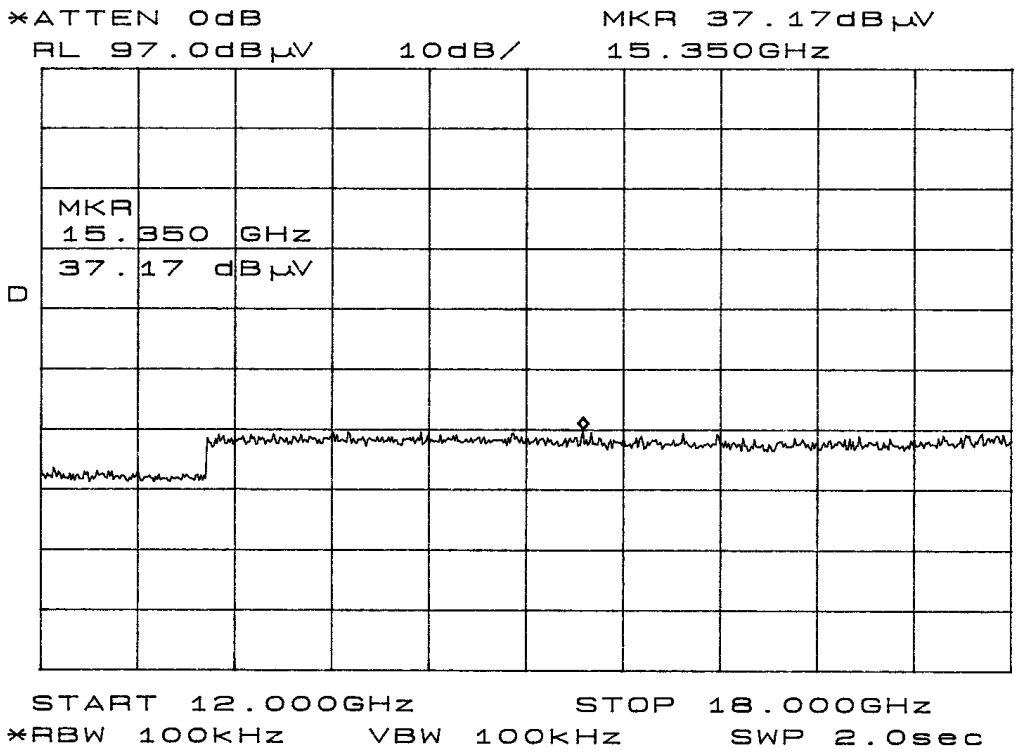

Figure Eight General Radiated Emissions taken at 1 meter in screen room

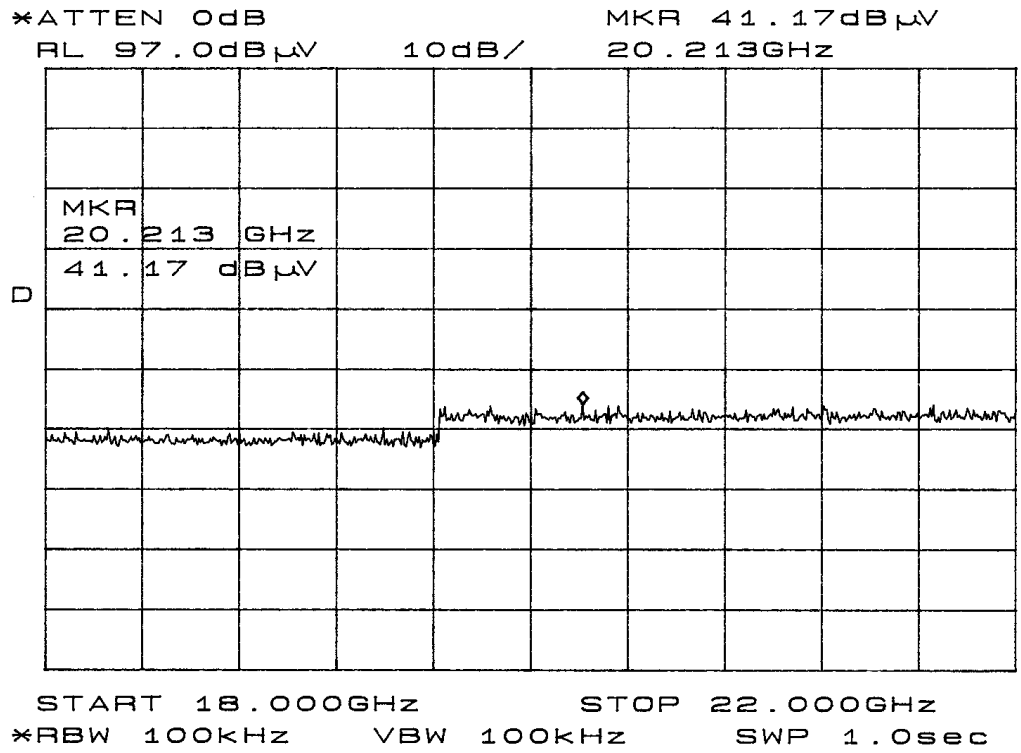

Figure Nine General Radiated Emissions taken at 1 meter in screen room

Radiated Emissions from EUT Data (Highest Emissions) 15.209

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	Limit @ 3m (dBµV/m)
97.7	48.6	49.1	7.3	30	25.9	26.4	43.5
129.0	48.6	52.1	8.0	30	26.6	30.1	43.5
130.2	52.2	53.6	8.0	30	30.2	31.6	43.5
147.5	46.4	47.1	12.5	30	28.9	29.6	43.5
161.0	51.3	52.3	8.8	30	30.1	31.1	43.5
227.9	51.5	47.8	11.3	30	32.8	29.1	46.0
299.9	48.7	40.7	12.9	30	31.6	23.6	46.0
396.3	43.6	44.4	16.3	30	29.9	30.7	46.0
399.5	45.8	47.0	16.6	30	32.4	33.6	46.0
455.8	44.8	45.5	17.8	30	32.6	33.3	46.0
460.8	42.7	44.3	17.8	30	30.5	32.1	46.0
520.8	38.7	26.2	19.1	30	27.8	15.3	46.0
553.0	40.0	38.0	19.5	30	29.5	27.5	46.0
599.1	38.6	40.2	19.2	30	27.8	29.4	46.0
626.8	37.2	40.5	19.5	30	26.7	30.0	46.0
718.9	31.1	42.9	20.7	30	21.8	33.6	46.0

Other emissions present had amplitudes at least 20 dB below the limit.

Summary of Results for General Radiated Emissions 15.209

The EUT demonstrated compliance with the radiated emissions requirements of CFR47 Part 15C paragraph 15.209 Intentional Radiators. The EUT demonstrated a minimum margin of 11.9 dB below the requirements. Other emissions were present with amplitudes at least 20 dB below the Limits.

Statement of Modifications and Deviations

No modifications to the EUT were required for the equipment to demonstrate compliance with the CISPR 22 or CFR47 emissions requirements. There were no deviations or exceptions to the specifications.

15.247 Operation in the Band 2400-2483.5 MHz

The power output was measured at the antenna pot and again on an Open Area Test Site at a 3 meters distance utilizing the antenna configurations listed. The EUT and test fixture was placed on a wooden turntable 0.8 meters above the ground plane and at a distance of 3 meters from the FSM antenna. The peak and average amplitude of the carrier frequency was measured using a spectrum analyzer. The peak and average amplitude of the spurious emissions above 1000 MHz were measured using a spectrum analyzer then data was recorded from the analyzer display. Refer to figures ten through twenty-four for plots of the transmitter emissions taken at the antenna port demonstrating compliance to the specifications. The EUT is a frequency hopping spread spectrum intentional radiator utilizing at least 75 hopping channels. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 0.4 seconds multiplied by number of channels employed. Figures twenty-one and twenty-two demonstrate dwell time on channel. As described in the operational description exhibit, the equipment complies with requirements of channel occupancy. The 2400 and 2483.5 MHz band edges are protected due to the lowest and highest channels used for frequency of operation. Figures twenty-three and twenty-four demonstrate compliance at band edges. The amplitude of each emission was maximized by varying the FSM antenna height, polarization, and by rotating the turntable. Emissions were measured in dBμV/m at three meters. The amplitude of each radiated emission measured was maximized by varying the FSM antenna height, polarization, and by rotating the turntable. A Biconilog Antenna was used for measuring emissions from 30 to 1000 MHz, a Log Periodic Antenna for 200 to 5000 MHz, and Double Ridge and/or Pyramidal Horn Antennas from 4 GHz to 40 GHz. Data was taken per Paragraph 2.1046(a), 15.247 and RSS-210.

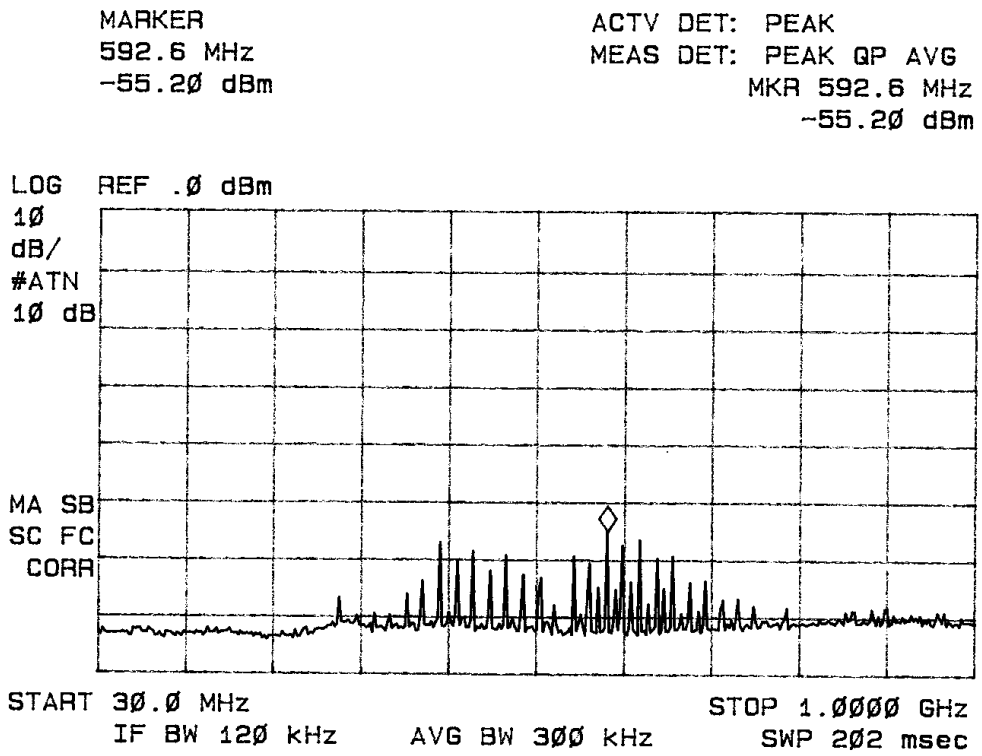

Figure Ten Plot of Antenna Port Conducted Emissions

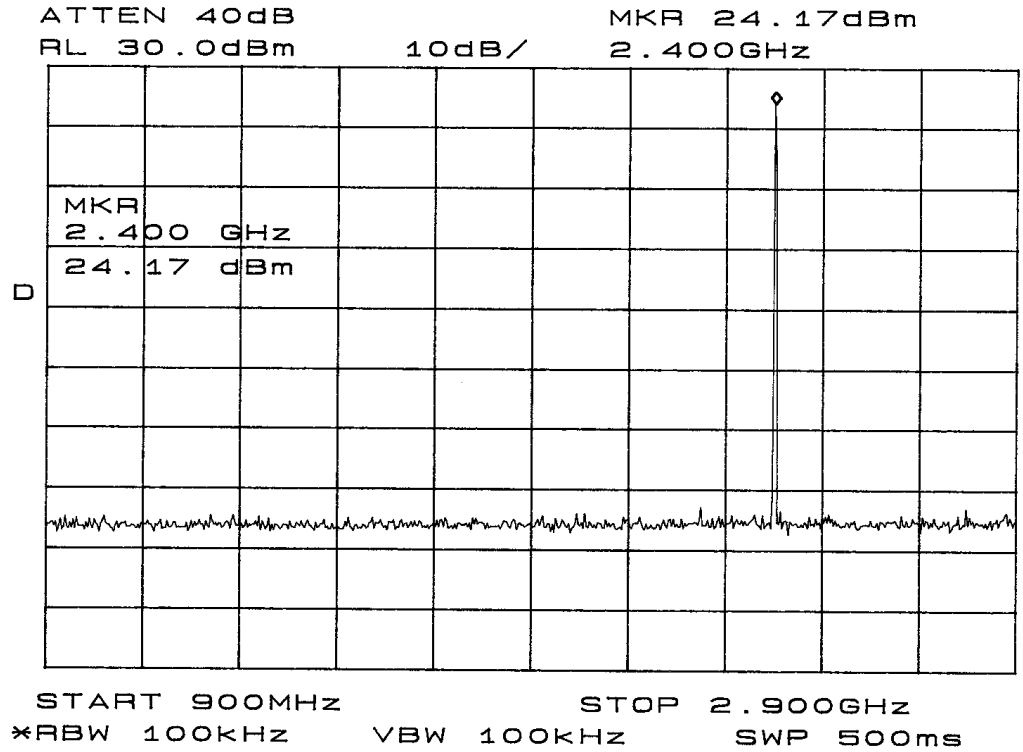

Figure Eleven Plot of Antenna Port Conducted Emissions

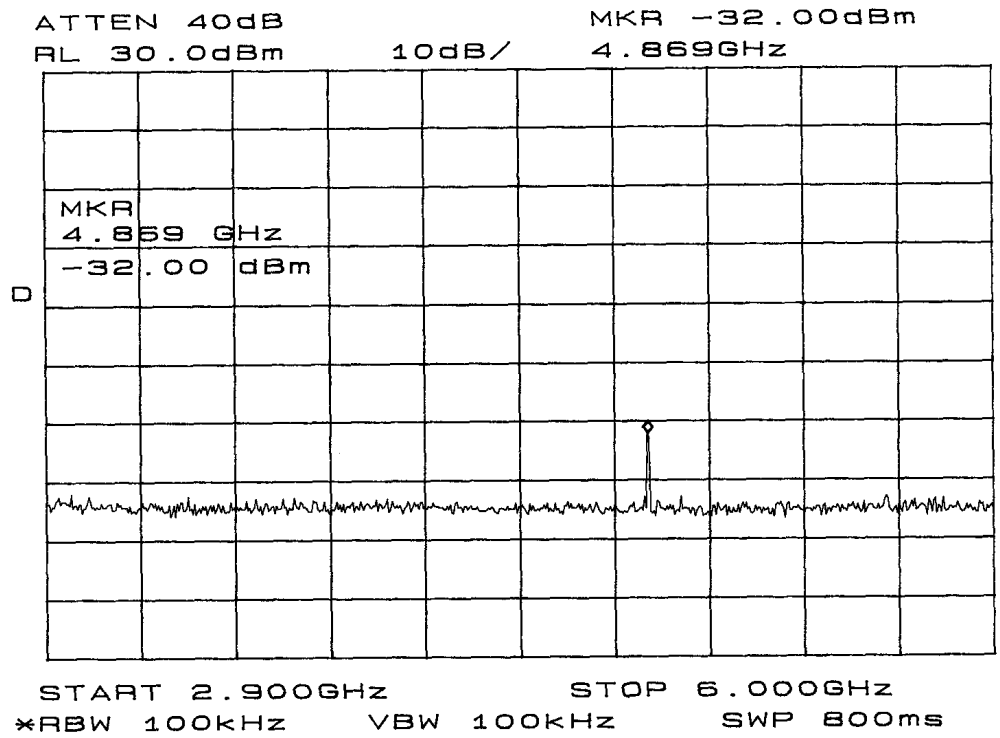

Figure Twelve Plot of Antenna Port Conducted Emissions

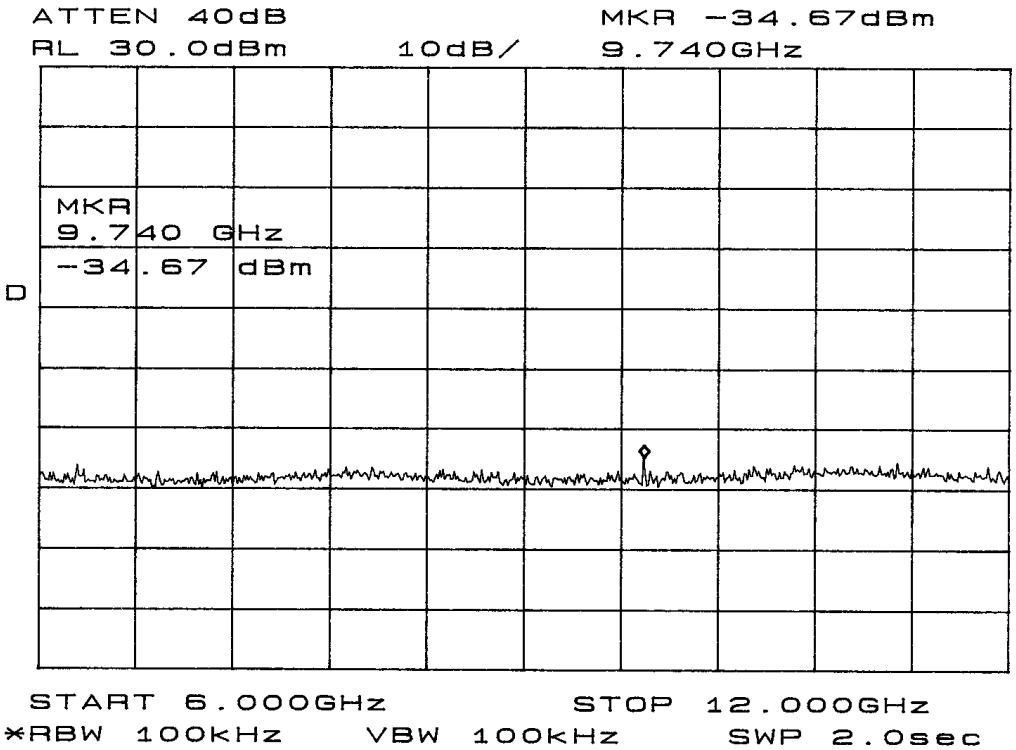

Figure Thirteen Plot of Antenna Port Conducted Emissions

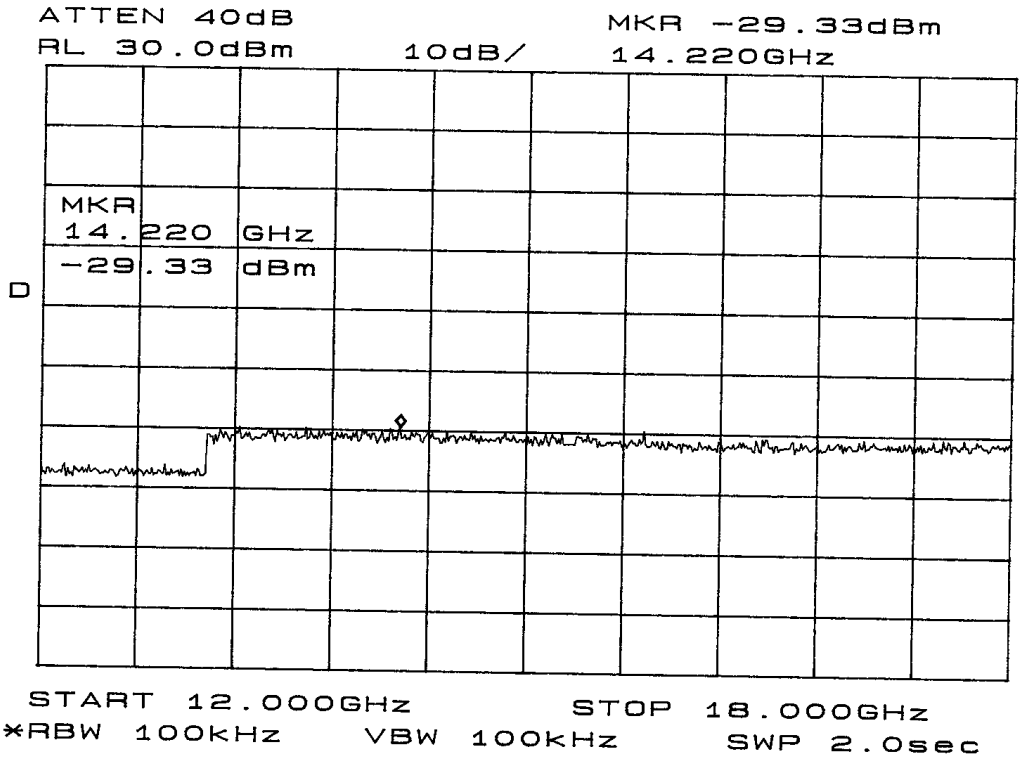

Figure Fourteen Plot of Antenna Port Conducted Emissions

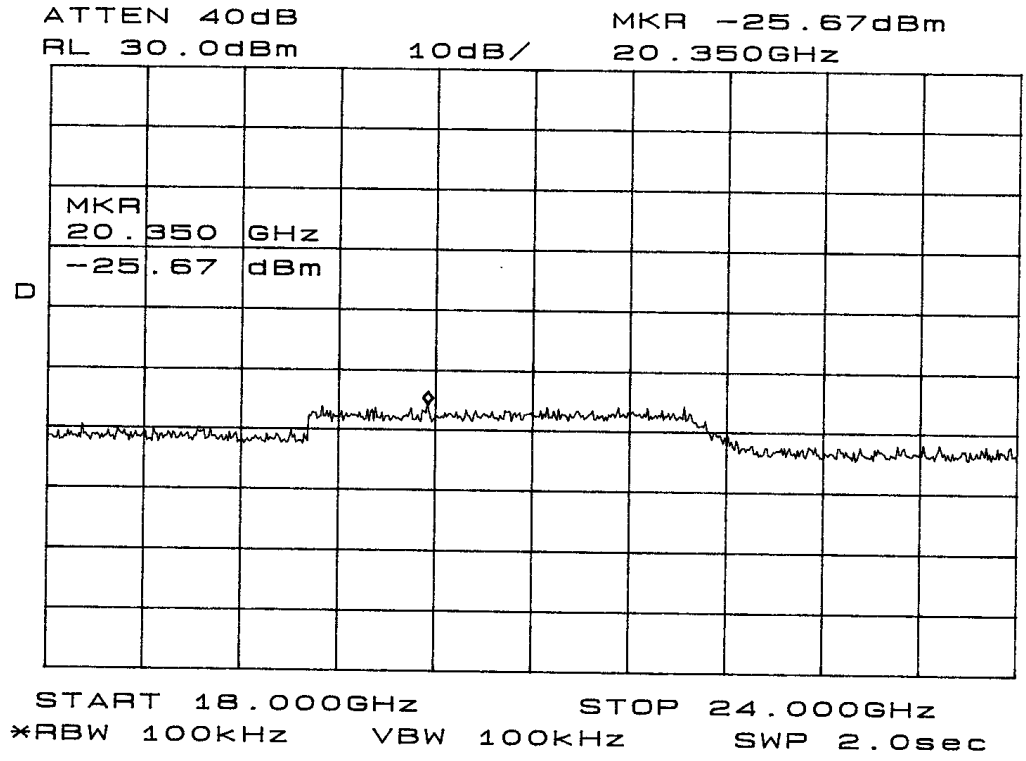

Figure Fifteen Plot of Antenna Port Conducted Emissions

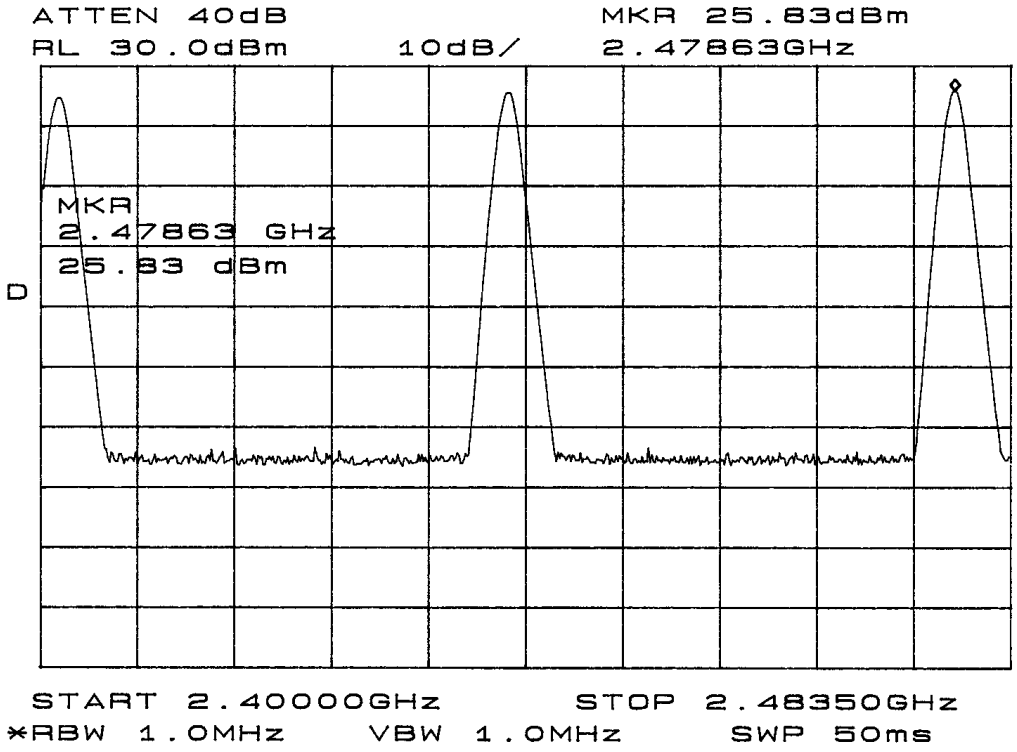

Figure Sixteen Plot of Power Output Across Operational Band

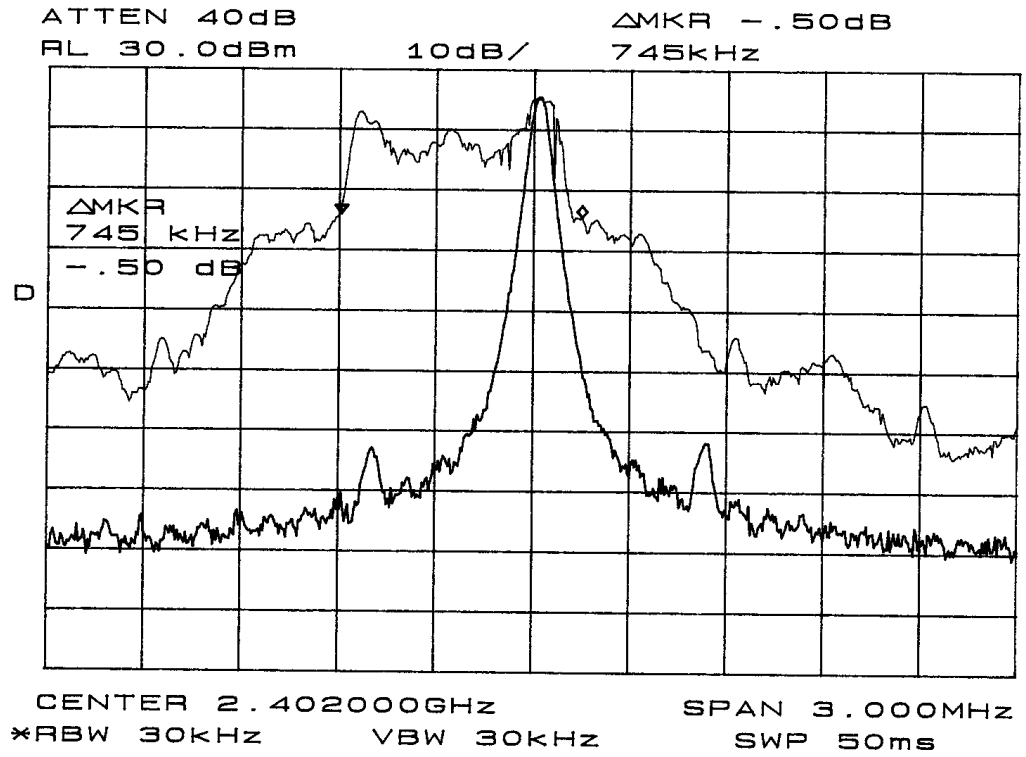

Figure Seventeen Plot of 20 dB Occupied Bandwidth

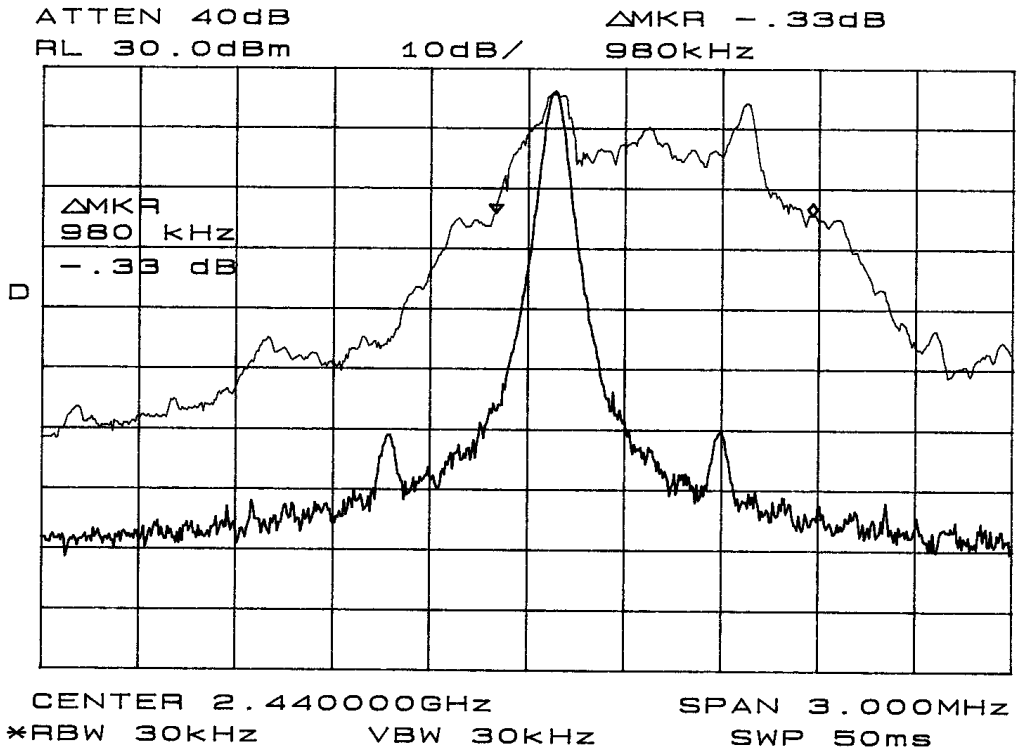

Figure Eighteen Plot of 20 dB Occupied Bandwidth

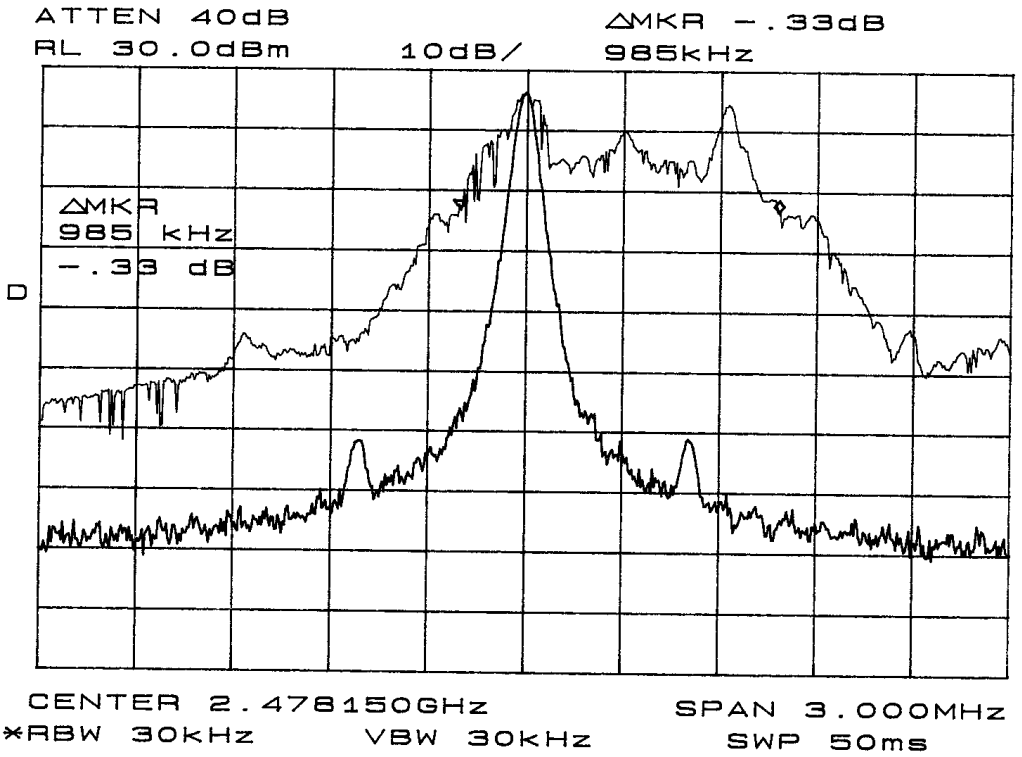

Figure Nineteen Plot of 20 dB Occupied Bandwidth

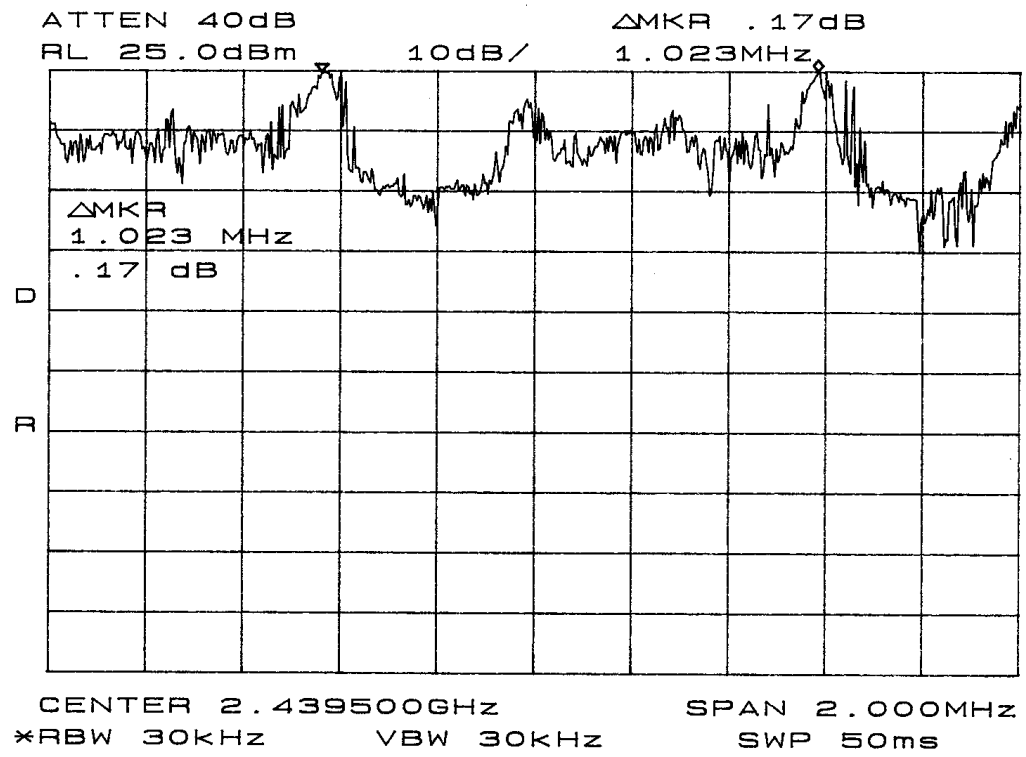

Figure Twenty Plot of Channel Spacing

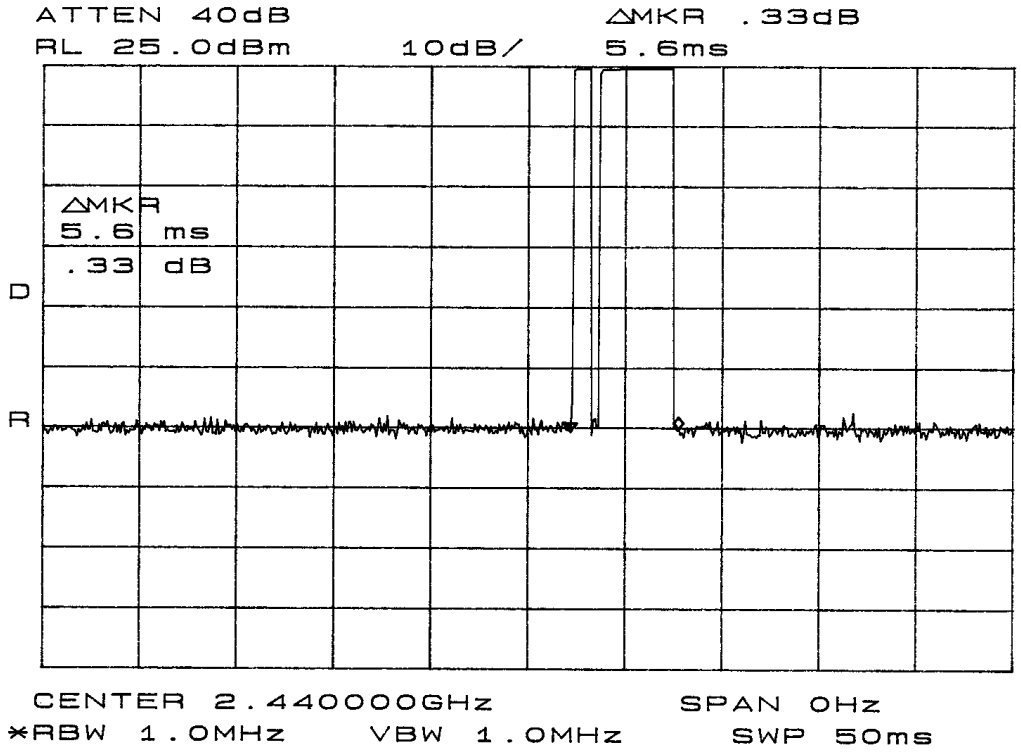

Figure Twenty-one Plot of Dwell time on Channel (LT4424-200)

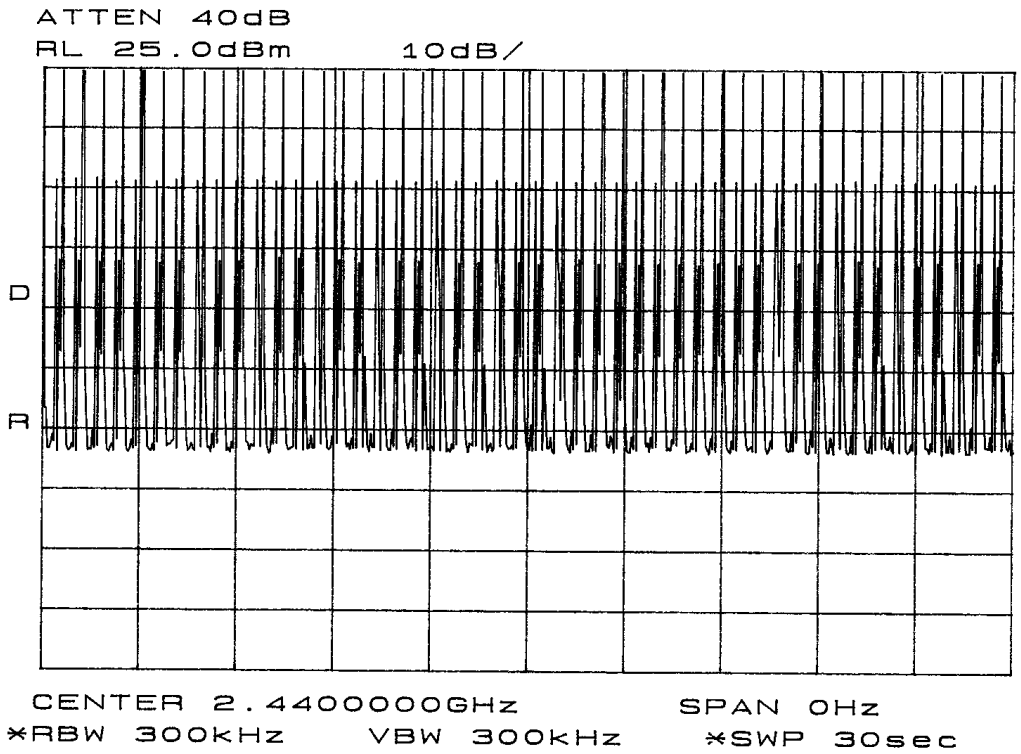

Figure Twenty-two Plot of Channel Occupancy (LT4424-200)

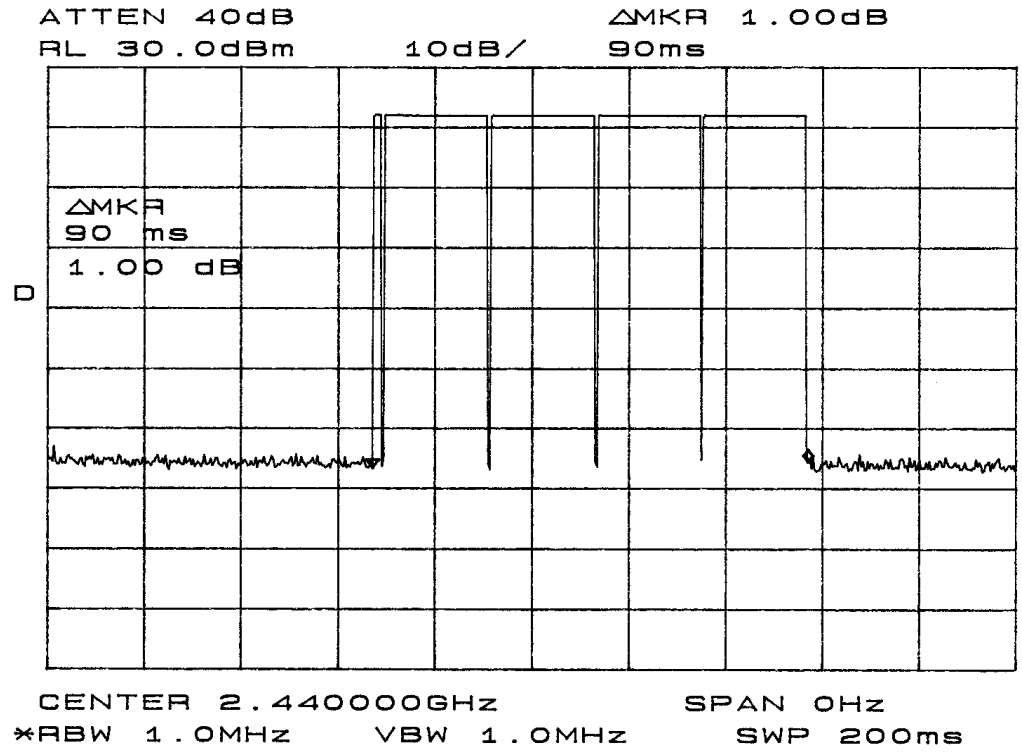

Figure Twenty-three Plot of Dwell time on Channel (LT3124-200)

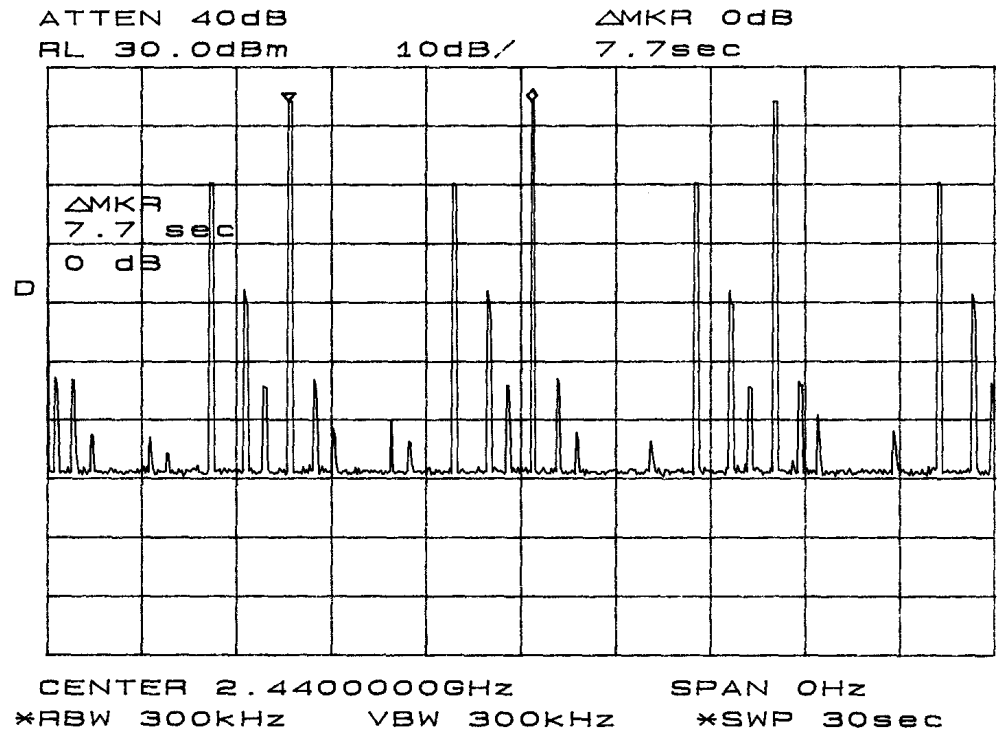

Figure Twenty-four Plot of Channel Occupancy (LT3124-200)

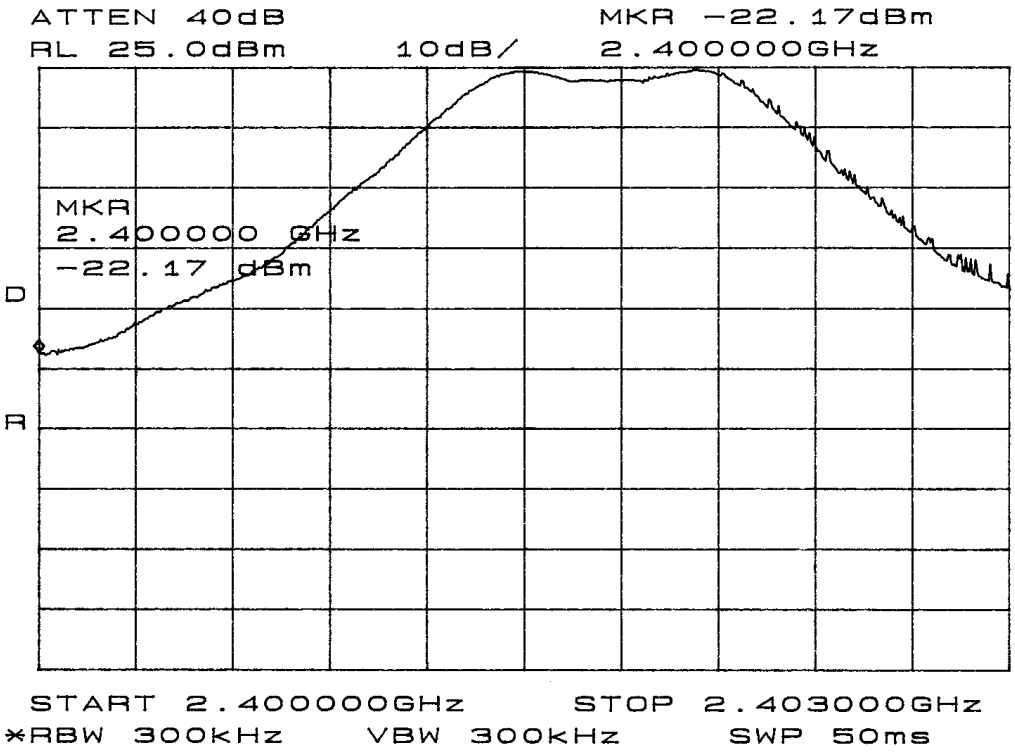

Figure Twenty-five Plot of Low Band Edge

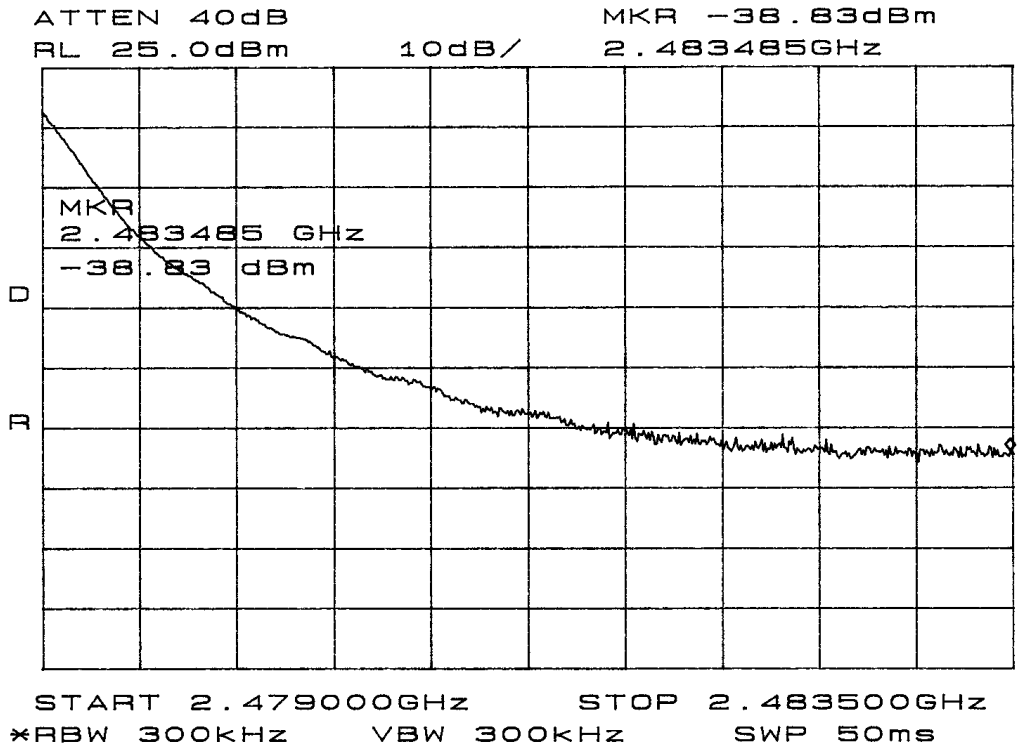

Figure Twenty-six Plot of High Band Edge

Transmitter Antenna Conducted Emissions Data

The antenna conducted output power, power spectral density, and 20-dB bandwidth were measured while operating in available modes. The data reported below represents the worst-case operational conditions.

Frequency MHz	Antenna Conducted Output Power dBm	Antenna Conducted Output Power mW	Occupied Bandwidth kHz
2402.0	25.33	341.2	745
2440.0	25.67	369.0	980
2478.2	25.83	382.8	985

Transmitter Radiated Emissions Data (1 dBi MicroStrip)

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	Limit @ 3m (dBµV/m)
2402.0	109.5	105.5	28.1	20	117.6	113.6	--
4804.0	15.7	16.5	32.9	20	28.6	29.4	54.0
7206.0	18.3	18.1	36.4	20	34.7	34.5	54.0
9608.0	17.2	18.5	38.1	20	35.3	36.6	54.0
12010.0	16.5	17.6	40.0	20	36.5	37.6	54.0
2440.1	111.8	107.5	28.1	20	119.9	115.6	--
4880.2	16.4	17.3	32.9	20	29.3	30.2	54.0
7320.3	18.8	17.5	36.4	20	35.2	33.9	54.0
9760.4	18.3	19.1	38.2	20	36.5	37.3	54.0
12200.5	16.3	17.5	40.4	20	36.7	37.9	54.0
2478.2	112.8	109.3	28.1	20	120.9	117.4	--
4956.3	18.3	17.5	32.9	20	31.2	30.4	54.0
7434.5	18.8	18.6	36.4	20	35.2	35.0	54.0
9912.6	19.5	19.2	38.3	20	37.8	37.5	54.0
12390.8	18.3	18.4	40.5	20	38.8	38.9	54.0
Band Edge Compliance							
2400.0	14.8	16.1	28.1	20	22.9	24.2	54.0
2483.5	17.3	17.6	28.1	20	25.4	25.7	54.0

Other emissions present had amplitudes at least 20 dB below the limit.

Transmitter Radiated Emissions Data (5 dBi Dipole)

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	Limit @ 3m (dBµV/m)
2402.0	108.8	117.0	28.1	20	116.9	125.1	--
4804.0	18.2	16.5	32.9	20	31.1	29.4	54.0
7206.0	18.3	18.1	36.4	20	34.7	34.5	54.0
9608.0	19.6	19.0	38.1	20	37.7	37.1	54.0
12010.0	17.0	17.8	40.0	20	37.0	37.8	54.0
2440.1	107.8	116.5	28.1	20	115.9	124.6	--
4880.2	17.8	17.0	32.9	20	30.7	29.9	54.0
7320.3	18.8	17.0	36.4	20	35.2	33.4	54.0
9760.4	19.3	19.3	38.2	20	37.5	37.5	54.0
12200.5	18.0	17.5	40.4	20	38.4	37.9	54.0
2478.2	107.2	116.3	28.1	20	115.3	124.4	--
4956.3	18.3	16.3	32.9	20	31.2	29.2	54.0
7434.5	19.8	19.6	36.4	20	36.2	36.0	54.0
9912.6	20.8	19.6	38.3	20	39.1	37.9	54.0
12390.8	19.8	17.3	40.5	20	40.3	37.8	54.0
Band Edge Compliance							
2400.0	14.2	16.3	28.1	20	22.3	24.4	54.0
2483.5	16.0	17.8	28.1	20	24.1	25.9	54.0

Other emissions present had amplitudes at least 20 dB below the limit.

Transmitter Radiated Emissions Data (8 dBi Omni)

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	Limit @ 3m (dBµV/m)
2402.0	107.5	120.2	28.1	20	115.6	128.3	--
4804.0	17.8	17.7	32.9	20	30.7	30.6	54.0
7206.0	19.5	19.8	36.4	20	35.9	36.2	54.0
9608.0	18.0	19.8	38.1	20	36.1	37.9	54.0
12010.0	18.1	19.3	40.0	20	38.1	39.3	54.0
2440.1	105.3	120.1	28.1	20	113.4	128.2	--
4880.2	17.0	17.8	32.9	20	29.9	30.7	54.0
7320.3	18.5	19.0	36.4	20	34.9	35.4	54.0
9760.4	18.3	22.3	38.2	20	36.5	40.5	54.0
12200.5	19.6	19.5	40.4	20	40.0	39.9	54.0
2478.2	105.0	120.0	28.1	20	113.1	128.1	--
4956.3	17.5	18.0	32.9	20	30.4	30.9	54.0
7434.5	18.6	19.0	36.4	20	35.0	35.4	54.0
9912.6	18.9	20.0	38.3	20	37.2	38.3	54.0
12390.8	19.1	18.5	40.5	20	39.6	39.0	54.0
Band Edge Compliance							
2400.0	18.5	15.5	28.1	20	26.6	23.6	54.0
2483.5	18.3	18.6	28.1	20	26.4	26.7	54.0

Other emissions present had amplitudes at least 20 dB below the limit.

Transmitter Radiated Emissions Data (9 dBi Panel)

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	Limit @ 3m (dBµV/m)
2402.0	113.0	121.5	28.1	20	121.1	129.6	--
4804.0	17.3	17.8	32.9	20	30.2	30.7	54.0
7206.0	18.3	19.3	36.4	20	34.7	35.7	54.0
9608.0	18.6	18.3	38.1	20	36.7	36.4	54.0
12010.0	19.8	19.0	40.0	20	39.8	39.0	54.0
2440.1	113.8	121.0	28.1	20	121.9	129.1	--
4880.2	17.3	17.0	32.9	20	30.2	29.9	54.0
7320.3	17.2	19.5	36.4	20	33.6	35.9	54.0
9760.4	18.5	19.1	38.2	20	36.7	37.3	54.0
12200.5	18.0	19.0	40.4	20	38.4	39.4	54.0
2478.2	112.2	120.3	28.1	20	120.3	128.4	--
4956.3	17.5	18.6	32.9	20	30.4	31.5	54.0
7434.5	18.5	19.7	36.4	20	34.9	36.1	54.0
9912.6	19.3	20.8	38.3	20	37.6	39.1	54.0
12390.8	18.1	19.3	40.5	20	38.6	39.8	54.0
Band Edge Compliance							
2400.0	15.8	17.1	28.1	20	23.9	25.2	54.0
2483.5	16.3	15.1	28.1	20	24.4	23.2	54.0

Other emissions present had amplitudes at least 20 dB below the limit.

Summary of Results for Radiated Emissions of Intentional Radiator 15.247

The EUT demonstrated antenna conducted output power of 50 milliwatt (at each antenna port) and had the highest radiated emission of 109.1 dBμV/m at 3 meters at the fundamental frequency of operation. The EUT demonstrated a worst-case of 13.5 dB margin below the limit for the harmonic emissions. The EUT demonstrated compliance with the radiated emissions requirements for CFR47 Part 15.247 Intentional Radiators. There are no measurable emissions in the restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 20 dB below the requirements. The specifications of 15.247 were met; there are no deviations or exceptions to the requirements.

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to demonstrate compliance with the CFR47 Part 15C emissions standards. There were no deviations to the specifications.

Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Test Equipment List
- Annex C Rogers Qualifications
- Annex D FCC Site Registration Letter
- Annex E Industry Canada Site Registration Letter

Annex A Measurement Uncertainty Calculations

Radiated Emissions Measurement Uncertainty Calculation

Measurement of vertically polarized radiated field strength over the frequency range 30 MHz to 1 GHz on an open area test site at 3m and 10m includes following uncertainty:

Contribution	Probability Distribution	Uncertainty (dB)
Antenna factor calibration	normal (k = 2)	±0.58
Cable loss calibration	normal (k = 2)	±0.2
Receiver specification	rectangular	±1.0
Antenna directivity	rectangular	±0.1
Antenna factor variation with height	rectangular	±2.0
Antenna factor frequency interpolation	rectangular	±0.1
Measurement distance variation	rectangular	±0.2
Site Imperfections	rectangular	±1.5

Combined standard uncertainty $u_c(y)$ is

$$U_c(y) = \pm \sqrt{\left[\frac{1.0}{2}\right]^2 + \left[\frac{0.2}{2}\right]^2 + \left[\frac{1.0^2 + 0.1^2 + 2.0^2 + 0.1^2 + 0.2^2 + 1.5^2}{3}\right]}$$

$U_c(y) = \pm 1.6$ dB

It is probable that $u_c(y) / s(q_k) > 3$, where $s(q_k)$ is estimated standard deviation from a sample of n readings unless the repeatability of the EUT is particularly poor, and a coverage factor of k = 2 will ensure that the level of confidence will be approximately 95%, therefore:

$$s(q_k) = \sqrt{\frac{1}{(n-1)} \sum_{k-1}^{n} (q_k - \bar{q})^2}$$

$U = 2\ U_c(y) = 2 \times \pm 1.6$ dB $= \pm 3.2$ dB

Notes:

1.1 Uncertainties for the antenna and cable were estimated, based on a normal probability distribution with k = 2.

1.2 The receiver uncertainty was obtained from the manufacturer's specification for which a rectangular distribution was assumed.

1.3 The antenna factor uncertainty does not take account of antenna directivity.

1.4 The antenna factor varies with height and since the height was not always the same in use as when the antenna was calibrated an additional uncertainty is added.

1.5 The uncertainty in the measurement distance is relatively small but has some effect on the received signal strength. The increase in measurement distance as the antenna height is increased is an inevitable consequence of the test method and is therefore not considered a contribution to uncertainty.

1.6 Site imperfections are difficult to quantify but may include the following contributions:
-Unwanted reflections from adjacent objects.
-Ground plane imperfections: reflection coefficient, flatness, and edge effects.
-Losses or reflections from "transparent" cabins for the EUT or site coverings.
-Earth currents in antenna cable (mainly effect biconical antennas).

The specified limits for the difference between measured site attenuation and the theoretical value (± 4 dB) were not included in total since the measurement of site attenuation includes uncertainty contributions already allowed for in this budget, such as antenna factor.

Conducted Measurements Uncertainty Calculation

Measurement of conducted emissions over the frequency range 9 kHz to 30 MHz includes following uncertainty:

Contribution	Probability Distribution	Uncertainty (dB)
Receiver specification	rectangular	±1.5
LISN coupling specification	rectangular	±1.5
Cable and input attenuator calibration	normal (k=2)	±0.5

Combined standard uncertainty $u_c(y)$ is

$$U_c(y) = \pm \sqrt{\left[\frac{0.5}{2}\right]^2 + \frac{1.5^2 + 1.5^2}{3}}$$

$U_c(y) = \pm 1.2$ dB

As with radiated field strength uncertainty, it is probable that $u_c(y) / s(q_k) > 3$ and a coverage factor of k = 2 will suffice, therefore:

$U = 2\ U_c(y) = 2 \times \pm 1.2$ dB $= \pm 2.4$ dB

Annex B Test Equipment List For Rogers Labs, Inc.

The test equipment used is maintained in calibration and good operating condition. Use of this calibrated equipment ensures measurements are traceable to national standards.

List of Test Equipment	Calibration Date
Oscilloscope Scope: Tektronix 2230	2/09
Wattmeter: Bird 43 with Load Bird 8085	2/09
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/09
H/V Power Supply: Fluke Model: 408B (SN: 573)	2/09
R.F. Generator: HP 606A	2/09
R.F. Generator: HP 8614A	2/09
R.F. Generator: HP 8640B	2/09
Spectrum Analyzer: HP 8562A, Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W HP Adapters: 11518, 11519, 11520	5/08
Spectrum Analyzer: HP 8591EM	5/08
Frequency Counter: Leader LDC825	2/09
Antenna: EMCO Biconilog Model: 3143	5/08
Antenna: EMCO Log Periodic Model: 3147	10/08
Antenna: Antenna Research Biconical Model: BCD 235	10/08
Antenna: EMCO Dipole Set 3121C	2/09
Antenna: C.D. B-101	2/09
Antenna: Solar 9229-1 & 9230-1	2/09
Antenna: EMCO 6509	2/09
Audio Oscillator: H.P. 201CD	2/09
R.F. Power Amp 65W Model: 470-A-1010	2/09
R.F. Power Amp 50W M185- 10-501	2/09
R.F. PreAmp CPPA-102	2/09
LISN 50 µHy/50 ohm/0.1 µf	10/08
LISN Compliance Eng. 240/20	2/09
LISN Fischer Custom Communications FCC-LISN-50-16-2-08	2/09
Peavey Power Amp Model: IPS 801	2/09
Power Amp A.R. Model: 10W 1010M7	2/09
Power Amp EIN Model: A301	2/09
ELGAR Model: 1751	2/09
ELGAR Model: TG 704A-3D	2/09
ESD Test Set 2010i	2/09
Fast Transient Burst Generator Model: EFT/B-101	2/09
Current Probe: Singer CP-105	2/09
Current Probe: Solar 9108-1N	2/09
Field Intensity Meter: EFM-018	2/09
KEYTEK Ecat Surge Generator	2/09

Annex C Rogers Qualifications

Scot D. Rogers, Engineer

Rogers Labs, Inc.

Mr. Rogers has approximately 17 years experience in the field of electronics. Six years working in the automated controls industry and 6 years working with the design, development and testing of radio communications and electronic equipment.

Positions Held

Systems Engineer: A/C Controls Mfg. Co., Inc. 6 Years

Electrical Engineer: Rogers Consulting Labs, Inc. 5 Years

Electrical Engineer: Rogers Labs, Inc. Current

Educational Background

1) Bachelor of Science Degree in Electrical Engineering from Kansas State University.

2) Bachelor of Science Degree in Business Administration Kansas State University.

3) Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming.

Scot D Rogers

Scot D. Rogers

NVLAP Lab Code 200087-0

Annex D FCC Site Registration Letter

FEDERAL COMMUNICATIONS COMMISSION

Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046

June 18, 2008

Registration Number: 90910

Rogers Labs, Inc.
4405 West 259th Terrace,
Louisburg, KS 66053

Attention: Scot Rogers

Re: Measurement facility located at Louisburg
3 & 10 meter site
Date of Renewal: June 18, 2008

Dear Sir or Madam:

Your request for renewal of the registration of the subject measurement facility has been received. The information submitted has been placed in your file and the registration has been renewed. The name of your organization will remain on the list of facilities whose measurement data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Please note that the file must be updated for any changes made to the facility and the registration must be renewed at least every three years.

Measurement facilities that have indicated that they are available to the public to perform measurement services on a fee basis may be found on the FCC website www.fcc.gov under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,

Phyllis Parrish
Industry Analyst

Annex E Industry Canada Site Registration Letter

Industry Canada Industrie Canada

July 29th, 2008

OUR FILE: 46405-3041
Submission No: 127059

Rogers Labs Inc.
4405 West 259th Terrace
Louisburg KY 66053
USA

Attention: Scot D. Rogers

Dear Sir/Madame:

The Bureau has received your application for the registration / renewal of a 3/10m OATS. Be advised that the information received was satisfactory to Industry Canada. The following number(s) is now associated to the site(s) for which registration / renewal was sought **(3040A-1).** Please reference the appropriate site number in the body of test reports containing measurements performed on the site. In addition, please be informed that the Bureau is now utilizing a **new site numbering scheme** in order to simplify the electronic filing process. Our goal is to reduce the number of secondary codes associated to one particular company. The following changes have been made to your records.

Your primary code is: **3041**
The company number associated to the site(s) located at the above address is: **3041A**
The table below is a summary of the changes made to the unique site registration number(s):

New Site Number	Obsolete Site Number	Description of Site	Expiry Date (YYYY-MM-DD)
3041A-1	3041-1	3 / 10m OATS	2010-07-29

Furthermore, to obtain or renew a unique site number, the applicant shall demonstrate that the site has been accredited to ANSI C63.4-2003 or later. A scope of accreditation indicating the accreditation by a recognized accreditation body to ANSI C63.4-2003 shall be accepted. Please indicate in a letter the previous assigned site number if applicable and the type of site (example: 3 meter OATS or 3 meter chamber). If the test facility is not accredited to ANSI C63.4-2003 or later, the test facility shall submit test data demonstrating full compliance with the ANSI standard. The Bureau will evaluate the filing to determine if recognition shall be granted.

The frequency for re-validation of the test site and the information that is required to be filed or retained by the testing party shall comply with the requirements established by the accrediting organization. However, in all cases, test site re-validation shall occur on an interval not to exceed two years. There is no fee or form associated with an OATS filing. OATS submissions are encouraged to be submitted electronically to the Bureau using the following URL;

If you have any questions, you may contact the Bureau by e-mail at certification.bureau@ic.gc.ca
Please reference our file and submission number above for all correspondence.

Yours sincerely,

S. Proulx Wireless Laboratory
Manager Certification and
Engineering Bureau Industry Canada
3701 Carling Ave., Building 94
Ottawa, Ontario K2H 8S2
Canada

Canada