



**FCC Test Report  
for  
CelPlan Technologies, Inc.  
FR-100 Flexi-Radio  
FCC ID: TFF-FR-100**

**March 30, 2007**

Revised: January 14, 2008

Prepared for:

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Prepared By:

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**FCC Certification Test Report  
for the  
CelPlan Technologies, Inc.  
FR-100 Flexi-Radio  
FCC ID: TFF-FR-100**

**March 30, 2007**

WLL JOB# 9148

Prepared by: Michael F. Violette  
President

Reviewed by: Steve Koster  
EMC Operations Manager

## Abstract

This report has been prepared on behalf of CelPlan Technologies, Inc. to support the attached Application for Equipment Authorization.

The CelPlan Technologies, Inc. FR-100 Flexi-Radio complies with the limits for a Transmitter device under FCC Part 15E.

## Composite Application

This report is one part of a two-part composite application for the FR-100 radio. The equipment described herein will also be authorized under Part 90 of the FCC Rules for operation in the 4940-4990 MHz band and the 5850-5925 band for licensed operation. A separate report has been prepared to document the testing for the licensed operation.

## Modular Approval

This application is for a Modular Approval under the provisions of DA 00-1407. The FR-100 transmitters that can be installed in CelPlan-configured systems as well as marketed to other assemblers as a Modular Approval.

The test report and application are submitted for a Transmitter under Part 15E of the FCC Rules and Regulations. This Certification Test Report documents the test configuration and test results for a CelPlan Technologies, Inc. FR-100 Flexi-Radio.

Radiated measurements were performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

Conducted measurements of power, power spectral density and bandwidth were performed by Celplan. Summaries of these data are provided herein as part of this report.

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## 1 Introduction

### 1.1 Compliance Statement

The CelPlan Technologies, Inc. FR-100 Flexi-Radio complies with the limits for a Digital Transmission System Transmitter device under FCC Part 15E.

### 1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed according to:

- DA 02-2138 - Measurement Procedure Updated for Peak Transmit Power in the Unlicensed National Information Infrastructure (U-NII) Bands
- ET Docket No. 03-122- Interim Measurement Procedures For DFS Equipped U-NII Devices
- DA 00-1407 - Part 15 Unlicensed Modular Transmitter Approval

All measurements were performed in accordance with the 2003 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

### 1.3 Contract Information

Customer: CelPlan Technologies, Inc.  
1835 Alexander Bell Drive  
Suite 200  
Reston, VA 20191

### 1.4 Test and Support Personnel

Washington Laboratories, LTD Mike Violette, Steve Dovell, Greg Snyder,  
John Repella

Client Representative Leonhard Korowajczuk, Nikhil Mahur

## 2 Equipment Under Test

### 2.1 Description of CelPlan Flexi-Radio

The Flexi-radio is a multi-band, multi-use radio using OFDM technology. It is wide-band tunable and is compliant with 802.11a/b/g communication standards.

The radio operates over the frequency range of 4940 to 5925MHz. The design of the radio is such that the supplier provides firmware settings that limit and manage the frequency and output powers at the channels of operation. *The end user has no capability of modifying these settings.*

Each radio has two antenna ports for diversity. The equipment is professionally installed with two antenna options (patch and omni). In its final configuration, the radio will be mobile, fixed to a building, outside in a pole-mounted configuration, and/or installed on an emergency vehicle, as allowed for in the operation of the FCC Rules and under Licensing provisions (as applicable).

Certification is sought under FCC Part 15E for a modular approval.

In a configuration supplied and configured for a typical user, other radio transmitters (of the same design) will be located in the same chassis, operating either under the unlicensed UNII bands or under the licensed operation of Part 90 for Public Safety and/or Intelligent Transportation Systems.

## 2.2 Certification Under Part 15E

Data are presented in this report for the following module:

FCC RULE	FREQUENCY BAND	CHANNELS MEASURED
15E	5150-5250 MHz	Low, High

At a nominal channel bandwidth of 20 MHz, the radio is capable of operating at 6, 12, 18, 36, 48 and 54 Mbps. Two modulations were measured BPSK and 64QAM at data rates of 6Mbps and 54MBps, respectively.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	CelPlan Technologies, Inc.
FCC ID:	TFF-FR-100
EUT Name:	Flexi-Radio
Model:	FR-100
<b>FCC Rule Parts:</b>	15E
<b>Frequency Ranges:</b>	5150-5250 MHz
<b>Maximum Output Power</b>	<b>dBm</b>
UNII: 5150-5250 MHz	17.0
<b>Modulation:</b>	OFDM
<b>Occupied Bandwidth:</b>	<b>MHz</b>
UNII: 5150-5250 MHz	23.9 MHz (26 dB Bandwidth)
Keying:	Continuous
Type of Information:	Data
Number of Channels:	N/A
Power Output Level	Fixed by Manufacturer
Antenna Connector	Two connectors for diversity for each output
Antenna Type	Omni, Patch and Bidirectional
Interface Cables:	N/A
Power Source & Voltage:	From Host System

### 2.3 Antennas Employed In Fixed Installations

Following are data on the antennas to be used in the system:

Type		5.2 GHz
Omni	Mfgr	Hyperlink
	Model	HG5310U
	Gain (dBi)	10
Panel (patch)	Mfgr	Hyperlink
	Model	HG4953P
	Gain (dBi)	8
Directional	Mfgr	MAXRAD
	Model	WISP4959018MBV
	Gain (dBi)	18

### 2.4 Test Configuration

The FR-100 was set up and operating under external PC control with no chassis. The PC commanded the Flexi-Radio to tune to the particular frequencies and adjust the power output.

### 2.5 Testing Algorithm

Worst case emission levels are provided in the test results data. The settings that are determined during compliance testing are stored in a “lookup” table in the radio firmware to assure that the power and frequency selection are maintained for compliance.

### 2.6 Test Location

Radiated measurements were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

Conducted quantities were measured by CelPlan engineers.

### 2.7 Measurements

#### 2.7.1 References

- FCC Public Notice DA 00-1407, *Part 15 Unlicensed Modular Transmitter Approval*. Released: June 26, 2000;
- ANSI C63.2 *Specifications for Electromagnetic Noise and Field Strength Instrumentation*

- ANSI C63.4 *American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz*

### 2.7.2 Measurement Uncertainty

All results reported herein relate only to the equipment tested. For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is  $\pm 2.3$  dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty =  $0.5 (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$  dB.

### 3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Site 1 List:

Test Name:		Test Date:	
Asset #	Manufacturer/Model	Description	Cal. Due
00382	SUNOL, JB1	BICONLOG	01/25/2007
00028	EMCO, 3146	ANTENNA, LOG PERIODIC	09/21/2006
00026	EMCO, 3110B	ANTENNA, BICONICAL	12/19/2006
00004	ARA, DRG-118/A	ANTENNA, DRG, 1-18GHZ	02/02/2007
00257	HP, 8672A-K22	FREQUENCY EXTENTION UNIT	10/2/2007
00075	HP, 8648C	GENERATOR, RF SIGNAL	05/15/2008
00069	HP, 85650A	ADAPTER, QP	06/26/2007
00071	HP, 85685A	PRESELECTOR, RF	06/26/2007
00073	HP, 8568B	ANALYZER, SPECTRUM	06/26/2007
00425	ARA, DRG-118/A	ANTENNA, DRG, 1-18GHZ	01/17/2007
00337	WLL, 1.2-5GHZ	FILTER, BAND PASS	2/7/2007
00080	HP, 8672A	GENERATOR, RF SIGNAL	10/2/2007

#### 3.1 Part 15E UNII Band

This section documents the results of measurements of the EUT to the requirements in Subpart E of Part 15 for the bands 5150-5250MHz.

Following is a summary of the settings that were used during the data collection.

Table 3. Summary of Operating Parameters

Frequency (MHz)	Bandwidth (MHz)	Data Rate (Mbit/s)	Modulation	Power #	Emission Bandwidth
5180	20	6	BPSK	13.5	23.8
5180	20	54	64QAM	13	23.9
5240	20	6	BPSK	12.5	23.0
5240	20	54	64QAM	13	23.7

##### 3.1.1 15.407(a) Peak Transmit Power

The Peak Transmit Power was measured during continuous transmission using a power meter with an rms detector.

The results are shown Table 4.

Table 4. Peak Transmit Power Results

Frequency Range	Measured Power (dBm)	Transmit Power Limit (dBm)	Result
5150-5250 MHz	17.0	17.0	Pass

### 3.1.2 15.407(a)(5) Power Spectral Density

The Power Spectral Density was measured during continuous transmission using a spectrum analyzer with an rms detector. The output of the radio was connected to the input of the spectrum analyzer set to a 1 MHz resolution bandwidth and the power spectral density function used to make the measurement.

The Power Spectral Density results are shown in Table 5.

Table 5. Peak Power Spectral Density

Frequency Range	Measured PSD	Limit dBm/MHz	Result
5150-5250 MHz	2.5	4	Pass

### 3.1.3 15.407(a)(6) Peak Excursion

The Peak Excursion was measured during continuous transmission using a spectrum analyzer with an rms detector. The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power (measured as specified above) shall not exceed the limits as shown in the table.

The output of the radio was connected to the input of the spectrum analyzer. Trace A was set to measure the power as reported above using rms detection. Trace B was set to “Peak Hold”. The difference between Trace A and Trace B is the Peak Excursion.

Table 6. Peak Excursion

Frequency Range	Measured Peak Excursion	Limit dBm/MHz	Result
5150-5250 MHz	4.0	13	Pass

### 3.1.4 Occupied Bandwidth

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer and measuring the 26dB BW per 15.403(i). A representative plot is shown below:

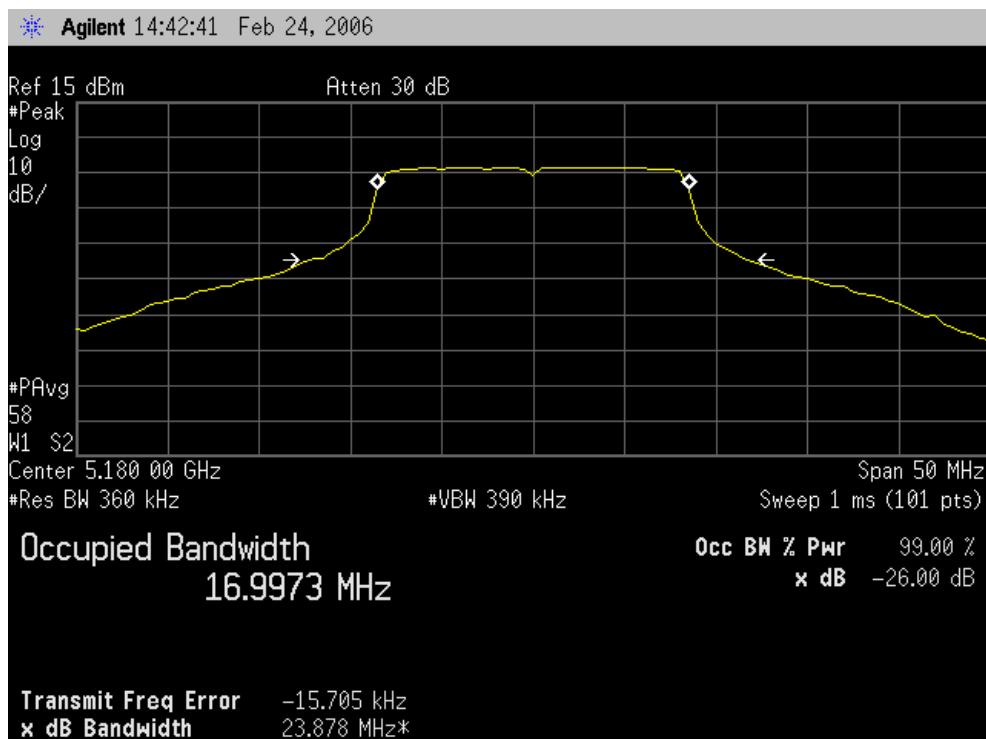


Figure 1. Emission Bandwidth

Table 7 provides a summary of the Occupied Bandwidth Results.

Table 7. Occupied Bandwidth Summary (26 dB BW)

Frequency Range	Occupied BW	Limit	Result
5150-5250 MHz	23.9	None	NA

### 3.1.5 15.407(b)(6) Undesirable Emissions; 30MHz-40GHz

#### 3.1.5.1 Spurious Conducted Emissions

Spurious conducted emissions were measured over the frequency range of 30 MHz to 40 GHz. The results of the emissions measurements are provided in the following figures.

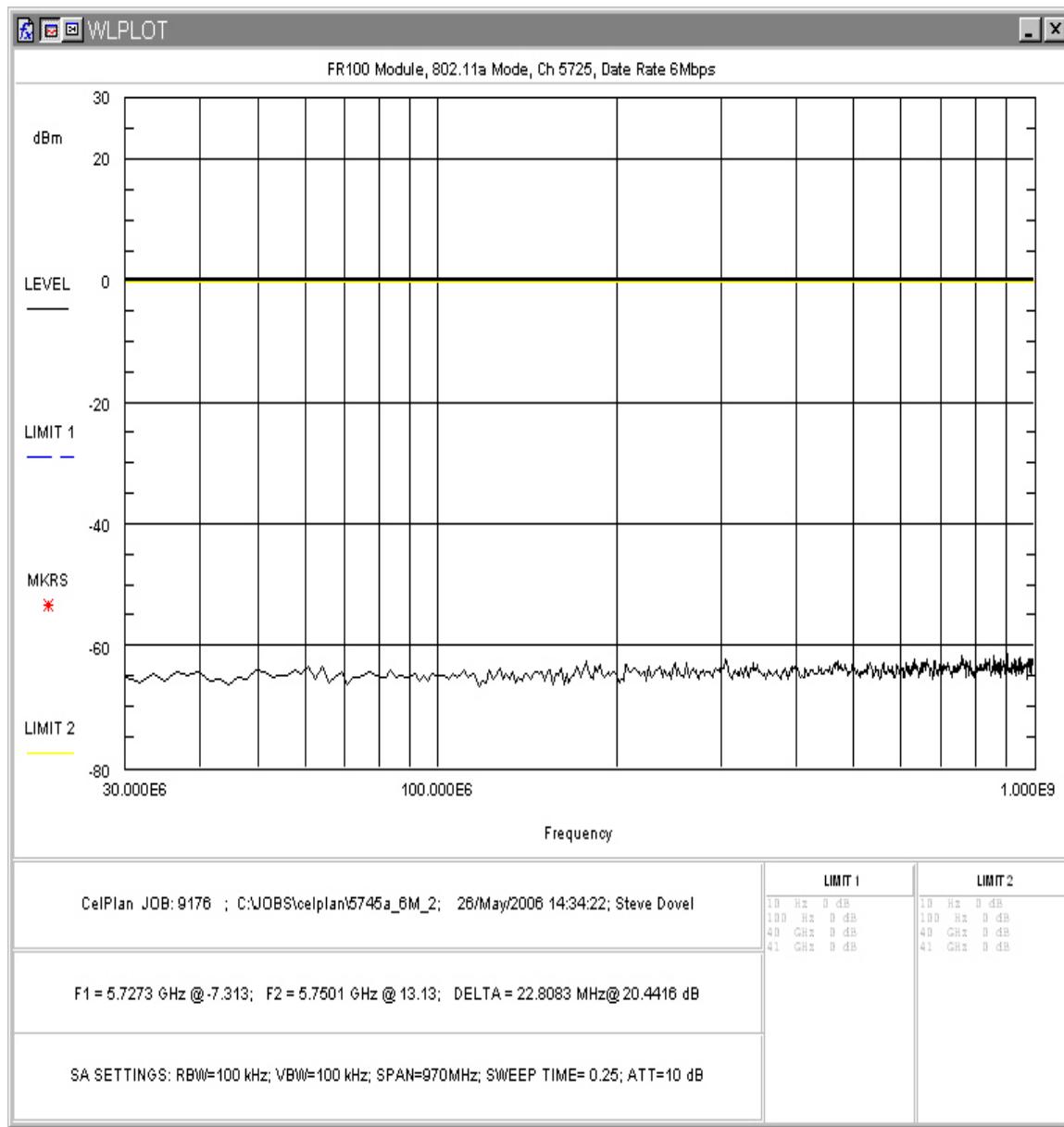


Figure 2. Spurious Emissions 5745 MHz 30MHz-1 GHz, 6 Mbps

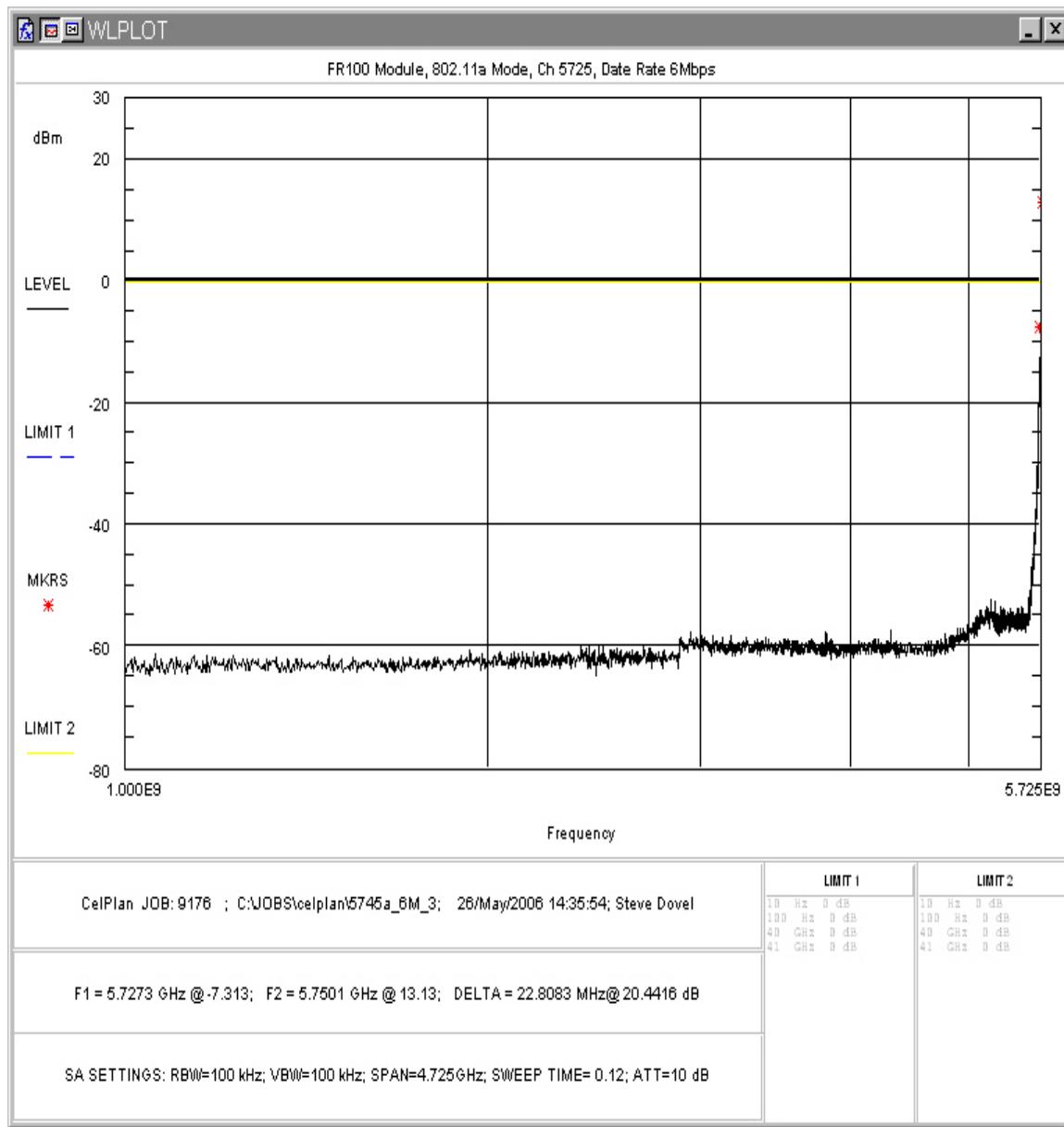


Figure 3. Spurious Emissions 5745 MHz 5-25GHz, 6 Mbps

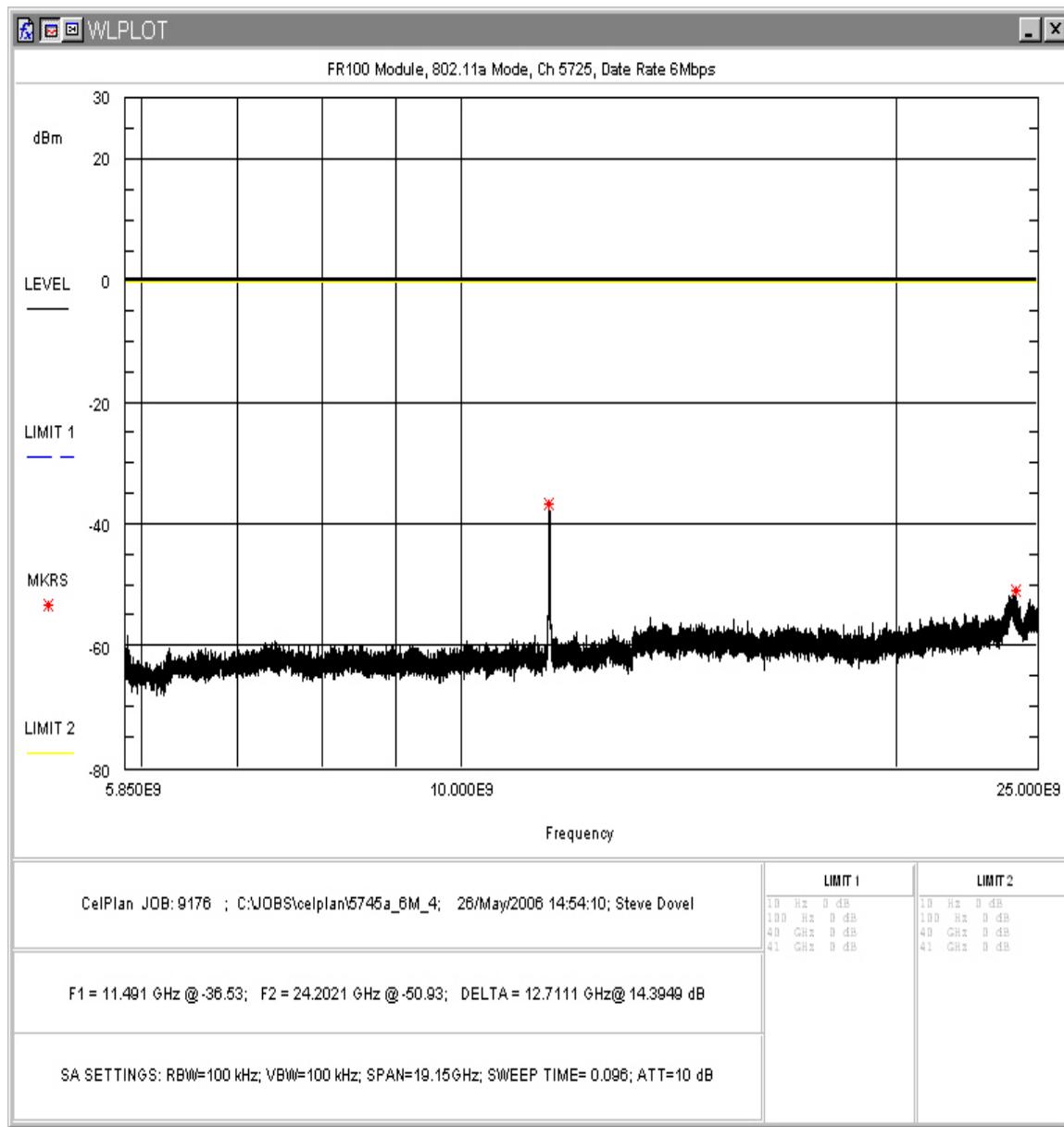


Figure 4. Spurious Emissions 5745 MHz 5-25GHz, 6 Mbps

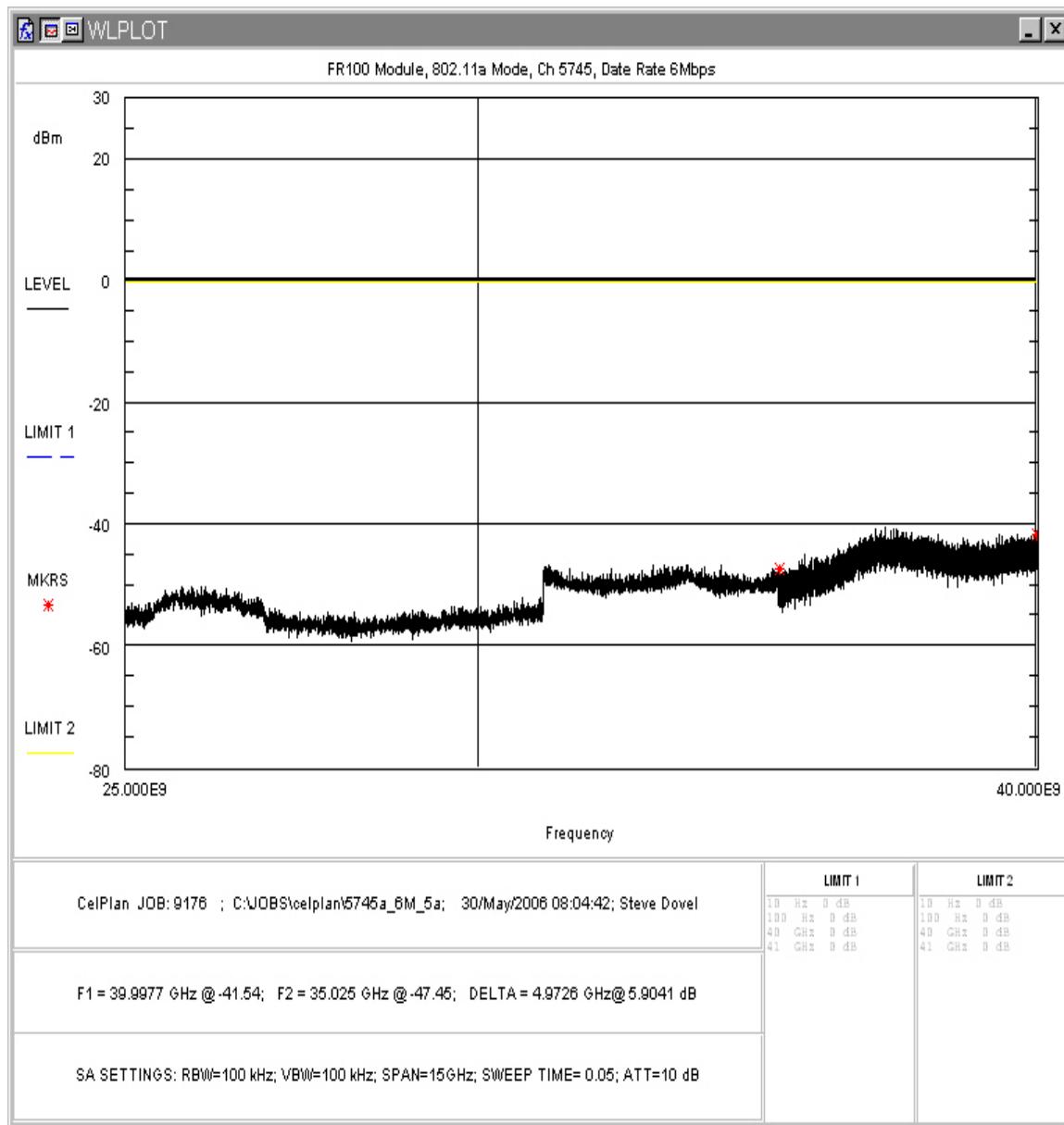


Figure 5. Spurious Emissions 5745 MHz 25-40 GHz, 6 Mbps

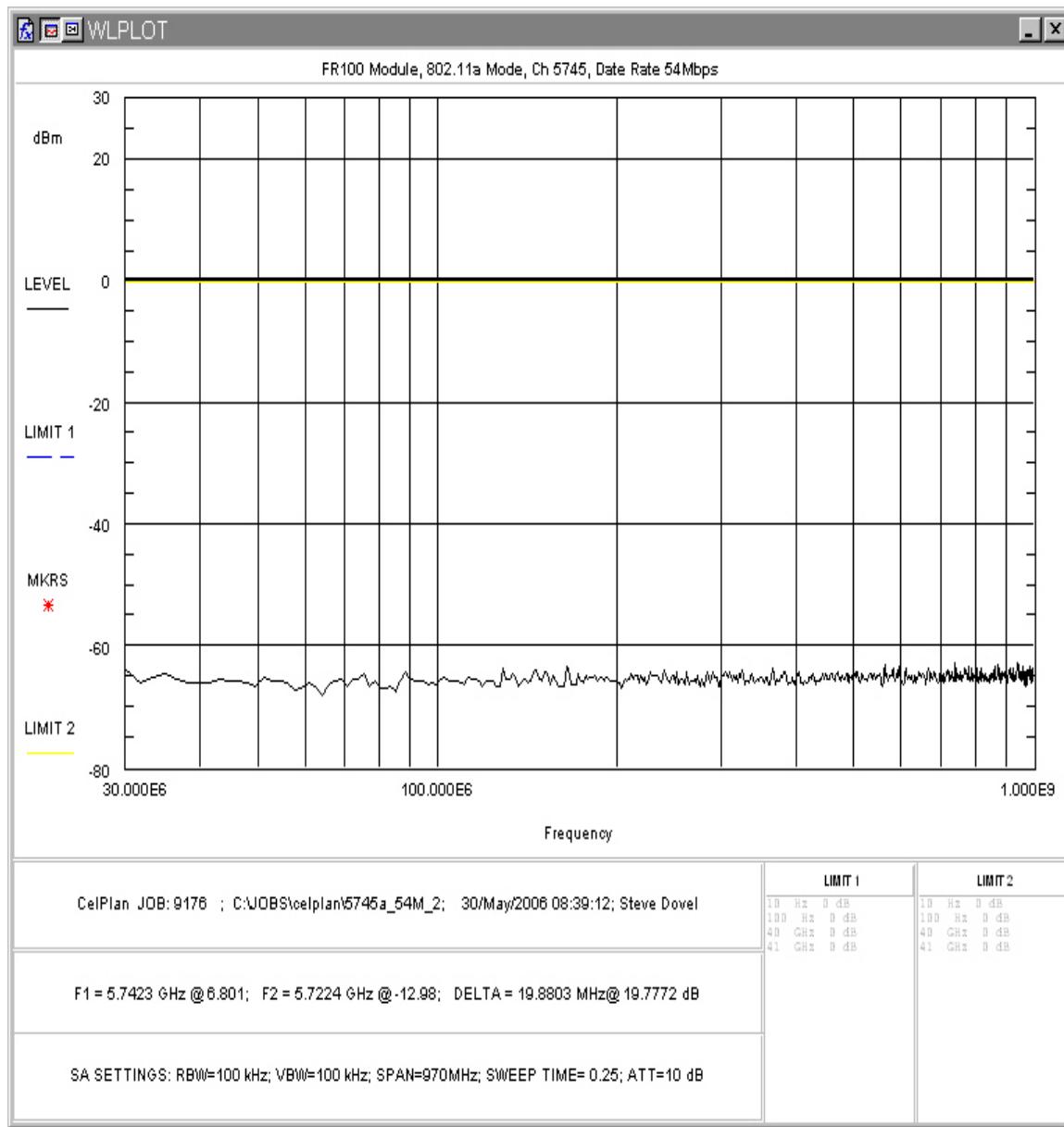


Figure 6. Spurious Emissions 5745 MHz 30MHz-1 GHz, 54 Mbps

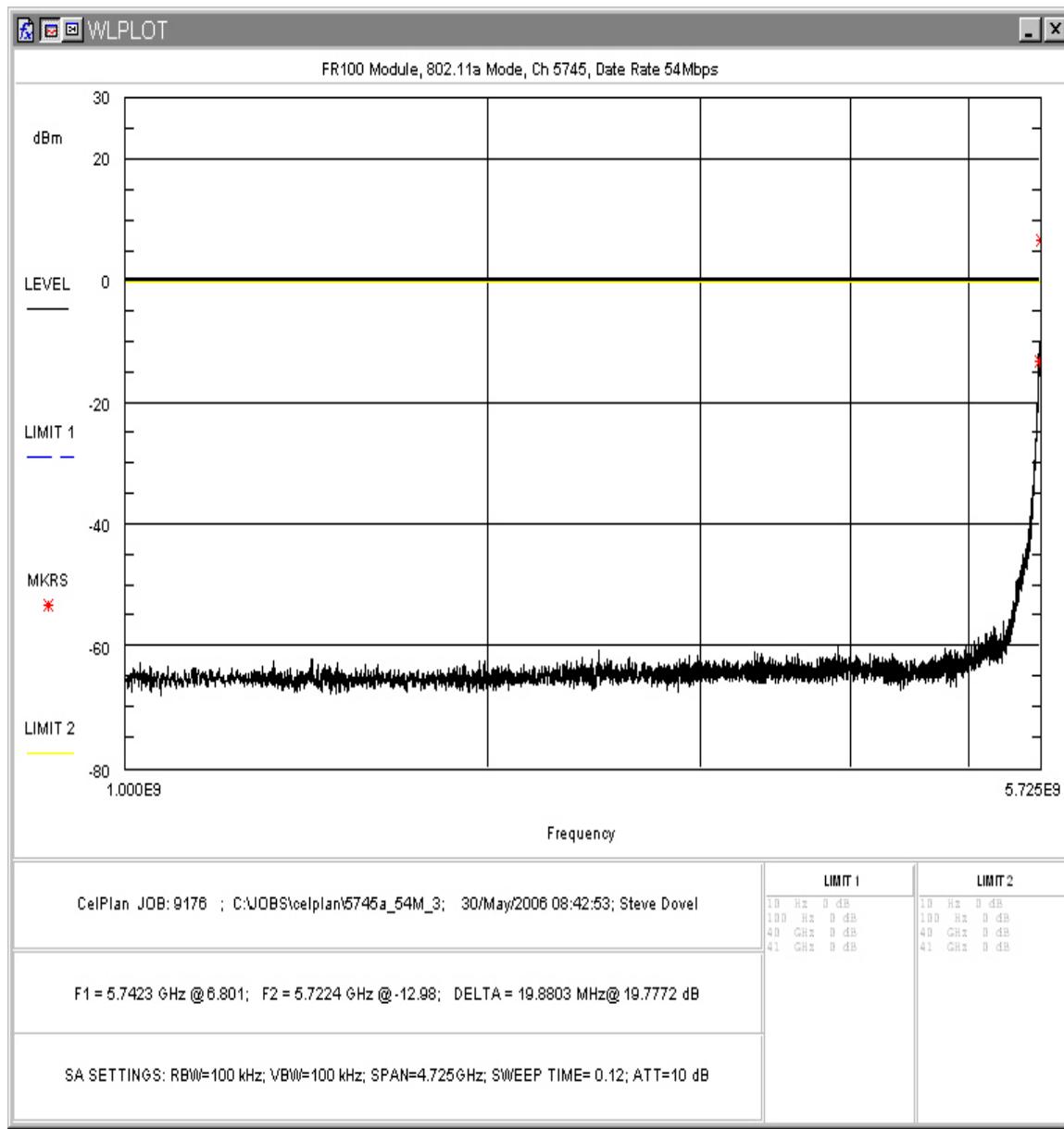


Figure 7. Spurious Emissions 5745 MHz 1-5 GHz, 54 Mbps

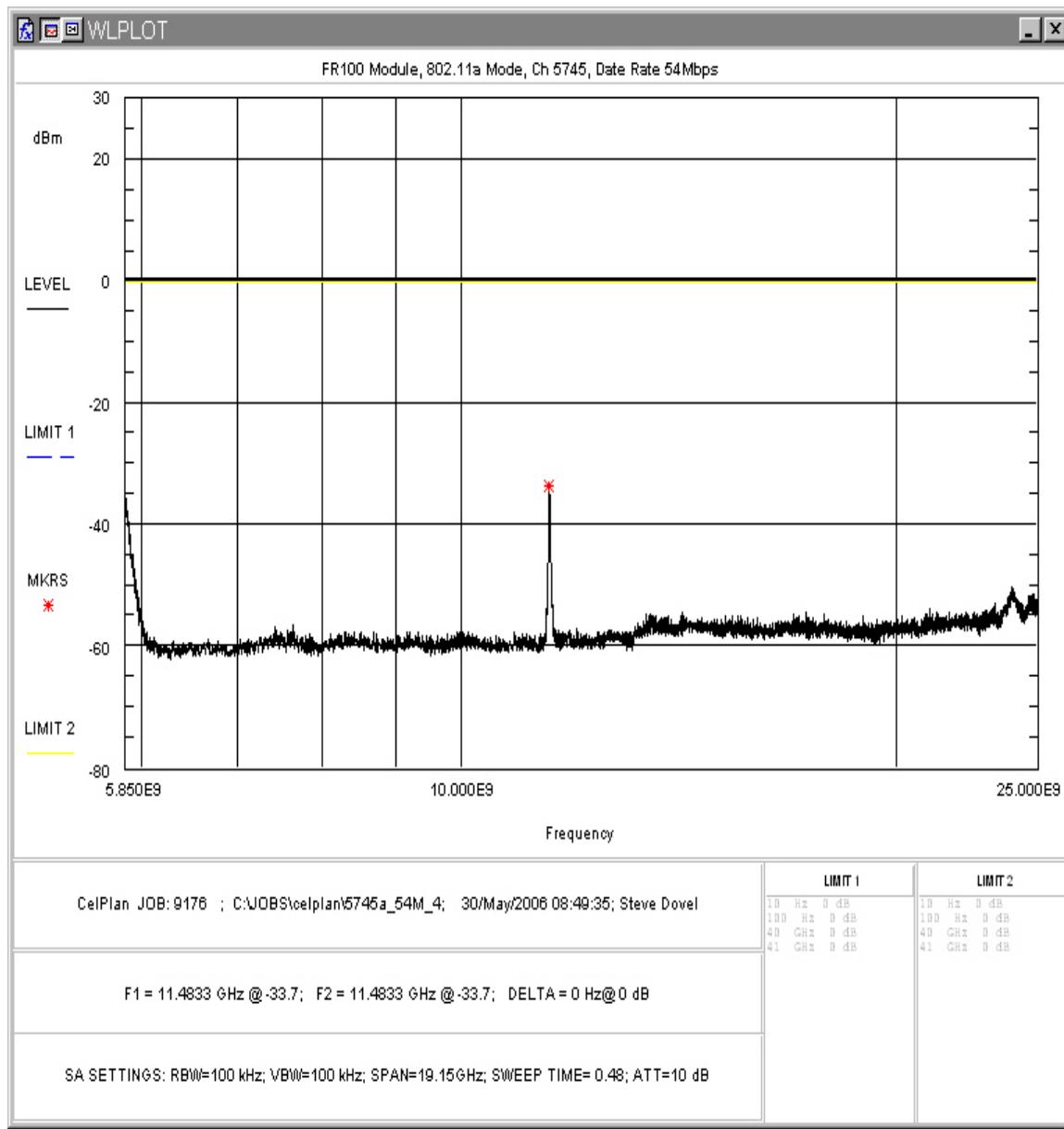


Figure 8. Spurious Emissions 5745 MHz 5-25GHz, 54 Mbps

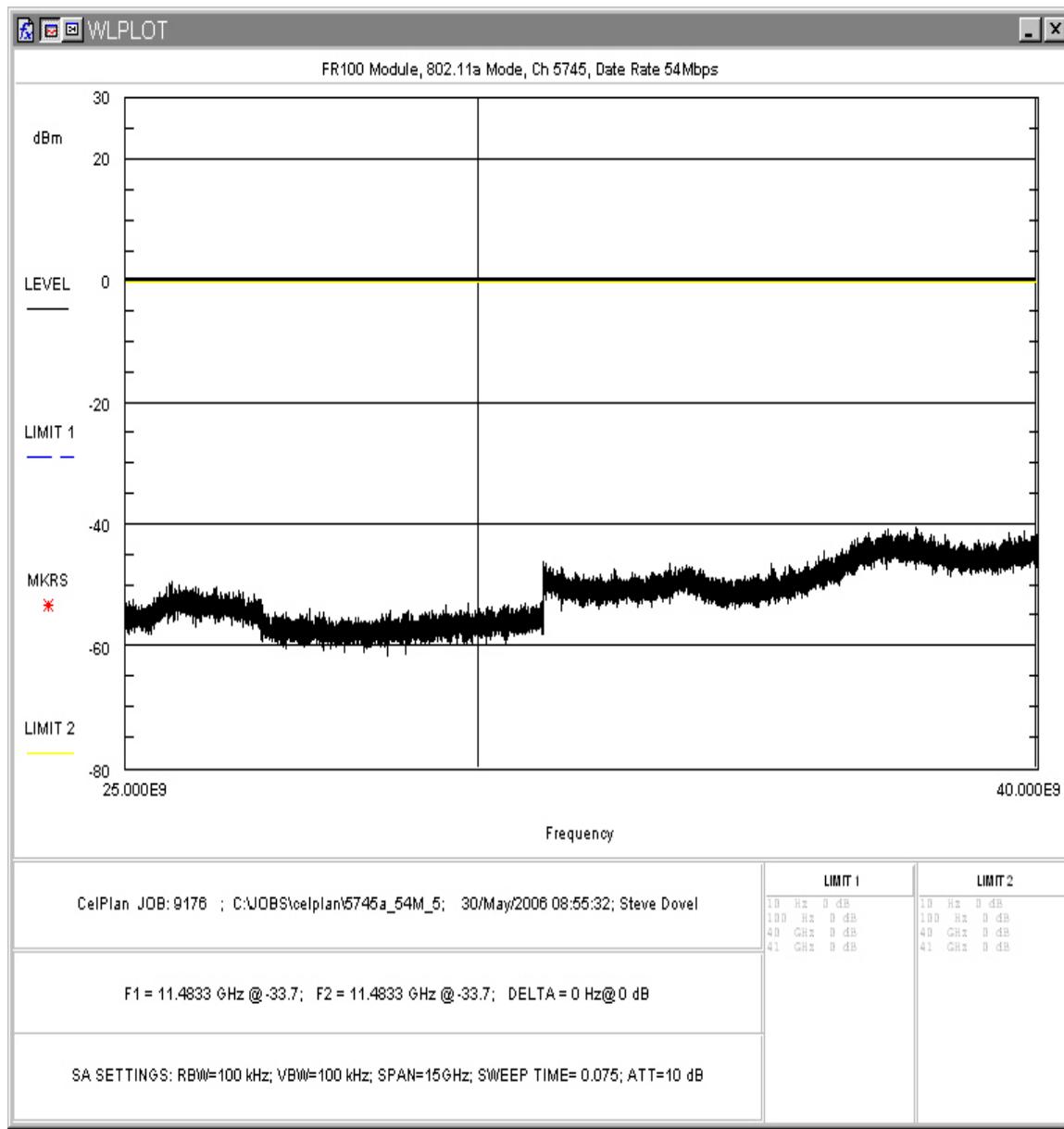


Figure 9. Spurious Emissions 5745 MHz 25-40 GHz, 54 Mbps

### 3.1.5.2 Band Edge Compliance

The peak emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

- (1) For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz.

The emission measurements were performed using a minimum resolution bandwidth of 1 MHz.

Table 8. Bandedge Data Table

<b>Client:</b>	CelPlan	<b>Date:</b>	6/9/2006
<b>Tester:</b>	S. Dovell	<b>Job #:</b>	9148/9149
<b>EUT Information:</b>		<b>Test Requirements:</b>	
<b>EUT:</b>	FR100	<b>TEST STANDARD:</b>	FCC Part 15
<b>Configuration:</b>	U-NII HG2418P ant.	<b>DISTANCE:</b>	3m
<b>Test Equipment (&lt;1GHz):</b>		<b>Test Equipment (&gt;1GHz):</b>	
<b>ANTENNA:</b>	A_00007	<b>ANTENNA:</b>	A_00425
<b>CABLE:</b>	CSITE2_3m	<b>CABLE:</b>	CSITE1_HF
<b>AMPLIFIER:</b>	A_00522		

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level QP dB $\mu$ V	Ant. Corr. dB/m	Cable Corr. (dB)	Amp Gain (dB)	Corr. Level dB $\mu$ V/m	E-Field $\mu$ V/m	Limit $\mu$ V/m	Margin (dB)	Note
<b>5180 (HG2418P)</b>												
10360.00	V	165.0	1.0	46.8	39.1	6.0	38.0	53.8	490.7	68.2	-14.4	peak
10360.00	V	165.0	1.0	34.8	39.1	6.0	38.0	41.8	123.3	54.0	-12.2	avg
10360.00	H		1.0	-	39.1	6.0	38.0			68.2	<-16	Amb
10360.00	H		1.0	-	39.1	6.0	38.0			54.0	<-16	Amb
<b>5240 (HG2418P)</b>												
10480.00	V	157.0	1.0	44.7	39.1	6.0	38.0	51.8	390.8	68.2	-16.4	peak
10480.00	V	157.0	1.0	33.0	39.1	6.0	38.0	40.1	101.6	54.0	-13.9	avg
10480.00	H		1.0	-	39.1	6.0	38.0			68.2	<-16	Amb
10480.00	H		1.0	-	39.1	6.0	38.0			54.0	<-16	Amb
<b>5320 (HG2418P)</b>												
10640.00	V	101.0	1.0	49.3	39.1	6.0	37.9	56.6	676.1	68.2	-11.6	peak
10640.00	V	101.0	1.0	36.5	39.1	6.0	37.9	43.8	154.9	54.0	-10.2	avg
10640.00	H		1.0	*	39.1	6.0	37.9			68.2	<-16	peak
10640.00	H		1.0	*	39.1	6.0	37.9			54.0	<-16	avg

### 3.2 Unwanted Emissions below 1 GHz

The EUT must comply with the requirements for radiated spurious emissions per §15.209.

#### 3.2.1.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2001. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The emissions were measured using the following resolution bandwidths:

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	>100 kHz
>1000 MHz	1 MHz	<30 Hz (Avg.) 1MHz (Peak)

Emissions data are provided in the Table below.

Table 9: Radiated Emission Test Data, Low Frequency Data (<1GHz)

CLIENT: Celplan  
TESTER: John Repella

DATE: 11/21/2006  
JOB #: 9148/8566

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level (QP) (dB $\mu$ V)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Corr. Level (dB $\mu$ V/m)	Corr. Level ( $\mu$ V/m)	Limit ( $\mu$ V/m)	Margin (dB)	Notes
44.650	V	263.0	1.5	7.2	10.2	1.3	18.7	8.6	100.0	-21.3	BB
48.026	V	263.0	1.5	11.0	8.5	1.3	20.8	11.0	100.0	-19.2	BB
50.228	V	263.0	1.5	12.5	7.6	1.3	21.4	11.7	100.0	-18.6	BB
50.710	V	263.0	1.5	13.3	7.5	1.3	22.1	12.8	100.0	-17.9	BB
51.805	V	263.0	1.5	13.9	7.4	1.3	22.6	13.5	100.0	-17.4	BB
52.600	V	263.0	1.5	13.3	7.3	1.3	21.9	12.5	100.0	-18.1	BB
53.172	V	263.0	1.5	13.3	7.2	1.3	21.9	12.4	100.0	-18.1	BB
60.950	V	263.0	1.5	14.7	7.4	1.5	23.6	15.1	100.0	-16.4	BB
61.980	V	263.0	1.5	12.9	7.5	1.5	21.9	12.4	100.0	-18.1	BB
75.725	V	263.0	1.5	6.6	8.0	1.6	16.2	6.4	100.0	-23.8	BB
84.350	V	263.0	1.5	11.6	7.4	1.7	20.7	10.9	100.0	-19.3	BB
109.150	V	263.0	1.5	2.6	12.5	1.9	17.1	7.1	150.0	-26.5	BB
165.036	V	0.0	2.0	4.8	12.0	2.4	19.2	9.1	150.0	-24.3	
198.033	V	306.0	1.5	9.1	12.2	2.6	23.9	15.6	150.0	-19.6	
250.018	V	0.0	2.0	6.1	11.5	3.0	20.6	10.7	200.0	-25.4	
264.031	V	306.0	2.0	5.1	12.6	3.1	20.8	11.0	200.0	-25.2	
297.034	V	0.0	2.0	7.7	13.4	3.3	24.5	16.8	200.0	-21.5	
396.031	V	306.0	2.0	4.0	15.5	3.9	23.4	14.8	200.0	-22.6	
462.031	V	306.0	2.0	5.1	17.3	4.3	26.7	21.5	200.0	-19.4	
52.600	H	180.0	3.5	4.9	7.3	1.3	13.5	4.7	100.0	-26.5	BB
53.172	H	180.0	3.5	5.9	7.2	1.3	14.5	5.3	100.0	-25.5	BB
60.950	H	180.0	3.5	11.4	7.4	1.5	20.3	10.3	100.0	-19.7	BB
61.980	H	180.0	3.5	13.1	7.5	1.5	22.1	12.7	100.0	-17.9	BB
75.725	H	180.0	3.5	15.2	8.0	1.6	24.8	17.3	100.0	-15.2	BB
84.350	H	263.0	3.5	6.8	7.4	1.7	15.9	6.3	100.0	-24.1	BB
109.150	H	0.0	3.5	7.1	12.5	1.9	21.6	12.0	150.0	-22.0	BB
165.036	H	107.0	3.5	7.1	12.0	2.4	21.5	11.9	150.0	-22.0	
198.033	H	90.0	3.5	5.1	12.2	2.6	19.9	9.9	150.0	-23.6	
250.031	H	180.0	3.5	8.2	11.5	3.0	22.8	13.7	200.0	-23.3	
264.031	H	180.0	3.5	5.6	12.6	3.1	21.3	11.6	200.0	-24.7	
297.034	H	0.0	3.5	7.2	13.4	3.3	24.0	15.8	200.0	-22.0	
396.031	H	180.0	3.5	2.2	15.5	3.9	21.6	12.1	200.0	-24.4	