FCC Certification Test Report

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:

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

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

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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 15.247 and 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 15.247 and 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 15.247 and as a UNII device under Part 15E.

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with 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 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 15.247 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 15

Data are presented in this report for the following module:

FCC RULE	FREQUENCY BAND	CHANNELS MEASURED
15.247: 802.11 b/g	2400 - 2483.5 MHz	Low, Middle, High
15.247 802.11a	5725 - 5850 MHz	Low, Middle, 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
FCC Rule Parts:		§15.247
Frequency Ranges:	**15.247:**	2400 - 2483.5 MHz 5725 - 5850 MHz
Maximum Output Power		**dBm**
DTS:	2400 - 2483.5 MHz	28.2
	5725 - 5850 MHz	26.0
Modulation:		OFDM
Occupied Bandwidth:		**MHz**
DTS:	2400 – 2483.5 MHz	13.0 MHz (6 dB Bandwidth)
	5725 – 5850 MHz	18.0 MHz (6 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		2.4 GHz	5.8 GHz
Omni	Mfgr	Hyperlink	Hyperlink
	Model	HG2415U/PRO	HG5812U/PRO
	Gain (dBi)	15	12

Panel (patch)	Mfgr	Hyperlink	Hyperlink
	Model	HG2418P	HG5158P
	Gain (dBi)	18	8
Directional	Mfgr	Hyperlink	MAXRAD
	Model	XA2424G	WISP4959018MBV
	Gain (dBi)	24	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 00-705, *Filing and Measurement Guidelines for Digital Transmission System Systems*
- 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 ±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

4 Test Results

4.1 2400-2483.5 MHz Band

4.1.1 RF Power Output: (FCC Part §2.1046)

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator, cable and other losses in the system.

Per 15.247b(3), the "Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level."

This is performed using the Agilent E4440A Spectrum Analyzer power measurement functions.

To collect these data, the sum of the average components of the signal are collected over the maximum signal spectrum with a resolution bandwidth of 100kHz. This is taken to be the maximum conducted power and is reported here.

Measurements were taken at the highest and lowest data rates (6 and 108 Mbps). The maximum measured powers are provided in Table 3.

Table 3. Measured Conducted Power

Frequency (MHz)	Bandwidth (MHz)	Data Rate (Mbit/s)	Modulation	Power #[1]	RMS Output Power dBm	Peak Conducted Output Power dBm
802.11b						
2412	20	6	BPSK	23	22.4	25.5
2412	20	54	64QAM	23	22.1	27.0
2437	20	6	BPSK	22	20.6	23.9
2437	20	54	64QAM	22	20.6	25.4
2462	20	6	BPSK	22	21.9	25.2
2462	20	54	64QAM	22	22.0	26.7
Max in Band					**22.4**	**27.0**
802.11g						
2412	20	6	BPSK	24.5	22.1	27.5
2412	20	54	64QAM	23.5	22.1	27.8
2437	20	6	BPSK	23	22.0	27.9
2437	20	54	64QAM	23.5	22.1	28.2
2462	20	6	BPSK	22	21.9	25.2
2462	20	54	64QAM	22	22.0	26.7
Max in Band					**22.1**	**28.2**

1. This is an index setting on the radio. It will be set in the firmware to limit the power to the settings above.

4.1.2 Occupied Bandwidth: (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer. The 6dB bandwidths were measured and are provided below:

Table 4. 6 dB Bandwidth Measurements

Occupied Bandwidth:	MHz	Limit	Result
DTS: 2400 – 2483.5 MHz	13.0	>0.5MHz	Pass

Note: There are no plots of the 6dB emissions bandwidth. The data were post-processed from scalar data taken from the output of the spectrum analyzer. For each modulation the 6dB bandwidth was calculated via a spreadsheet and the data compiled.

Following is an excerpt from the spreadsheet showing the calculation that was performed and the result of the calculation. The 6dB bandwidth was calculated over the frequency data where the (MAX power minus 6 dB) was between -1 and +1 dB was valid. In the case below, this is true between 2.41GHz and 2.423GHz, resulting in a 6dB bandwidth of 13MHz. Of course, the frequency data are shown truncated, however, the full significant digit information was used in the bandwidth calculation.

Table 5. Calculation of 6dB Bandwidth (Post-processed)

Frequency (Hz)	Trace1 (dBm)	Max – 6dB	IS -1< (MAX-6dB)<+1?
2.40E+09	-8.800E-01	-8.7	FALSE
2.40E+09	3.594E+00	-4.2	FALSE
2.41E+09	6.475E+00	-1.3	FALSE
2.41E+09	**8.532E+00**	**0.7**	**2.41E+09**
2.41E+09	**1.057E+01**	**2.8**	**2.41E+09**
2.41E+09	**1.217E+01**	**4.4**	**2.41E+09**
2.41E+09	**1.278E+01**	**5.0**	**2.41E+09**
2.41E+09	**1.361E+01**	**5.8**	**2.41E+09**
2.41E+09	**1.370E+01**	**5.9**	**2.41E+09**
2.41E+09	**1.359E+01**	**5.8**	**2.41E+09**
2.41E+09	**1.381E+01**	**6.0**	**2.41E+09**
2.41E+09	**1.373E+01**	**5.9**	**2.41E+09**
2.42E+09	**1.288E+01**	**5.1**	**2.42E+09**
2.42E+09	**1.242E+01**	**4.6**	**2.42E+09**
2.42E+09	**1.092E+01**	**3.1**	**2.42E+09**
2.42E+09	**8.808E+00**	**1.0**	**2.42E+09**
2.42E+09	**6.909E+00**	**-0.9**	**2.42E+09**
2.42E+09	4.031E+00	-3.8	FALSE
	MAX POWER	**1.381E+01**	
	MAX – 6dB	**7.810E+00**	
6 dB Bandwidth (MHZ)		**13.0**	

4.1.3 Conducted Spurious Emissions at Antenna Terminals (FCC Part §2.1051)

The EUT must comply with requirements for spurious emissions at antenna terminals. Per §15.247(c) all spurious emissions in any 100 kHz bandwidth outside the frequency band in which the spread spectrum device is operating shall be attenuated 20 dB below the highest power level in a 100 kHz bandwidth within the band containing the highest level of the desired power.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 10 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 100 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the carrier frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

The following are plots of the conducted spurious emissions data.

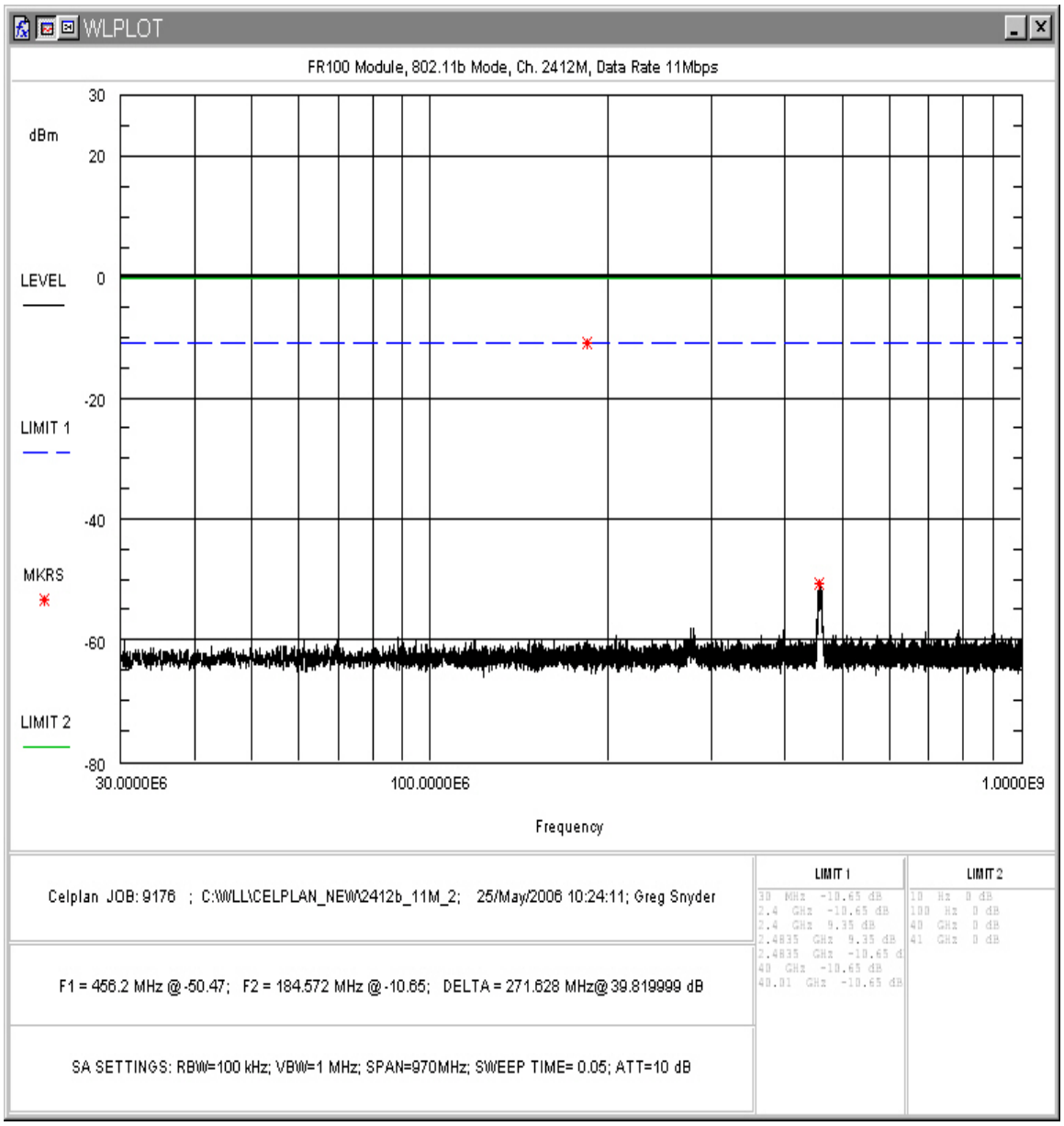

Figure 1. Conducted Spurious Emissions. 1 MB/s. 30MHz-1GHz

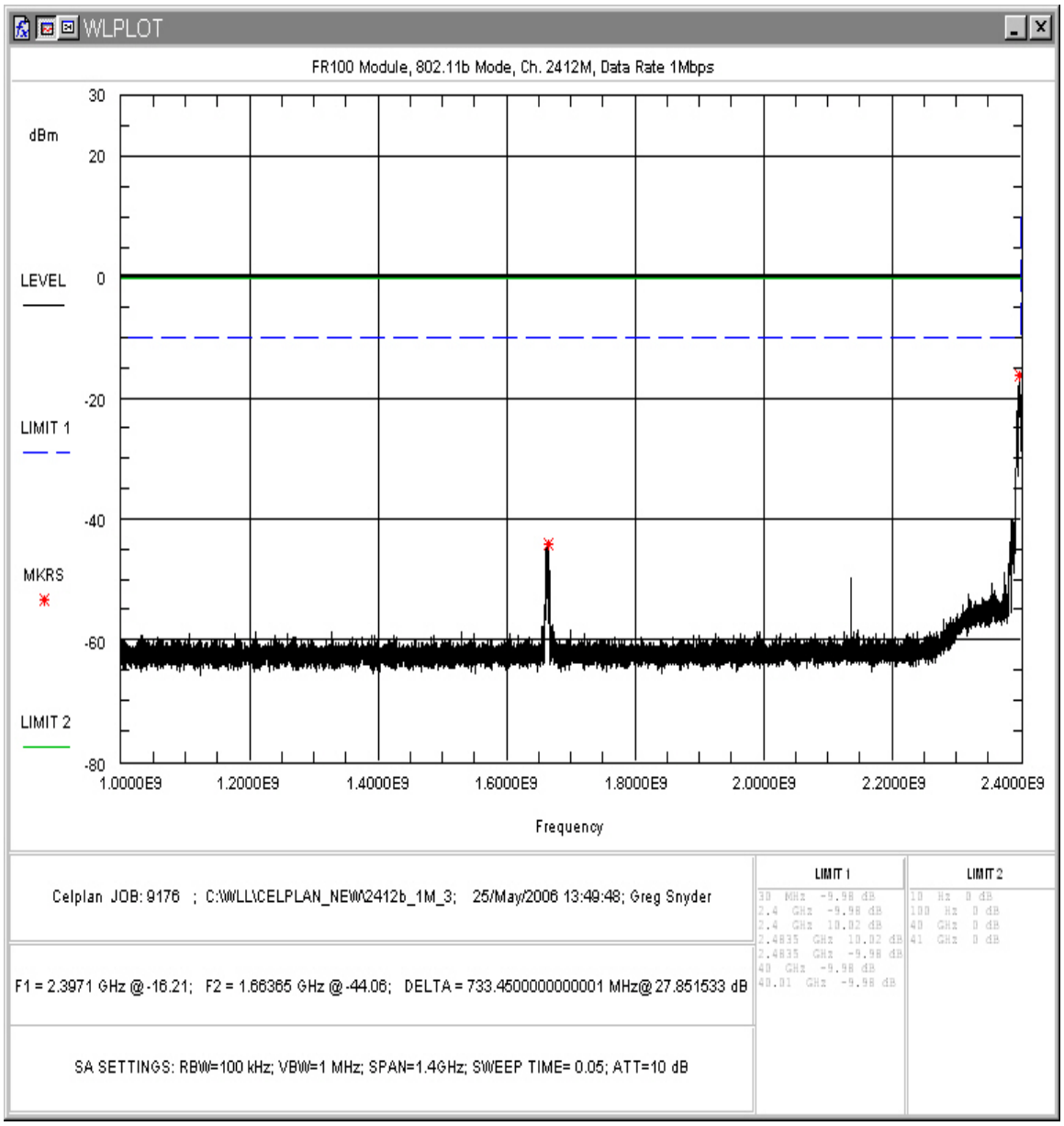

Figure 2. Conducted Spurious Emissions. 1 MB/s. 1GHz-2.4GHz

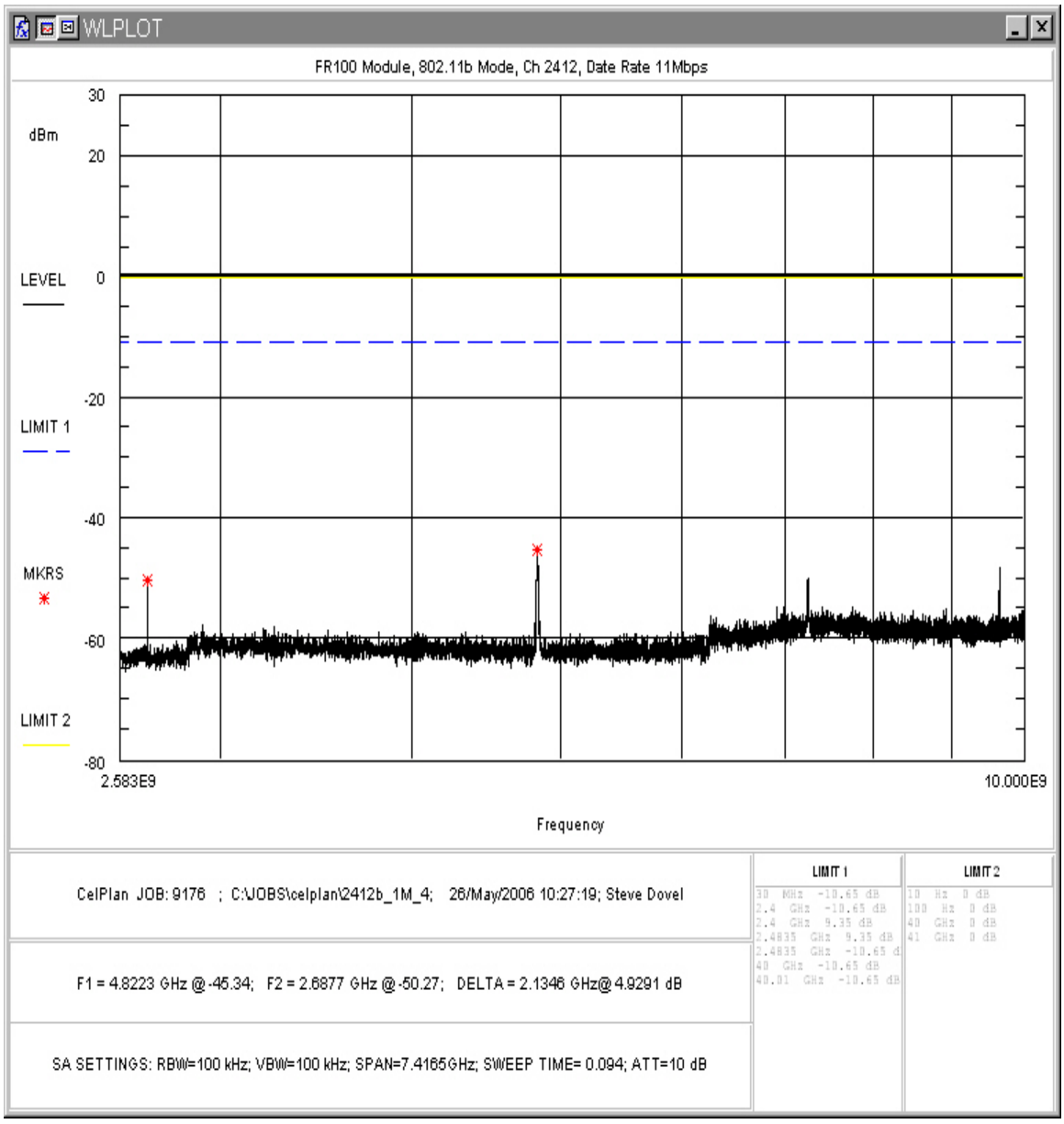

Figure 3. Conducted Spurious Emissions. 1 MB/s. 2.4GHz-10GHz

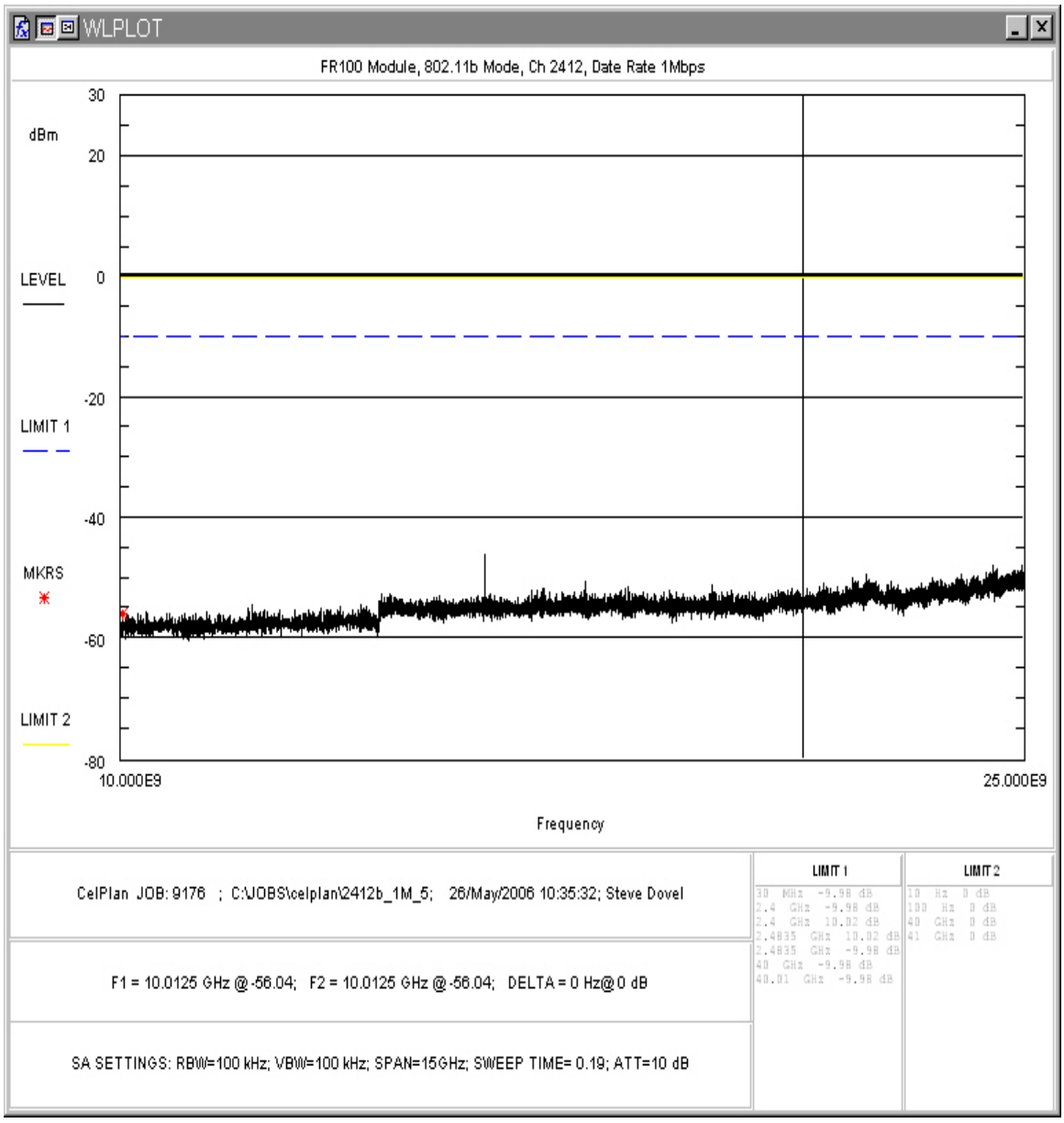

Figure 4. Conducted Spurious Emissions. 1 MB/s. 10GHz-25GHz

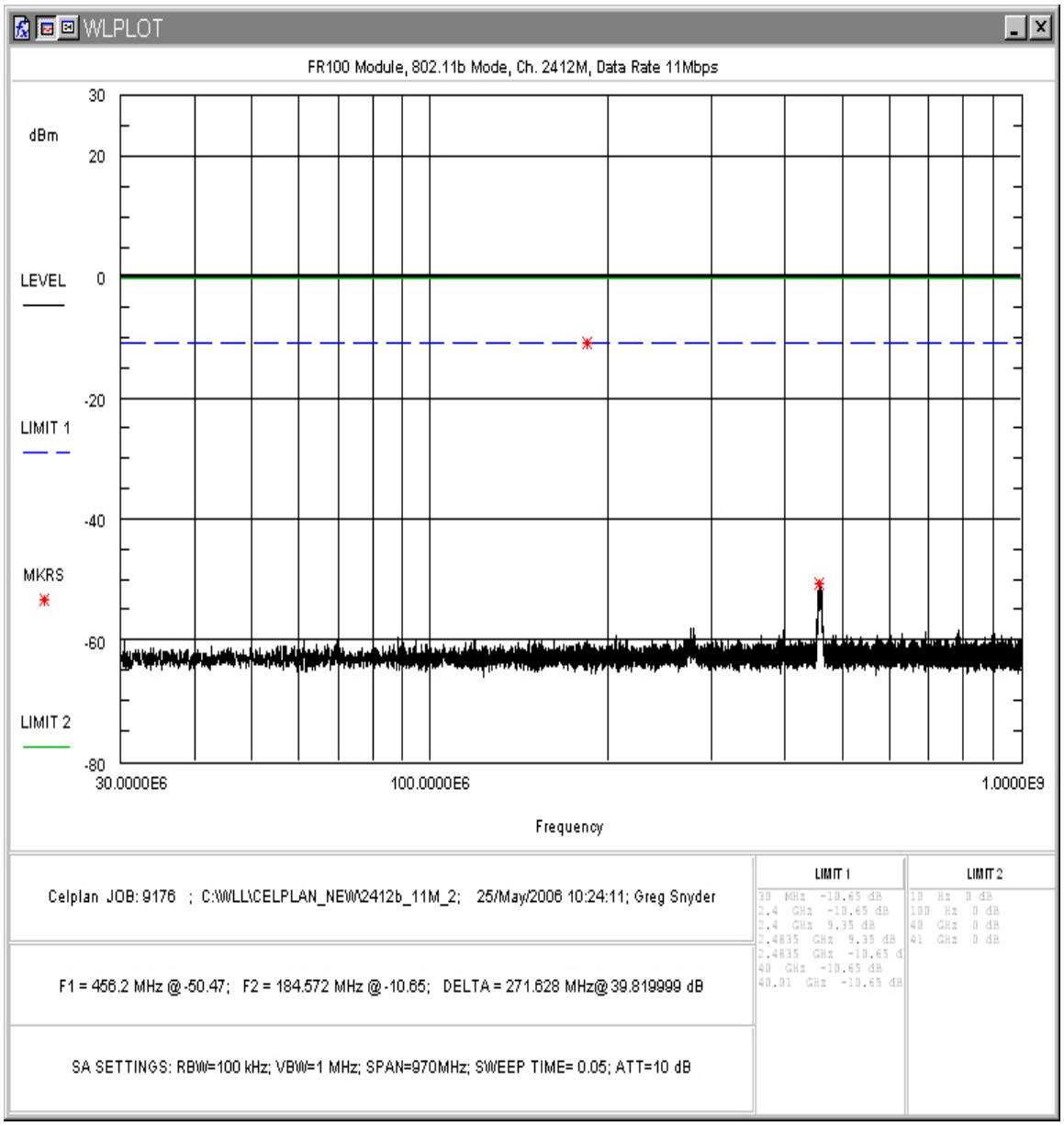

Figure 5. Conducted Spurious Emissions. 11MB/s. 30MHz-1GHz

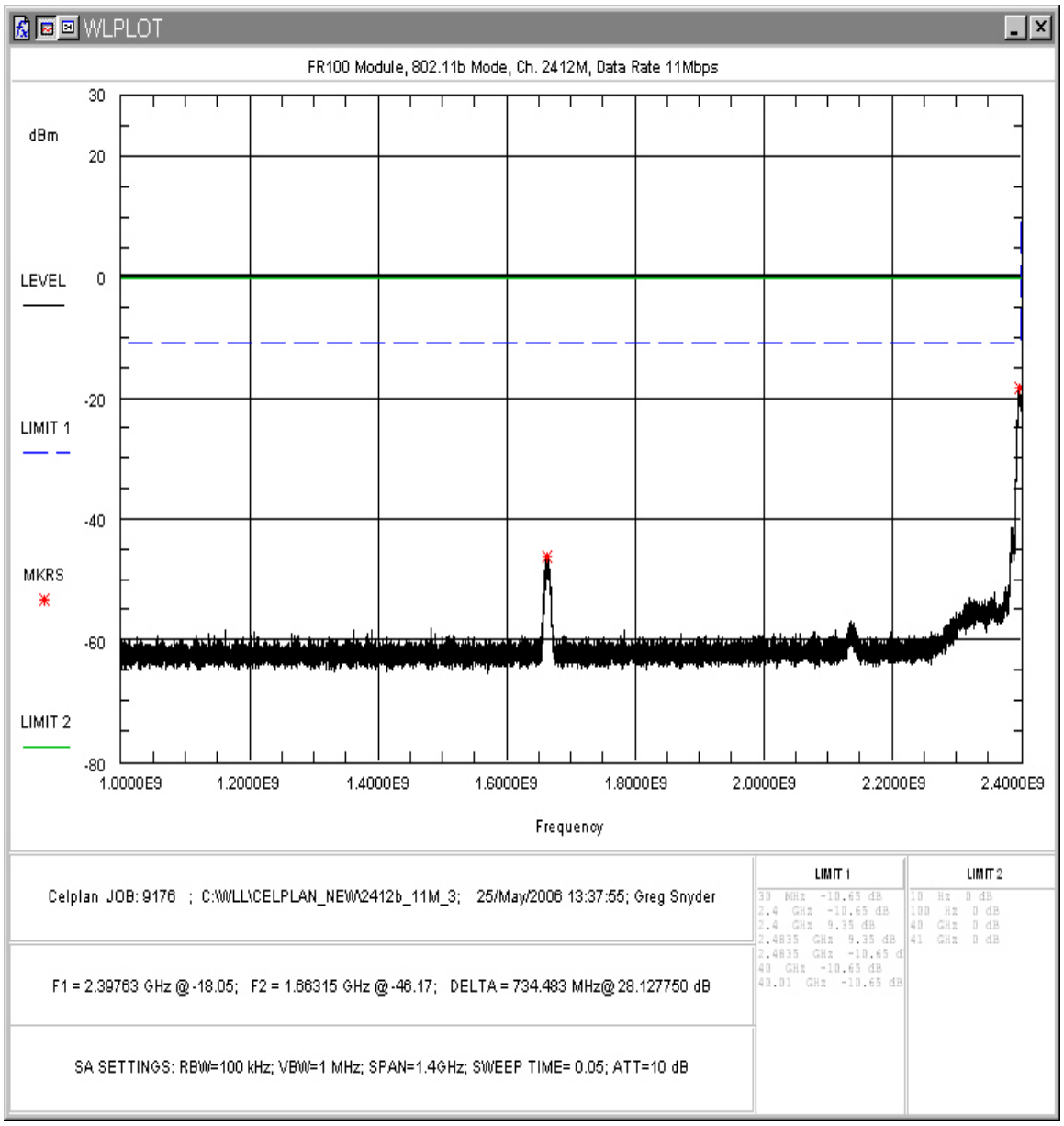

Figure 6. Conducted Spurious Emissions. 11MB/s. 1GHz-2.4GHz

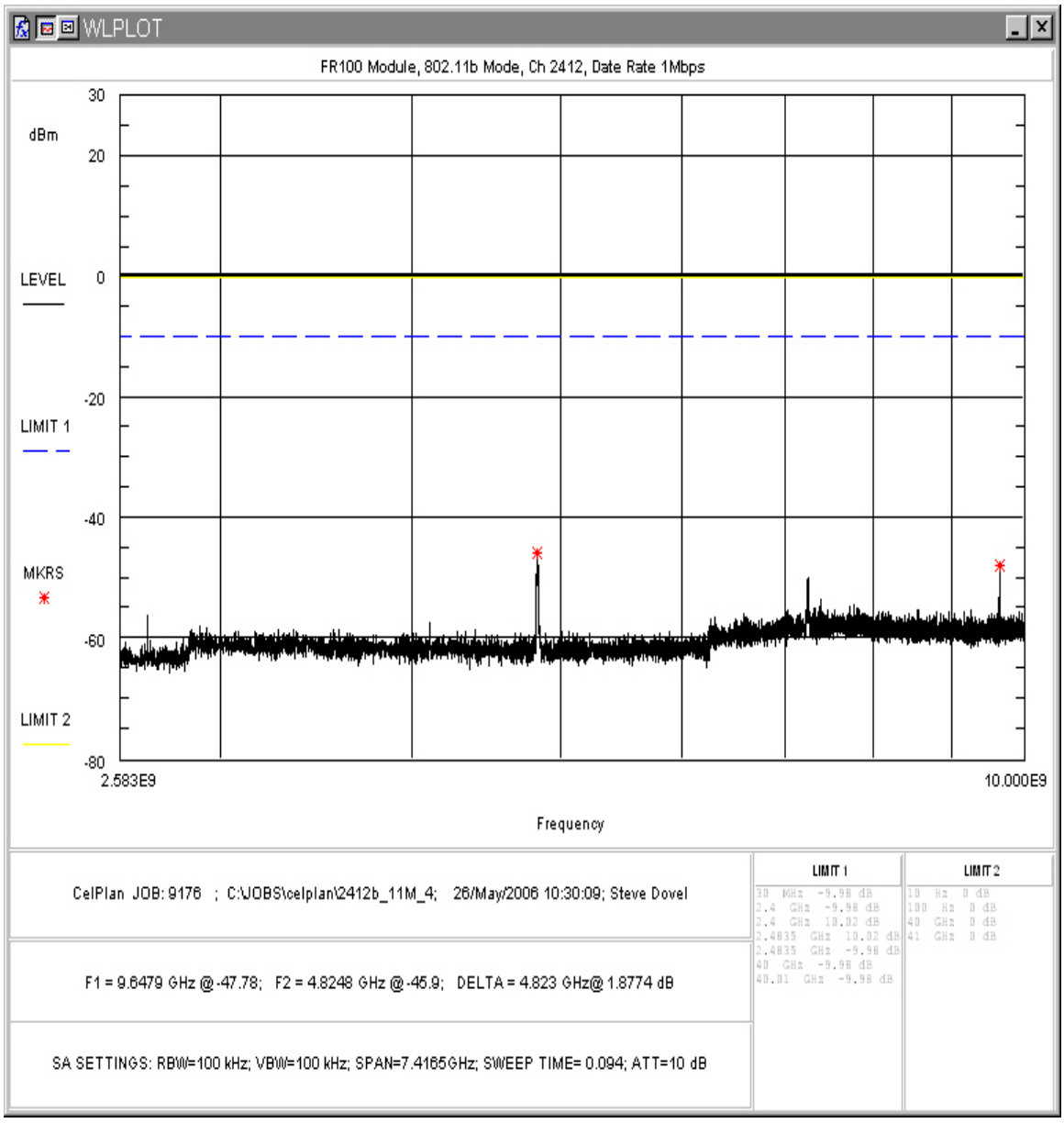

Figure 7. Conducted Spurious Emissions. 11MB/s. 2.4GHz-10GHz

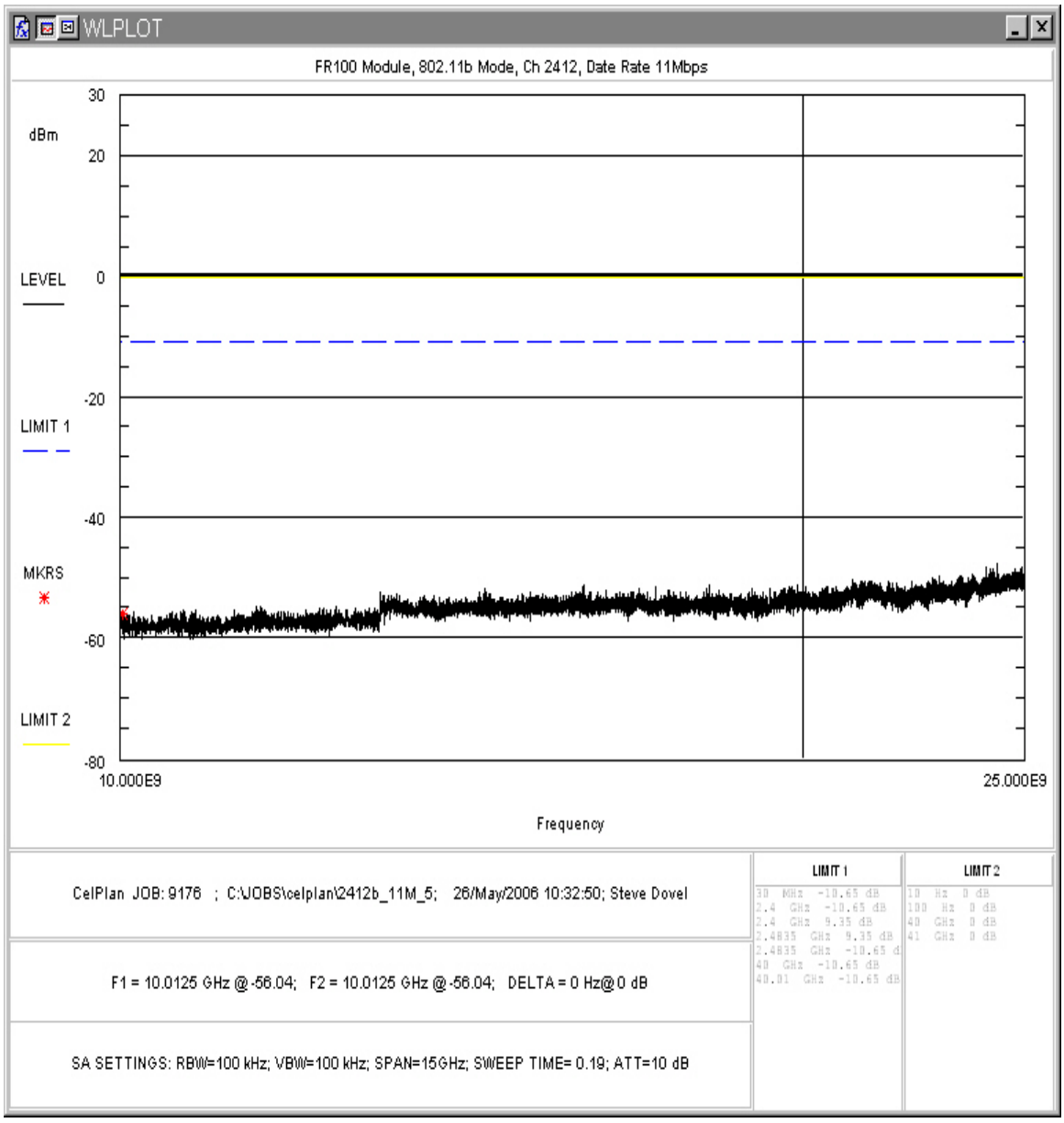

Figure 8. Conducted Spurious Emissions. 11MB/s. 10GHz-25GHz

4.1.4 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with the requirements for radiated spurious emissions that fall within the restricted bands. These emissions must meet the limits specified in §15.209 and §15.35(b) for peak measurements.

4.1.4.1 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 C63.4-2003. 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)

The emissions were scanned to the tenth harmonic of the fundamental; however no signals were seen from the unit past 5 GHz.

Table 6: Radiated Emission Test Data, Low Frequency Data (<1GHz)

CLIENT: Celplan DATE: 11/21/2006
TESTER: John Repella JOB #: 9148/8566

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/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

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin (dB)	Notes
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	

Client: Celplan **Date:** 6/9/2006
Tester: Steve Dovell **Job #:** 9148-9149
EUT Information: **Test Requirements:**
EUT: FR100 TEST STANDARD: FCC Part 15
DISTANCE: 3m

Test Equipment (<1GHz): **Test Equipment (>1GHz):**
ANTENNA: A_00007 ANTENNA: A_00004
LIMIT: LFCC_3m_Class_B
CABLE: CSITE2_3m CABLE: CSITE1_HF
AMPLIFIER: A_00522

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level QP dBµV	Ant. Corr. dB/m	Cable Corr. (dB)	Amp Gain (dB)	Corr. Level dBµV/m	E-Field µV/m	Limit µV/m	Margin (dB)	Note
2412 Antenna: HG2418P												
2386.100	V	325.0	1.0	40.0	28.9	2.9	0.0	71.8	3882.7	5000.0	-2.2	peak
2386.100	V	325.0	1.0	21.0	28.9	2.9	0.0	52.8	435.6	500.0	-1.2	avg
4824.000	V	318.0	1.0	48.8	32.5	4.1	37.2	48.2	256.5	5000.0	-25.8	peak
4824.000	V	318.0	1.0	40.0	32.5	4.1	37.2	39.4	93.1	500.0	-14.6	avg
4824.000	H	330.0	1.0	45.0	32.5	4.1	37.2	44.4	165.6	5000.0	-29.6	peak
4824.000	H	330.0	1.0	32.0	32.5	4.1	37.2	31.4	37.1	500.0	-22.6	avg
2437 Antenna: HG218P												
2390.000	V	322.0	1.0	35.2	28.9	2.9	0.0	67.0	2237.1	5000.0	-7.0	peak
2390.000	V	315.0	1.0	21.0	28.9	2.9	0.0	52.8	436.2	500.0	-1.2	avg
4874.000	V	273.0	1.0	46.2	32.6	4.1	37.2	45.7	192.2	500.0	-8.3	peak
4874.000	V	273.0	1.0	37.8	32.6	4.1	37.2	37.3	73.1	500.0	-16.7	avg
4874.000	H	338.0	1.0	46.8	32.6	4.1	37.2	46.3	205.9	5000.0	-27.7	peak
4874.000	H	338.0	1.0	35.5	32.6	4.1	37.2	35.0	56.1	500.0	-19.0	avg
2462 Antenna: HG2418P												
2488.000	V	326.0	1.0	30.8	29.1	3.0	0.0	62.9	1391.2	5000.0	-11.1	peak
2488.000	V	326.0	1.0	19.7	29.1	3.0	0.0	51.8	387.6	500.0	-2.2	avg
4924.000	V	268.0	1.0	49.2	32.7	4.1	37.2	48.8	274.3	5000.0	-25.2	peak

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level QP dBµV	Ant. Corr. dB/m	Cable Corr. (dB)	Amp Gain (dB)	Corr. Level dBµV/m	E-Field µV/m	Limit µV/m	Margin (dB)	Note
4924.000	V	268.0	1.0	42.2	32.7	4.1	37.2	41.8	122.5	500.0	-12.2	avg
4924.000	H	330.0	1.0	45.0	32.7	4.1	37.2	44.6	169.1	500.0	-9.4	peak
4924.000	H	330.0	1.0	33.8	32.7	4.1	37.2	33.4	46.6	500.0	-20.6	avg
2412 Antenna: HG2415U												
2390.000	V	130.0	1.0	32.5	28.9	2.9	0.0	64.3	1639.4	5000.0	-9.7	peak
2390.000	V	130.0	1.0	21.8	28.9	2.9	0.0	53.6	478.3	500.0	-0.4	avg
4824.000	V	142.0	1.0	50.0	32.5	4.1	37.2	49.4	294.5	5000.0	-24.6	peak
4824.000	V	142.0	1.0	44.7	32.5	4.1	37.2	44.1	160.0	500.0	-9.9	avg
2437 Antenna: HG215U												
4874.000	V	113.0	1.0	49.2	32.6	4.1	37.2	48.7	271.4	5000.0	-25.3	peak
4874.000	V	113.0	1.0	42.0	32.6	4.1	37.2	41.5	118.5	500.0	-12.5	avg
4874.000	H	200.0	1.0	46.8	32.6	4.1	37.2	46.3	205.9	5000.0	-27.7	peak
4874.000	H	200.0	1.0	38.8	32.6	4.1	37.2	38.3	82.0	500.0	-15.7	avg
2462 Antenna: HG2415U												
4924.000	V	134.0	1.0	49.9	32.7	4.1	37.2	49.5	297.3	5000.0	-24.5	peak
4924.000	V	134.0	1.0	45.3	32.7	4.1	37.2	44.9	175.1	500.0	-9.1	avg
4924.000	H	128.0	1.0	46.5	32.7	4.1	37.2	46.1	201.0	5000.0	-27.9	peak
4924.000	H	128.0	1.0	35.3	32.7	4.1	37.2	34.9	55.4	500.0	-19.1	avg
2412 Antenna: XA2424G												
2390.000	V	328.0	1.0	30.0	28.9	2.9	0.0	61.8	1229.4	5000.0	-12.2	peak
2390.000	V	328.0	1.0	18.0	28.9	2.9	0.0	49.8	308.8	500.0	-4.2	avg
2390.000	H	348.0	1.0	29.0	28.9	2.9	0.0	60.8	1095.7	5000.0	-13.2	peak
2390.000	H	348.0	1.0	18.0	28.9	2.9	0.0	49.8	308.8	500.0	-4.2	avg
4824.000	V	329.0	1.0	53.8	32.5	4.1	37.2	53.2	457.7	5000.0	-20.8	peak
4824.000	V	328.0	1.0	48.8	32.5	4.1	37.2	48.2	256.5	500.0	-5.8	avg
2437 Antenna: XA2424G												
4874.000	V	330.0	1.0	53.2	32.6	4.1	37.2	52.7	430.2	5000.0	-21.3	peak
4874.000	V	330.0	1.0	47.8	32.6	4.1	37.2	47.3	231.0	500.0	-6.7	avg
2462 Antenna: XA2424G												
2483.500	V	345.0	1.0	30.7	29.1	3.0	0.0	62.8	1373.4	5000.0	-11.2	peak
2483.500	V	345.0	1.0	19.2	29.1	3.0	0.0	51.3	365.4	500.0	-2.7	avg
2483.500	H	345.0	1.0	31.8	29.1	3.0	0.0	63.9	1558.8	5000.0	-10.1	peak
2483.500	H	345.0	1.0	18.0	29.1	3.0	0.0	50.1	318.3	500.0	-3.9	avg
4924.000	V	325.0	1.0	54.0	32.7	4.1	37.2	53.6	476.7	5000.0	-20.4	peak
4924.000	V	325.0	1.0	49.3	32.7	4.1	37.2	48.9	277.5	500.0	-5.1	avg
4924.000	H	325.0	1.0	46.5	32.7	4.1	37.2	46.1	201.0	5000.0	-27.9	peak
4924.000	H	325.0	1.0	34.2	32.7	4.1	37.2	33.8	48.8	500.0	-20.2	avg

4.1.5 Band Edge Compliance

Radiated emissions measurements were taken at the band edges to assure compliance with the radiated emissions at the forbidden bands.

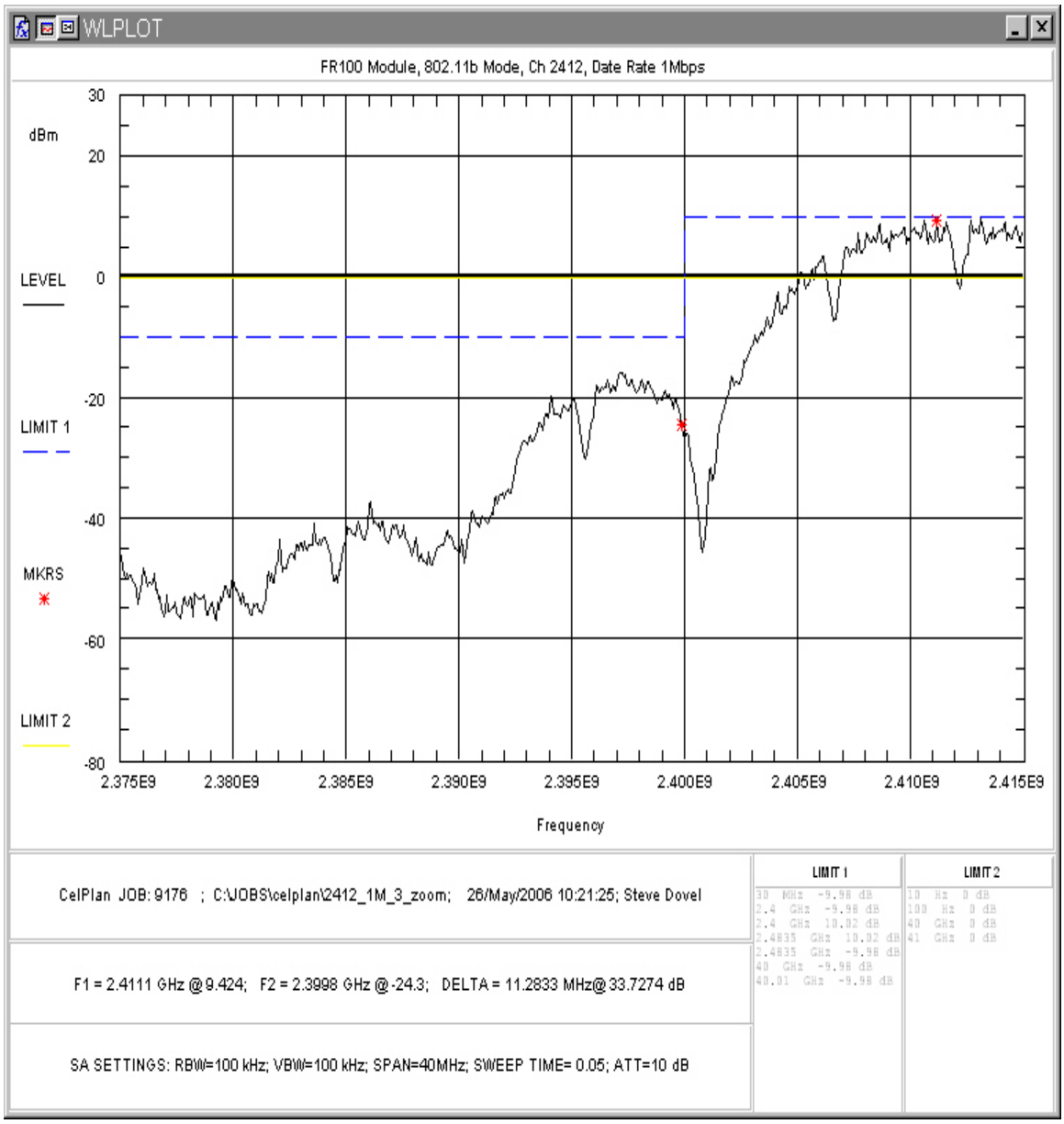

Figure 9. Low Band Edge Compliance: 2412MHz. 1Mbps

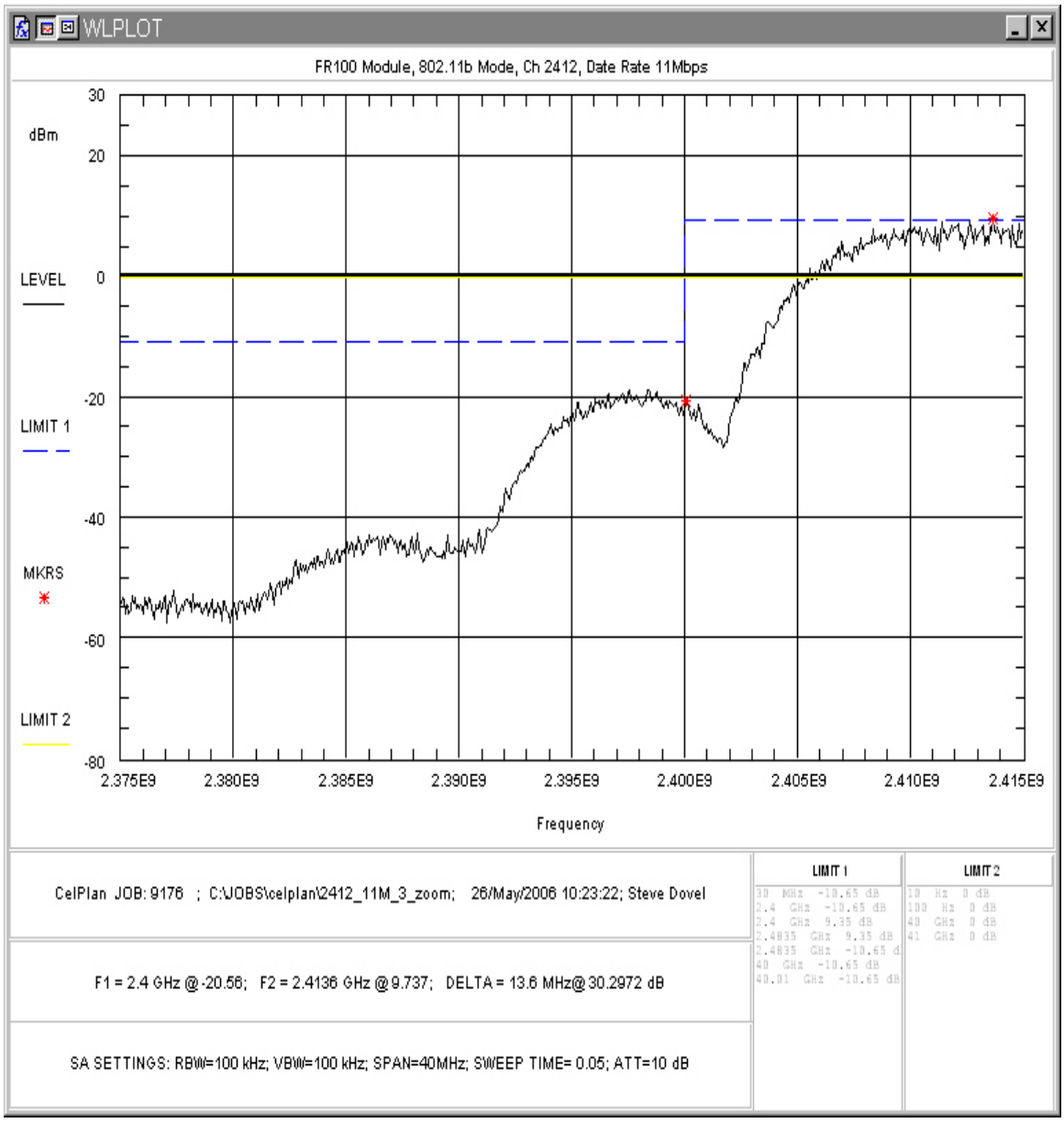

Figure 10. Low Band Edge Compliance: 2412MHz. 11Mbps

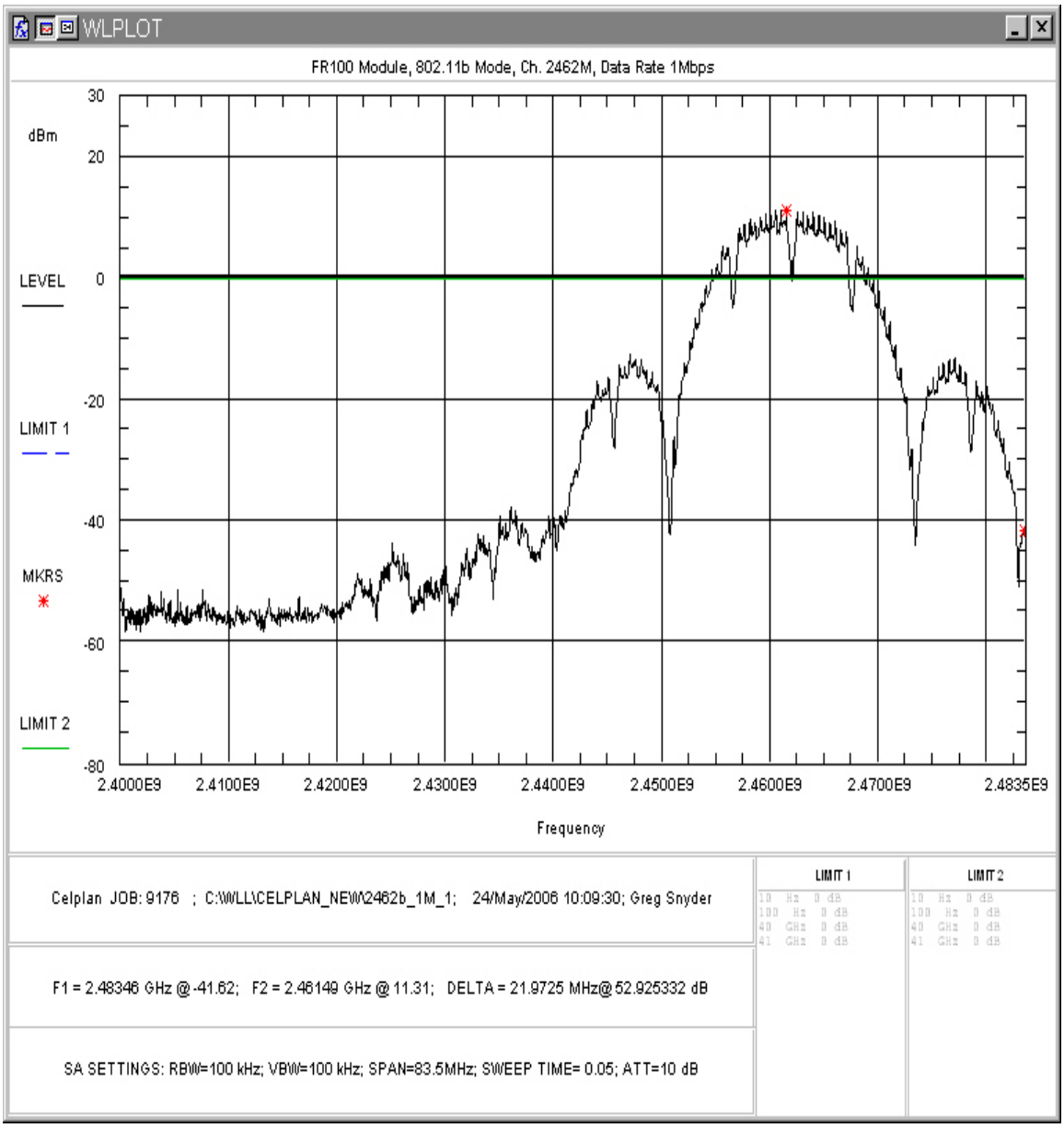

Figure 11. High Band Edge Compliance: 2462MHz. 1Mbps

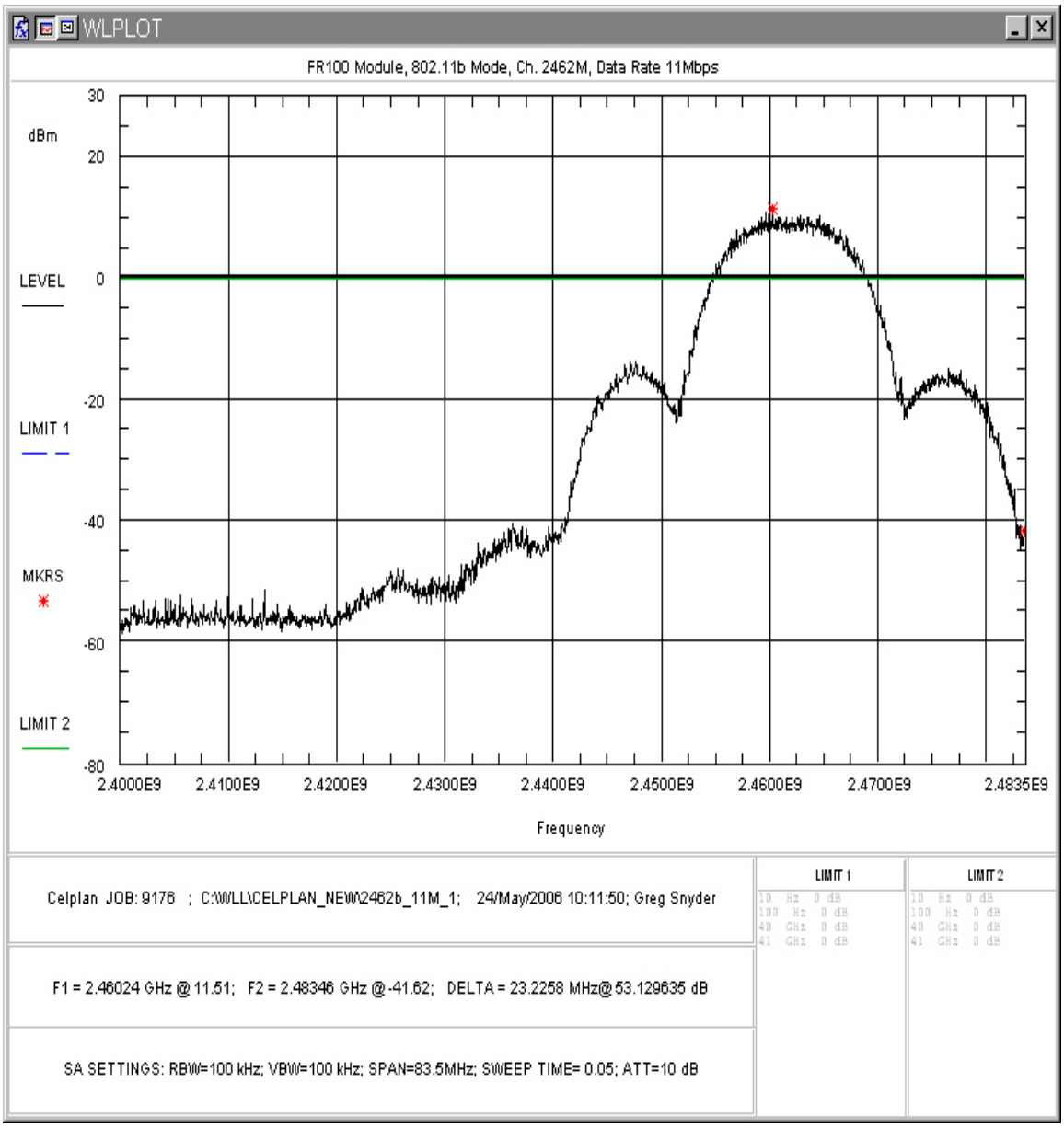

Figure 12. High Band Edge Compliance: 2462MHz. 11Mbps

xxxxxx

4.2 5725-5850 MHz Band

4.2.1 RF Power Output: (FCC Part §2.1046)

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator, cable and other losses in the system.

Per 15.247b(3), the "Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level."

This is performed using the Agilent E4440A Spectrum Analyzer power measurement functions.

To collect these data, the sum of the average components of the signal are collected over the maximum signal spectrum with a resolution bandwidth of 100kHz. This is taken to be the maximum conducted power and is reported here.

Measurements were taken at the highest and lowest data rates (6 Mbps and 54 Mbps). The maximum powers are provided in Table 7 for the FR-100.

Table 7. RF Power Output

Freq (MHz)	BW (MHz)	Data Rate (Mbit/s)	Modulation	Power #	RMS Output Power dBm	Emission BW dB	Peak Conducted Output Power dBm	Power Spectral Density dB/MHz
802.11a								
5745	20	6	BPSK	22.5	19.16	71.0	25.5	-13.2
5745	20	54	64QAM	22.5	19.26	68.5	21.6	-13.1
5785	20	6	BPSK	22.5	18.36	74.0	25.4	-15.1
5785	20	54	64QAM	22.5	18.36	73.7	24.6	-15.2
5805	20	6	BPSK	22.5	18.66	68.6	26.0	-14.7
5805	20	54	64QAM	22.5	18.56	67.4	25.1	-14.7
Max in Band					**19.3**	**74.0**	**26.0**	**-13.1**

4.2.2 Occupied Bandwidth: (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

For Digital Transmission System Systems, FCC Part 15.247 requires the 6 dB bandwidth be greater than 500 kHz.

Table 8 provides a summary of the Occupied Bandwidth Results. The bandwidth were calculated for all data rates and three channels per the discussion accompanying Table 5 above.

Table 8. Occupied Bandwidth

Occupied Bandwidth:	MHz	Limit	Result
DTS: 5725 – 5850 MHz	18.0	>0.5MHz	Pass

4.2.3 Conducted Spurious Emissions at Antenna Terminals (FCC Part §2.1051)

The EUT must comply with requirements for spurious emissions at antenna terminals. Per §15.247(c) all spurious emissions in any 100 kHz bandwidth outside the frequency band in which the spread spectrum device is operating shall be attenuated 20 dB below the highest power level in a 100 kHz bandwidth within the band containing the highest level of the desired power.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 10 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 100 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the carrier frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

The following are plots of the conducted spurious emissions data. The data presented are for a single channel in the band.

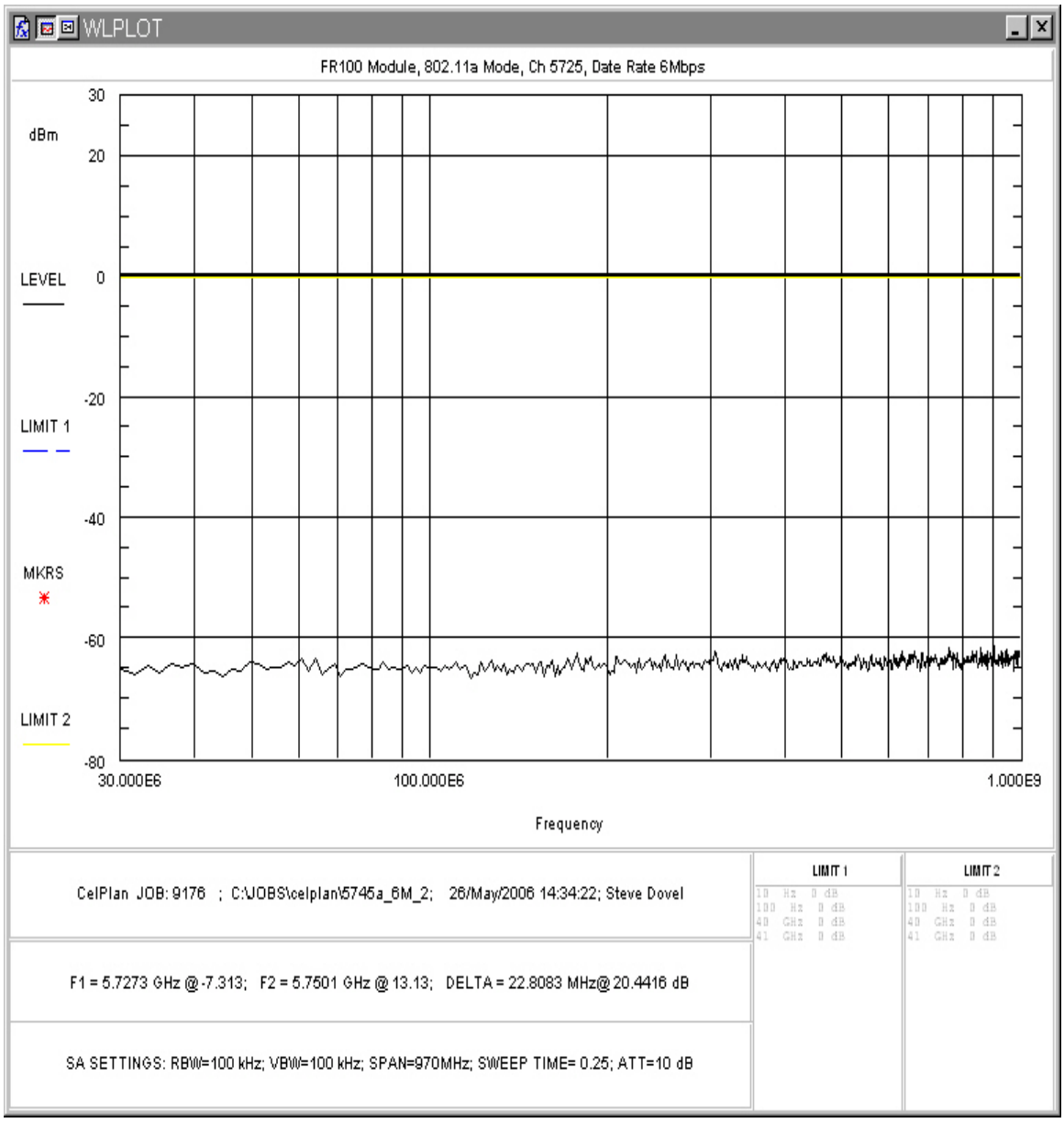

Figure 13. Conducted Spurious Emissions, 30 MHz– 1 GHz. 5745 MHz @ 6 Mbps