FCC Certification Test Report

FCC Part 90M & 90Y Certification Test Report

for

CelPlan Technologies, Inc.

Flexi-Radio

FCC ID: TFF-FR-100

December 18, 2007

Prepared for:

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for the
CelPlan Technologies, Inc.
Flexi-Radio FR-100

WLL JOB# 9149

December 18, 2007

Prepared by: _____
Michael Violette
President

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Abstract

This report has been prepared on behalf of CelPlan Technologies, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Licensed Non-Broadcast Station Transmitter under Part 90M & 90Y of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a CelPlan Technologies, Inc. Flexi-Radio operating in the 4.9GHz and 5.9GHz bands

Testing was 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. 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.

The CelPlan Technologies, Inc. complies with the limits for a licensed transmitter under Parts 90M and 90Y of the FCC Rules and Regulations for

- Intelligent Transportation Systems (ITS) Digital Short Range Communications Systems (DSRC): 5850-5925 MHz
- Public Safety Service: 4940-4990 MHz

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1 Introduction

1.1 Compliance Statement

The CelPlan Technologies, Inc. Flexi-Radio complies with the limits of Part 90M & 90Y of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated and conducted emissions were performed. All measurements were performed according to the 2001 version of ANSI C63.4 and EIA/TIA 603. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	CelPlan Technologies
Quotation Number:	61944
Test Dates:	Testing was performed over the period of March 2006 to January 2007

1.4 Test and Support Personnel

Washington Laboratories:	Mike Violette, Steve Dovell, James Ritter, Greg Snyder
CelPlan Technologies:	Leonhard Korowajczuk, Nikhil Mathur

2 Equipment Under Test

2.1 EUT Identification & Description

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 4940MHz to 4990 MHz and from 5850 MHz to 5925 MHz. The design of the radio is such that the supplier provides a set of firmware settings that limit and manage the frequency and the output powers at the channels of operation. *The user has no control over these settings*.

Each radio has two antenna ports for diversity. The equipment is professionally-installed with different antenna options. In its final configuration, the radio will either be mobile, fixed to a building, outside in a pole-mounted configuration, and/or 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 90M & 90Y for a modular approval. The hardware will be configured per customer requirements.

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 90M & 90Y for Public Safety and/or Intelligent Transportation Systems.

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:	§90M, §90Y
Frequency Ranges:	4640 MHz-4990 MHz 5850-5925 MHz
Maximum Output Power (dBm): 5850-5925 MHz 4640 MHz-4990 MHz	 Part 90M: (Conducted-Fixed Installations) 14.88 (0.03W) Part 90Y: M-Mask: 24.13 (0.258) L-Mask: 13.1 (0.02)
Modulation:	OFDM
Occupied Bandwidth: 5850-5925 MHz 4640-4990 MHz	 12.54 MHz 23.8 MHz
Emissions Designators: §90M 5850-5925 MHz §90Y 4640-4990 MHz	 16MD1D
Keying:	Continuous
Type of Information:	Data
Number of Channels:	Variable, depends on the channel bandwidths Channelization per Part 90 and 95
Power Output Level	Fixed
Antenna Connector	Two U u.FL(v) LP-040 connectors for diversity
Antenna Type	Patch, panel and monopole
Antenna Gain (Fixed Installations): 4640 -4990 MHz 5850-5925 MHz	Max: 18 dBi 18 dBi
Interface Cables:	Ethernet and serial
Power Source & Voltage:	120VAC from host

2.2 Test Configuration

The EUT was configured in a host board that was connected via LAN interface to a personal computer. The computer issued commands to change the frequencies and levels during the testing.

2.3 Antennas Employed In Fixed Installations

The 18 dBi Antennas are being used for all the 10MHz Channels (EIRP 33 dBm). However only for the 20MHz Channels, i.e., channels 175 and 181 Celplan will use 12dBi antennas in order to meet the EIRP requirements (23 dBi).

Type	Characteristics	4.9 GHz	5.9 GHz
Omni	manufacturer Model gain (dBi)	Antenna Products PSB360-4940-10-T0-N 10	Hyperlink HG5812U/PRO 12
Panel (patch)	manufacturer Model gain (dBi)	Hyperlink HG4953P 8	Hyperlink HG5158P 8
Directional/dish	manufacturer Model gain (dBi)	MAXRAD WISP4959018MBV 18	MAXRAD WISP4959018MBV 18

2.4 Testing Algorithm

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.

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

2.5 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 and are reported here.

2.6 Measurements

2.6.1 References

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 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:

Equipment	WLL Asset #	Calibration Due
Sunol JB1 Biconilog Antenna	0382	1/25/2007
ARA DRG118/A Microwave Horn Antenna	0425	1/17/2008
Hewlett-Packard 8568B Spectrum Analyzer	0072	7/3/2007
Hewlett-Packard 91480A Quasi-Peak Adapter	0068	7/3/2007
Hewlett-Packard 85685A RF Preselector	0070	7/3/2007
Hewlett-Packard 8593A Spectrum Analyzer	0074	10/13/2007
Hewlett-Packard 8449B Microwave Preamp	0066	6/22/2007
Solar Electronics 8028-50-TS-24-BNC LISN	0125	1/31/2007
Solar Electronics 8028-50-TS-24-BNC LISN	0126	1/31/2007
Agilent E4440A Spectrum Analyzer	0528	6/20/2007

4 Test Results

4.1 FCC Part 90M & 90Y Intelligent Transportation Systems

Test results are for compliance to the requirements for Dedicated Short-Range Communications Service (DSRCS). Measurements were made at the following frequency and test conditions. Data are reported for each of the listed channel bandwidths, representing worst-case data for all conditions.

Under the conditions of operation, controlled by the factory settings, the following channel bandwidths and power levels and can be supported.

Modulations: BPSK, QPSK, 8QAM, 16QAM, 64QAM

The transmitter was operating continuously.

4.1.1 RF Power Output: (FCC Part §2.1046)

4.1.2 Peak Transmit Power

The peak transmit power is measured as a conducted emission over any interval of continuous transmission calibrated in terms of an RMS-equivalent voltage. Data for the measured power are shown in Table 3. There are three antennas intended with the maximum gain shown for each intended channel as follows in Table 3. There is also an 8dBi antenna which may be used on any of the channels. The antenna gains are entered into the table and the maximum EIRP levels computed against the limit.

Table 3. Transmit Power Results: Road Side Units

Antenna Gain =12/18dBi (selected to comply with EIRP limits)

No	CF	BW MHz	Max		Max Measured Power		Ant Gn	EIRP	LIM	P/F	Margin
	MHz	MHz	dBm	Rate	Rate 3/6 Mbps	Rate 27/54 Mbps	dB	dBm	dBm		dBm
170	5855	5	20	3/27			12		Res'd		
172	5865	10	20	3/27	14.7	14.88	18	32.88	33	P	-0.12
174	5875	10	20	3/27			18		33		
175	5885	20	20	6/54	9.54	9.26	**12**	21.54	23	P	-1.46
176	5885	10	20	3/27			18		33		
178	5895	10	20	3/27	14.58	14.48	18	32.58	33	P	-0.42
180	5905	10	20	3/27			18		23		
181	5915	20	20	6/54	9.34	9.15	**12**	21.34	23	P	-1.66
182	5915	10	20	3/27			18		23		

184	5925	10	20	3/27	14.39	14.48	18	32.48	33	P	-0.52

4.1.3 Power Spectral Density

Power spectral density measurements are shown in the following table

Table 4. Power Spectral Density Limits

Frequency (MHz)	Peak Power Spectral density dB/MHz	Limit dBm
5860	-3.6	N/A
5875	-8.9	N/A
5890	-3.1	N/A
5905	-7.7	N/A
5920	-2.2	N/A

4.1.4 Occupied Bandwidth (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the radio to the input of a spectrum analyzer via an attenuator.

Table 12 provides a summary of the Occupied Bandwidth Results. Maximum authorized bandwidth is 20 MHz.

Table 5. Occupied Bandwidth Results

Frequency (MHz)	Emission Bandwidth MHz
5860	6.03
5875	11.7
5890	6.1
5905	11.7
5920	6.1

At full modulation, the occupied bandwidth was measured as shown in the following figures, which show a representative measurement for each of the masks. Note that the 26dB bandwidth is reported in the above table.

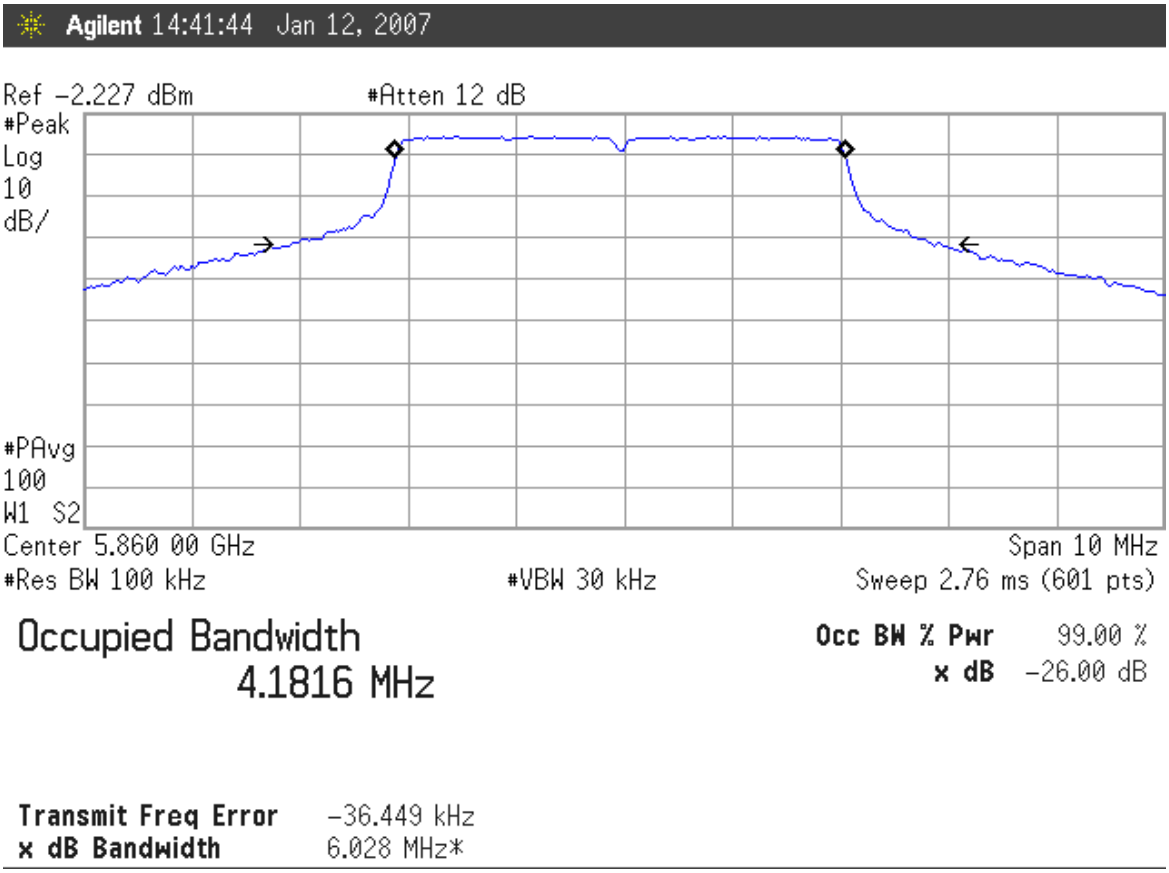

Figure 1. Emission Bandwdth: 5860 MHz; 3 Mbps

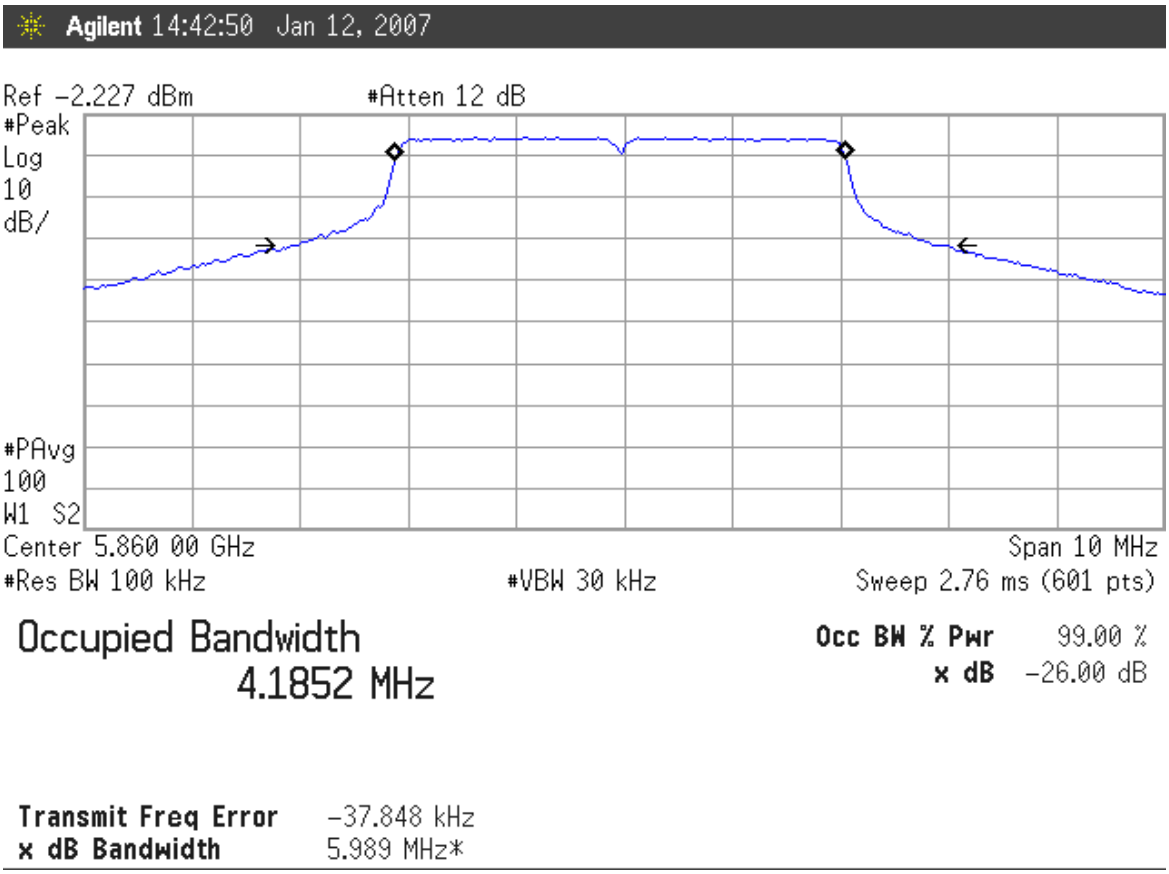

Figure 2. Emission Bandwidth: 5860 MHz; 54 Mbps

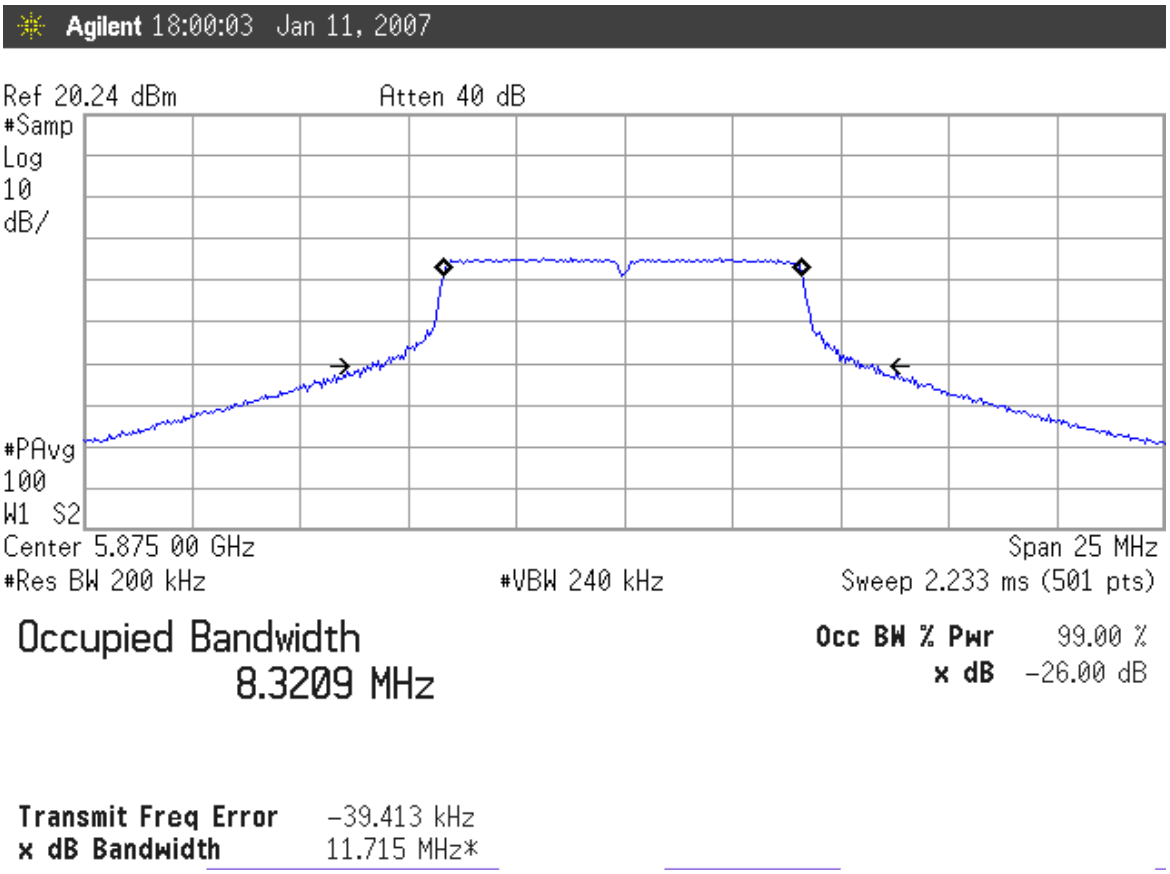

Figure 3. Emission Bandwidth: 5875 MHz; 6 Mbps

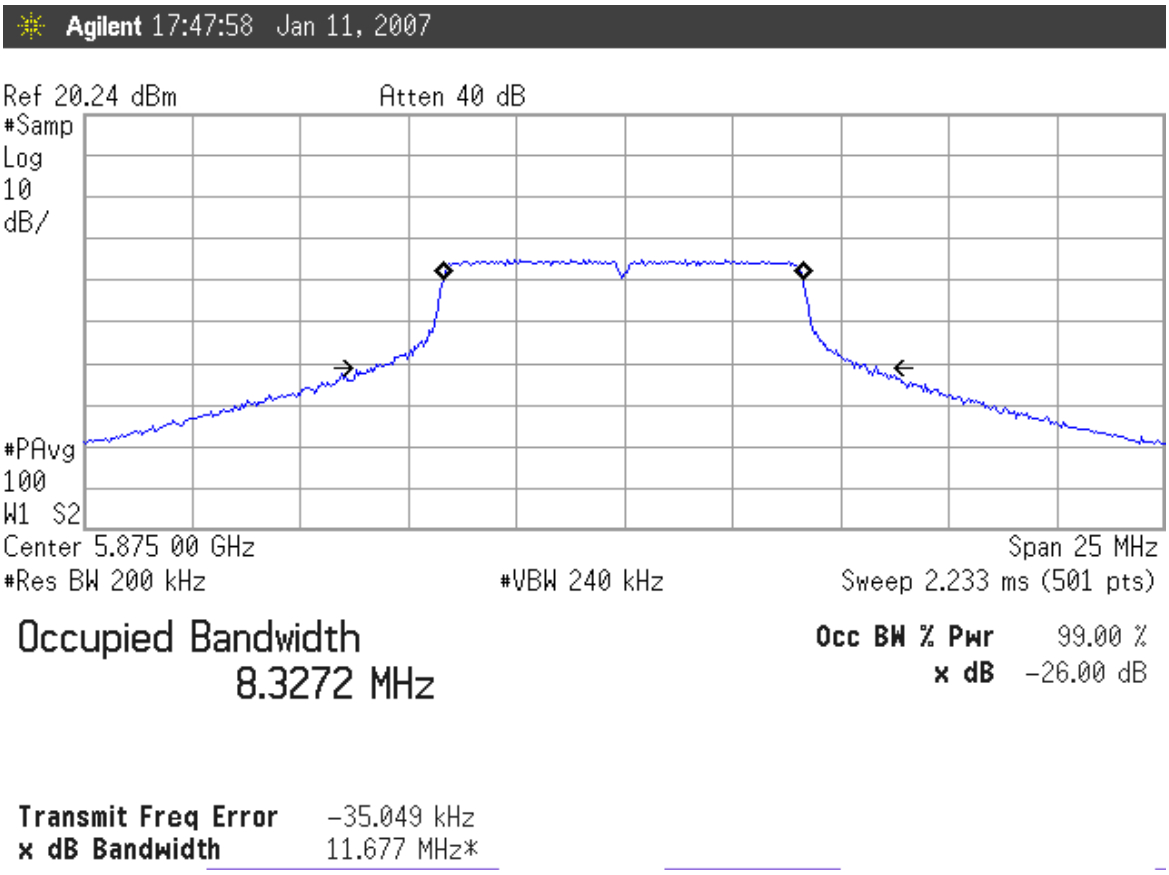

Figure 4. Emission Bandwidth: 5875 MHz; 54 Mbps

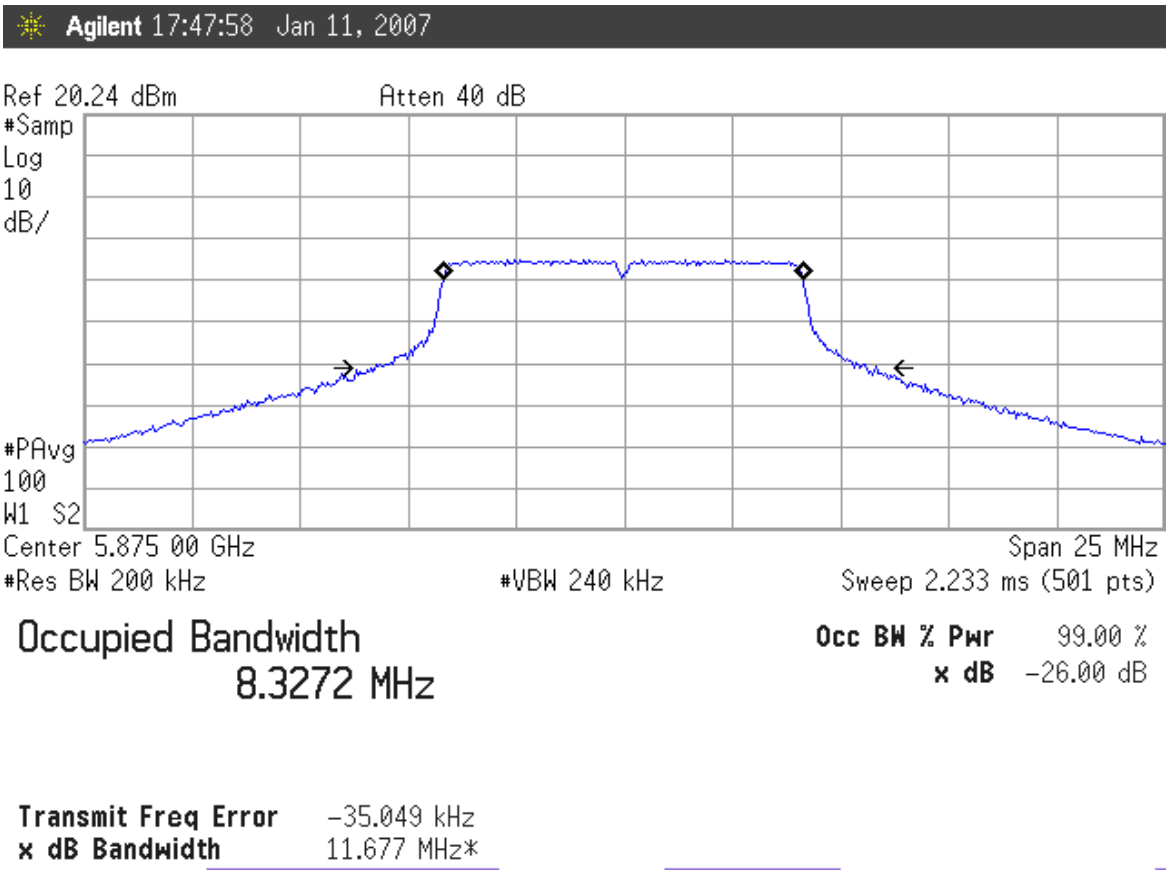

Figure 5. Emission Bandwidth: 5890 MHz; 6 Mbps

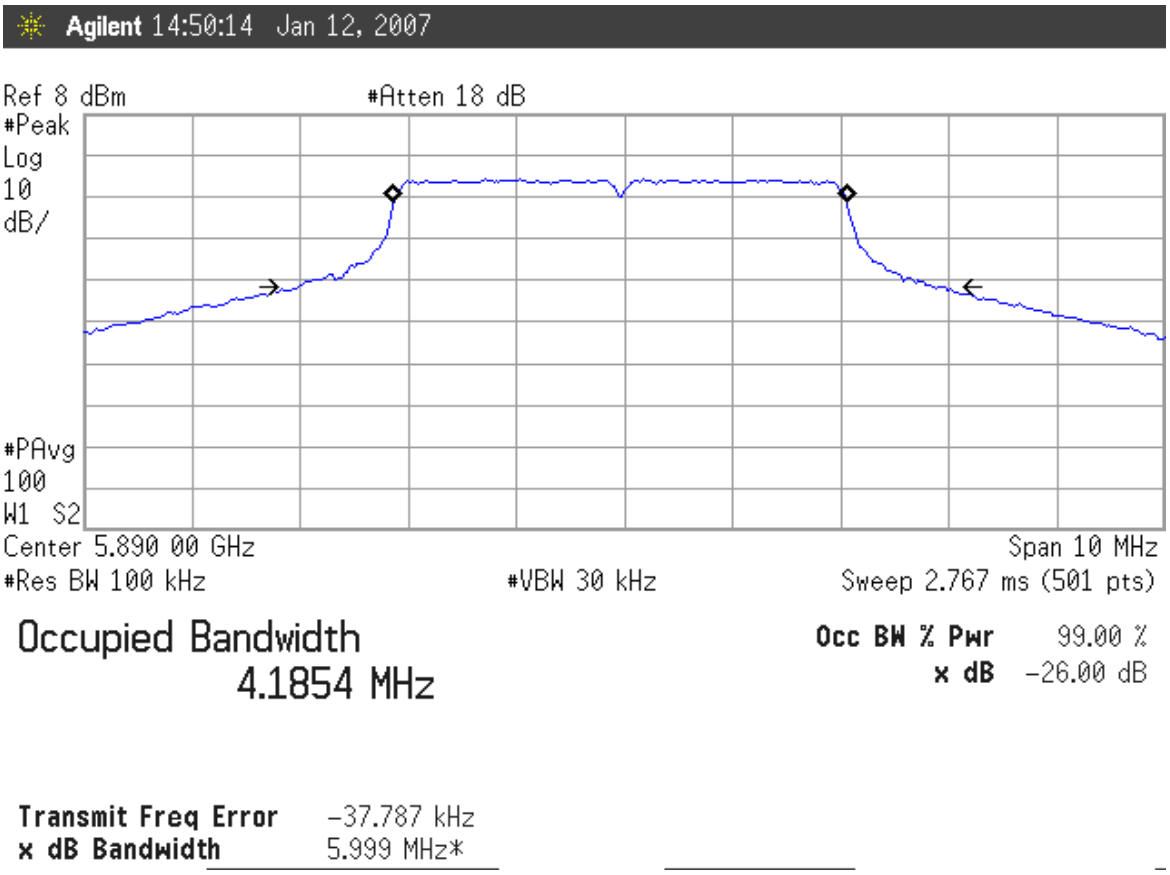

Figure 6. Emission Bandwidth: 5890 MHz; 54 Mbps

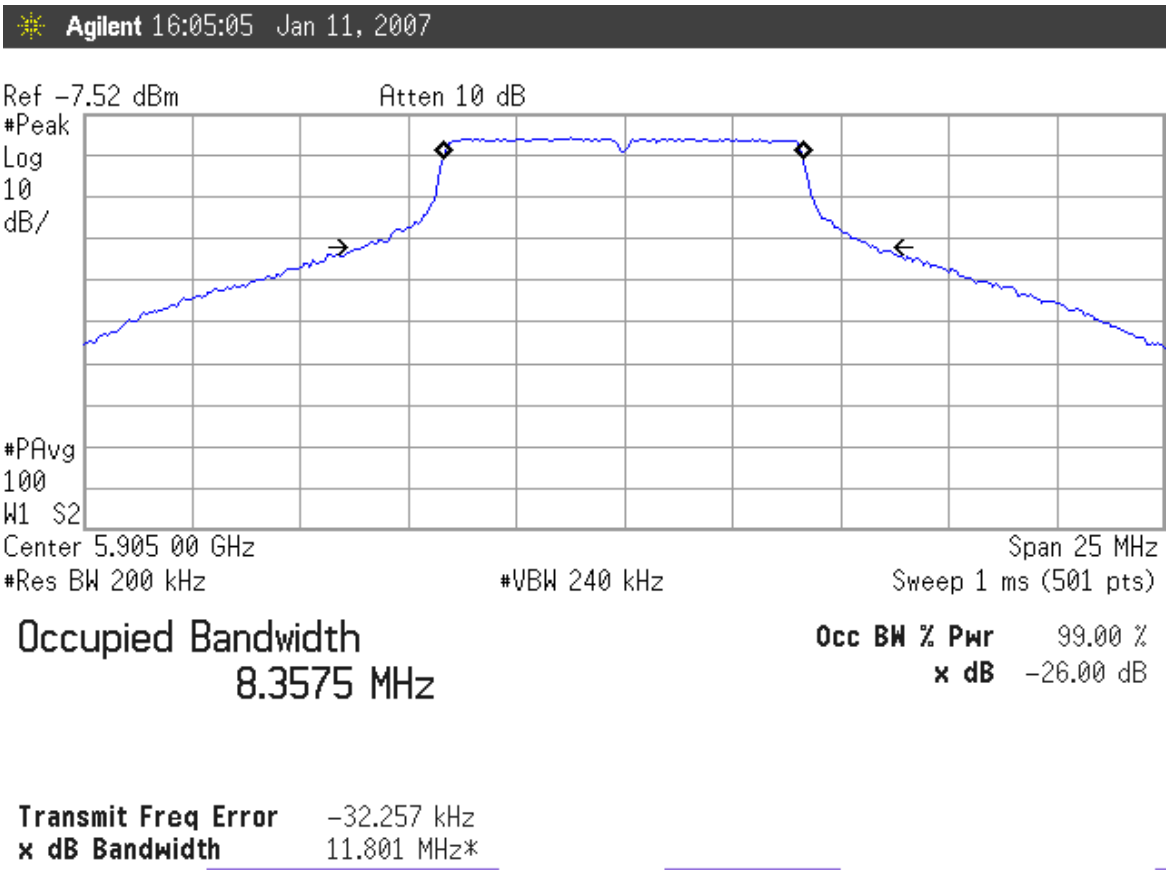

Figure 7. Emission Bandwidth 5905MHz; 6 Mbps

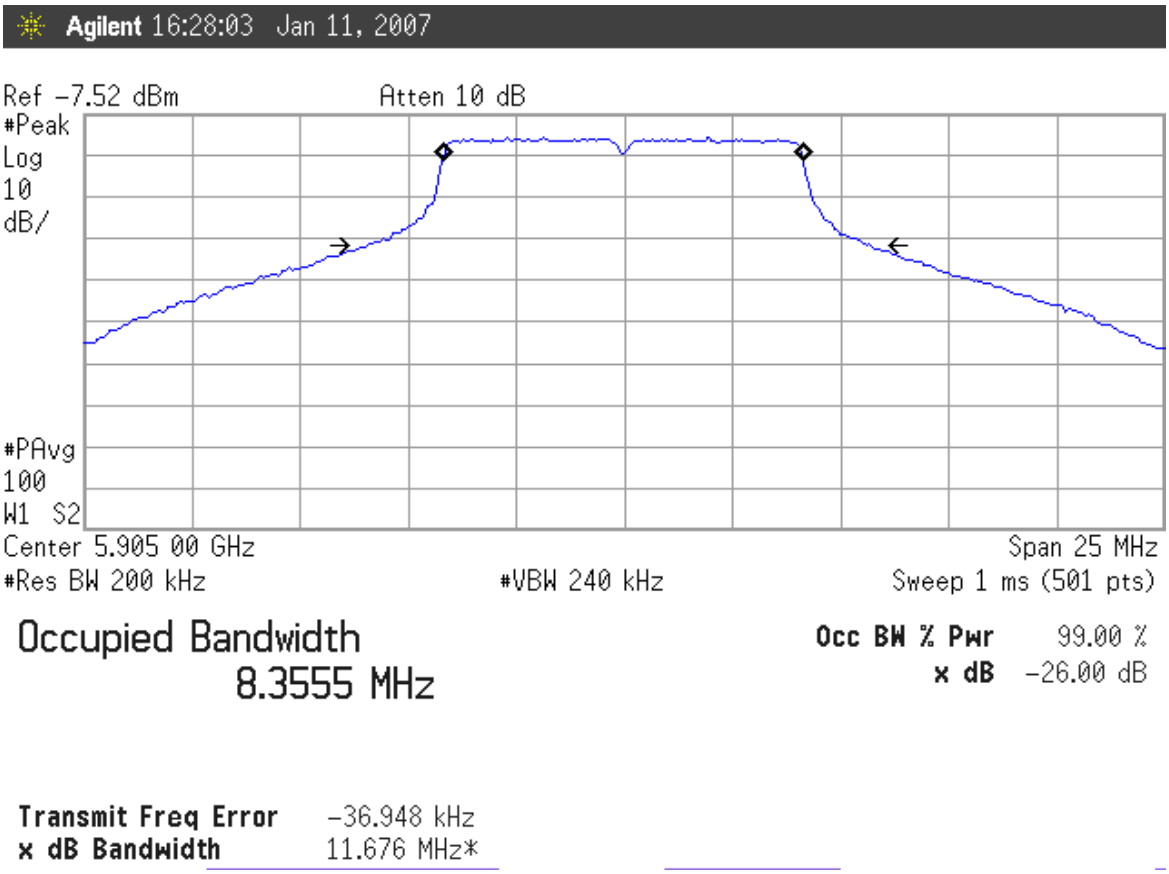

Figure 8. Emission Bandwidth: 5905 MHz; 54 Mbps

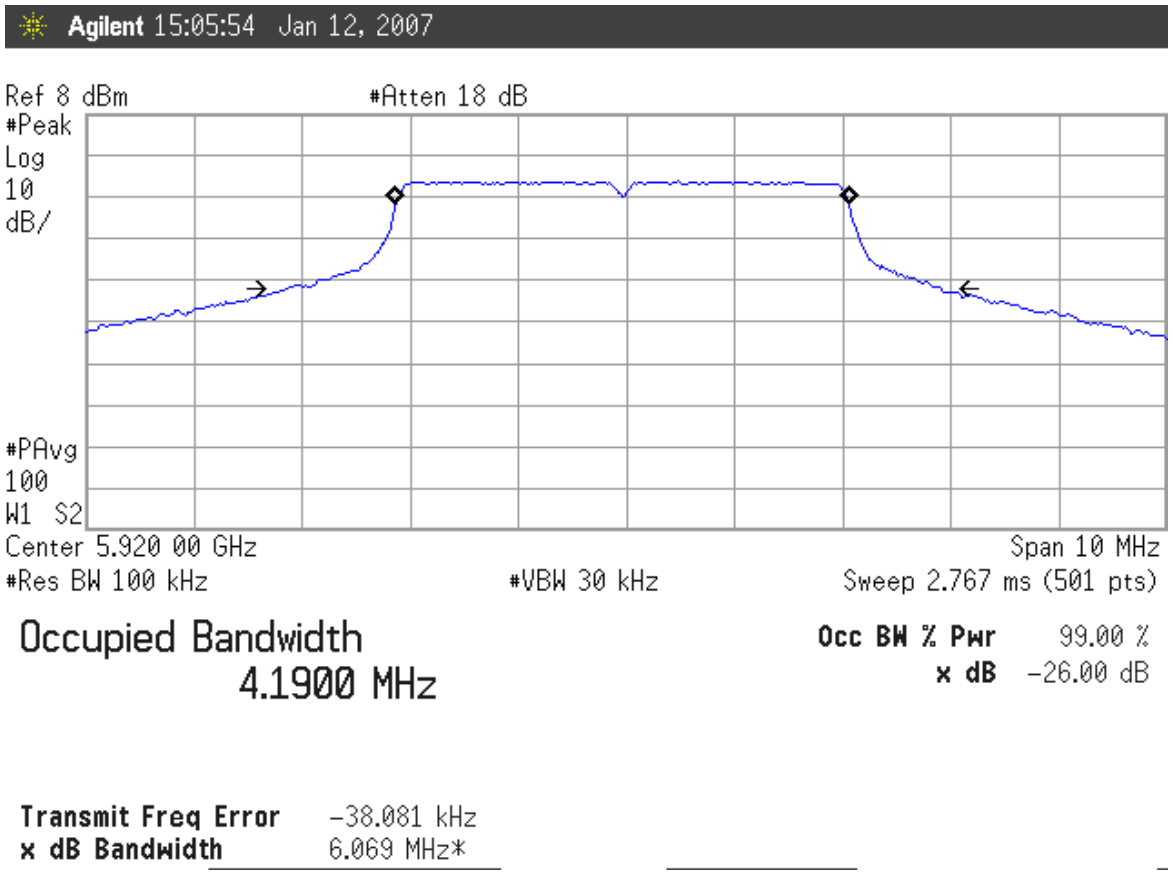

Figure 9. Emission Bandwidth: 5920 MHz; 6 Mbps

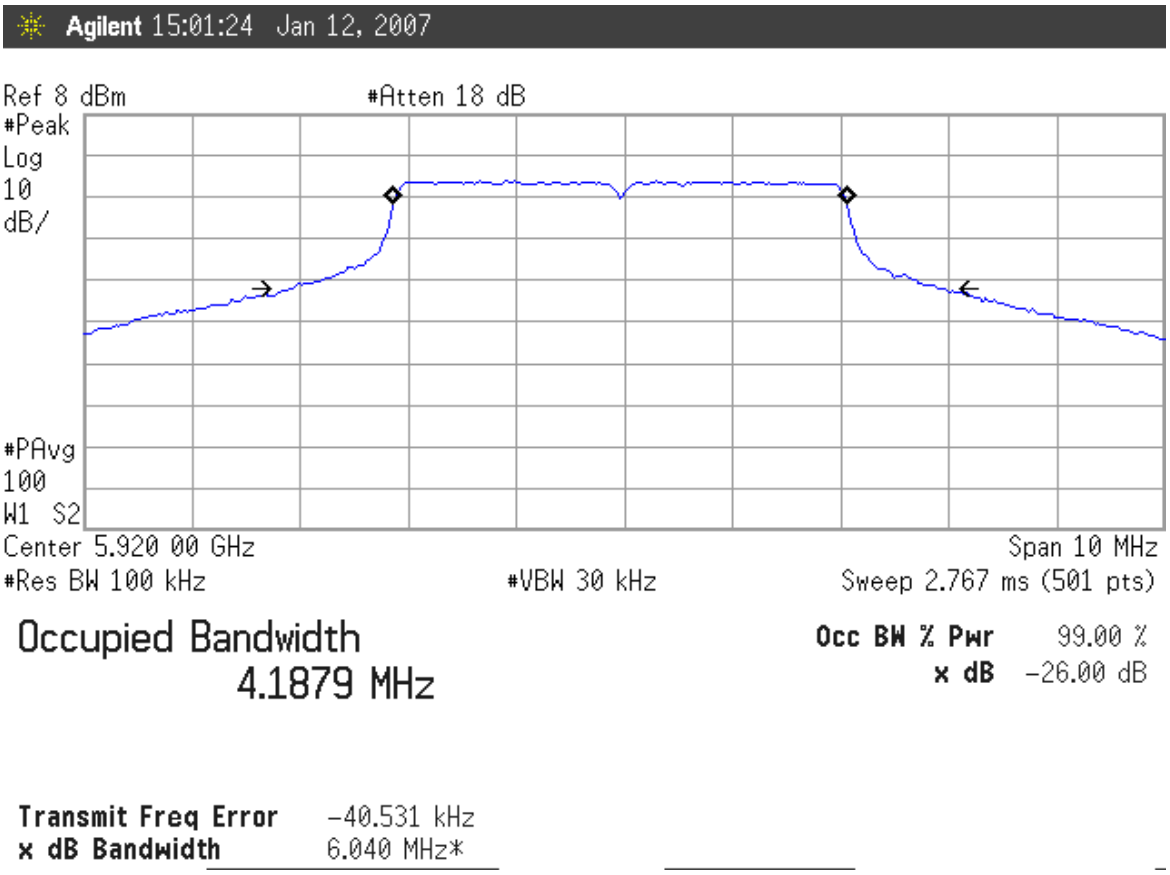

Figure 10. Emission Bandwidth: 5920 MHz; 54 Mbps

4.1.5 Emissions and emission limitations to §90.210

Emissions limitations are specified in §90M and refer to The American Society for Testing and Materials (ASTM) E2213–03, "Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems—5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications."

There are several Road Side Units (RSU) classes which are described in §90.375 **RSU license areas, communication zones and registrations** with the appropriate limits listed in §90.375(c) (reproduced below).

RSU class	Max. output power (dBm) \1\	Communications zone (meters)
A	0	15
B	10	100
C	20	400
D	28.8	1000

\1\ The ASTM-DSRC Standard is incorporated by reference in accordance with 5 U.S.C. 552(a) and 1 CFR part 51 and approved by The Director of the Federal Register.

Table 9 of ASTM E2213-03 refers to the DSRC Device Classes A through D (reproduced below).

TABLE 9 DSRC Device Classes and Transmit Power Levels[A]

Device Class	Maximum Device Output Power, dBm
A	0
B	10
C	20
D	28.8 or more

[A] From IEEE 802.11a. Copyright 1999 IEEE. All rights reserved.

The CelPlan FR-100 radio complies with Device Class C with the attendant emissions mask reproduced from E2213-03 shown below:

E 2213 – 03

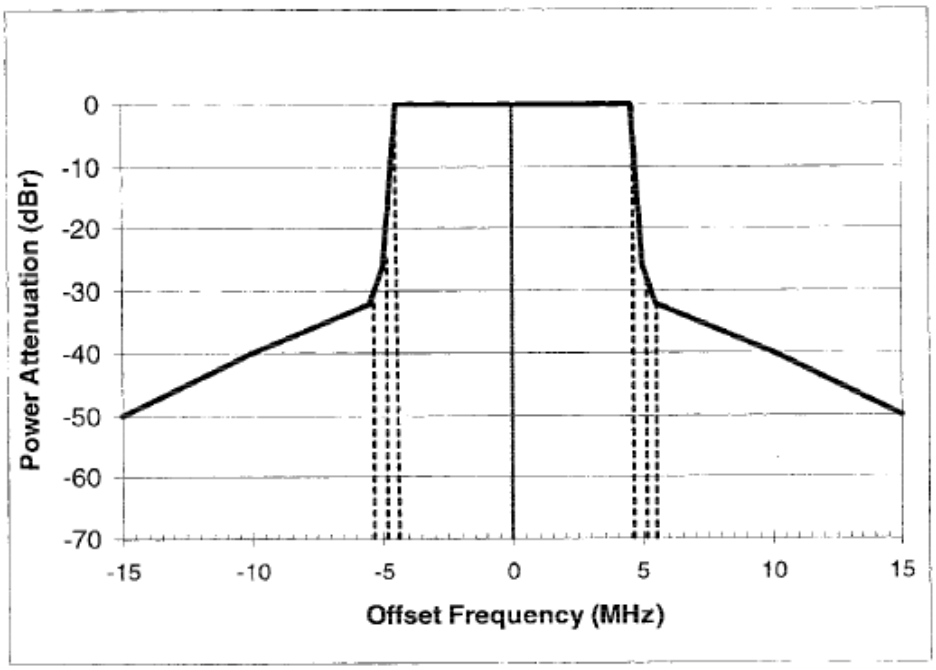

FIG. 14 Class C Transmit Spectrum Mask

Figure 11. DSRC Class C Spectrum Mask

The results of the emissions masks measurements are provided below.

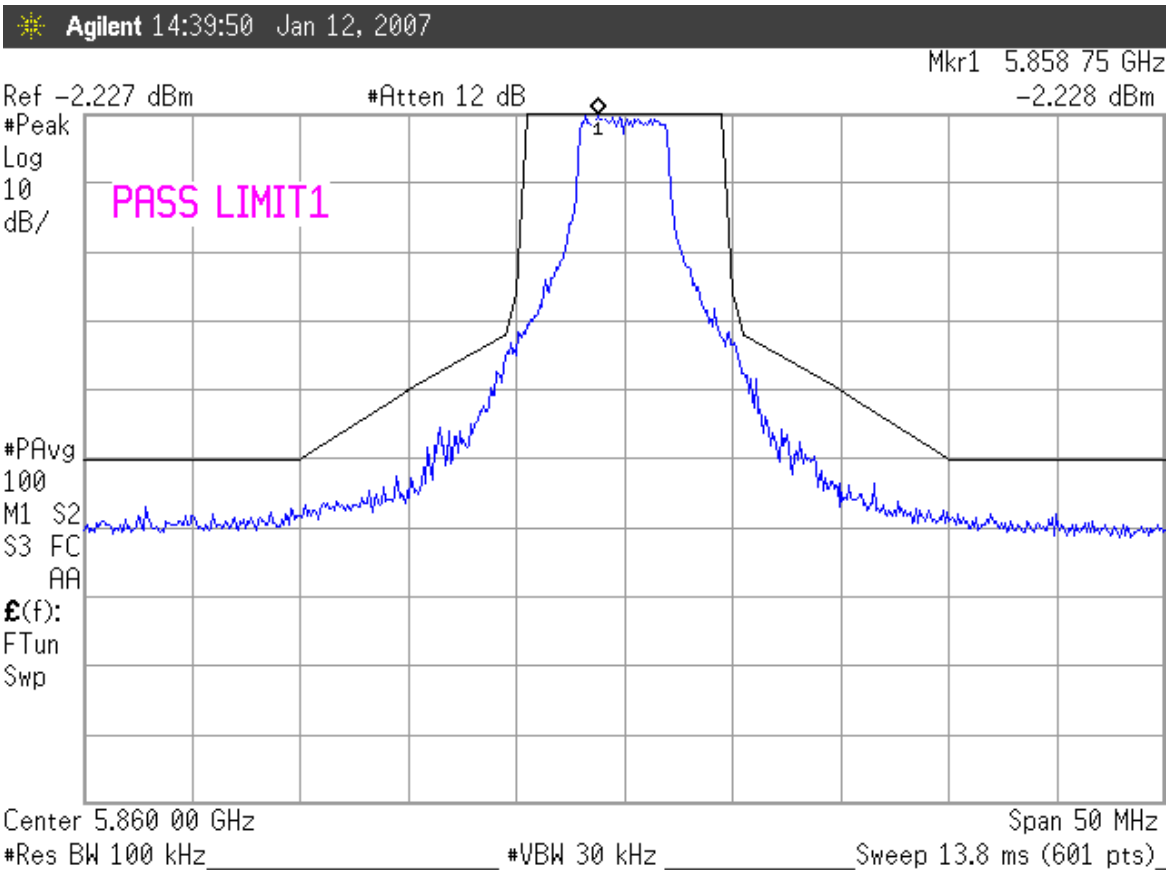

Figure 12. 5860 MHz; 3 MBps w/10 MHz BW

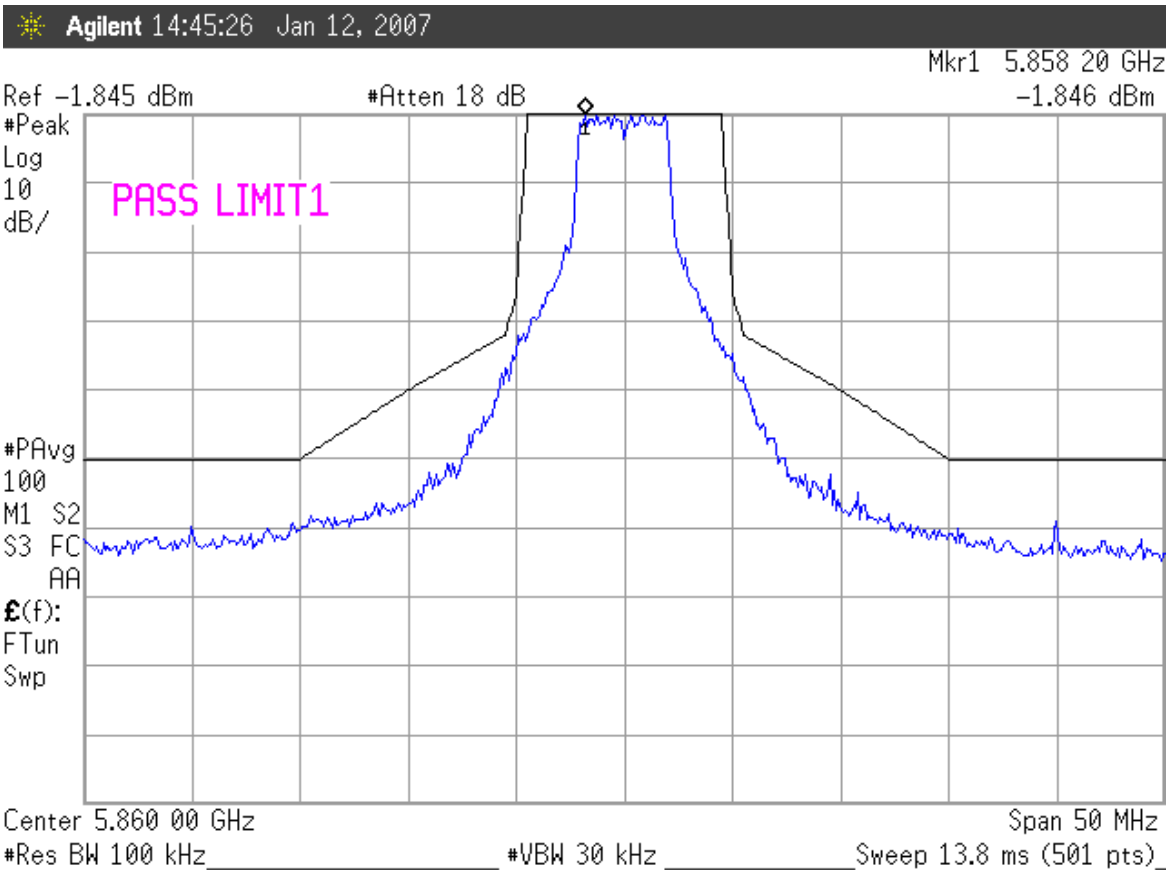

Figure 13. 5860 MHz; 54 MBps w/10 MHz BW

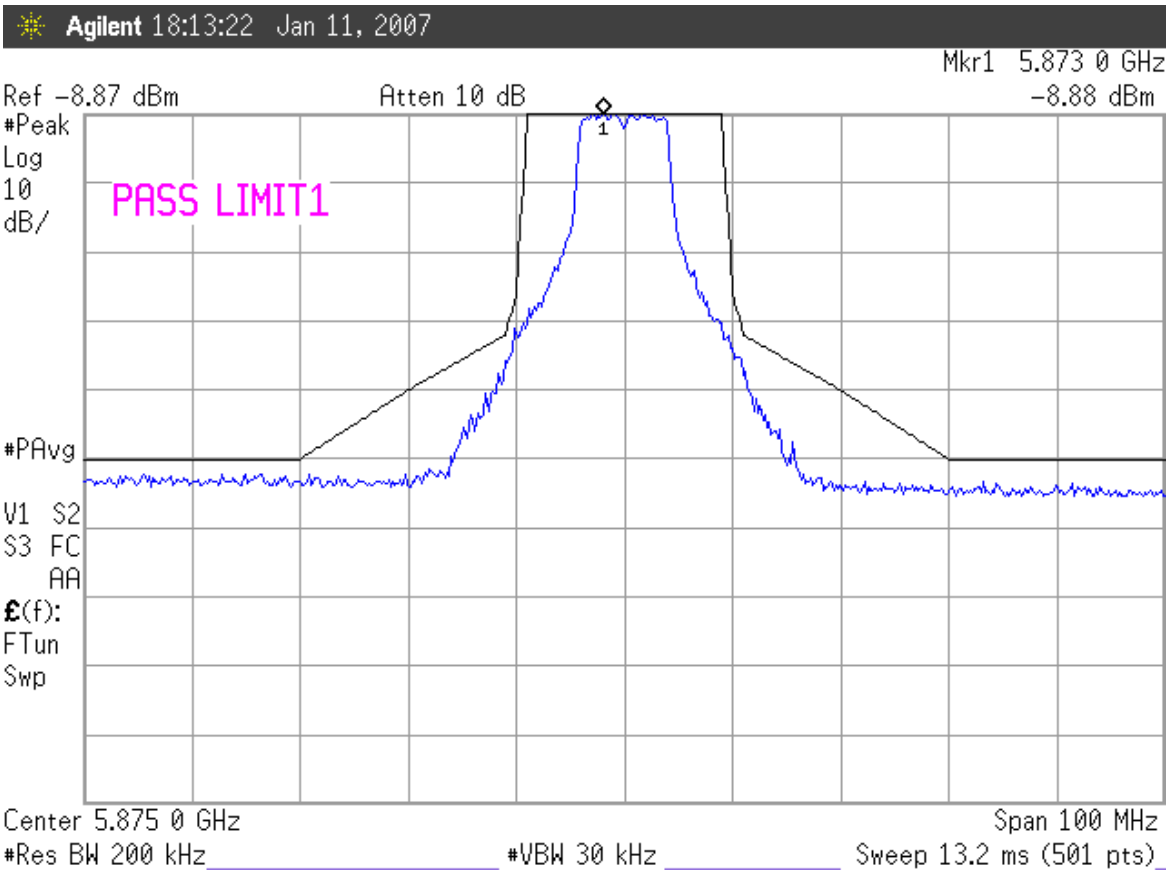

Figure 14. 5875 MHz; 3 MBps w/10 MHz BW

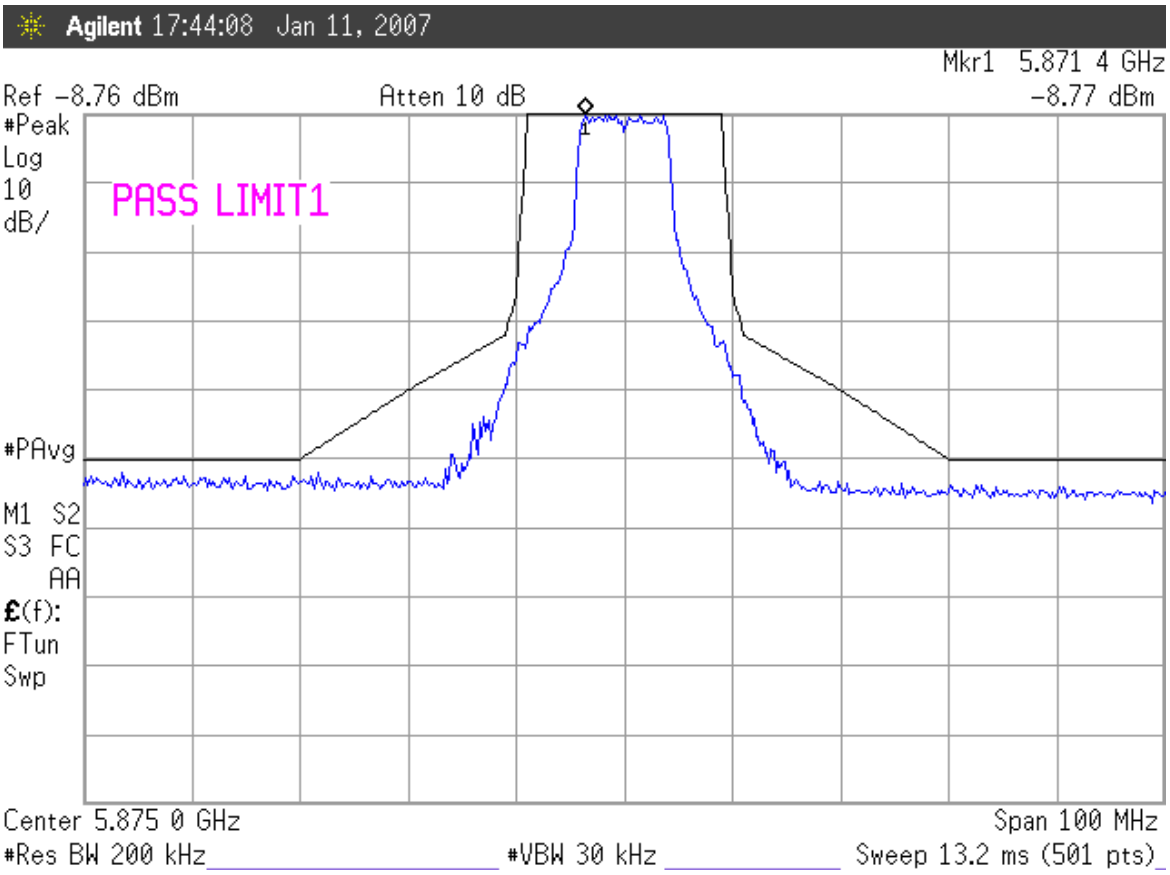

Figure 15. 5875 MHz; 54 MBps w/10 MHz BW

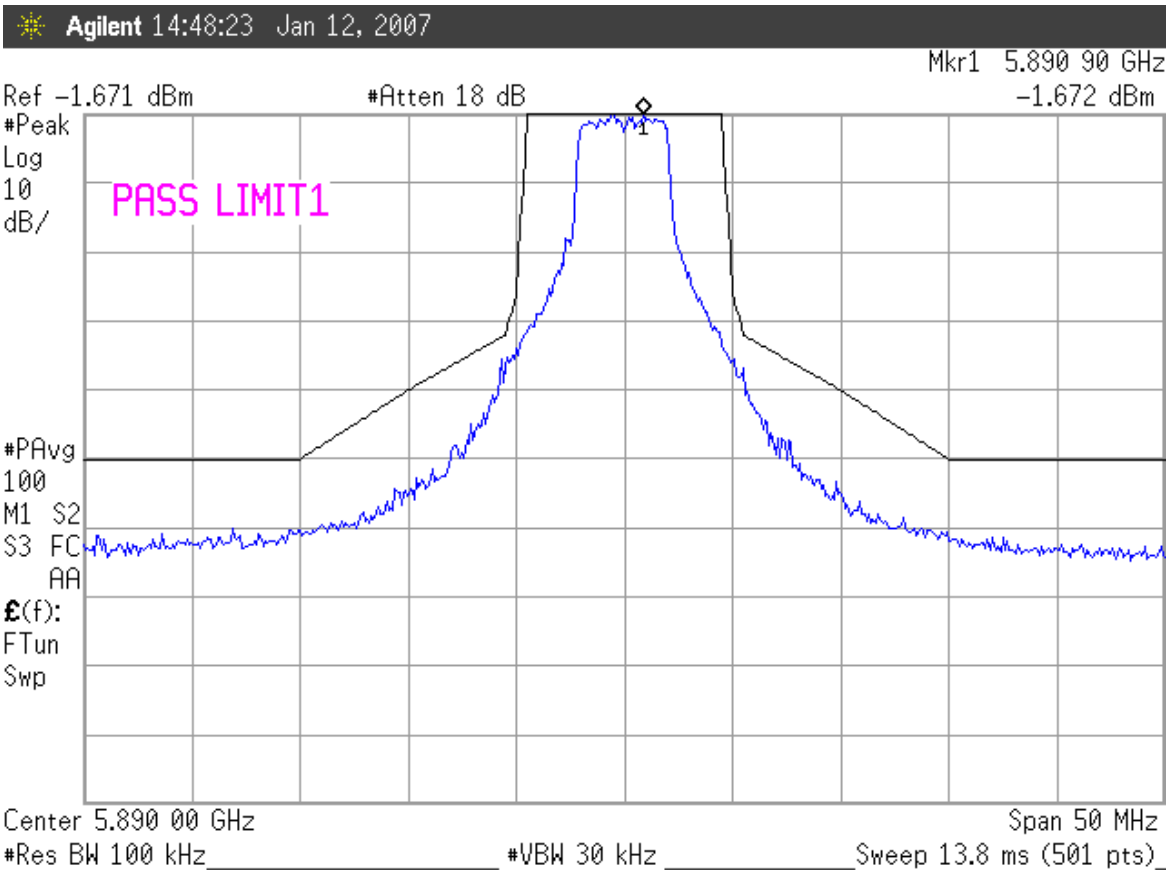

Figure 16. 5890 MHz; 3 MBps w/10 MHz BW

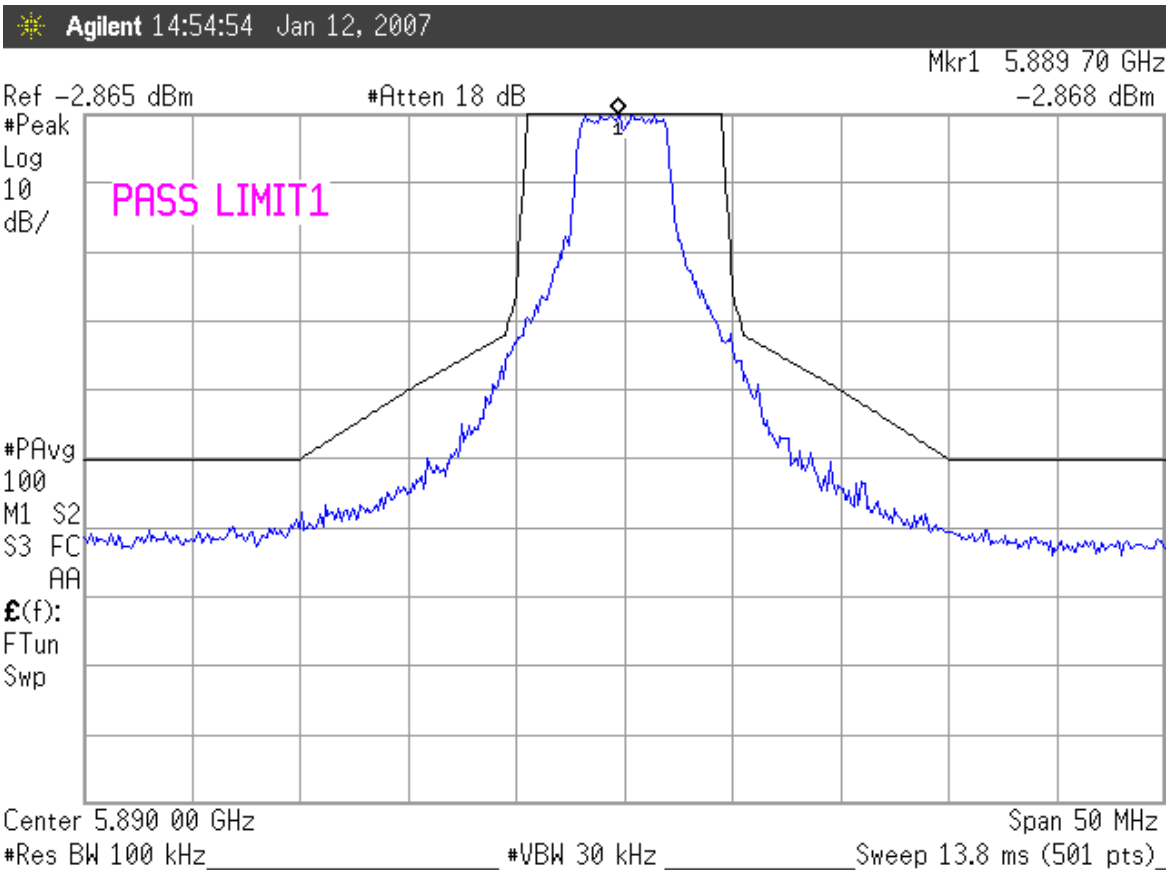

Figure 17. 5890 MHz. 27 MBps w/10 MHz BW

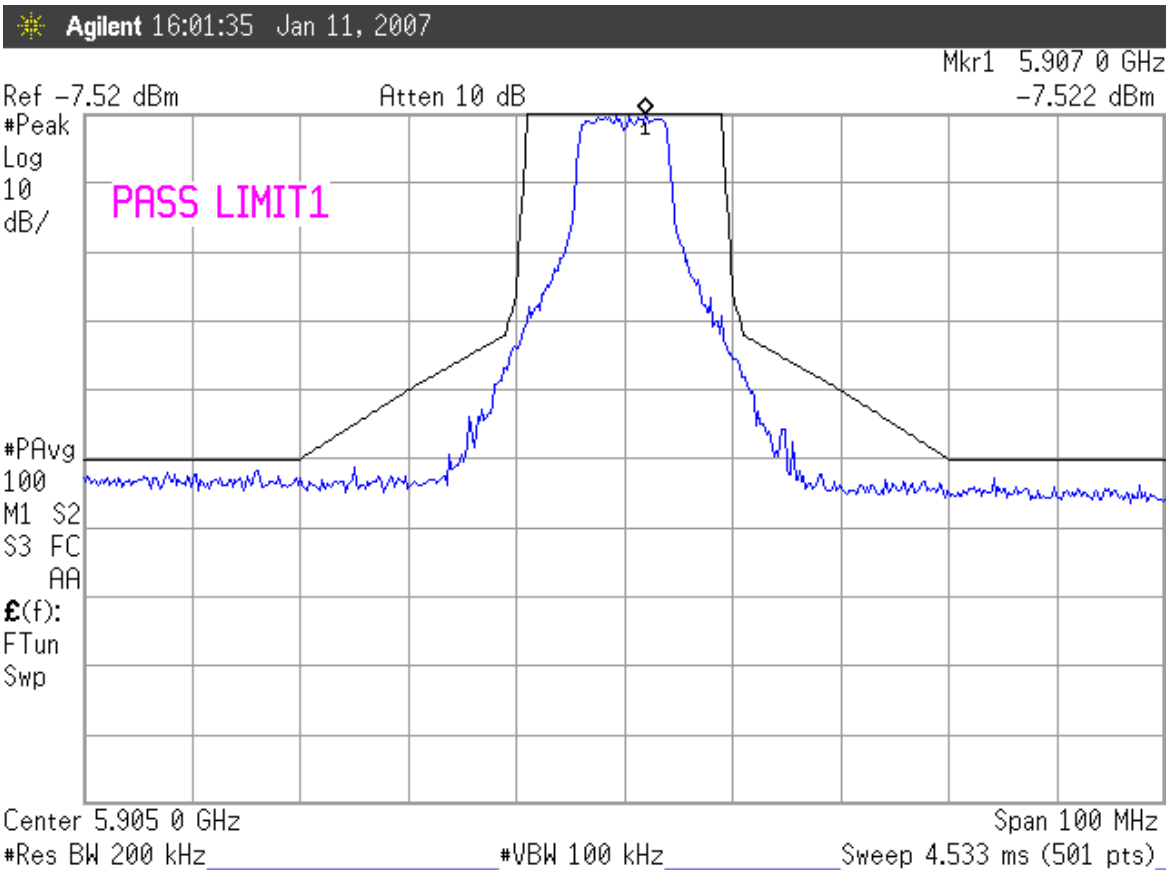

Figure 18. 5905 MHz. 6 MBps w/20 MHz BW

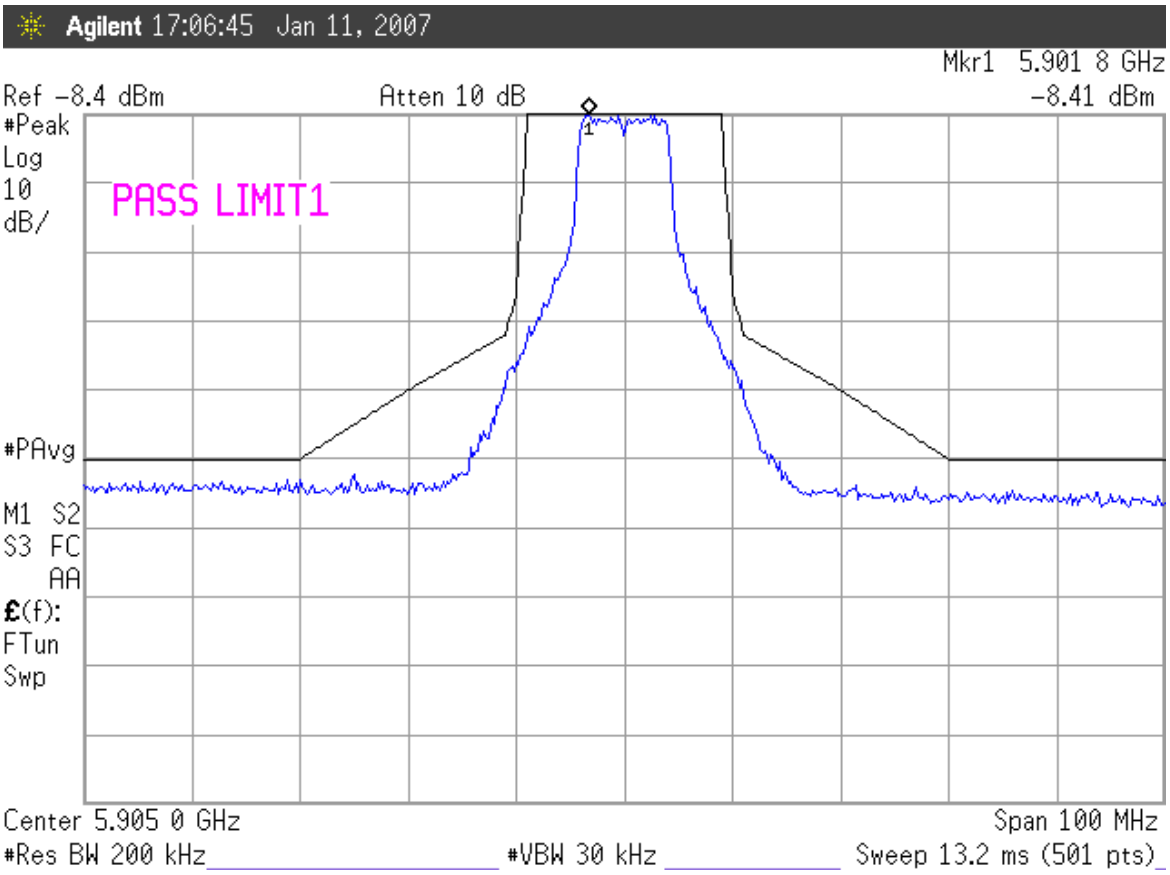

Figure 19. 5905 MHz. 54 MBps w/20 MHz BW

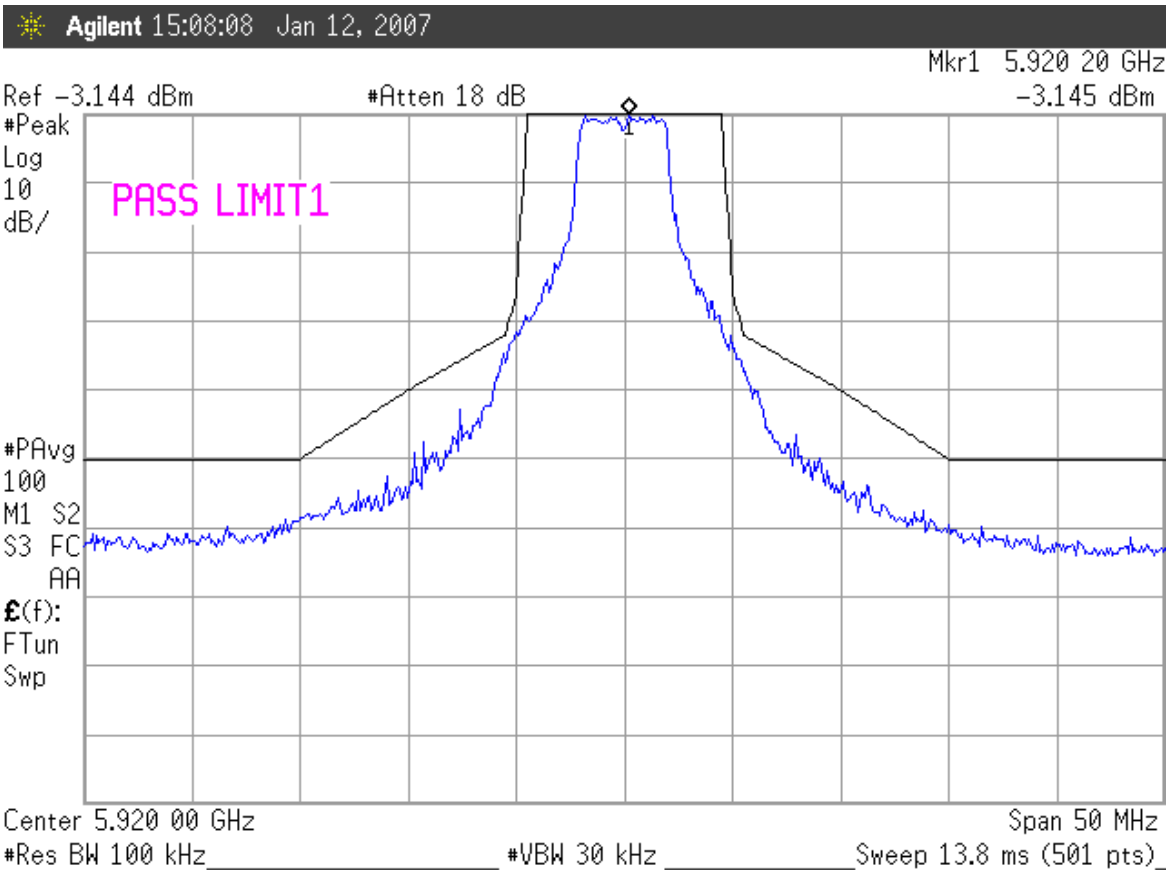

Figure 20. 5920 MHz. 6 MBps w/10 MHz BW

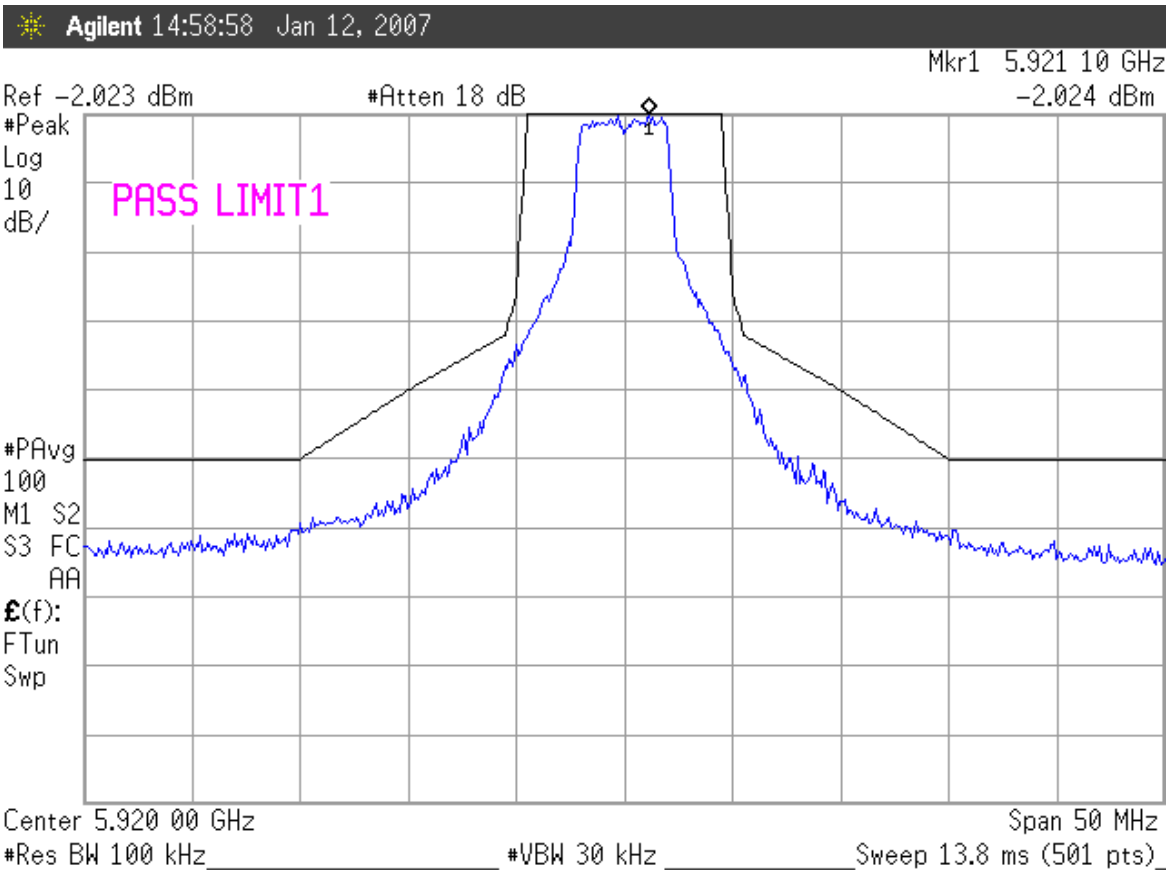

Figure 21. 5920 MHz. 54 MBps w/10 MHz BW

4.1.6 Spurious Emissions

The power was set to the maximum power index number and the spurious emissions measured from 30 MHz to 40 GHz. The data are provided in the following figures.

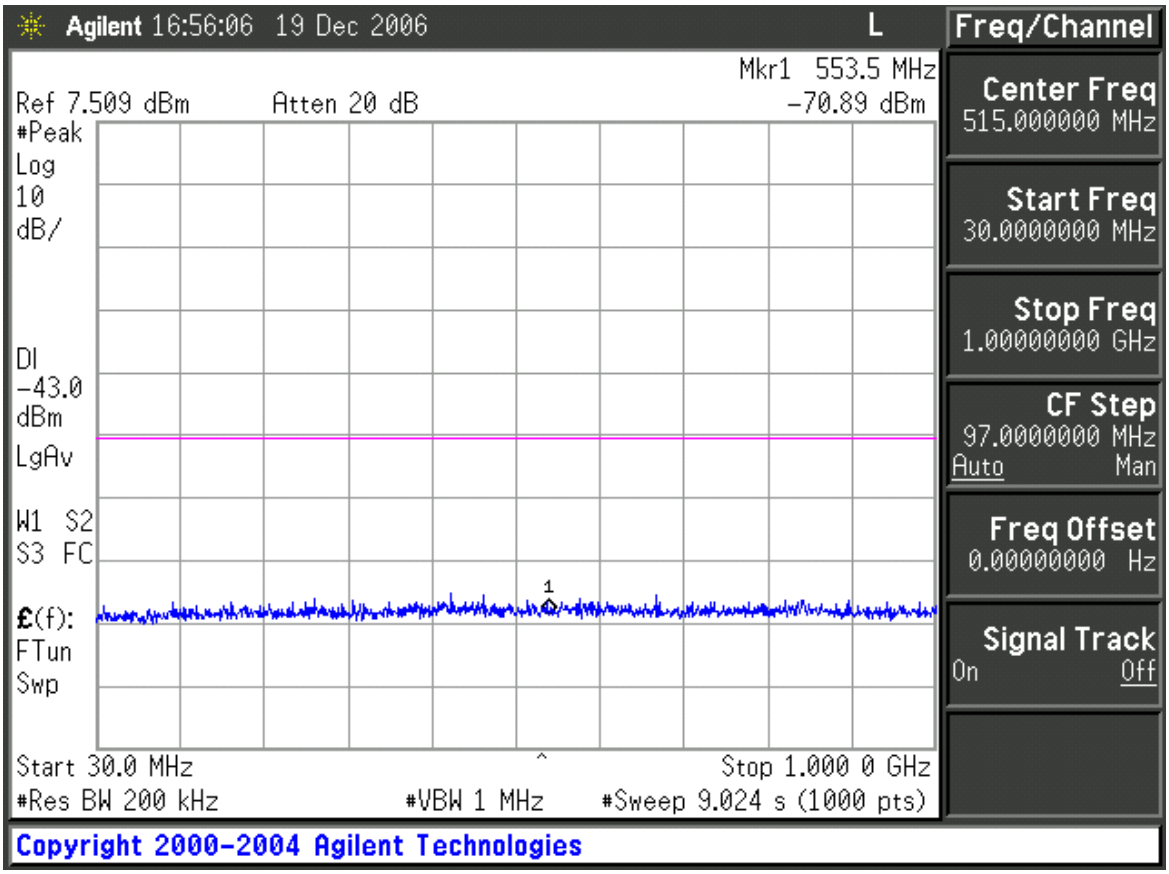

Figure 22. Spurious Emissions, 30M – 1GHz

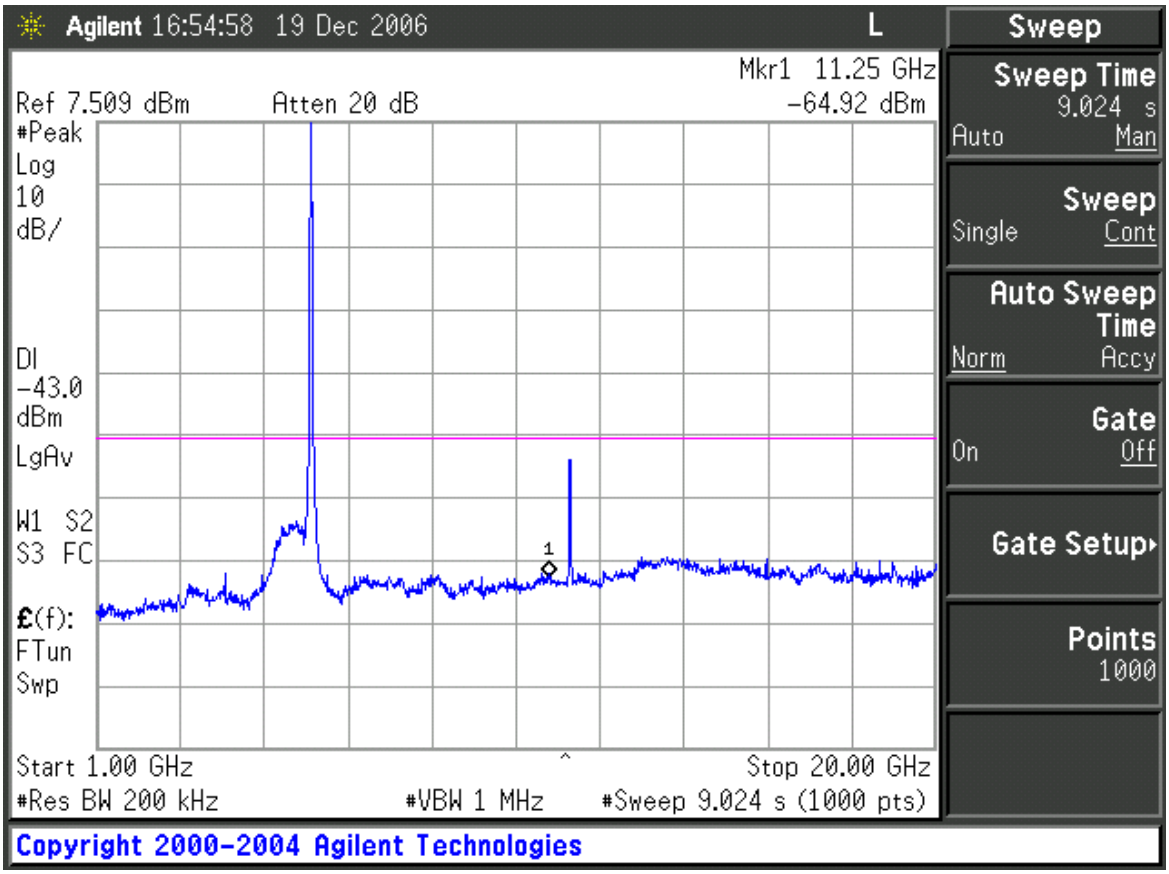

Figure 23. Spurious Emissions, 1-20GHz

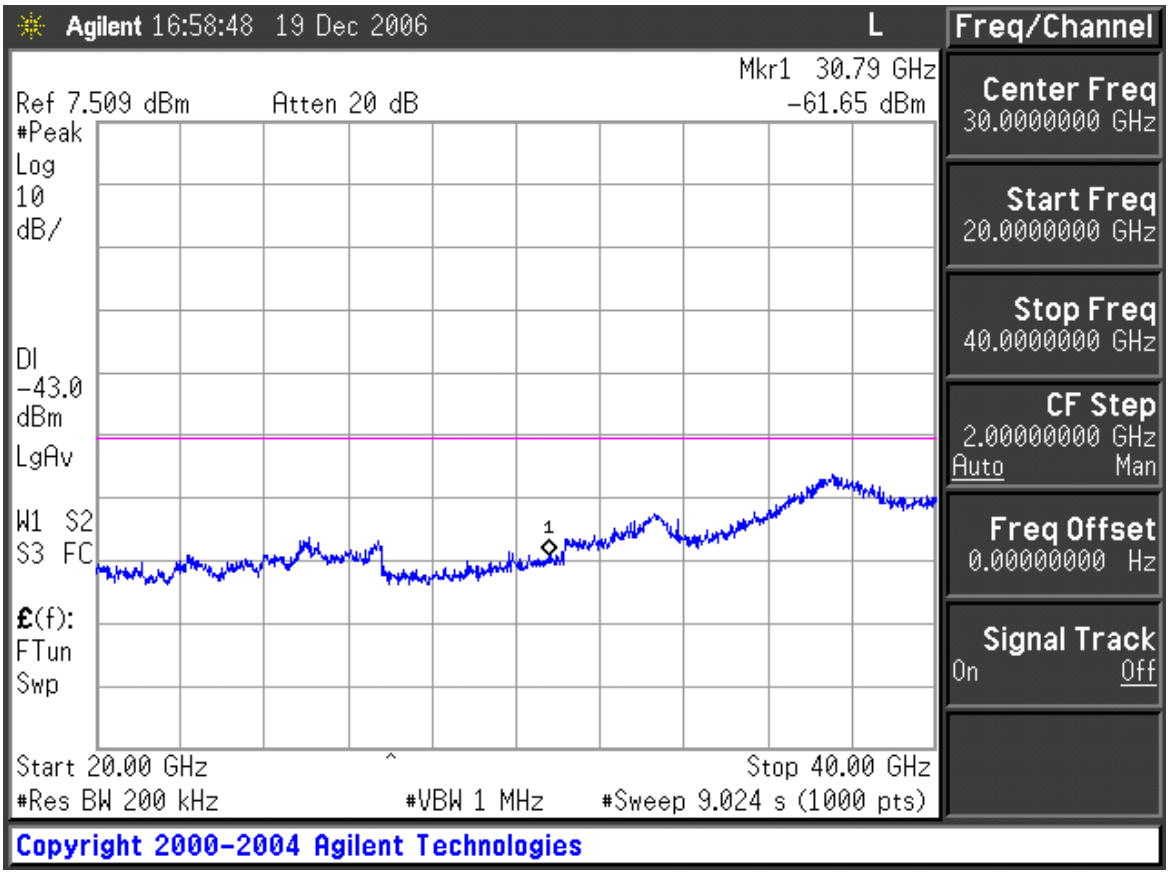

Figure 24. Spurious Emissions, 20-40GHz

4.1.7 Radiated Emissions (Unintentional)

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.

Where emissions were detected, the EIRP levels were determined using the method of signal substitution.

The frequency range of 30 MHz to 40 GHz was measured. All emissions detected are recorded in Table 6 and Table 7.

Table 6. Radiated Emissions: Digital Emissions

Client:	CelPlan	**Date:**	11/21/2006
Tester:	John Repella	**Job #:**	9149
EUT Information:		**Test Requirements:**	
EUT:	FR3000	TEST STANDARD:	FCC Part 15
Configuration:	Table-top	DISTANCE:	3m
Clocks:		CLASS:	B
Test Equipment (<1GHz):		**Test Equipment (>1GHz):**	
ANTENNA:	A_00382	ANTENNA:	A_00004
LIMIT:	LFCC_3m_Class_B		
CABLE:	CSITE1_3m	CABLE:	CSITE2_HF

Freq MHz	Pol H/V	Az	Ant Ht m	SA Level QP dBµV	Ant. Corr.ddB	Cable Corr. dB	Corr. Level dBµV/m	Level µV/m	Limit µV/m	Margin dB
44.65	V	263	1.5	7.2	10.2	1.3	18.7	8.6	100.0	-21.3
48.02	V	263	1.5	11.0	8.5	1.3	20.8	11.0	100.0	-19.2
50.22	V	263	1.5	12.5	7.6	1.3	21.4	11.7	100.0	-18.6
50.71	V	263	1.5	13.3	7.5	1.3	22.1	12.8	100.0	-17.9
51.80	V	263	1.5	13.9	7.4	1.3	22.6	13.5	100.0	-17.4
52.60	V	263	1.5	13.3	7.3	1.3	21.9	12.5	100.0	-18.1
53.17	V	263	1.5	13.3	7.2	1.3	21.9	12.4	100.0	-18.1
60.95	V	263	1.5	14.7	7.4	1.5	23.6	15.1	100.0	-16.4
61.98	V	263	1.5	12.9	7.5	1.5	21.9	12.4	100.0	-18.1
75.72	V	263	1.5	6.6	8.0	1.6	16.2	6.4	100.0	-23.8
84.35	V	263	1.5	11.6	7.4	1.7	20.7	10.9	100.0	-19.3
109.15	V	263	1.5	2.6	12.5	1.9	17.1	7.1	150.0	-26.5
165.03	V	0.0	2.0	4.8	12.0	2.4	19.2	9.1	150.0	-24.3
198.03	V	306	1.5	9.1	12.2	2.6	23.9	15.6	150.0	-19.6
250.01	V	0.0	2.0	6.1	11.5	3.0	20.6	10.7	200.0	-25.4
264.03	V	306	2.0	5.1	12.6	3.1	20.8	11.0	200.0	-25.2
297.03	V	0.0	2.0	7.7	13.4	3.3	24.5	16.8	200.0	-21.5

Freq MHz	Pol H/V	Az	Ant Ht m	SA Level QP dBµV	Ant. Corr.ddB	Cable Corr. dB	Corr. Level dBµV/m	Level µV/m	Limit µV/m	Margin dB
396.03	V	306	2.0	4.0	15.5	3.9	23.4	14.8	200.0	-22.6
462.03	V	306	2.0	5.1	17.3	4.3	26.7	21.5	200.0	-19.4
52.60	H	180	3.5	4.9	7.3	1.3	13.5	4.7	100.0	-26.5
53.17	H	180	3.5	5.9	7.2	1.3	14.5	5.3	100.0	-25.5
60.95	H	180	3.5	11.4	7.4	1.5	20.3	10.3	100.0	-19.7
61.98	H	180	3.5	13.1	7.5	1.5	22.1	12.7	100.0	-17.9
75.72	H	180	3.5	15.2	8.0	1.6	24.8	17.3	100.0	-15.2
84.35	H	263	3.5	6.8	7.4	1.7	15.9	6.3	100.0	-24.1
109.15	H	0.0	3.5	7.1	12.5	1.9	21.6	12.0	150.0	-22.0
165.03	H	107	3.5	7.1	12.0	2.4	21.5	11.9	150.0	-22.0
198.03	H	90	3.5	5.1	12.2	2.6	19.9	9.9	150.0	-23.6
250.03	H	180	3.5	8.2	11.5	3.0	22.8	13.7	200.0	-23.3
264.03	H	180	3.5	5.6	12.6	3.1	21.3	11.6	200.0	-24.7
297.03	H	0.0	3.5	7.2	13.4	3.3	24.0	15.8	200.0	-22.0
396.03	H	180	3.5	2.2	15.5	3.9	21.6	12.1	200.0	-24.4

Table 7. Radiated Emissions: Transmitter Spurious

CLIENT: CelPlan
TESTER: John Repella
DATE: 1/23/2007
JOB #: 9149

EUT Information:
EUT: FR100
Configuration: Tabletop, Antenna terminated
TX Frequency: 5890MHz

Test Requirements:
TEST STANDARD: FCC Part 90 & 95
DISTANCE: 3m

Test Equipment/Limit:
LIMIT: Part 90M & 90Y Mask A, B, C, G, H, I

Freq (MHz)	Polarity H/V	Azimuth Degree	Ant. Height (m)	Spurious Level dBµV	Sub. Sig. Gen. Level dBm	Sub. Power Level dBm	Sub. Ant. Factor dB/m	Sub. Ant. Gain dBi	EIRP Level dBm	Limit dBm	Margin dB	Notes
5890.000	V	36.0	1.0	47.58								Fund
11780.00	V	0.0	1.0	32.03	-31.9	-64.0	47.5	4.1	-59.9	-40.0	-19.9	AMB
17670.000	V	0.0	1.0	31.47	-32.2	-64.7	56.9	-1.7	-66.4	-40.0	-26.4	AMB
5890.000	H	270.0	1.0	44.94								Fund
11780.000	H	0.0	1.0	32.49	-31.6	-55.3	47.5	4.1	-51.1	-40.0	-11.1	AMB
17670.000	H	0.0	1.0	32.50	-32.2	-64.7	56.9	-1.7	-66.4	-40.0	-26.4	AMB

4.1.8 Emission Designator

The emission designator is determined from the necessary bandwidth, the type of modulation and the information conveyed in the signal.

For the subject unit, the following Emission Designator has been determined according to Section 2.201 of the FCC Rules and Appendix J of the May 2006 revision of the NTIA Redbook (http://www.ntia.doc.gov/osmhome/redbook/J.pdf).

Necessary bandwidth for OFDM Modulation is:

Bn = (NS + 16.25)CS

where,

NS = Number of Subcarriers

CS = Separation in frequency between adjacent sub-carriers or carriers of a multi-carrier modulation (in MHz)

Bn = (48 + 16.25) X 0.25 = 16.1 MHz

The necessary bandwith is 16.1 MHz

The information is data and sent in a single channel with the main carrier being amplitude and angle-modulated in a pre-established sequence.

Hence, the emission designator is 16M1D1D

4.1.9 Frequency Stability: (FCC Part §2.1055)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

The EUT is powered by the host system.

Transmit frequency tolerance is specified in section 8.9.4 of ASTM E22213-03 and is reproduced below.

> 8.9.4 *Transmit Center Frequency Tolerance*—The transmitted center frequency tolerance shall be ±10 ppm maximum for RSUs and ±10 ppm maximum for OBUs. The transmit center

Table 8. Frequency Deviation

Job#:	9149
Company:	Celplan
EUT:	FR-100
Standard/Test Level:	Part Part 90M & 90Y
Test Engineer:	ER
Reviewed by:	MV
Test Start Date:	1/18/2007

Limit: 0.001% ASTM E22213-03 Section 8.9.4

Nominal Frequency 5900MHz

Temperature (Centigrade)	Frequency (MHz)	Difference (Hz)	Deviation (%)
Ambient	5899.953600	0.0	0
-30	5899.960500	6900.0	0.000117
-20	5899.964800	11200.0	0.000190
-10	5899.964900	11300.0	0.000192
0	5899.966400	12800.0	0.000217
10	5899.963500	9900.0	0.000168
20	5899.959700	6100.0	0.000103
30	5899.951300	-2300.0	0.000039
40	5899.954100	500.0	0.000008
50	5899.975700	22100.0	0.000375

Voltage (Volts)	Frequency (MHz)	Difference (Hz)	Deviation (%)	Voltage (Volts)
At rated	5899.953600	0	0.0	120VAC
At 85%	5899.955300	-1700	0.000029	102VAC
At 115%	5899.958100	-4500	0.000076	13.8VAC

Notes: Measured in Peak, CW mode

4.2 FCC Part 90Y Public Safety

Measurements were made at the following frequency and test conditions. Data are reported for each of the listed channel bandwidths, representing worst-case data for all conditions.

Under the conditions of operation, controlled by the factory settings, the following channel bandwidths and power levels and can be supported.

Table 9. Test Conditions: CTL Settings for Different Operation Configurations

	Channel Bandwidth (MHz)		Channel Bandwidth (MHz)		Channel Bandwidth (MHz)
	20 MHz		10 MHz		5 MHz
	Sub-carrier spacing (kHz)		Sub-carrier spacing (kHz)		Sub-carrier spacing (kHz)
	312	156	156	78	78
Data Rate (Mbit/s)	Nominal Power (dBm)		Nominal Power (dBm)		Nominal Power (dBm)
54	20				
48	20				
36	20				
24	20		20		
18	20		20		
12	20		20	33	20
9	20		20	33	20
6	20		20	33	20
Mask	L		L	M	L

Modulations: BPSK, QPSK, 8QAM, 16QAM, 64QAM

The transmitter was operating continuously.

4.2.1 RF Power Output: (FCC Part §2.1046)

4.2.2 Peak Transmit Power

The peak transmit power is measured as a conducted emission over any interval of continuous transmission calibrated in terms of an RMS-equivalent voltage. Data for the measured power are shown in **Table 10**.

Table 10. Transmit Power Results

Frequency (MHz)	Data Rate Mbit/s	Modulation	Power #	Output Power dBm	Limit	Result
20L						
4955.00	6	BPSK	4.5	12.2	33.0	PASS
4955.00	54	64QAM	5	13.1	33.0	PASS
4975.00	6	BPSK	5	11.7	33.0	PASS
4975.00	54	64QAM	5	12.2	33.0	PASS
10M						
4945.00	6	BPSK	15	22.8	30.0	PASS
4945.00	54	64QAM	15	23.5	30.0	PASS
4965.00	6	BPSK	15	22.8	30.0	PASS
4965.00	54	64QAM	15	22.5	30.0	PASS
4985.00	6	BPSK	15	21.4	30.0	PASS
4985.00	54	64QAM	15	21.5	30.0	PASS
10L						
4945.00	3	BPSK	3.5	10.9	17.0	PASS
4945.00	27	64QAM	3.5	12.3	17.0	PASS
4965.00	6	BPSK	5	10.9	20.0	PASS
4965.00	54	64QAM	5	13.0	20.0	PASS
4985.00	6	BPSK	5	11.5	20.0	PASS
4985.00	54	64QAM	5	11.5	20.0	PASS
5L						
4942.50	6	BPSK	3.5	9.8	14.0	PASS
4942.50	54	64QAM	5	13.0	14.0	PASS
4967.50	6	BPSK	4	10.5	14.0	PASS
4967.50	54	64QAM	4	10.5	14.0	PASS
4987.50	6	BPSK	4	10.2	14.0	PASS
4987.50	54	64QAM	4	9.9	14.0	PASS

4.2.3 Power Spectral Density

Power spectral density measurements are taken

Table 11. Power Spectral Density Limits

Frequency (MHz)	Peak Power Spectral density dB/MHz	Limit dBm	Result
20L			
4955.00	-10.1	8.0	PASS
4955.00	-8.6	8.0	PASS
4975.00	-10.8	8.0	PASS
4975.00	-10.3	8.0	PASS
10M			
4945.00	4.9	21.0	PASS
4945.00	5.5	21.0	PASS
4965.00	0.7	21.0	PASS
4965.00	5.4	21.0	PASS
4985.00	3.6	21.0	PASS
4985.00	4.6	21.0	PASS
10L			
4945.00	-3.7	8.0	PASS
4945.00	-10.2	8.0	PASS
4965.00	-2.3	8.0	PASS
4965.00	-2.3	8.0	PASS
4985.00	-10.7	8.0	PASS
4985.00	-10.2	8.0	PASS
5L			
4942.50	-10.4	8.0	PASS
4942.50	-6.7	8.0	PASS
4967.50	-10.0	8.0	PASS
4967.50	-9.2	8.0	PASS
4987.50	-10.9	8.0	PASS
4987.50	-9.9	8.0	PASS

[1]High power point-to-point or point-to-multipoint operation (both fixed and temporary-fixed rapid deployment) may employ transmitting antennas with directional gain up to 26 dBi without any corresponding reduction in the transmitter power or spectral density. Corresponding reduction in the peak transmit power and peak power spectral density should be the amount in decibels that the directional gain of the antenna exceeds 26 dBi.

[2]Low power devices are also limited to a peak power spectral density of 8 dBm per one MHz. Low power devices using channel bandwidths other than those listed above are permitted; however, they are limited to a peak power spectral density of 8 dBm/MHz. If transmitting antennas of directional gain greater than 9 dBi are used, both the peak transmit power and the peak power spectral density should be reduced by the amount in decibels that the directional gain of the antenna exceeds 9 dBi.

4.2.4 Occupied Bandwidth (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the radio to the input of a spectrum analyzer via an attenuator.

Table 12 provides a summary of the Occupied Bandwidth Results. Maximum authorized bandwidth is 50 MHz.

Table 12. Occupied Bandwidth Results

Frequency (MHz)	Emission Bandwidth MHz
20L	
4955.00	22.5
4955.00	22.8
4975.00	23.8
4975.00	23.6
10M	
4945.00	6.4
4945.00	6.7
4965.00	6.7
4965.00	6.7
4985.00	6.3
4985.00	6.3
10L	
4945.00	11.7
4945.00	11.8
4965.00	11.8
4965.00	12.0
4985.00	12.0
4985.00	11.8
5L	
4942.50	5.9
4942.50	5.7
4967.50	5.8
4967.50	5.9
4987.50	5.8
4987.50	5.84

At full modulation, the occupied bandwidth was measured as shown in the following figures, which show a representative measurement for each of the masks. Note that the 26dB bandwidth is reported in the above table.

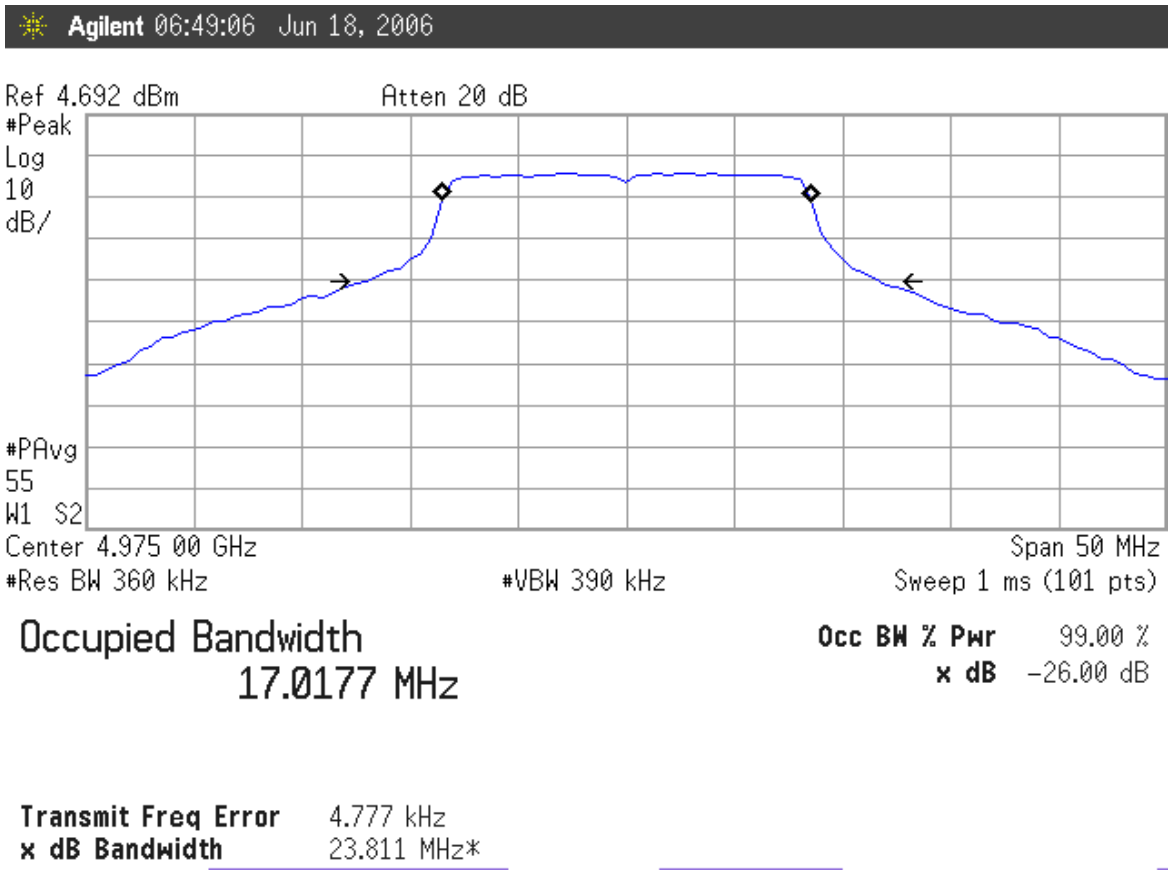

Figure 25. Emission Bandwidth 20L

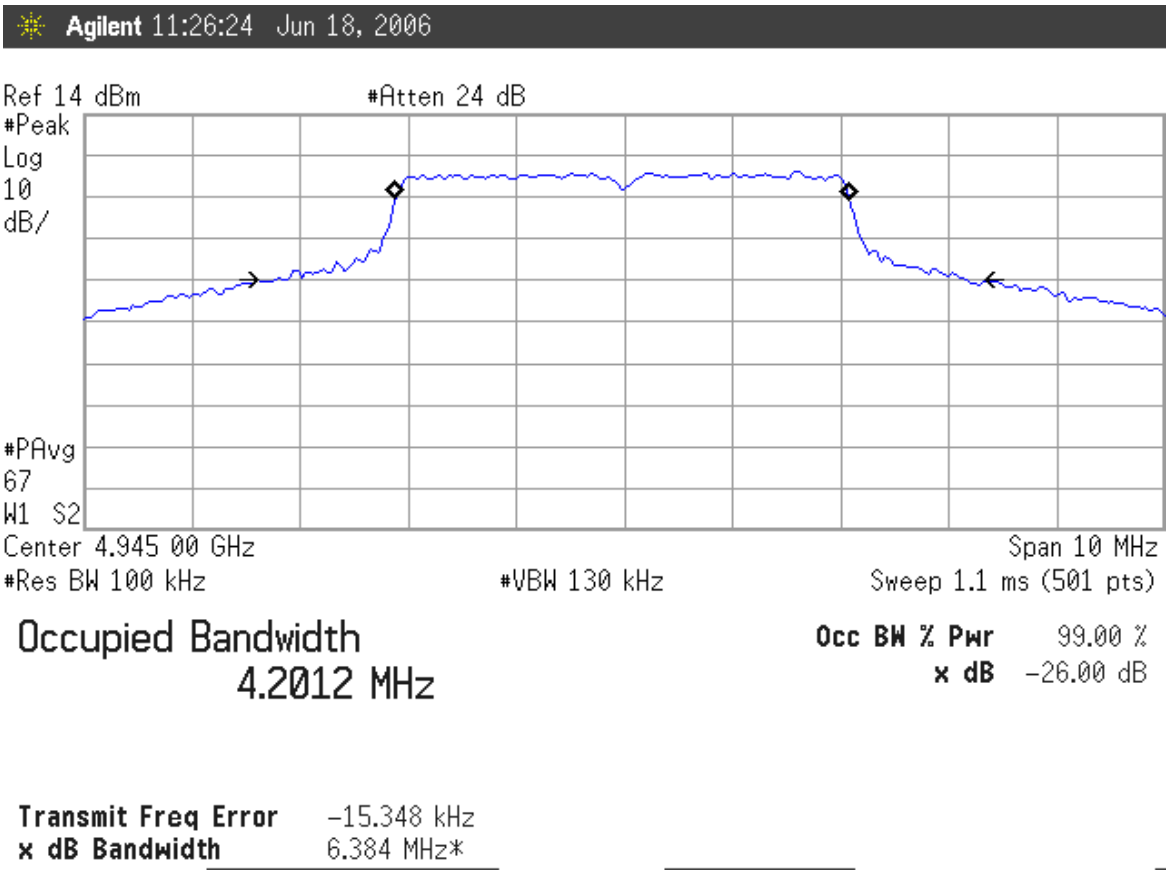

Figure 26. Emission Bandwidth 10L

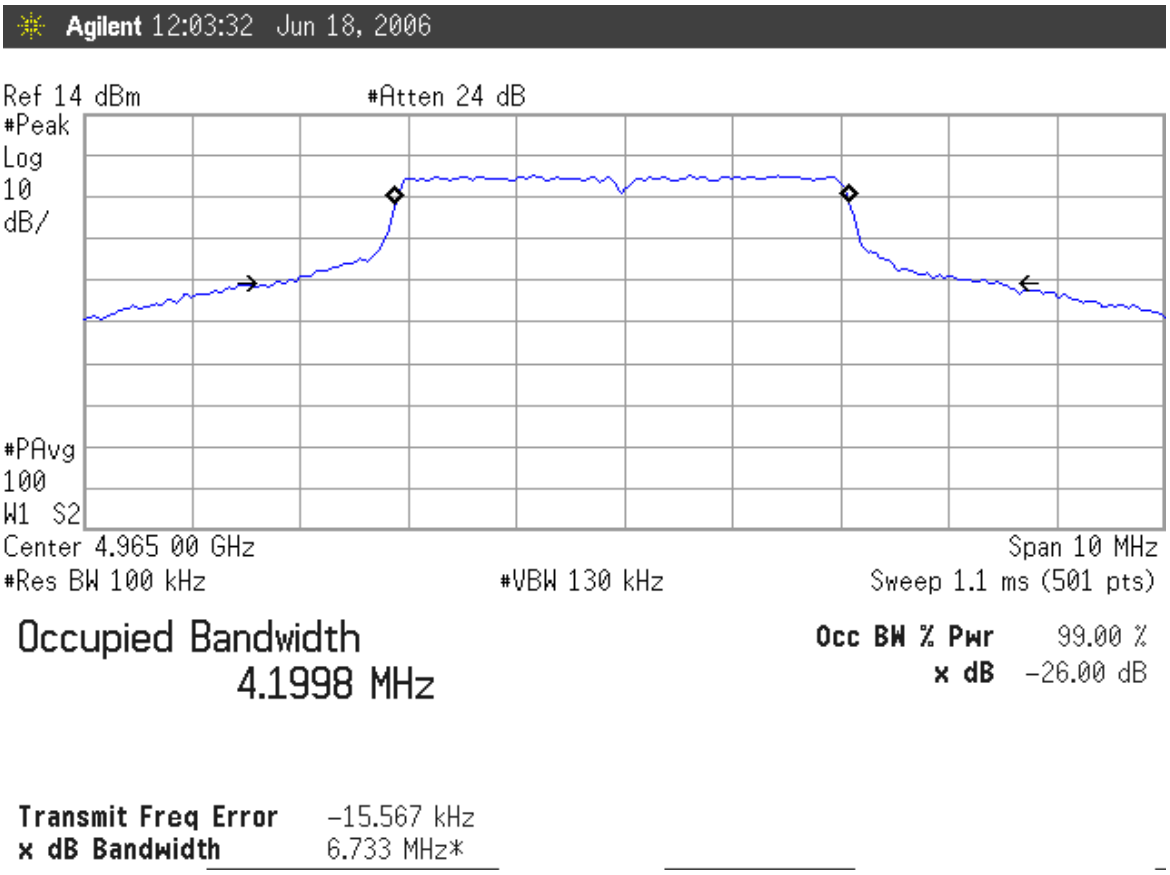

Figure 27. Emission Bandwidth 10M

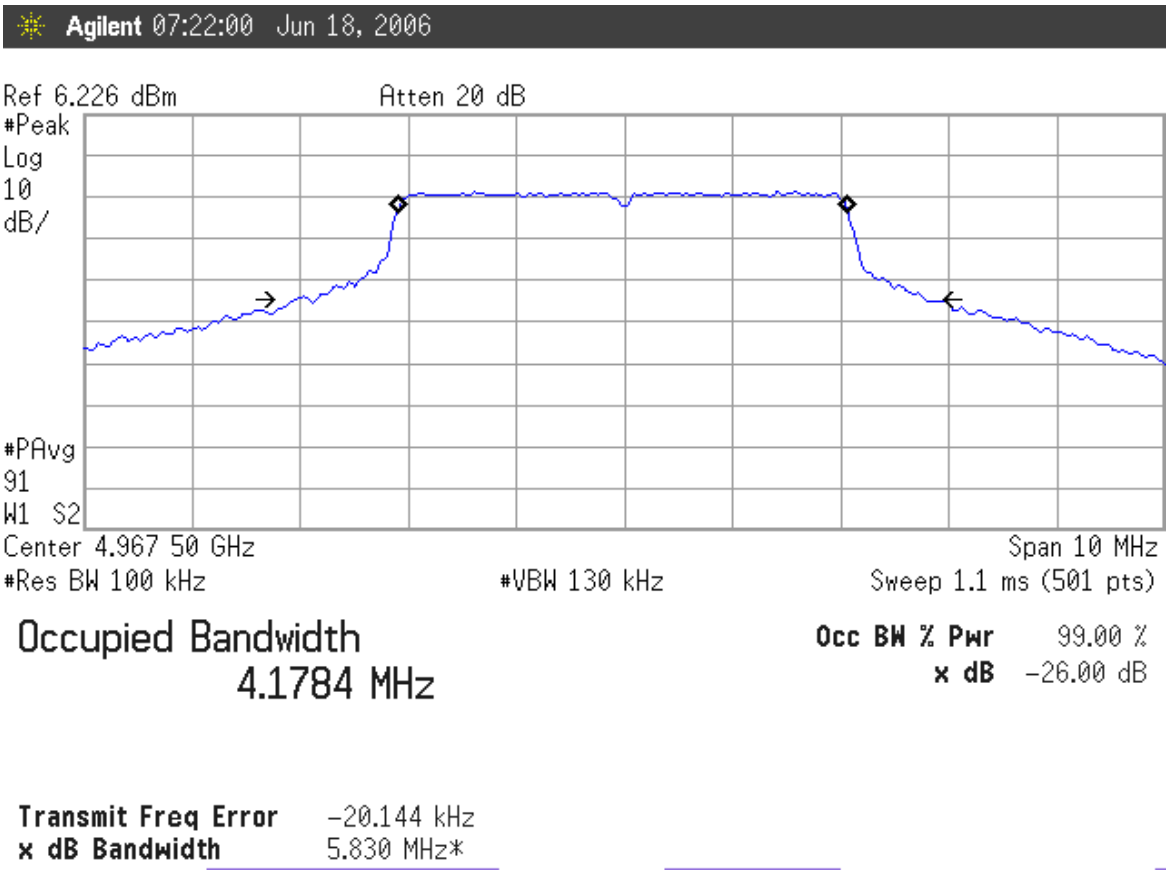

Figure 28. Emission Bandwidth 5L

4.2.5 Emissions and emission limitations to §90.210

Emissions limitations are specified in §90.210 for L and M Masks.

(l) Emission Mask L. For low power transmitters (20 dBm or less) operating in the 4940–4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:

(1) On any frequency removed from the assigned frequency between 0–45% of the authorized bandwidth (BW): 0 dB.

(2) On any frequency removed from the assigned frequency between 45–50% of the authorized bandwidth: 219 log (% of (BW)/45) dB.

(3) On any frequency removed from the assigned frequency between 50–55% of the authorized bandwidth: 10 + 242 log (% of (BW)/50) dB.

(4) On any frequency removed from the assigned frequency between 55–100% of the authorized bandwidth: 20 + 31 log (% of (BW)/55) dB attenuation.

(5) On any frequency removed from the assigned frequency between 100–150% of the authorized bandwidth: 28 + 68 log (% of (BW)/100) dB attenuation.

(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 50 dB.

(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

(m) Emission Mask M. For high power transmitters (greater that 20 dBm) operating in the 4940–4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:

(1) On any frequency removed from the assigned frequency between 0–45% of the authorized bandwidth (BW): 0 dB.

(2) On any frequency removed from the assigned frequency between 45–50% of the authorized bandwidth: 568 log (% of (BW)/45) dB.

(3) On any frequency removed from the assigned frequency between 50–55% of the authorized bandwidth: 26 + 145 log (% of BW/50) dB.

(4) On any frequency removed from the assigned frequency between 55–100% of the authorized bandwidth: 32 + 31 log (% of (BW)/55) dB.

(5) On any frequency removed from the assigned frequency between 100–150% of the authorized bandwidth: 40 + 57 log (% of (BW)/100) dB.

(6) On any frequency removed from the assigned frequency between above 150% of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

Note to paragraph m: Low power devices may as an option, comply with paragraph (m).

SPECIAL NOTE:

In reviewing the mask in the appendix the emission mask as written in the order is not the 802.11a mask as adopted in the order. For the mask to be correct for "L"#6 should read 40dB instead of 50dB.
I discussed this with Tim Maguire of the FCC Wireless Bureau on 7/22/2005 and he confirmed that there is an error and it should read 40dB instead of 50dB for #6 of emission mask "L".

The output of the transmitter was connected to the input of the spectrum analyzer and the transmitter modulated with data. Conducted emissions from the antenna port were measured from 30 MHz to 40GHz.

4.2.5.1

Emissions masks are provided in the following figures for the four channel bandwidth and power levels.

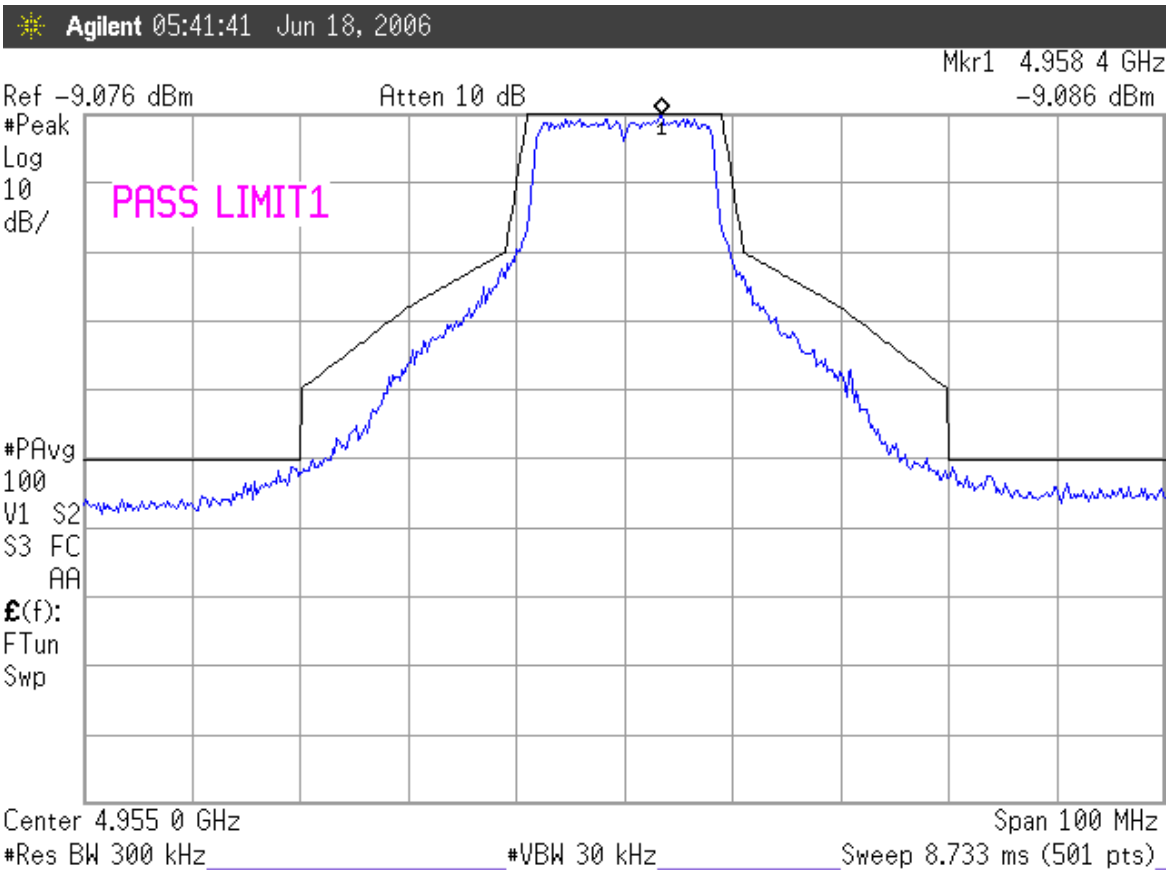

Figure 29. L Mask: 20MHz Channel

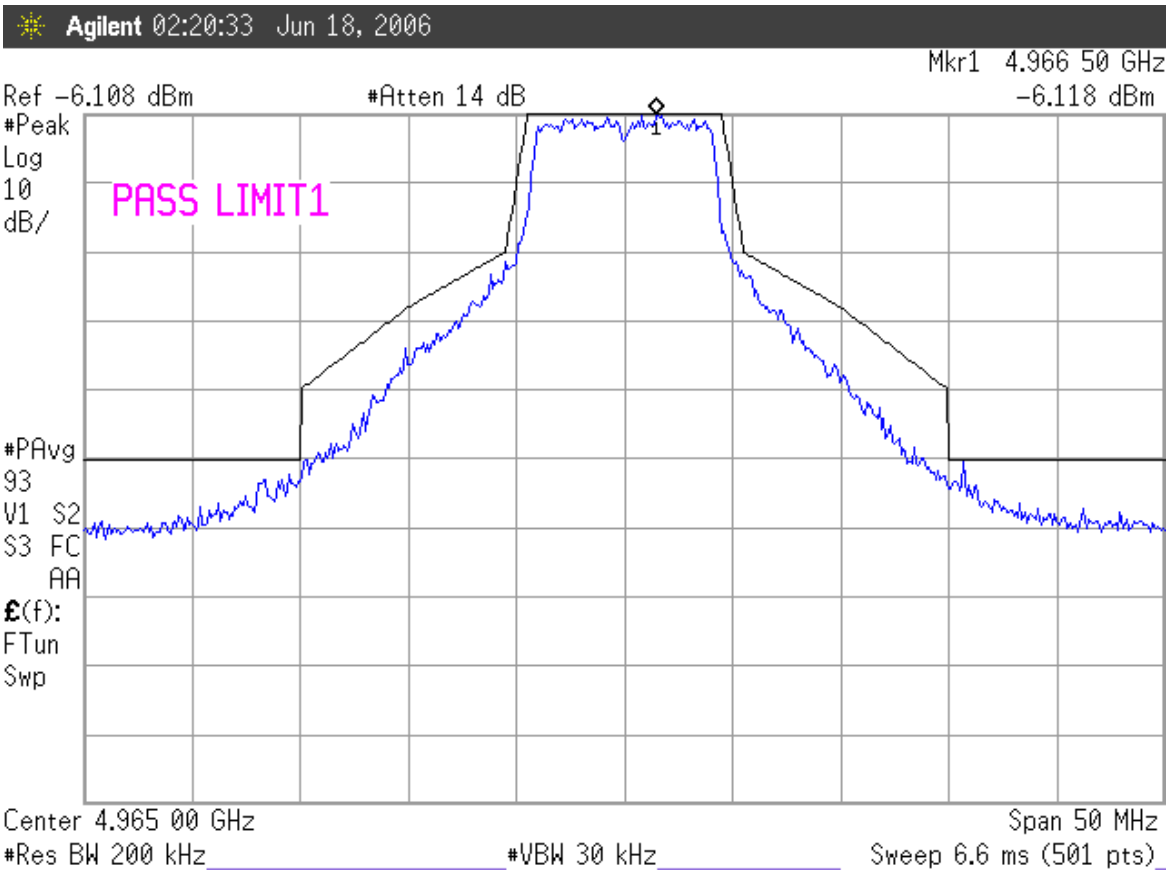

Figure 30. L Mask 10 MHz Channel

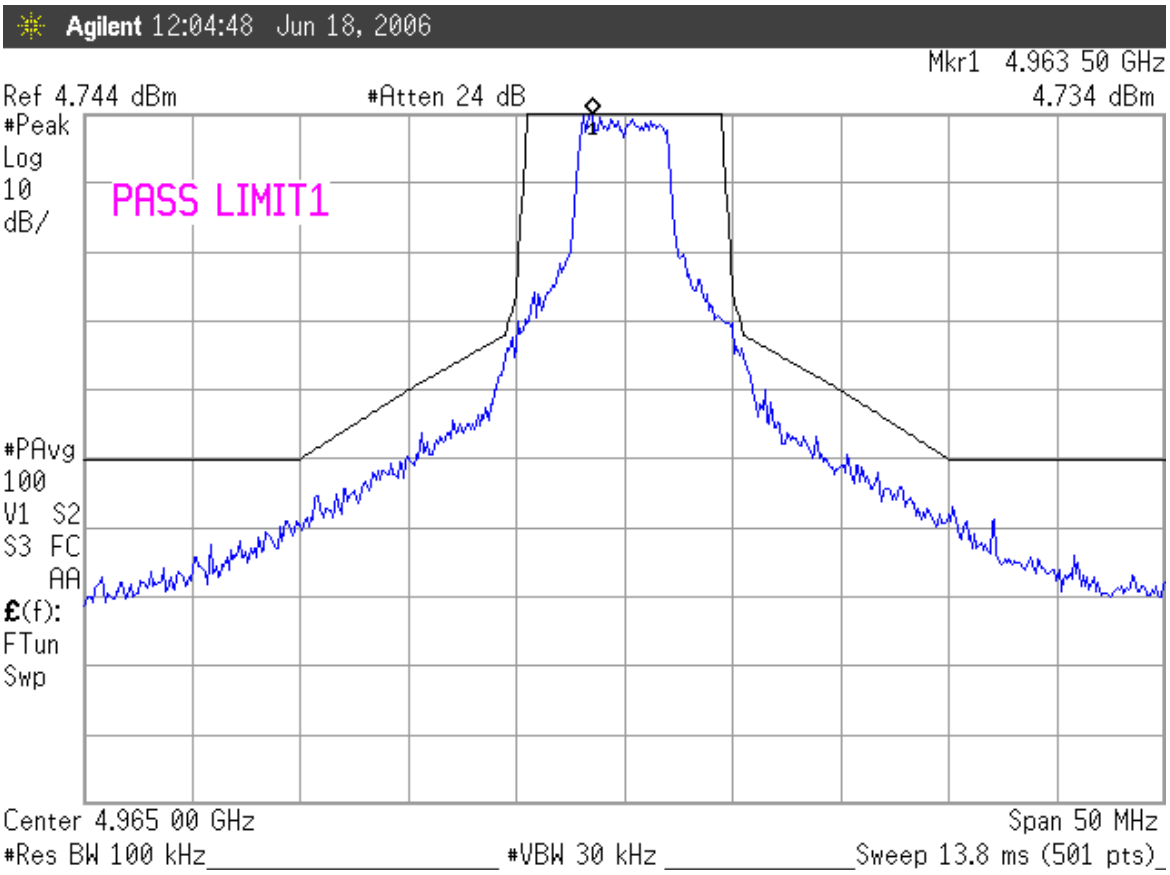

Figure 31. M Mask 10 MHz Channel

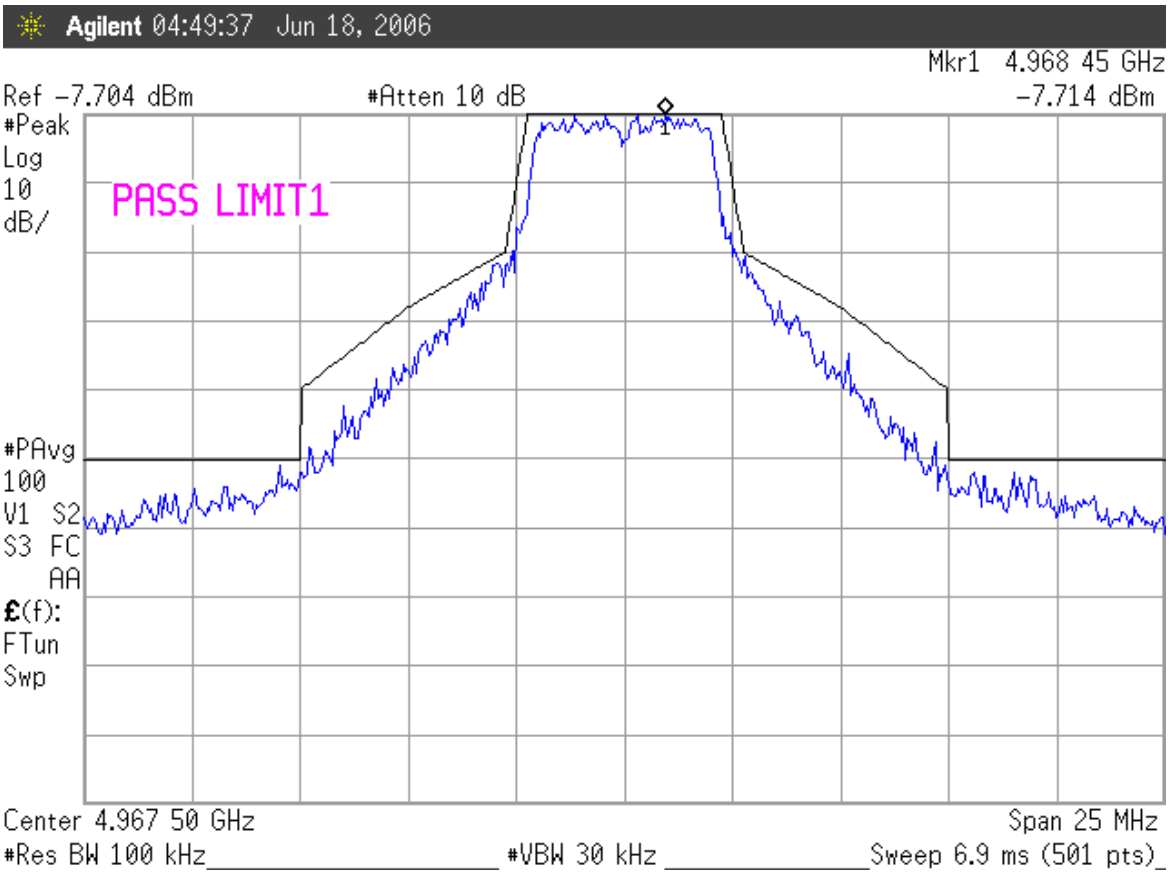

Figure 32. L Mask 5 MHz Channel

Data are supplied in the following figures.

4.2.6 Spurious Emissions

The power was set to the maximum power index number and the spurious emissions measured from 30 MHz to 40 GHz. The data are provided in the following figures.

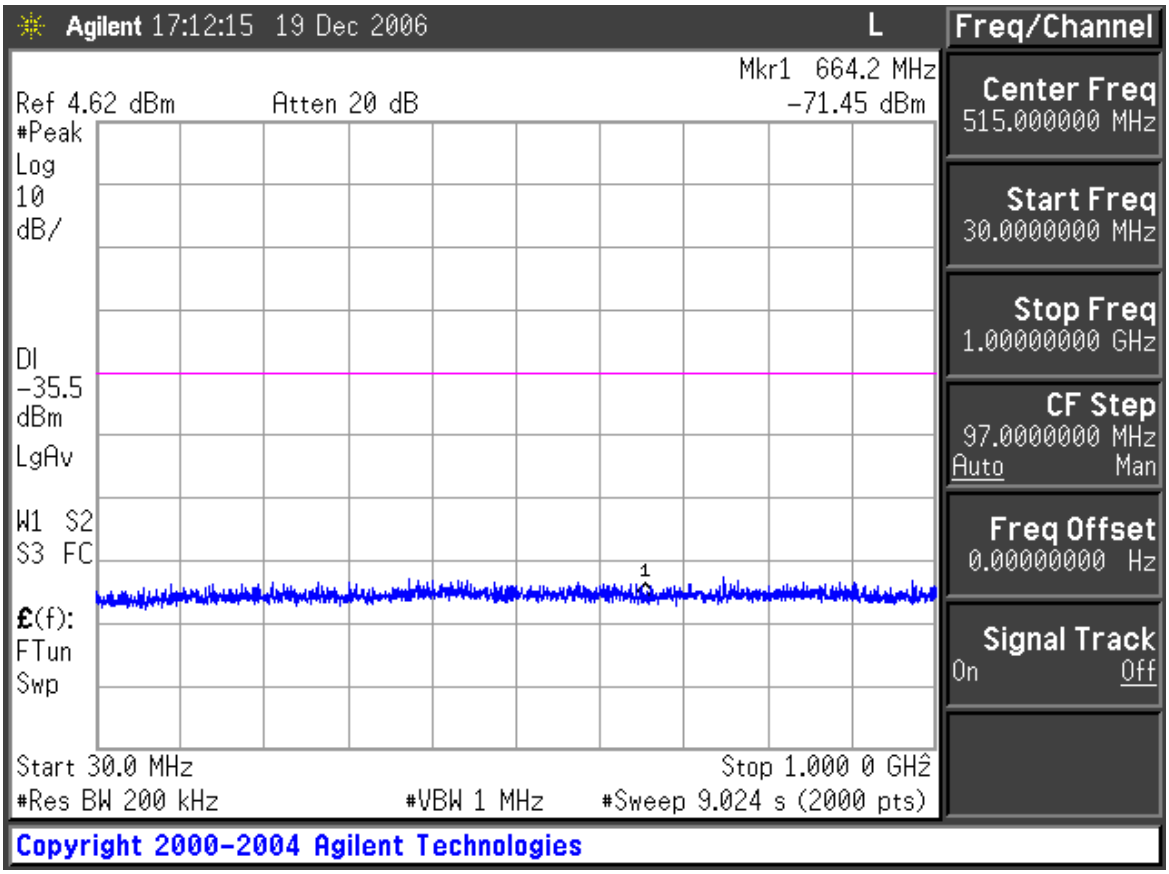

Figure 33. Spurious Emissions, 30M – 1GHz

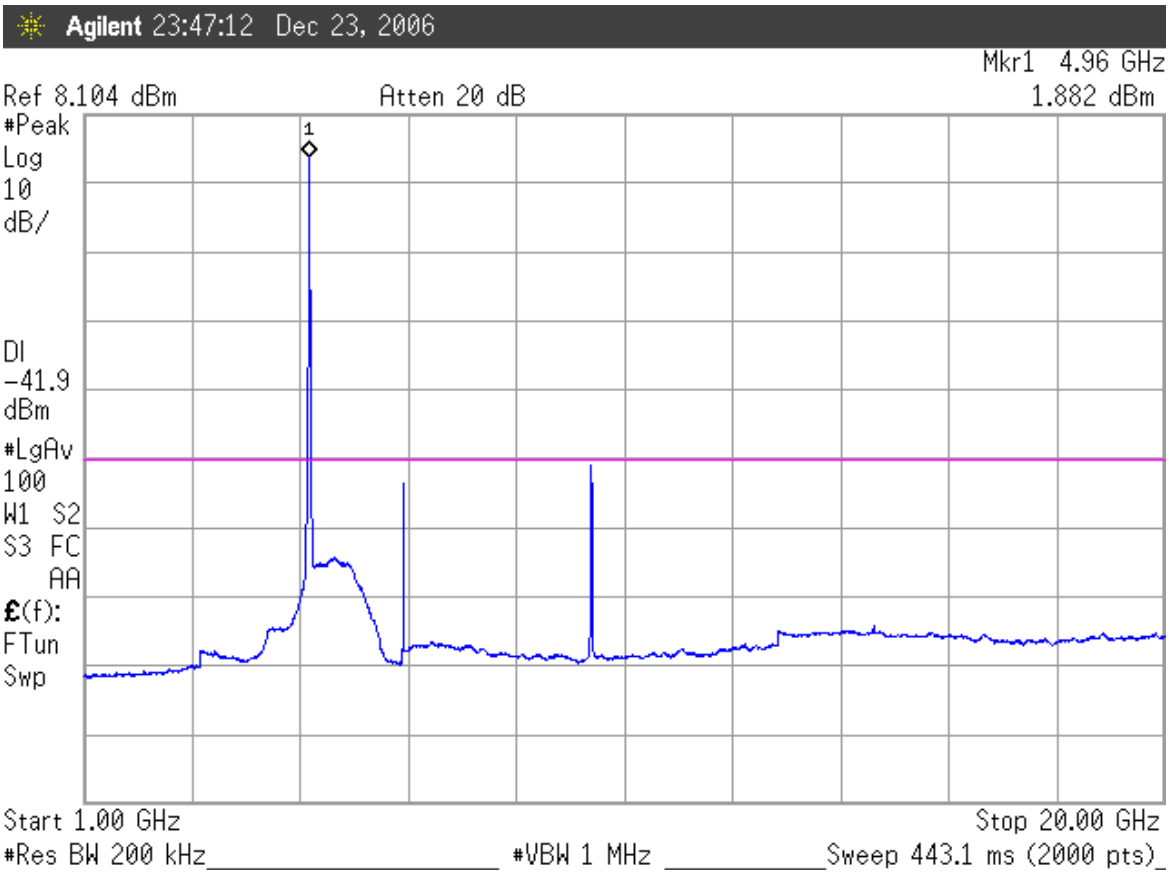

Figure 34. Spurious Emissions, 1-20GHz

Date: 17.JAN.2007 15:53:01

Figure 35. Spurious Emissions, 20-40GHz

4.3 Radiated Emissions (Unintentional)

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.

Where emissions were detected, the ERP levels were determined using the method of signal substitution.

The frequency range of 30 MHz to 40 GHz was measured. All emissions detected are recorded in Table 13 and Table 14.

Table 13. Radiated Emissions

Client:	CelPlan	**Date:**	11/21/2006
Tester:	John Repella	**Job #:**	9149
EUT Information:		**Test Requirements:**	
EUT:	FR3000	TEST STANDARD:	FCC Part 15
Configuration:	Table-top	DISTANCE:	3m
Clocks:		CLASS:	B
Test Equipment (<1GHz):		**Test Equipment (>1GHz):**	
ANTENNA:	A_00382	ANTENNA:	A_00004
LIMIT:	LFCC_3m_Class_B	AMPLIFIER:	A_00066
CABLE:	CSITE1_3m	CABLE:	CSITE2_HF

Freq MHz	Pol H/V	Az	Ant Ht m	SA QP dBµV	Ant. Corr. dB/m	Cable Corr. dB	Corr Level dBµV/m	Level µV/m	Limit µV/m	Margin dB
44.65	V	263	1.5	7.2	10.2	1.3	18.7	8.6	100.0	-21.3
48.02	V	263	1.5	11.0	8.5	1.3	20.8	11.0	100.0	-19.2
50.22	V	263	1.5	12.5	7.6	1.3	21.4	11.7	100.0	-18.6
50.71	V	263	1.5	13.3	7.5	1.3	22.1	12.8	100.0	-17.9
51.80	V	263	1.5	13.9	7.4	1.3	22.6	13.5	100.0	-17.4
52.60	V	263	1.5	13.3	7.3	1.3	21.9	12.5	100.0	-18.1
53.17	V	263	1.5	13.3	7.2	1.3	21.9	12.4	100.0	-18.1
60.95	V	263	1.5	14.7	7.4	1.5	23.6	15.1	100.0	-16.4
61.98	V	263	1.5	12.9	7.5	1.5	21.9	12.4	100.0	-18.1
75.72	V	263	1.5	6.6	8.0	1.6	16.2	6.4	100.0	-23.8
84.35	V	263	1.5	11.6	7.4	1.7	20.7	10.9	100.0	-19.3
109.15	V	263	1.5	2.6	12.5	1.9	17.1	7.1	150.0	-26.5
165.03	V	0.0	2.0	4.8	12.0	2.4	19.2	9.1	150.0	-24.3
198.03	V	306	1.5	9.1	12.2	2.6	23.9	15.6	150.0	-19.6
250.01	V	0.0	2.0	6.1	11.5	3.0	20.6	10.7	200.0	-25.4
264.03	V	306	2.0	5.1	12.6	3.1	20.8	11.0	200.0	-25.2
297.03	V	0.0	2.0	7.7	13.4	3.3	24.5	16.8	200.0	-21.5
396.03	V	306	2.0	4.0	15.5	3.9	23.4	14.8	200.0	-22.6

Freq MHz	Pol H/V	Az	Ant Ht m	SA QP dBµV	Ant. Corr. dB/m	Cable Corr. dB	Corr Level dBµV/m	Level µV/m	Limit µV/m	Margin dB
462.03	V	306	2.0	5.1	17.3	4.3	26.7	21.5	200.0	-19.4
52.600	H	180	3.5	4.9	7.3	1.3	13.5	4.7	100.0	-26.5
53.172	H	180	3.5	5.9	7.2	1.3	14.5	5.3	100.0	-25.5
60.950	H	180	3.5	11.4	7.4	1.5	20.3	10.3	100.0	-19.7
61.980	H	180	3.5	13.1	7.5	1.5	22.1	12.7	100.0	-17.9
75.725	H	180	3.5	15.2	8.0	1.6	24.8	17.3	100.0	-15.2
84.350	H	263	3.5	6.8	7.4	1.7	15.9	6.3	100.0	-24.1
109.15	H	0.0	3.5	7.1	12.5	1.9	21.6	12.0	150.0	-22.0
165.03	H	107	3.5	7.1	12.0	2.4	21.5	11.9	150.0	-22.0
198.03	H	90	3.5	5.1	12.2	2.6	19.9	9.9	150.0	-23.6
250.03	H	180	3.5	8.2	11.5	3.0	22.8	13.7	200.0	-23.3
264.03	H	180	3.5	5.6	12.6	3.1	21.3	11.6	200.0	-24.7
297.03	H	0.0	3.5	7.2	13.4	3.3	24.0	15.8	200.0	-22.0
396.03	H	180	3.5	2.2	15.5	3.9	21.6	12.1	200.0	-24.4

Table 14. Radiated Emissions: Transmitter Spurious

CLIENT: CelPlan DATE: 1/23/2007
TESTER: John Repella JOB #: 9149
EUT Information: **Test Requirements:**
EUT: FR100 TEST STANDARD: FCC Part 90 & 95
Configuration: Tabletop, Ant terminated DISTANCE: 3m
TX Frequency: 4965MHz
Test Equipment/Limit:
LIMIT: Part 90M & 90Y Mask A, B, C, G, H, I

Freq (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	Spurious Level dBµV	Sub. Sig. Gen. Level dBm	Sub. Power Level dBm	Sub. Ant. Factor dB/m	Sub. Ant. Gain dBi	ERP Level dBm	Limit dBm	Margin dB	Notes
4965.00	V	32.0	1.0	49.21								Fund
9930.00	V	0.0	1.0	33.33	-34.3	-56.5	45.5	4.6	-53.0	-40.0	-13.0	AMB
14895.00	V	0.0	1.0	32.22	-33.9	-63.2	52.6	1.1	-64.3	-40.0	-24.2	AMB
4965.00	H	270.0	1.0	44.17								Fund
9930.00	H	0.0	1.0	34.10	-34.6	-56.7	45.5	4.6	-54.2	-40.0	-14.3	AMB
14895.00	H	0.0	1.0	32.50	-34.0	-63.6	52.6	1.1	-64.6	-40.0	-24.6	AMB

4.4 Emission Designator

The emission designator is determined from the necessary bandwidth, the type of modulation and the information conveyed in the signal.

For the subject unit, the following Emission Designator has been determined according to Section 2.201 of the FCC Rules.

- First Symbol, type of modulation of the main carrier: F-Frequency Modulation
- Second Symbol, nature of signal(s) modulating the main carrier: 1
- Third Symbol, type of information to be transmitted: D-Digital

The necessary bandwidth, Bn, is taken to be the occupied bandwidth of the signal: 23.8MHz

Hence, the emission designator for the FR-100 is 23M8F1D.

4.5 Frequency Stability: (FCC Part §2.1055)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

The EUT is powered by the host system.

Table 15. Frequency Deviation

Nominal Frequency 4960 MHz

Temperature (Centigrade)	Frequency (MHz)	Difference (Hz)	Deviation (%)
Ambient	4959.959710	0.0	0
-30	4959.958900	-810.0	0.000016
-20	4959.971300	11590.0	0.000234
-10	4959.972000	12290.0	0.000248
0	4959.971500	11790.0	0.000238
10	4959.967600	7890.0	0.000159
20	4959.963200	3490.0	0.000070
30	4959.960700	990.0	0.000020
40	4959.961700	1990.0	0.000040
50	4959.973300	13590.0	0.000274

Voltage (Volts)	Frequency (MHz)	Difference (Hz)	Deviation (%)	Voltage (Volts)
At rated	4959.961800	0	0.0	120VAC
At 85%	4959.964500	-2700	0.000054	102VAC
At 115%	4959.961100	700	0.000014	138VAC

Notes: Measured in Peak mode