

# TEST REPORT

## Class II Permissive Change

### Airport Extreme 802.11b/g WLAN Module

New Host: P86 EMAC Desktop Computer

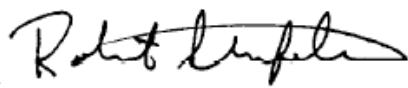
Model #: A1026

Apple Computer  
March 21, 2003

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## Test Report Summary

Specification	Test Description	Results
CFR 15.207 (a)	AC Line Conducted Emission	Pass
CFR 15.209 (a)	Radiated Emissions	Pass
CFR 15.247 (c)	RF Conducted Emissions	Pass

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1 General Information

1.1 About this Class II Permissive Change

Apple Computer will use the 2.4GHz WLAN card listed below in a new Apple Desktop Computer (P86 desktop) with an Apple antenna.

1.2 Product Information

Existing WLAN Card Information	
Model Number	A1026
FCC ID	BCGA1026
Emissions Designator	22M0F7D
Date of Original FCC Grant	January 7, 2003
Class	Spread Spectrum Transceiver
Method	Orthogonal Division Multiplexing / Direct Sequence Spread Spectrum
Max RF Power Output	0.0691 W
Frequency Range	2412 Mhz – 2462 Mhz
Number of Channels	11
Data Rates (Mbps)	1,2,5.5,6,8,11,12,18,24,36,48,54

P86 Host Information	
The P86 EMAC desktop is an all in one personal computer with an integrated 17” CRT display. The microprocessor runs at 1 GHz.	
Computer Model Number	A1002
Antenna Model Number	6134907
Antenna Type	Inverted F
Antenna Gain	1.16 dBi

1.3 Product Photograph



Figure 1a: P86 Desktop

Figure 1b: I/O ports

Figure 1c: P50 Module Port

1.4 P50 Regulatory Certification



## AirPort Regulatory Certification

Country	Certification Model Number	Certification Number
Austria, Belgium, Denmark, Finland, Germany, Greece, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom	A1027	CE 0984 ⓘ To comply with French wireless regulations, when in France use only channels 10, 11, 12 and 13.
Canada	A1026	Industry Canada 579CA1026. For indoor use only.
France	A1028	CE 0984 ⓘ For indoor use only.
Italy	A1027	CE 0984 ⓘ If used outside of own premises, general authorization is required.
United States (including Puerto Rico)	A1026	FCC ID: BCGA1026

1.4 Antenna Photograph

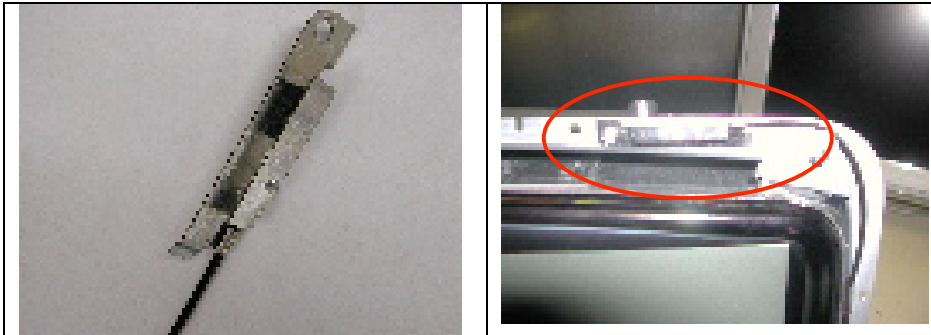


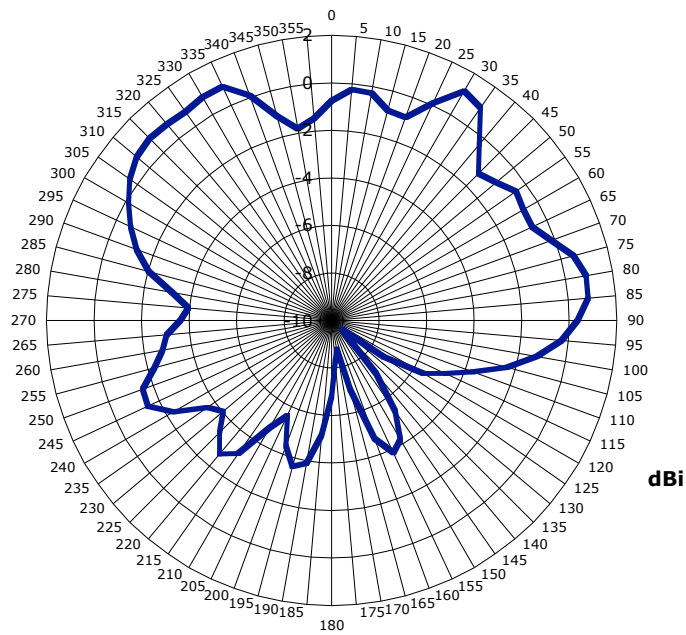
Figure 2: P86 TX Antenna

1.5 Antenna Radiation Data

Degree	Gain (dBi)	Degree	Gain (dBi)	Degree	Gain (dBi)
0	-0.76	120	-5.53	240	-2.31
5	-0.25	125	-7.33	245	-1.47
10	-0.28	130	-9.42	250	-1.54
15	-0.85	135	-9.16	255	-2.29
20	-0.92	140	-7.09	260	-2.78
25	0.08	145	-5.35	265	-3.03
30	1.16	150	-4.21	270	-3.63
35	0.92	155	-3.85	275	-3.96
40	-0.33	160	-4.70	280	-3.18
45	-1.26	165	-6.98	285	-2.04
50	-0.96	170	-8.77	290	-1.26
55	-0.52	175	-8.28	295	-0.68
60	-0.68	180	-6.80	300	-0.13
65	-0.69	185	-5.15	305	0.36
70	-0.17	190	-3.91	310	0.70
75	0.54	195	-3.63	315	0.85
80	0.88	200	-4.38	320	0.77
85	0.83	205	-5.60	325	0.72
90	0.35	210	-4.78	330	0.84
95	-0.30	215	-3.15	335	0.86
100	-1.24	220	-2.66	340	0.08
105	-2.38	225	-3.33	345	-1.10
110	-3.69	230	-4.04	350	-1.82
115	-4.72	235	-3.63	355	-1.48

1.5 Antenna Radiation Pattern

**Azimuth Pattern P86 DVT AirPort**



2 AC Line Conducted Emissions

Tests were carried out in accordance with FCC 15.207a

Section 15.207 Conducted limits.

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

\* Decreases with the logarithm of the frequency.

2.1 Setup



Figure 3: Front and side views of EUT setup

The AC Line conductive emissions tests were performed at the Apple Computer EMC lab located at 20650 Valley Green Drive. The EUT and attached devices were placed on a nonmetallic table in accordance with C63-4-200, 6.2.1.3

2.2 Test Equipment

Description	Manufacturer	Model No.	Identification No.	Last Cal	Next Cal
Spectrum Analyzer	HP	8568	AOU107886	4/22/02	4/22/03
LISN	Rhode & Schwarz	ESHS3-Z5	100140	6/19/02	6/19/03
Cable	Blue room	N/A	Blue Room Cable	5/28/02	5/28/03

2.3 Test Procedure

Inside the lab, a laptop (also containing a P50 module) was used to create a peer-to-peer wireless network. While the EUT transferred a large file (1.6GB) to the laptop, emissions were measured (Figure 2). The following cases were considered each for line one and line two of the LISN. In total, this means six sets of measurements were taken.

Channel	Center Frequency	Rate
1	2412 MHz	1 Mbps
6	2437 MHz	24 Mbps
11	2462 MHz	54 Mbps

The 150Khz to 30MHz frequency range was considered in three different ranges using the following settings to improve measurement performance. The frequency responses of these bands were then concatenated to show the response of the full range.

Frequency Range	Resolution BW	Video BW	Reference Level	Attenuation	Sweep Time
.15 MHz – .5 MHz	10 kHz	10 kHz	90 dB	10 dB	30 ms
.4 MHz – 5 MHz	10 kHz	10 kHz	90 dB	10 dB	100 ms
4.5 MHz – 30 MHz	10 kHz	10 kHz	90 dB	10 dB	750 ms

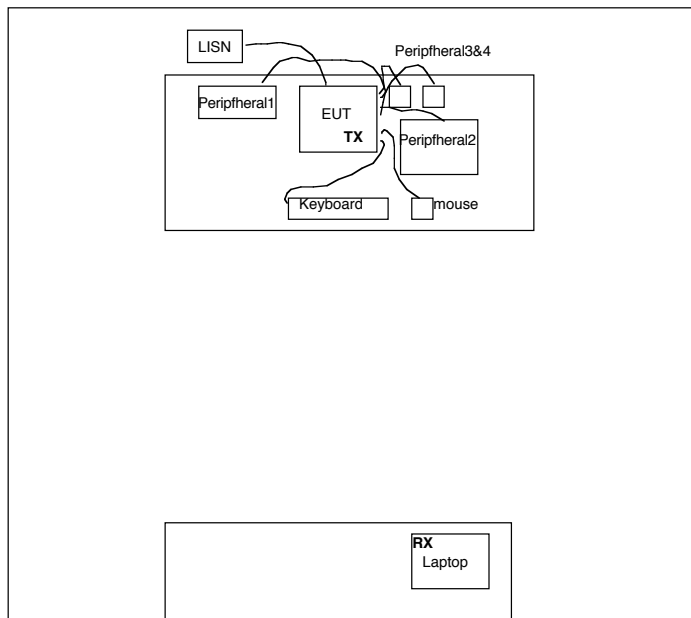


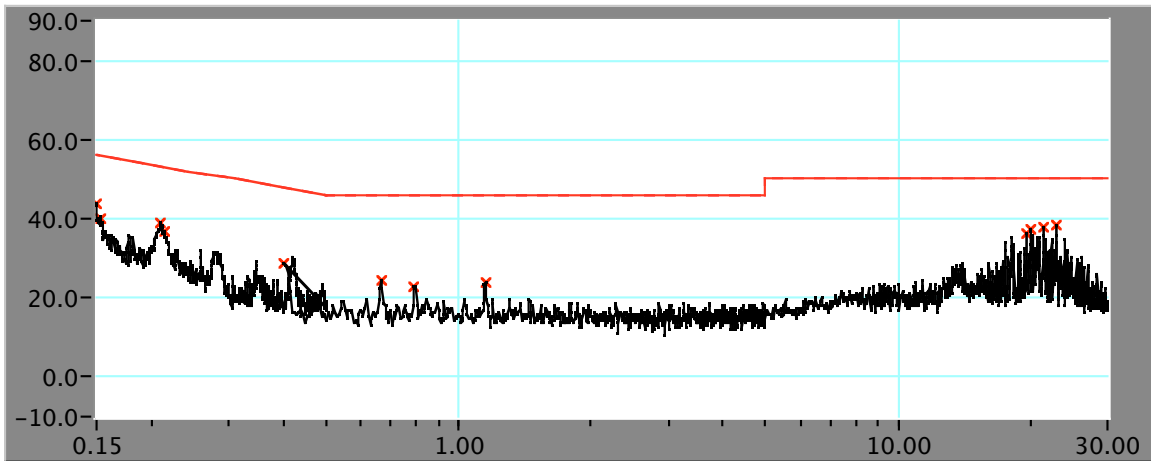
Figure 2: Overhead view of setup in Apple Computer EMC Lab



2.4 AC Line Conducted Emissions Measurements

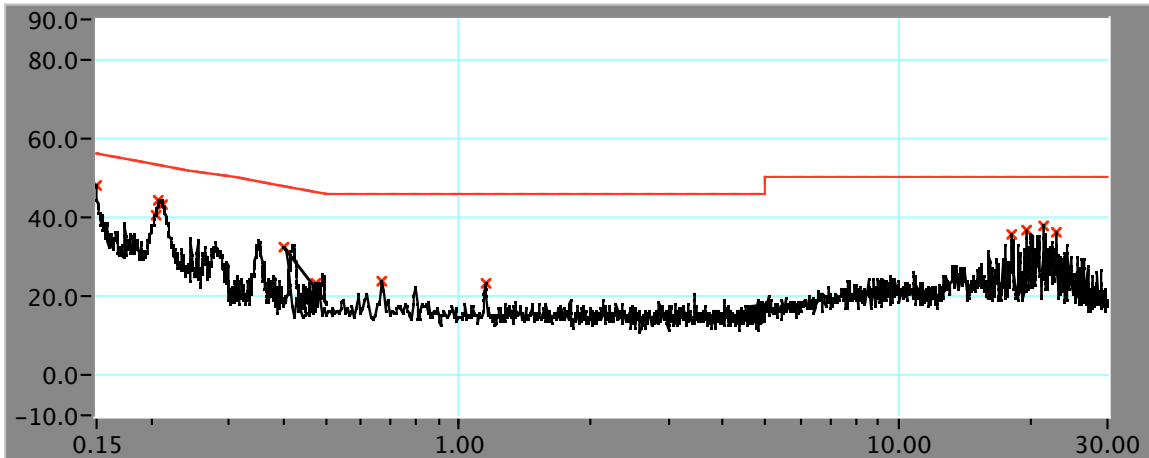
There was very little variation in the separate cases of low, mid, and hi channel transmission. In all cases, the *peak* emissions were well below the *average* limit. All of the cases listed in the test procedure were tested, but for efficiency, only the low channel transmission cases have been reported. In the following plots, the peak emissions were recorded against the average limit.

Line	Channel	Center Frequency	Rate
1	1	2412 MHz	1 Mbps



Frequency MHz	Level dBuV	Limit dBuV	Delta dB	Raw Data dBuV	LISN dB	Cable dB	All Factors dB
0.150	43.6	56.0	-12.4	41.02	2.52	0.06	-2.58
0.154	40.1	55.8	-15.7	37.57	2.47	0.06	-2.53
0.209	38.7	53.2	-14.5	36.80	1.84	0.06	-1.90
0.214	36.8	53.1	-16.3	34.93	1.81	0.06	-1.87
0.400	28.7	47.9	-19.2	27.74	0.89	0.07	-0.96
0.667	24.2	46.0	-21.8	23.55	0.57	0.09	-0.65
0.791	22.9	46.0	-23.1	22.31	0.49	0.10	-0.59
1.150	24.1	46.0	-21.9	23.58	0.41	0.11	-0.52
19.596	36.4	50.0	-13.6	35.29	0.66	0.45	-1.11
20.157	37.3	50.0	-12.7	36.18	0.67	0.45	-1.12
21.534	37.9	50.0	-12.1	36.62	0.81	0.47	-1.28
22.987	38.2	50.0	-11.8	36.89	0.82	0.49	-1.31

Line	Channel	Center Frequency	Rate
2	1	2412 MHz	1 Mbps



Frequency MHz	Level dBuV	Limit dBuV	Delta dB	Raw Data dBuV	LISN dB	Cable dB	All Factors dB
0.150	48.1	56.0	-7.9	45.59	2.45	0.06	-2.51
0.204	40.7	53.5	-12.8	38.81	1.83	0.06	-1.89
0.208	44.5	53.3	-8.8	42.63	1.81	0.06	-1.87
0.212	43.4	53.1	-9.7	41.56	1.78	0.06	-1.84
0.400	32.3	47.9	-15.6	31.36	0.87	0.07	-0.94
0.474	23.5	46.5	-23.0	22.69	0.74	0.07	-0.81
0.671	23.9	46.0	-22.1	23.28	0.53	0.09	-0.62
1.150	23.1	46.0	-22.9	22.60	0.39	0.11	-0.50
18.142	35.7	50.0	-14.3	34.72	0.55	0.43	-0.98
19.596	36.9	50.0	-13.1	35.87	0.59	0.45	-1.03
21.534	37.7	50.0	-12.3	36.51	0.72	0.47	-1.19
22.987	36.0	50.0	-14.0	34.66	0.85	0.49	-1.34

2.5 AC Line Conducted Emissions Test Conclusion

In all AC Line conducted emissions test cases as specified in 3.3, which include the results presented in 3.3, peak spurious content was well below the average limits.

**CONCLUSION: PASS**

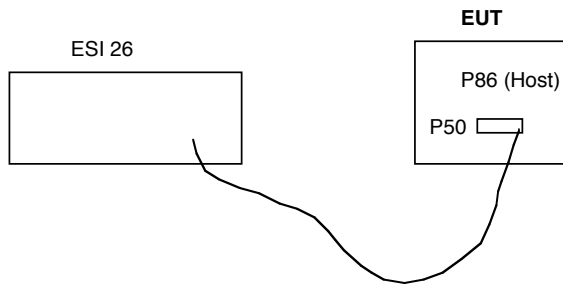
### III TX Output Conducted Emissions

Tests were carried out in accordance with FCC 15.247 (c) shown below:

(c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

#### 3.1 SETUP

Figure 3: TX Conducted Emissions Setup



The RF output conductive emissions tests were performed at the Apple Computer EMC lab located at 20650 Valley Green Drive. The RF output of the EUT was directly connected to the spectrum analyzer as shown above.

#### 3.2 TEST EQUIPMENT SETUP

Description	Manufacturer	Model No.	Identification No.	Last Cal	Next Cal
Spectrum Analyzer	Rhode & Schwarz	ESI 26	Ssr32AA12	6/17/02	7/17/03
Cable	Flexco	FC182	FC182_4m	12/15/02	12/15/03

The 2GHz to 25GHz frequency range was considered in two different ranges using the following settings to improve frequency resolution

Frequency Range	Resolution BW	Video BW	Reference Level	Attenuation	Sweep Time
2 GHz – 2.5 GHz	100 kHz	100 kHz	90 dB	10 dB	125 ms
2.5 GHz – 25 GHz	100 kHz	100 kHz	90 dB	10 dB	5.8 s

#### 3.3 TEST PROCEDURE

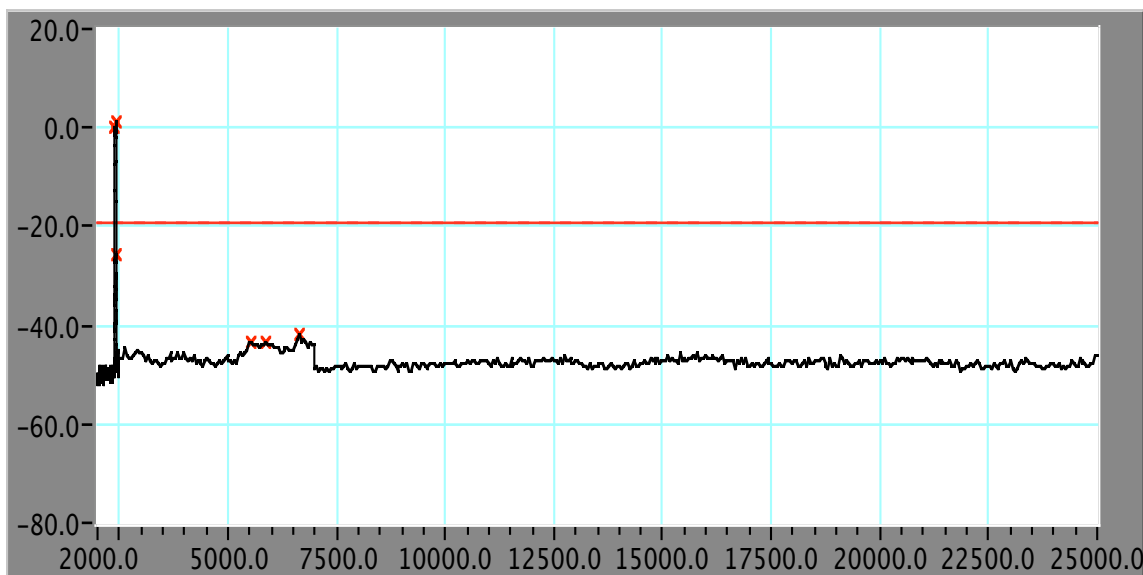
A software tool was used to place the P50 in transmit mode while emissions were measured. For the low, mid, and high channel tests, measurements were taken using various transmission rates. However, for efficiency, the following cases have been reported:

Channel	Center Frequency	Rate
1	2412 MHz	1 Mbps
6	2437 MHz	28 Mbps
11	2462 MHz	54 Mbps

3.4 TX OUTPUT CONDUCT EMISSIONS MEASUREMENTS

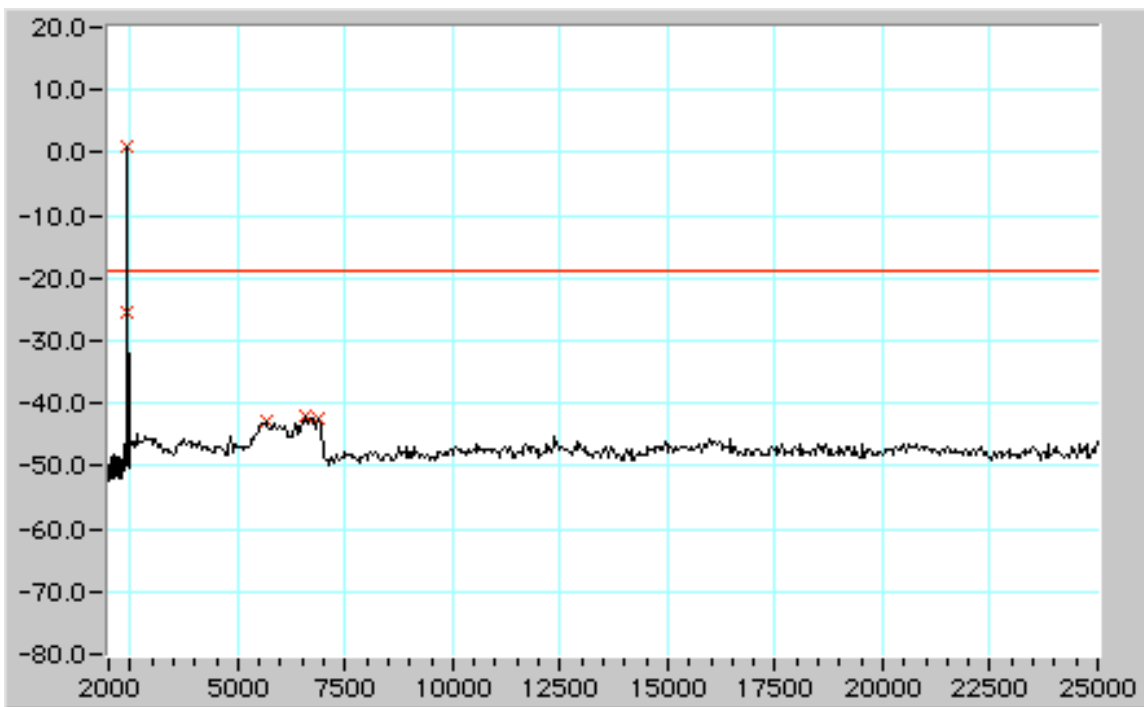
The following plots show the peak emissions recorded against the average limit.

Channel	Center Frequency	Rate
1	2412 MHz	1 Mbps



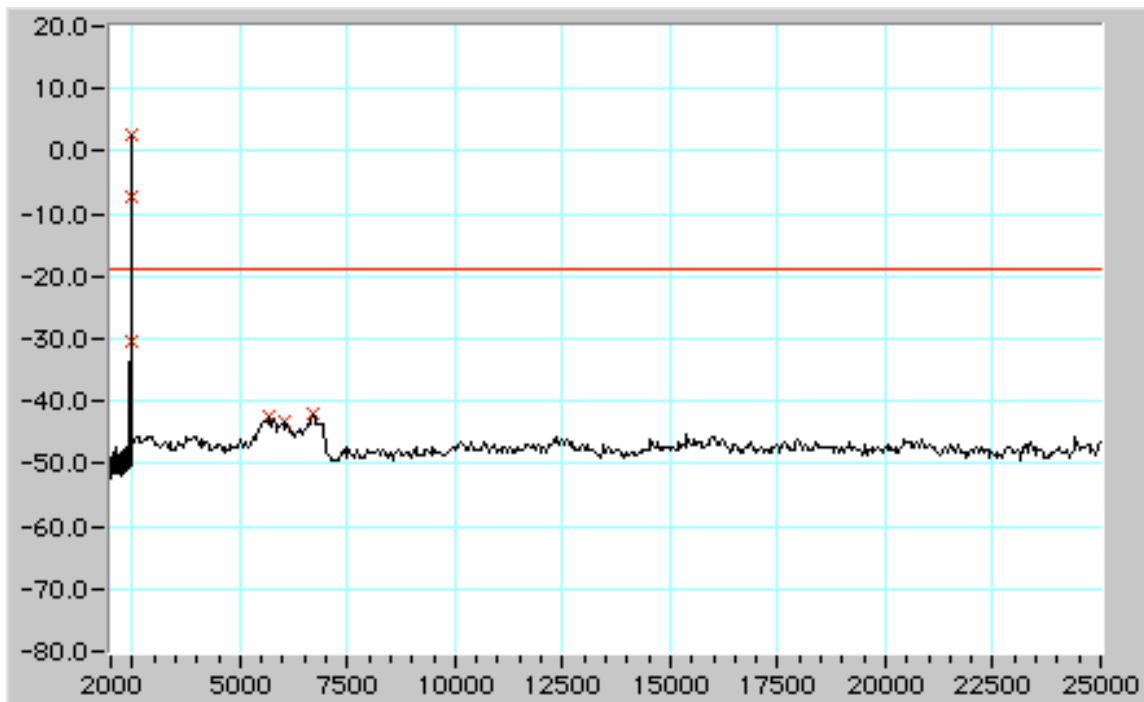
Frequency MHz	Level dBm	Limit dBm	Delta dB
2409.8	-0.0	-19.0	19.0
2415.8	1.2	-19.0	20.2
2421.8	-25.7	-19.0	-6.7
5521.0	-43.3	-19.0	-24.3
5881.8	-43.2	-19.0	-24.2
6648.3	-42.1	-19.0	-23.1

Channel	Center Frequency	Rate
6	2432 MHz	36 Mbps



Frequency MHz	Level dBm	Limit dBm	Delta dB
2427.9	-25.4	-19.0	-6.4
2434.9	0.8	-19.0	19.8
2440.9	0.8	-19.0	19.8
5656.3	-42.7	-19.0	-23.7
6603.2	-42.0	-19.0	-23.0
6873.7	-42.5	-19.0	-23.5

Channel	Center Frequency	Rate
11	2462 MHz	54 Mbps



Frequency MHz	Level dBm	Limit dBm	Delta dB
2459.9	-7.1	-19.0	11.9
2465.9	2.8	-19.0	21.8
2471.9	-30.4	-19.0	-11.4
5701.4	-42.4	-19.0	-23.4
6017.0	-43.0	-19.0	-24.0
6693.4	-42.1	-19.0	-23.1

2.5 TX Output Conducted Emissions Test Conclusion

All TX output conducted emissions test results, including those that have been reported in 2.4, showed peak spurious content to be well below the average limit.

**CONCLUSION: PASS**

## IV Radiated Emissions

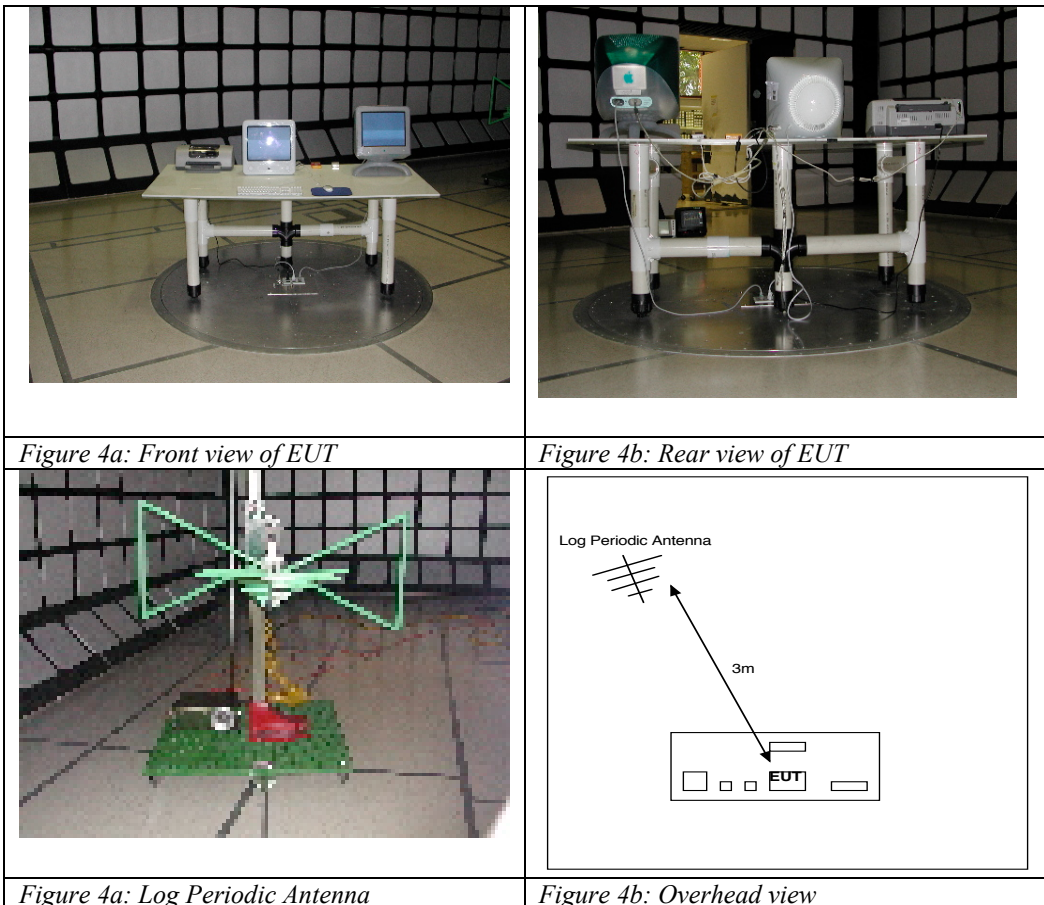
Tests were carried out in accordance with FCC 15.247 (c) shown below:

(c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

To best fulfill the requirements above, the radiated emissions tests were conducted in three separate parts:

- i. RADIATED EMISSIONS BELOW 1 GHZ
- ii. RADIATED EMISSIONS ABOVE 1GHZ
- iii. RADIATED EMISSIONS AT BAND EDGES

### 4.1.1 Radiated Emissions Below 1 GHz Setup



4.1.2 Radiated Emissions Below 1 GHz Test Equipment

Description	Manufacturer	Model No.	Identification No.	Last Cal	Next Cal
Spectrum Analyzer	Rhode & Schwarz	ESI 26	Sssr32AA12	6/17/02	7/17/03
Antenna	CBL6112B	CBL6112B	2517	5/14/02	5/14/03
Amplifier	Eveln 1 Amplifier	4	SN 103	1/28/03	1/28/04
Cable	Tower 1	Primary	Primary	9/16/02	9/16/03

4.1.3 Radiated Emissions Below 1 GHz Test Procedure

The EUT and attached devices were placed on a nonmetallic table in accordance with C63-4-200, 6.2.1.3 (see Figure 4) and a log periodic antenna was placed 3m away. While the table was rotated, the ESI 26 spectrum analyzer was placed in max hold mode and emissions data was collected.

A laptop (also containing a P50 module) was used to setup a peer-to-peer network with the EUT. A large file was then transferred to the laptop. (See AC line conducted emissions test procedure)

Frequency Range	Resolution BW	Video BW	Reference Level	Attenuation	Sweep Time
30MHz – 1 GHz	100 kHz	100 kHz	90 dB	10 dB	245 ms

The following cases were recorded with the measured peak emissions plotted against the average limit:

Channel	Rate (54 Mbps)	Antenna Polarity
1	1	Vertical
1	1	Horizontal
6	36	Vertical
6	36	Horizontal
11	54	Vertical
11	54	Horizontal

There was very little variation in radiated emissions when the transmitting channel was changed. Although testing was conducted for all cases above, only the channel 1 transmission results have been reported



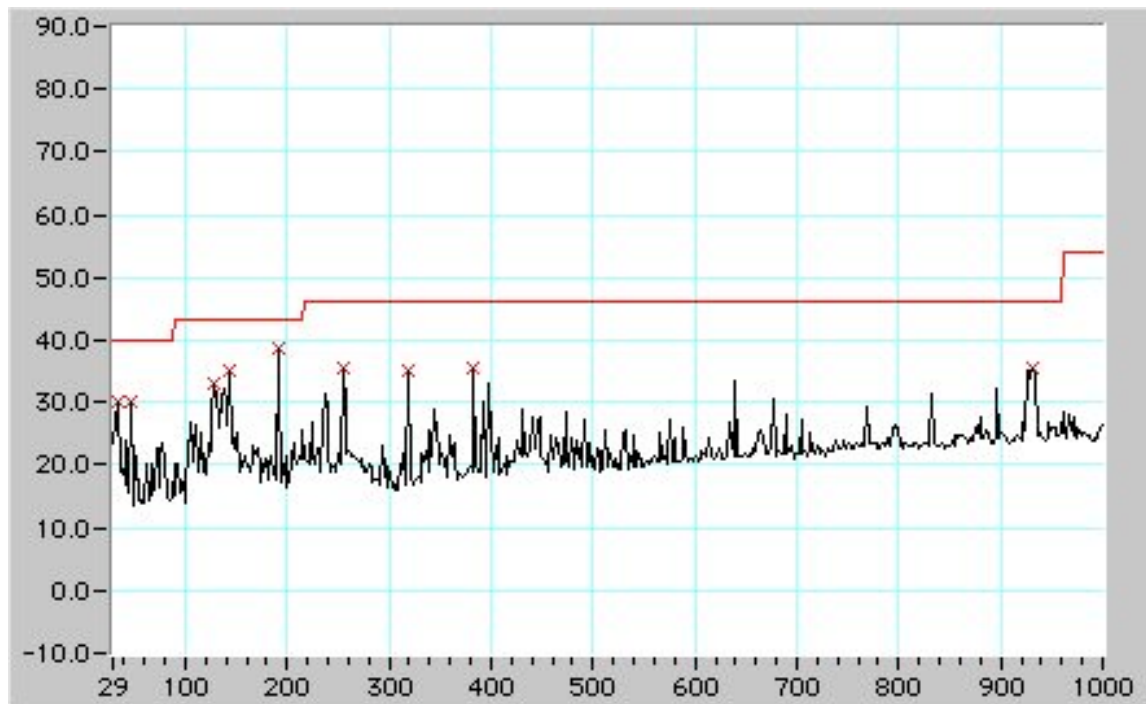
4.1.4 Radiated Emissions Below 1 GHz Test Results

Channel	Rate (Mbps)	Polarity
1	1	Vertical



Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV/m	dB	dB	dB	dB
32.89	30.8	40.0	-9.2	65.82	16.74	0.78	52.54	35.02
46.51	28.1	40.0	-11.9	68.44	10.96	0.90	52.21	40.35
128.24	37.1	43.5	-6.4	72.92	13.17	1.38	50.38	35.84
143.81	39.9	43.5	-3.6	76.16	12.45	1.45	50.14	36.24
190.51	32.2	43.5	-11.3	70.23	10.10	1.63	49.77	38.04
318.94	34.6	46.0	-11.4	67.49	14.00	2.15	49.05	32.90
396.77	34.7	46.0	-11.3	65.13	16.01	2.41	48.85	30.43
676.98	35.5	46.0	-10.5	61.47	19.30	3.23	48.45	25.92
929.95	34.8	46.0	-11.2	58.63	20.80	3.83	48.46	23.84

Channel	Rate (Mbps)	Polarity
1	1	Horizontal



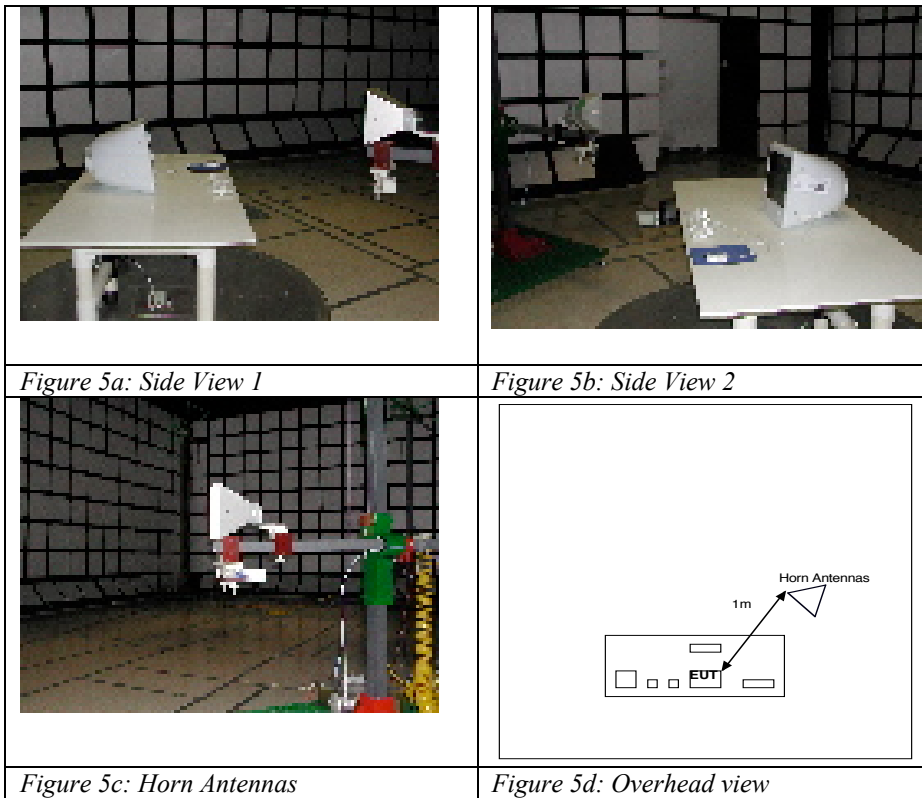
Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV/m	dB	dB	dB	dB
34.84	30.1	40.0	-9.9	64.66	17.19	0.80	52.53	34.54
46.51	30.2	40.0	-9.8	70.57	10.97	0.90	52.21	40.34
128.24	32.8	43.5	-10.7	69.22	12.57	1.38	50.38	36.44
143.81	34.9	43.5	-8.6	71.77	11.85	1.45	50.14	36.84
190.51	38.8	43.5	-4.7	77.17	9.82	1.63	49.77	38.32
254.72	35.3	46.0	-10.7	69.50	13.28	1.92	49.39	34.20
318.94	35.1	46.0	-10.9	67.60	14.38	2.15	49.05	32.52
383.15	35.6	46.0	-10.4	66.05	15.96	2.37	48.81	30.48
931.89	35.4	46.0	-10.6	58.18	21.80	3.83	48.45	22.82

4.1.5 Radiated Emissions Below 1 GHz Test Conclusions

In all tests specified in 4.1.3, which include the reported results found in 4.1.4, the peak spurious content was found to be below the average limit of -20dBc

**CONCLUSION: PASS**

4.2.1 Radiated Emissions Above 1 GHz Setup



The EUT was placed on a turntable and two high frequency horn antennas placed 1m away were used to collect radiated emissions data. The ESI 26 spectrum analyzer was placed in max hold mode while the EUT was rotated and the antenna was varied in elevation. These tests were performed at Apple’s EMC Lab in Mountain View, CA.

4.2.2 Radiated Emissions Above 1GHz Test Equipment

Equipment Description	Model Number	Serial Number	Last Calibration	Next Calibration
Spectrum Analyzer	ESI 26	sssr32AA12	17 Jun 2002	17 Jun 2003
Receiver	ESI 26	1088.7490_26	30 Aug 2002	30 Aug 2003
Antenna	EMCO 3115	9205-3852	5 Sep 2000	5 Sep 2003
Antenna	18-26 GHz Horn	1264	1 Sep 2001	1 Nov 2003
Amplifier	Apple1m	1	12 Dec 2002	12 Dec 2003
Amplifier	HP 8449B (1-26.5 GHz)	3008A00713	20 Mar 2003	20 Mar 2004
Cable	Flexco FC182	FC182_4m	15 Dec 2002	15 Dec 2003

4.2.3 Radiated Emissions Above 1GHz Test Procedure

A laptop (also containing a P50 module) was placed inside the chamber with the EUT to setup a peer-to-peer network. A large file was then transferred from the EUT to the laptop.

The EUT transmission rate was set to 1Mbps in all measurements to model the worst case of radiated emissions. Therefore, the following cases were considered:

Channel	Rate (Mbps)	Antenna Polarity
1	1	Vertical
1	1	Horizontal
6	1	Vertical
6	1	Horizontal
11	1	Vertical
11	1	Horizontal

To improve measurement accuracy, the 1GHz – 25 GHz frequency range was separated into the following bands and then later concatenated:

Frequency Range	Resolution BW	Video BW	Reference Level	Attenuation	Sweep Time
1GHz – 2.31 GHz	1000 kHz	1000 kHz	70 dB	0 dB	5 ms
2.5 GHz – 2.75 GHz	1000 kHz	10 kHz	70 dB	0 dB	70 s
2.75 GHz – 5 GHz	1000 kHz	1000 kHz	70 dB	0 dB	6 ms
5 GHz – 13 GHz	1000 kHz	1000 kHz	80 dB	0 dB	46 ms
13 GHz – 18 GHz	1000 kHz	1000 kHz	90 dB	0 dB	29 ms
18 GHz – 25 GHz	1000 kHz	1000 kHz	80 dB	0 dB	40 ms

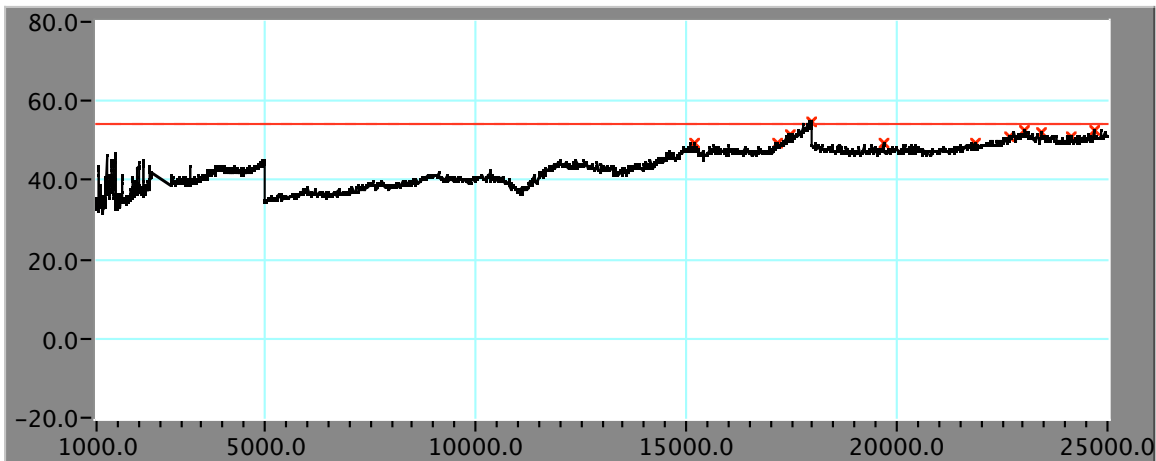
An additional plot was made to improve accuracy even further in a frequency range where the peak emissions appeared to approach or exceed the average limit:

17 GHz – 18 GHz	1000 kHz	20 kHz	80 dB	0 dB	125 ms
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\*\*Note: The 20 kHz video bandwidth specified in the 17 GHz to 18 GHz range is greater than the 0.01 kHz bandwidth normally used for an average measurement reading. It was chosen to increase sweep speed and since it is lower bounded by the average measurement, any recorded emissions that fall under the average will prove that average emissions are also in compliance.

4.2.4 Radiated Emissions Above 1 GHz Test Results

Channel	Rate (54 Mbps)	Antenna Polarity
1	1	Vertical



Frequency MHz	Level dBuV	Limit dBuV	Delta dB	Raw Data dBuV	Antenna dB	Cable dB	All Factors dB
15194.39	49.5	54.0	-4.5	45.49	42.23	4.36	-4.03
17158.32	49.4	54.0	-4.6	44.31	41.93	5.35	-5.10
17478.96	51.7	54.0	-2.3	44.45	43.40	5.40	-7.26
17989.98	54.6	54.0	0.6	44.39	45.26	5.47	-10.21
19683.37	49.3	54.0	-4.7	45.45	40.31	5.40	-3.82
21857.71	49.4	54.0	-4.6	45.48	40.38	6.07	-3.91
22671.34	51.0	54.0	-3.0	45.60	40.41	6.14	-5.39
23050.10	52.5	54.0	-1.5	46.52	40.42	6.13	-5.96
23442.89	52.3	54.0	-1.7	46.99	40.43	6.14	-5.28
24144.29	51.2	54.0	-2.8	46.76	40.45	6.23	-4.47
24677.36	52.7	54.0	-1.3	47.64	40.47	6.50	-5.08

*It appears that the 17GHz – 18GHz range, the peak admissions are over the average limit. The following plot will show that the emissions are in compliance.*