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Measured Radio Frequency Emissions
From

Ford WLAN Transceiver
FCC ID: KMHSYNCG2
IC: 1422A-SYNCG2

Report No. 417124-556
March 27, 2010

For:
Ford Motor Company
Building 5 20300 Rotunda Dr.
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United States

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Summary
Tests for compliance with FCC Regulations, CFR 47, Part 15 and with Industry Canada RSS-210/Gen, were performed on a Ford, FCC ID: KMHSYNCG2, IC: 1422A-SYNCG2. This device under test (DUT) is subject to the rules and regulations as a Transceiver.

In testing completed on March 14, 2010, the DUT tested met the allowed specifications for radiated emissions by 1.7 dB. AC Power line conducted emissions are not subject to regulation as the DUT is powered by a 12 VDC battery.

Table of Contents

1 Introduction

This Ford transceiver was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989 as subsequently amended, and with Industry Canada RSS-210/Gen, Issue 7, June 2007. Tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-2003 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz".
FCC OET guidelines for Measurement of Digital Transmission Systems Operating under Section 15.247 were also followed. The Site description and attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland (FCC Reg. No: 91050) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057A-1).

2 Test Procedure and Equipment Used

The pertinent test equipment commonly used in our facility for measurements is listed in Table 2.1 below. The middle column identifies the specific equipment used in these tests. The quality system employed at the University of Michigan Radiation Laboratory Willow Run Test Range has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to national standards.

Table 2.1 Test Equipment.

Test Instrument	Used	Manufacturer/Model	Q Number
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E, SN: 3412A01131	HP8593E1
Spectrum Analyzer (9kHz-6.5GHz)	X	Hewlett-Packard 8595E, SN: 3543A01546	JDB8595E
Power Meter		Hewlett-Packard, 432A	HP432A1
Harmonic Mixer (26-40 GHz)		Hewlett-Packard 11970A, SN: 3003A08327	HP11970A1
Harmonic Mixer (40-60 GHz)		Hewlett-Packard 11970U, SN: 2332A00500	HP11970U1
Harmonic Mixer (75-110 GHz)		Hewlett-Packard 11970W, SN: 2521A00179	HP11970W1
Harmonic Mixer (140-220 GHz)		Pacific Millimeter Prod., GMA, SN: 26	PMPGMA1
S-Band Std. Gain Horn	X	S/A, Model SGH-2.6	SBAND1
C-Band Std. Gain Horn	X	University of Michigan, NRL design	CBAND1
XN-Band Std. Gain Horn	X	University of Michigan, NRL design	XNBAND1
X-Band Std. Gain Horn		S/A, Model 12-8.2	XBAND1
X-band horn (8.2- 12.4 GHz)		Narda 640	XBAND2
X-band horn (8.2- 12.4 GHz)	X	Scientific Atlanta , 12-8.2, SN: 730	XBAND3
K-band horn (18-26.5 GHz)	X	FXR, Inc., K638KF	KBAND1
Ka-band horn (26.5-40 GHz)		FXR, Inc., U638A	KABAND1
U-band horn (40-60 GHz)		Custom Microwave, HO19	UBAND1
W-band horn(75-110 GHz)		Custom Microwave, HO10	WBAND1
G-band horn (140-220 GHz)		Custom Microwave, HO5R	GBAND1
Bicone Antenna (30-250 MHz)	X	University of Michigan, RLBC-1	LBBIC1
Bicone Antenna (200-1000 MHz)	X	University of Michigan, RLBC-2	HBBIC1
Dipole Antenna Set (30-1000 MHz)	X	University of Michigan, RLDP-1,-2,-3	UMDIP1
Dipole Antenna Set (30-1000 MHz)		EMCO 3121C, SN: 992 (Ref. Antennas)	EMDIP1
Active Rod Antenna (30 Hz-50 MHz)		EMCO 3301B, SN: 3223	EMROD1
Active Loop Antenna (30 Hz-50 MHz)		EMCO 6502, SN:2855	EMLOOP1
Ridge-horn Antenna (300-5000 MHz)	X	University of Michigan	UMRH1
Amplifier (5-1000 MHz)	X	Avantek, A11-1, A25-1S	AVAMP1
Amplifier (5-4500 MHz)	X	Avantek	AVAMP2
Amplifier (4.5-13 GHz)	X	Avantek, AFT-12665	AVAMP3
Amplifier (6-16 GHz)	X	Trek	TRAMP1
Amplifier (16-26 GHz)	X	Avantek	AVAMP4
LISN Box		University of Michigan	UMLISN1
Signal Generator		Hewlett-Packard 8657B	HPSG1

3 Device Under Test

3.1 Description and Block Diagram

The DUT is a 2412-2462 MHz WLAN transceiver designed for automotive/vehicular applications, and as such it is powered by a 12 VDC source. This chipset is also capable of operating as a Bluetooth FHSS transceiver, testing of which is covered in the associated BT Test Report. The device is housed in a metal case approximately 20 x 12 x 3 cm in dimension. For testing, a generic harness and auxiliary equipment were provided by the manufacturer. The DUT is designed for Ford Motor Company, Building 5 20300 Rotunda Dr., Dearborn, MI 48124, United States.

Device	**[Make], Model**	**[S/N],P/N**	**EMC Consideration**
SNYC2	[Ford], KMHSYNCG2	[#1], BT4T-14F239-CC	Fully Tested
SNYC2	[Ford], KMHSYNCG2	[#2], BT4T-14F239-CC	Spurious emissions tested
SNYC2	[Ford], KMHSYNCG2	[XX], BT4T-14F239-CC	dismantled for photos
Auxiliary Devices			
LCD Display	[Ford]	BT4T-18B955-AB	Used to program the DUT into the various modes used in testing.
USB Keyboard	[GranTec], FLX-500U		

Cable	**[Make], Model**	**Length**	**EMC Consideration**
DC Power	[Generic]	1 m	Two-wire, unshielded

3.2 Samples & Variants

There is only a single variant of this device. Three samples were provided, two normal operating samples with custom software to enable radio modes (Tx and Rx) and one sample that could be easily dismantled for photos. One of the normal operating samples was provided with an antenna port connector populated for testing purposes. In normal construction the DUT has only a chip antenna soldered onto the PCB and the RF connector is depopulated.

3.3 Modes of Operation

As an 802.11 b/g mode device, the following modes of operation are employed.

802.11b Rate (Mbps)	packet length (ms)	802.11g Rate (Mbps)	packet length (ms)	802.11g Rate (Mbps)	packet length (ms)
1	12.4	6	2.07	24	0.535
2	6.3	9	1.39	36	0.366
5.5	2.42	12	1	48	0.28
11	1.31	18	0.7	54	0.25

For the measurements presented here the DUT was set to transmit with the shortest available packet length with the minimum packet spacing (maximum on time) allowed by the radio chipset software. The Bluetooth operation of this device has also been tested, and results are reported in a separate Bluetooth test report. The Bluetooth and WLAN are sequenced never to transmit at the same time.

3.4 EMI Relevant Modifications & Exemptions

No modifications were made to the DUT by this laboratory during testing. The DUT is permanently installed in a transportation vehicle. As such, digital emissions are exempt from regulation (per FCC 15.103(a) and IC correspondence on ICES-003).

4 Emission Limits

4.1 Radiated Emission Limits

Since the DUT is a spread spectrum device, wherein the radiated emissions are subject to emissions limits in the restricted bands The applicable frequencies, through ten harmonics, are given below in Table 4.1. Emission limits from digital circuitry are specified in Table 4.2.

Table 4.1. Tx. Radiated Emission Limits (FCC: 15.247/15.209; IC: RSS-210e A2.9).

Frequency (MHz)	Fundamental Ave. Elim (3m)		Spurious* Ave. Elim (3m)	
	(μV/m)	dB (μV/m)	(μV/m)	dB (μV/m)
2400-2483.5	---		---	
2310-2390 2483.5-2500 4500-5250	Restricted Bands		500	54.0
7250-7750 14470-14500 17700-21400 22010-23120 23600-24000	Restricted Bands		500	54.0

1) Emissions radiated outside of the specified frequency bands shall meet the general radiated emission limits in Section 15.209 (Class B).
2) Peak field strength of any emission above 1GHz shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. (FCC 15.35)

Table 4.2. Spurious Emission Limits (FCC: 15.33, .35, .109/209; IC: RSS-210 2.7, T2)

Freq. (MHz)	Elim (3m) μV/m	Elim dB(μV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
960-2000	500	54.0

Note: Average readings apply above 1000 MHz (1 MHz BW), Quasi-Peak readings apply to 1000 MHz (120 kHz RBW), PRF of intentional emissions > 20 Hz for QPK to apply.

4.2 Power Line Conducted Emissions Limits

Table 4.3 Emission Limits (FCC:15.107 (CISPR); IC: RSS-Gen, 7.2.2 T2).

Frequency (MHz)	Class A (dBμV)		Class B (dBμV)	
	Quasi-peak	Average	Quasi-peak	Average
.150 - 0.50	79	66	66 - 56*	56 - 46*
0.50 - 5	73	60	56	46
5 - 30	73	60	60	50

Notes:
1. The lower limit shall apply at the transition frequency
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15-0.50 MHz:
   *Class B Quasi-peak: dBμV = 50.25 - 19.12*log(f)
   *Class B Average: dBμV = 40.25 - 19.12*log(f)
3. 9 kHz RBW

5 Measurement Procedures

5.1 Semi-Anechoic Chamber Radiated Emissions

To become familiar with the radiated emission behavior of the DUT, the device is first studied and measured in our shielded semi-anechoic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with a turntable, an antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed.

The DUT is laid on the test table as shown in the included block diagram and/or photographs. A shielded loop antenna is employed when studying emissions from 9 kHz to 30 MHz. Above 30 MHz and below 250 MHz a biconical antenna is employed. Above 250 MHz a ridge or and standard gain horn antennas are used. The spectrum analyzer resolution and video bandwidths are set so as to measure the DUT emission without decreasing the emission bandwidth (EBW) of the device. Emissions are studied for all orientations (3-axes) of the DUT and all test antenna polarizations. In the chamber, spectrum and modulation characteristics of intentional carriers are recorded. Receiver spurious emissions are measured with an appropriate carrier signal applied. Associated test data is presented in subsequent sections.

5.2 Outdoor Radiated Emissions

After measurements are performed indoors, emissions on our outdoor 3-meter Open Area Test Site (OATS) are made, when applicable. If the DUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. Any intentionally radiating elements are placed on the test table flat, on their side, and on their end (3-axes) and worst case emissions are recorded. For each configuration the DUT is rotated 360 degrees about its azimuth and the receive antenna is raised and lowered between 1 and 4 meters to maximize radiated emissions from the device. Receiver spurious emissions are measured with an appropriate carrier signal applied. For devices with intentional emissions below 30 MHz, our shielded loop antenna at a 1 meter receive height is used. Low frequency field extrapolation to the regulatory limit distance is employed as needed. Emissions between 30 MHz and 1 GHz are measured using tuned dipoles and/or biconical antennas. Care is taken to ensure that the RBW and VBW used meet the regulatory requirements, and that the EBW of the DUT is not reduced. The Photographs included in this report show the Test Setup.

5.3 Radiated Field Computations

To convert the dBm values measured on the spectrum analyzer to dB(μV/m), we use expression

$$E3(dB\mu V/m) = 107 + PR + KA - KG + KE - CF$$

where	PR	=	power recorded on spectrum analyzer, dBm, measured at 3 m
	KA	=	antenna factor, dB/m
	KG	=	pre-amplifier gain, including cable loss, dB
	KE	=	duty correction factor, dB
	CF	=	distance conversion (employed only if limits are specified at alternate distance), dB

When presenting the data at each frequency, the highest measured emission under all of the possible DUT orientations (3-axes) is given.

5.4 Indoor Power Line Conducted Emissions

When applicable, power line conducted emissions are measured in our semi-anechoic chamber. If the DUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in

ANSI C63.4 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration.

The conducted emissions measured with the spectrum analyzer and recorded (in dBμV) from 0-2 MHz and 2-30 MHz for both the ungrounded (Hi) and grounded (Lo) conductors. The spectrum analyzer is set to peak-hold mode in order to record the highest peak throughout the course of functional operation. Only when the emission exceeds or is near the limit are quasi-peak and average detection used.

5.5 Supply Voltage Variation

Measurements of the variation in the fundamental radiated emission are performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value. For battery operated equipment, tests were performed using a new battery, and worst case emissions are re-checked employing a new battery.

6 Test Results

6.1 Radiated Emissions

6.1.1 Peak-to-Average Ratio (15.35(b))

For the measurements presented here (e.g. emissions in restricted bands and output power measurement), the DUT was set to transmit with the shortest available packet length and with the minimum packet spacing (maximum on time) allowed by the radio software. The following packet rates were measured with spectrum analyzer set in zero-span mode (see Figure 6.1).

Data Rate (Mbps)	Packet Length (T) (ms)	Packet Period (ms)	Duty Cycle (%)
11 (802.11 b)	1.313	1.365	96.2%
54 (802.11 g)	0.250	0.270	92.6%

Average spurious emissions measurements above 1 GHz are measured using 1 MHz RBW and VBW = 10 kHz > 1/T. Peak spurious measurements are made using 1 MHz RBW and 3 MHz VBW. The peak to average ratio of the fundamental emission (in a 1 MHz receiver bandwidth) was measured to be 10.8 dB.

6.1.2 Emission Bandwidth (15.247(a)(2))

For this test, the DUT was put in a test mode with the shortest available packet length with the minimum packet spacing allowed by the radio software. Measurements were made at 3 meters using a standard gain horn. The 6-dB bandwidth and 26 dB EBW were measured for lowest, middle, and highest channels available. The 99% Emission bandwidth per IC test procedures is also reported here. See figure 6.2.

Data Rate (Mbps)	Channel	6 dB BW (MHz)	26 dB EBW (MHz)	IC 99% PWR BW (MHz)
11 (802.11 b)	1	7.65	16.58	13.50
	6	8.32	16.88	13.58
	11	7.73	16.95	13.50
54 (802.11 g)	1	15.90	19.13	16.50
	6	15.90	18.45	16.35
	11	15.90	19.20	16.50

6.2 Conducted Emissions

6.2.1 Conducted Output Power (15.247(b))

DUT output power is computed from antenna port conducted emissions. Since the emission bandwidth of the DUT is greater than the maximum RBW of the spectrum analyzer employed, power output Option 2, Method 3 of the FCC's DTS measurement procedures is used in determining output power. The SA is set in linear mode, sample detected, with a SPAN = 30 MHz, RBW = 1 MHz, VBW = 10 kHz, and a free running trigger. Data is MAX held for 60 seconds. The scale is returned to log mode so that power is properly computed by the SA's integration routine across no less than the 26 dB EBW. See figure 6.3.

Data Rate (Mbps)	Channel	Power (dBm)
11 (802.11 b)	1	15.45
	6	15.25
	11	15.35
54 (802.11 g)	1	14.19
	6	13.87
	11	14.59

6.2.2 Spurious Emissions (15.247(c))

For this test, the DUT was put in a test mode with the shortest available packet length with the minimum packet spacing allowed by the radio software. The DUT was attached directly to the SA via a small length of cable. The analyzer was set for RBW=100 kHz, VBW=300 kHz, and radiated emissions were recorded from 0 MHz to 25 GHz. See Figure 6.4. In all cases, spurious emissions are more than 30 dB below the carrier level. Included in Figure 6.4 are plots demonstrating band-edge compliance at lower and upper edges of the operating band.

6.2.3 Power Spectral Density and Line Spacing (15.247(d))

For this test, the DUT was put in a test mode with the shortest available packet length with the minimum packet spacing allowed by the radio software. The spectrum analyzer was connected directly to the unit. The spectrum was first scanned for the maximum spectrum peaks and then at these peaks the sweep was repeated with RBW=3 kHz, VBW=300 kHz, SPAN=300 kHz, and RBW=1 kHz, VBW=300 kHz, SPAN=100 kHz. A sweep time of 100 sec was maintained to ensure peak signal was measured in each bin of the SA. See Figure 6.5. The readings obtained are:

Data Rate (Mbps)	Channel	PSD (dBm/3 kHz)	Line Spacing (kHz)
11 (802.11 b)	1	-8.0	5.5
	6	-7.7	5.5
	11	-9.9	4.8
54 (802.11 g)	1	-12.1	4.0
	6	-11.5	3.8
	11	-9.7	4.0

6.2.4 Potential Health Hazard EM Radiation Level

The following table summarizes the power density at a distance of 20 cm from the device as calculated from FCC OET Bulletin 65.

Table 6.3 Potential Health Hazard Radiation Level – WLAN Mode

Ant.	Ant.Gain (dBi)*	Po (mW)	EIRP (mW)**	S (mW/cm^2)
PCB	-19.9	35.1	35.1	0.00698

*Note: Antenna gain was computed by the test lab by comparing the conducted output power measured at the RF port to the maximum EIRP computed from the peak measured field strength at 3 meters distance. This was done for the Bluetooth mode of operation with the RBW > EBW.
**Note: Per FCC OET Bulletin 65, the EIRP employed is the greater of the conducted output power and the EIRP. For this filing, the conducted output power is significantly greater than the measured EIRP.

6.2.5 Supply Voltage Variation

Measurements of the 802.11 b (11 Mbps) output power at the center operating channel (2437 MHz) was performed with the supply voltage varied from 6 VDC to 18 VDC. Results are depicted in figure 6.6. The DUT draws 310 mA DC during repeated packet transmission with LCD display attached.

6.2.6 AC Power Line Conducted Emissions (15.207)

The DUT is not subject to AC power line conducted emissions as it is permanently installed in a transportation vehicle.

Table 6.1(a) Highest Emissions Measured

#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det.* Used	Ka dB/m	Kg dB	E3** dBµV/m	E3lim dBµV/m	Pass dB	Comments
	Restricted Band Radiated Emissions (802.11 b)										Ford SYNC2; FCC/IC
1	2390.0	Horn S	H/V	-80.9	Avg	21.5	- 1.5	49.1	54.0	**4.9**	Low Channel, 2412 MHz
2	2390.0	Horn S	H/V	-86.9	Avg	21.5	- 1.5	43.1	54.0	10.9	Mid Channel, 2437 MHz, noise
3	2390.0	Horn S	H/V	-86.9	Avg	21.5	- 1.5	43.1	54.0	10.9	High Channel, 2462MHz, noise
4	2483.5	Horn S	H/V	-86.8	Avg	21.5	- 1.5	43.2	54.0	10.8	Low, noise
5	2483.5	Horn S	H/V	-86.8	Avg	21.5	- 1.5	43.2	54.0	10.8	Mid, noise
6	2483.5	Horn S	H/V	-83.4	Avg	21.5	- 1.5	46.6	54.0	7.4	High
7	4824.0	Horn C	H/V	-46.6	Avg	24.6	38.0	47.0	54.0	7.0	Low
8	4874.0	Horn C	H/V	-51.4	Avg	24.6	38.0	42.2	54.0	11.8	Mid
9	4924.0	Horn C	H/V	-59.1	Avg	24.6	38.0	34.5	54.0	19.5	High
10	7236.0	Horn XN	H/V		Avg	25.1	36.8	-	N/A	-	Low
11	7311.0	Horn XN	H/V	-50.6	Avg	25.2	36.8	44.8	54.0	9.2	Mid
12	7386.0	Horn XN	H/V	-49.7	Avg	25.3	36.8	45.8	54.0	8.2	High
13	9648.0	Horn X	H/V		Avg	27.8	36.8	-	N/A	-	Low
14	9748.0	Horn X	H/V		Avg	27.9	36.8	-	N/A	-	Mid
15	9848.0	Horn X	H/V		Avg	27.9	36.8	-	N/A	-	High
16	12060.0	Horn X	H/V	-70.8	Avg	31.8	35.4	32.6	54.0	21.4	Low, noise
17	12185.0	Horn X	H/V	-71.8	Avg	31.8	34.3	32.7	54.0	21.3	Mid, noise
18	12310.0	Horn X	H/V	-72.4	Avg	31.9	33.2	33.3	54.0	20.7	High, noise
19	14472.0	Horn Ku	H/V	-71.3	Avg	33.2	17.3	51.6	54.0	2.4	Low, noise
20	14622.0	Horn Ku	H/V		Avg	33.3	17.3	-	N/A	-	Mid
21	14772.0	Horn Ku	H/V		Avg	33.4	17.3	-	N/A	-	High
22	16884.0	Horn Ku	H/V		Avg	34.7	34.0	-	N/A	-	Low
23	17059.0	Horn Ku	H/V		Avg	34.8	34.0	-	N/A	-	Mid
24	17234.0	Horn Ku	H/V		Avg	34.9	34.0	-	N/A	-	High
25	19296.0	Horn K	H/V	-70.5	Avg	32.2	32.0	36.7	54.0	17.3	Low, noise
26	19496.0	Horn K	H/V	-68.0	Avg	32.3	32.0	39.3	54.0	14.7	Mid, noise
27	19696.0	Horn K	H/V	-67.6	Avg	32.3	32.0	39.7	54.0	14.3	High, noise
28	21708.0	Horn K	H/V		Avg	32.7	32.0	-	N/A	-	Low
29	21933.0	Horn K	H/V		Avg	32.7	32.0	-	N/A	-	Mid
30	22158.0	Horn K	H/V	-64.4	Avg	32.8	32.0	43.4	54.0	10.6	High, noise
31	24120.0	Horn K	H/V		Avg	33.2	32.0	-	N/A	-	Low
32	24370.0	Horn K	H/V		Avg	33.2	32.0	-	N/A	-	Mid
33	24620.0	Horn K	H/V		Avg	33.3	32.0	-	N/A	-	High
34											
35											
36	Note: Peak (1 MHz RBW/ 3 MHz VBW) relative to average (1 MHz RBW , 10 kHz VBW) was measured to be 10.8 dB.										
37	* Avg measured with 1 MHz RBW and 10 kHz VBW, emission duty cycle was measured to be 10.8 dB in a 1 MHz RBW.										

Meas. 03/07/2010; U of Mich.

Table 6.1(b) Highest Emissions Measured

Restricted Band Radiated Emissions (802.11 g)											Ford SYNC2; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det.* Used	Ka dB/m	Kg dB	E3** dBμV/m	E3lim dBμV/m	Pass dB	Comments
1	2390.0	Horn S	H/V	-77.7	Avg	21.5	- 1.5	52.3	54.0	**1.7**	Low Channel, 2412 MHz
2	2390.0	Horn S	H/V	-85.4	Avg	21.5	- 1.5	44.6	54.0	9.4	Mid Channel, 2437 MHz
3	2390.0	Horn S	H/V	-86.9	Avg	21.5	- 1.5	43.1	54.0	10.9	High Channel, 2462MHz
4	2483.5	Horn S	H/V	-86.8	Avg	21.5	- 1.5	43.2	54.0	10.8	Low, noise
5	2483.5	Horn S	H/V	-84.3	Avg	21.5	- 1.5	45.7	54.0	8.3	Mid
6	2483.5	Horn S	H/V	-77.7	Avg	21.5	- 1.5	52.3	54.0	**1.7**	High
7	4824.0	Horn C	H/V	-54.4	Avg	24.6	38.0	39.2	54.0	14.8	Low
8	4874.0	Horn C	H/V	-57.0	Avg	24.6	38.0	36.6	54.0	17.4	Mid
9	4924.0	Horn C	H/V	-63.9	Avg	24.6	38.0	29.7	54.0	24.3	High
10	7236.0	Horn XN	H/V		Avg	25.1	36.8	-	N/A	-	Low
11	7311.0	Horn XN	H/V	-53.8	Avg	25.2	36.8	41.6	54.0	12.4	Mid
12	7386.0	Horn XN	H/V	-53.9	Avg	25.3	36.8	41.6	54.0	12.4	High
13	9648.0	Horn X	H/V		Avg	27.8	36.8	-	N/A	-	Low
14	9748.0	Horn X	H/V		Avg	27.9	36.8	-	N/A	-	Mid
15	9848.0	Horn X	H/V		Avg	27.9	36.8	-	N/A	-	High
16	12060.0	Horn X	H/V	-70.8	Avg	31.8	35.4	32.6	54.0	21.4	Low, noise
17	12185.0	Horn X	H/V	-71.8	Avg	31.8	34.3	32.7	54.0	21.3	Mid, noise
18	12310.0	Horn X	H/V	-72.4	Avg	31.9	33.2	33.3	54.0	20.7	High, noise
19	14472.0	Horn Ku	H/V	-71.3	Avg	33.2	17.3	51.6	54.0	2.4	Low
20	14622.0	Horn Ku	H/V		Avg	33.3	17.3	-	N/A	-	Mid
21	14772.0	Horn Ku	H/V		Avg	33.4	17.3	-	N/A	-	High
22	16884.0	Horn Ku	H/V		Avg	34.7	34.0	-	N/A	-	Low
23	17059.0	Horn Ku	H/V		Avg	34.8	34.0	-	N/A	-	Mid
24	17234.0	Horn Ku	H/V		Avg	34.9	34.0	-	N/A	-	High
25	19296.0	Horn K	H/V	-70.5	Avg	32.2	32.0	36.7	54.0	17.3	Low, noise
26	19496.0	Horn K	H/V	-68.0	Avg	32.3	32.0	39.3	54.0	14.7	Mid, noise
27	19696.0	Horn K	H/V	-67.6	Avg	32.3	32.0	39.7	54.0	14.3	High, noise
28	21708.0	Horn K	H/V		Avg	32.7	32.0	-	N/A	-	Low
29	21933.0	Horn K	H/V		Avg	32.7	32.0	-	N/A	-	Mid
30	22158.0	Horn K	H/V	-64.4	Avg	32.8	32.0	43.4	54.0	10.6	High, noise
31	24120.0	Horn K	H/V		Avg	33.2	32.0	-	N/A	-	Low
32	24370.0	Horn K	H/V		Avg	33.2	32.0	-	N/A	-	Mid
33	24620.0	Horn K	H/V		Avg	33.3	32.0	-	N/A	-	High
34											
35											
36	Note: Peak (1 MHz RBW/ 3 MHz VBW) relative to average (1 MHz RBW , 10 kHz VBW) was measured to be 10.8 dB.										
37	* Avg measured with 1 MHz RBW and 10 kHz VBW, emission duty cycle was measured to be 10.8 dB in a 1 MHz RBW.										

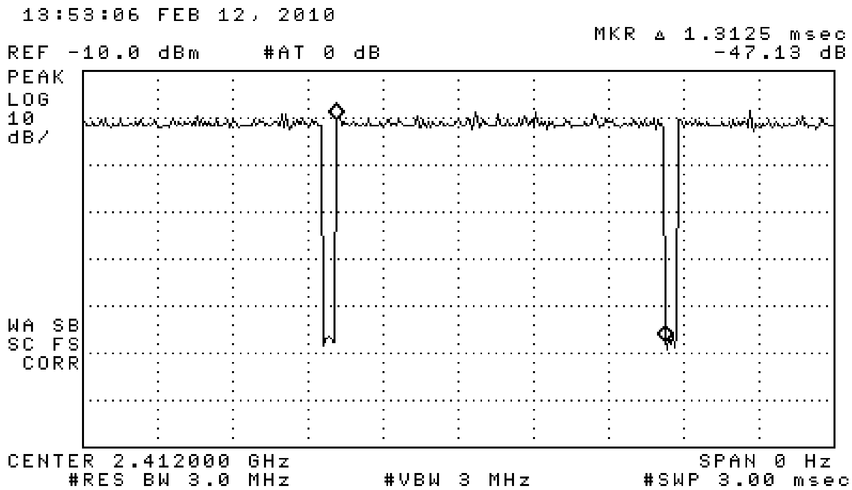
Meas. 03/07/2010; U of Mich.

Table 6.1(c) Highest Emissions Measured

Tx and Rx Spurious Emissions													Ford, SYNC2; FCC/IC
#	Freq. kHz	Ant. Used	Ant. Pol.	Pr (avg) dBm	Pr (pk) dBm	Ka dB/m	Kg dB	E3 (avg) dBμV/m	E3lim (avg) dBμV/m	E3 (avg) dBμV/m	E3lim (pk) dBμV/m	Pass dB	Comments
1	1963.0	R-Horn	H/V		-67.6	22.4	28.0		54.0	33.8	74.0	40.2	noise
2	1200.0	R-Horn	H/V		-68.1	20.4	28.0		54.0	31.3	74.0	42.7	noise
3	1898.0	R-Horn	H/V		-68.5	22.2	28.0		54.0	32.7	74.0	41.3	noise
4	1445.0	R-Horn	H/V		-69.1	21.2	28.0		54.0	31.1	74.0	42.9	noise
5	1745.0	R-Horn	H/V		-69.1	21.9	28.0		54.0	31.8	74.0	42.2	noise
6	1730.0	R-Horn	H/V		-69.3	21.9	28.0		54.0	31.6	74.0	42.4	noise
7	1790.0	R-Horn	H/V		-69.6	22.0	28.0		54.0	31.4	74.0	42.6	noise
8	1873.0	R-Horn	H/V		-69.6	22.2	28.0		54.0	31.6	74.0	42.4	noise
9	1683.0	R-Horn	H/V		-69.7	21.7	28.0		54.0	31.0	74.0	43.0	noise
10	1150.0	R-Horn	H/V		-69.7	20.2	28.0		54.0	29.5	74.0	44.5	noise
11	3120.0	R-Horn	H/V		-68.8	25.7	25.0		54.0	38.9	74.0	35.1	noise
12	4200.0	Horn C	H/V		-68.9	21.5	22.7		54.0	36.9	74.0	37.1	noise
13	5695.0	Horn C	H/V	-68.7	-24.9	24.8	38.0	5.1	54.0	68.9	74.0	**5.1**	max all
14	5697.0	Horn C	H/V	-68.7	-25.2	24.8	38.0	25.1	54.0	68.6	74.0	5.4	max all
15	5708.0	Horn C	H/V	-68.7	-29.4	24.8	38.0	25.1	54.0	64.4	74.0	9.6	max all
16	5719	Horn C	H/V	-68.7	-30.7	24.8	38.0	25.1	54.0	63.1	74.0	10.9	max all
17	5715.5	Horn C	H/V	-68.7	-31.3	24.8	38.0	25.1	54.0	62.5	74.0	11.5	max all
18	5763.1	Horn C	H/V	-68.7	-35.5	24.8	38.0	25.1	54.0	58.4	74.0	15.6	max all
19	6380.0	Horn XN	H/V		-59.2	24.4	38.0		54.0	34.2	74.0	39.8	max all
20	7230.0	Horn XN	H/V		-53.2	25.1	36.8		54.0	42.1	74.0	31.9	max all
21													
22													
23	* Note: Rx WLAN VCO appears between 5650 to 5800 MHz.												
24	All emissions below 1 GHz are considered Digital Emissions												
25	* Avg measured with 1 MHz RBW and 10 kHz VBW. Pk measured with 1 MHz RBW, 3 MHz VBW.												
26													
27													

Digital Radiated Emissions*													
#	Freq. kHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m			Pass dB	Comments
28													
29													
30													
31													
32													
33													
34	* For devices used in transportation vehicles, digital emissions are exempt per FCC 15.103(a), ICES-003/RSS-GEN												

Meas. 03/12/2010; U of Mich.



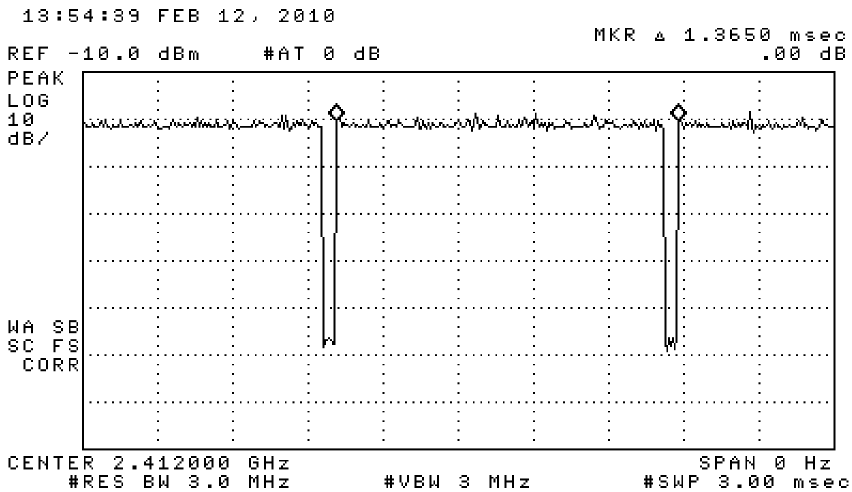
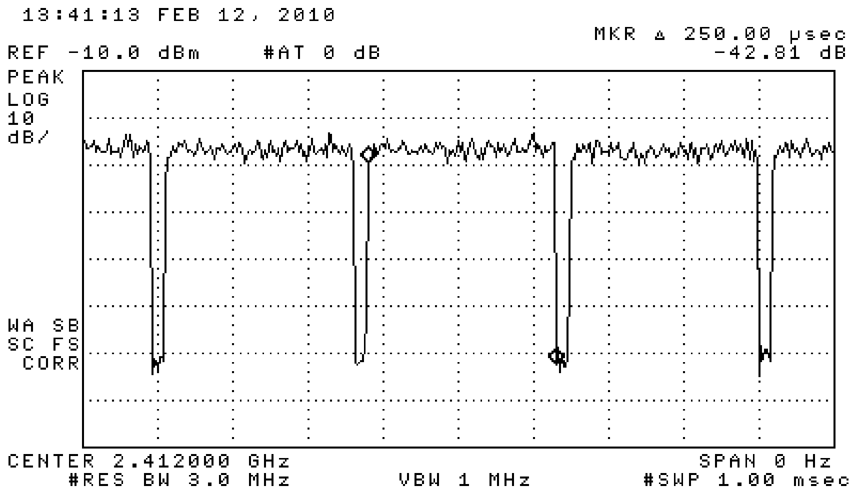


Figure 6.1(a) Worst Case 802.11 b mode of operation (11 Mbps).
(top) packet length, (bottom) packet period.



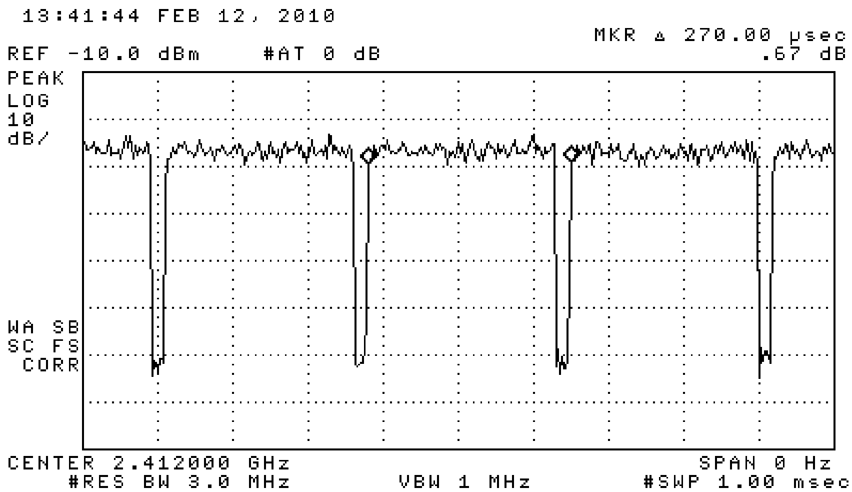


Figure 6.1(b) Worst Case 802.11 g mode of operation (54 Mbps).
(top) packet length, (bottom) packet period.

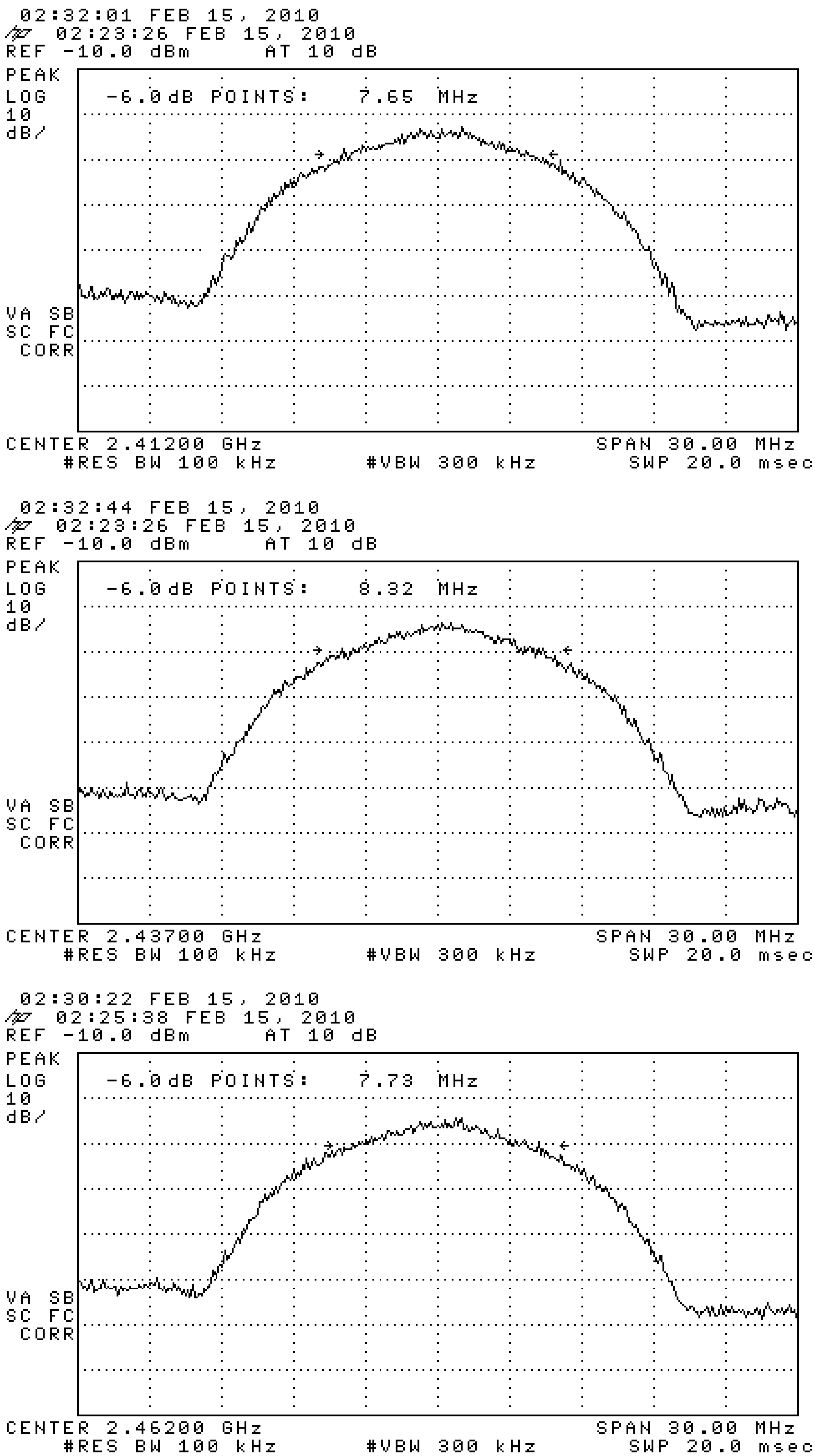


Figure 6.2(a) 6 dB Emission Bandwidth.
(top) Low Channel, (middle) Middle Channel, (bottom) High Channel

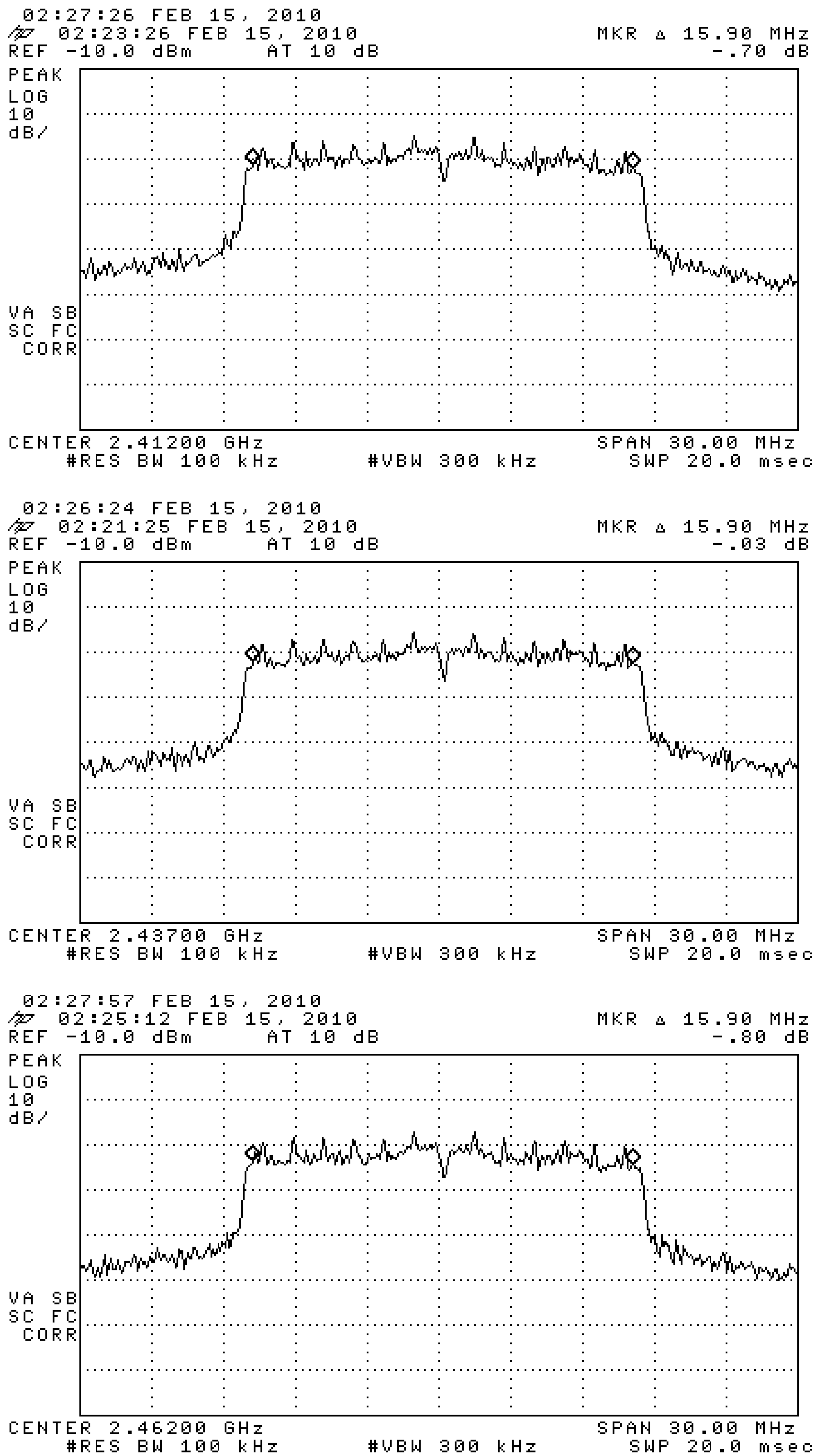


Figure 6.2(b) 6 dB Emission Bandwidth.
(top) Low Channel, (middle) Middle Channel, (bottom) High Channel

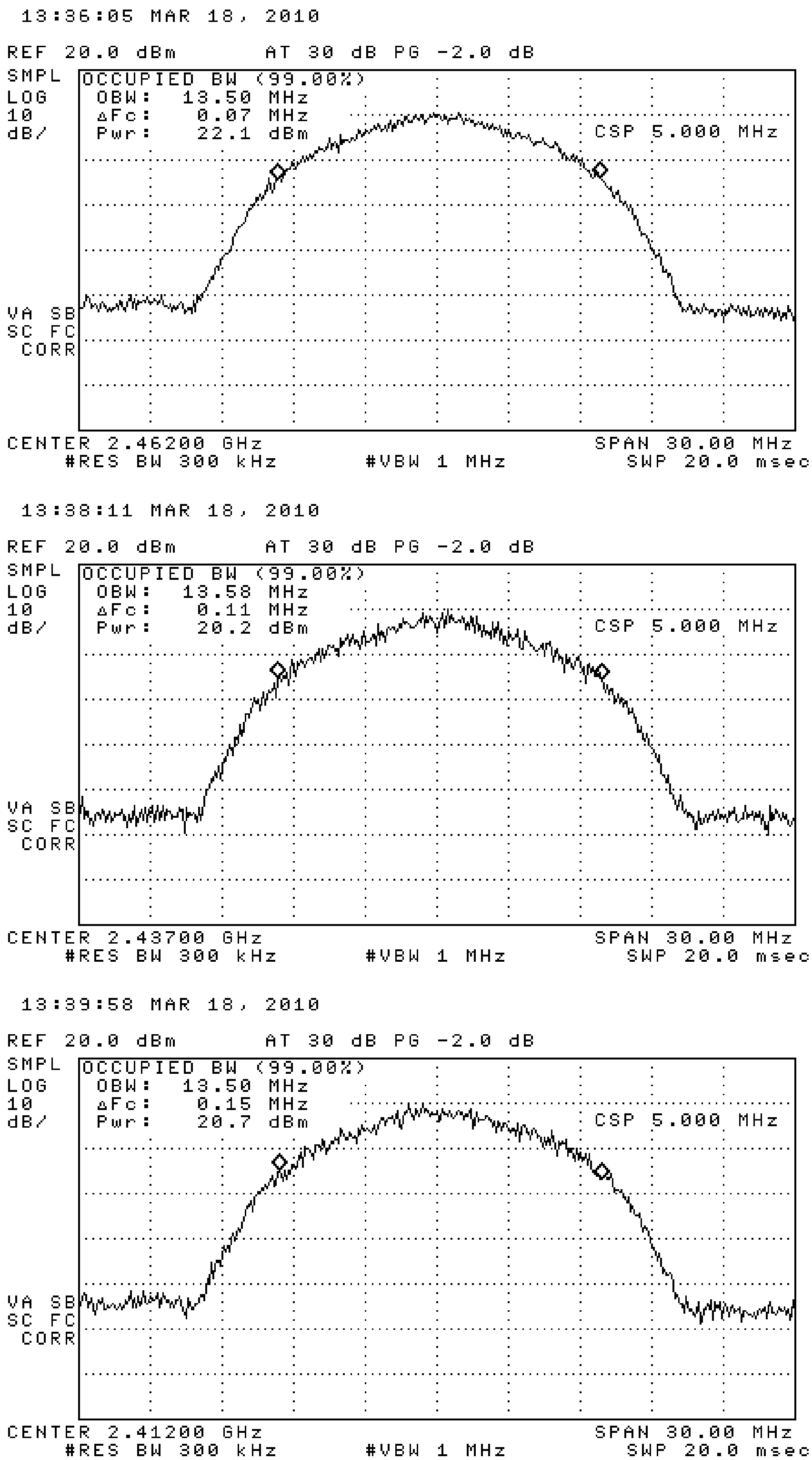
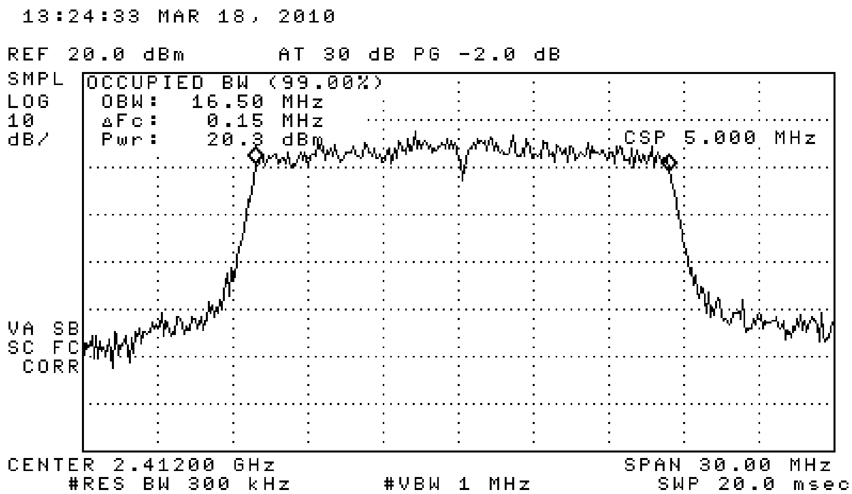
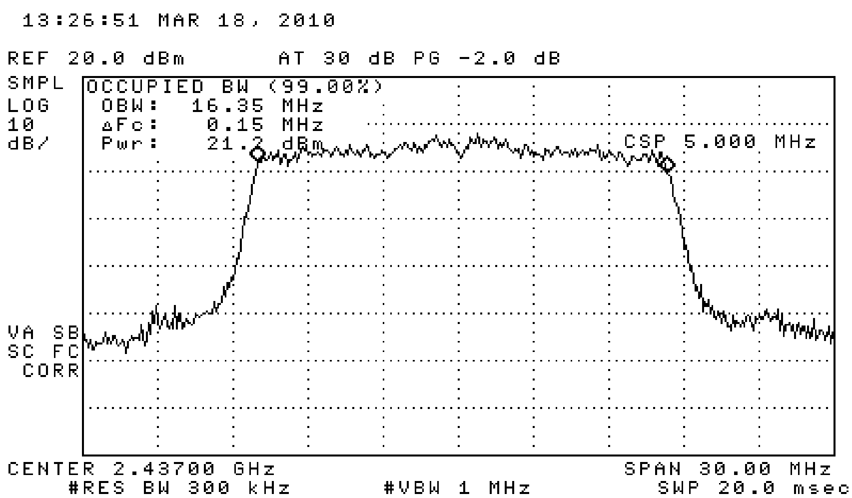


Figure 6.2(c) 802.11b Mode IC 99% Power Bandwidth.
(top) Low Channel, (middle) Middle Channel, (bottom) High Channel





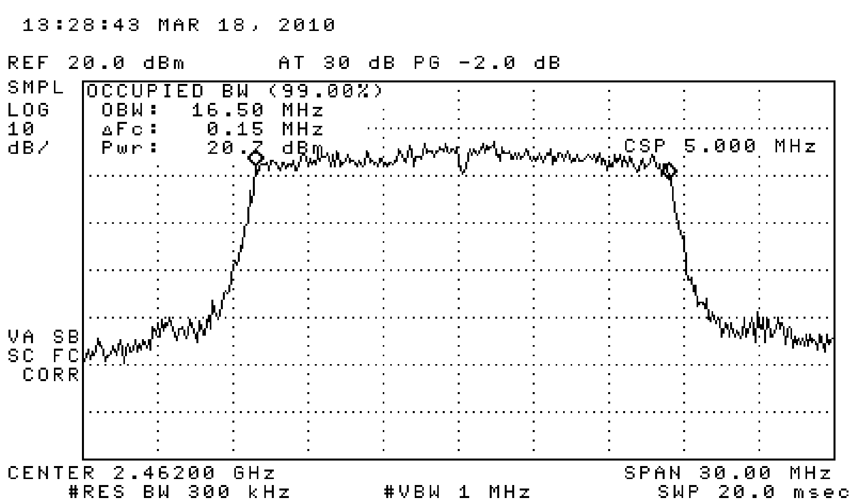


Figure 6.2(d) 802.11g Mode IC 99% Power Bandwidth.
(top) Low Channel, (middle) Middle Channel, (bottom) High Channel

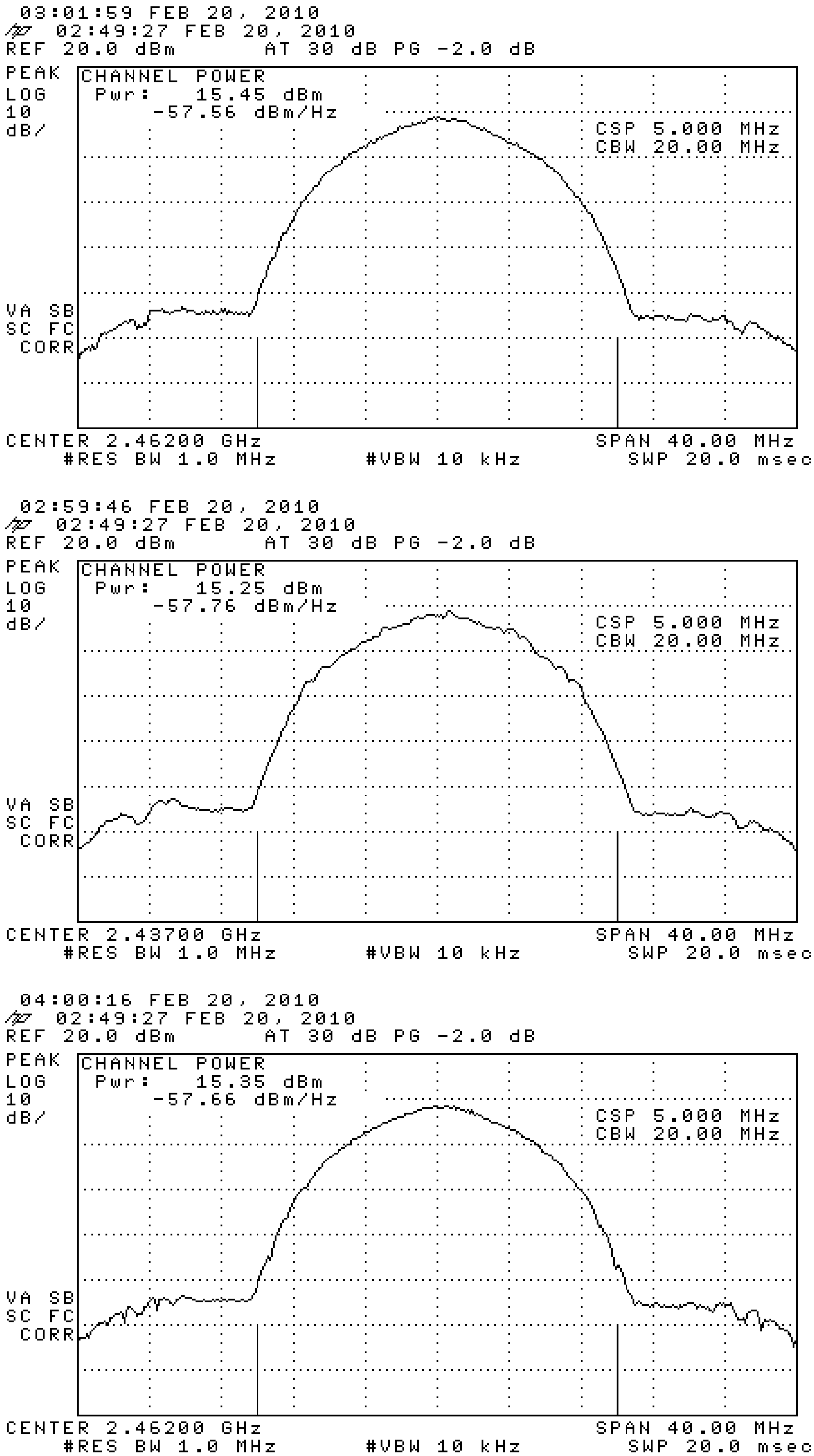
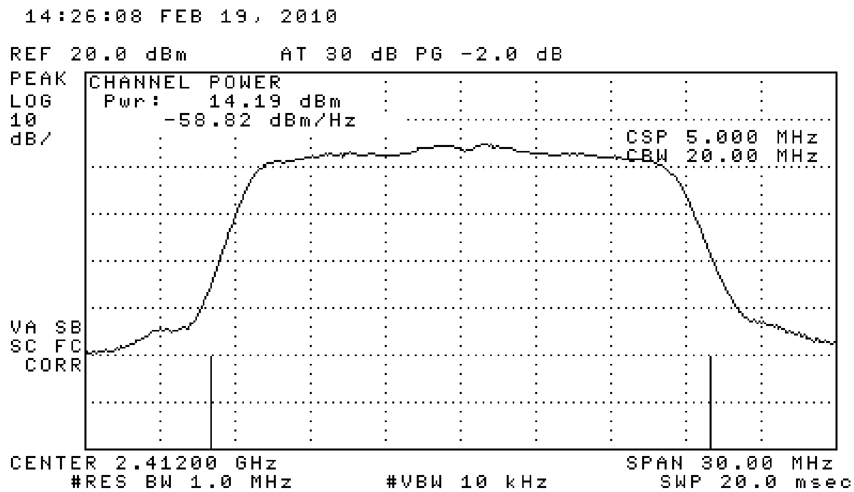
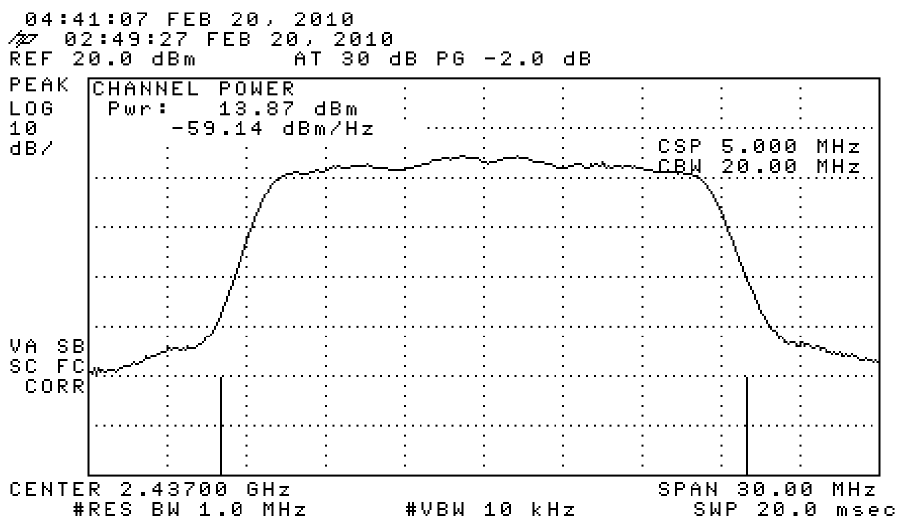


Figure 6.3(a) Output Power (802.11 b mode).
(top) Low Channel, (middle) Middle Channel, (bottom) High Channel





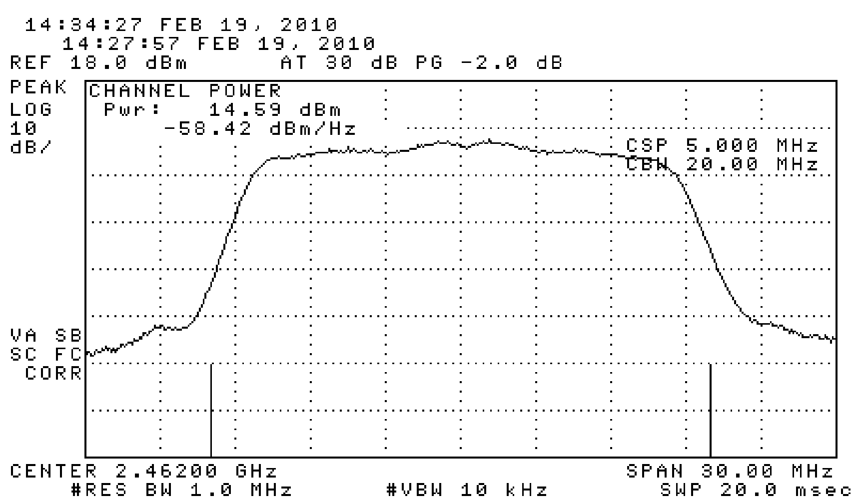
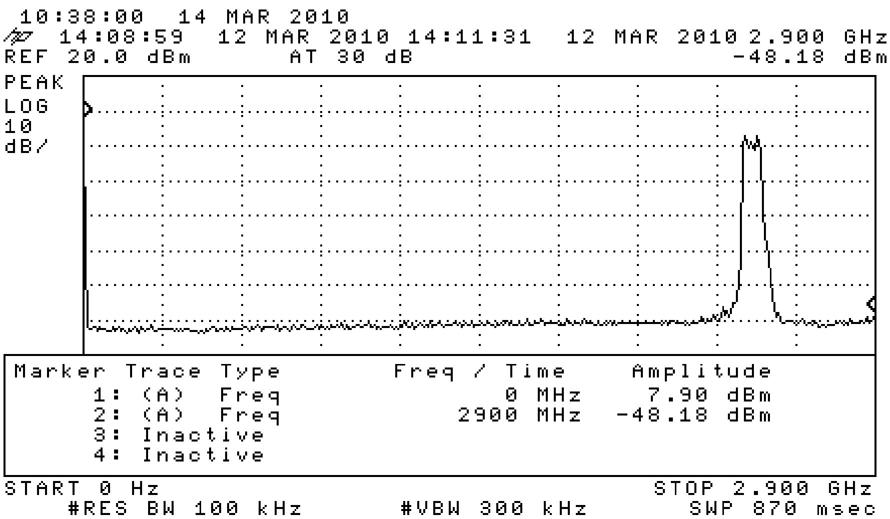
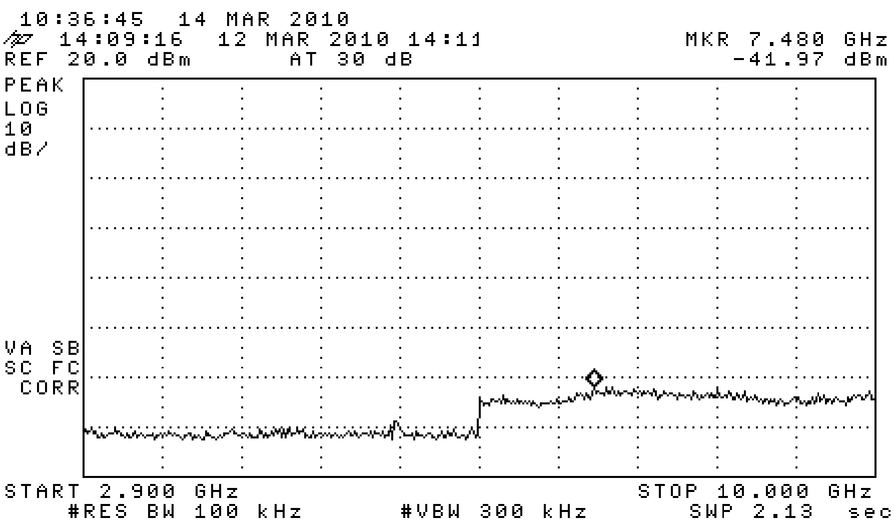


Figure 6.3(b) Output Power (802.11 g mode).
(top) Low Channel, (middle) Middle Channel, (bottom) High Channel





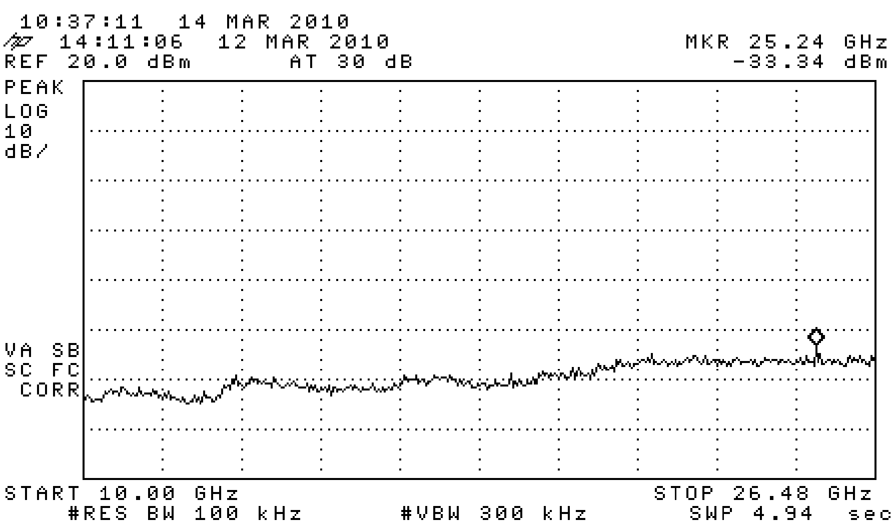
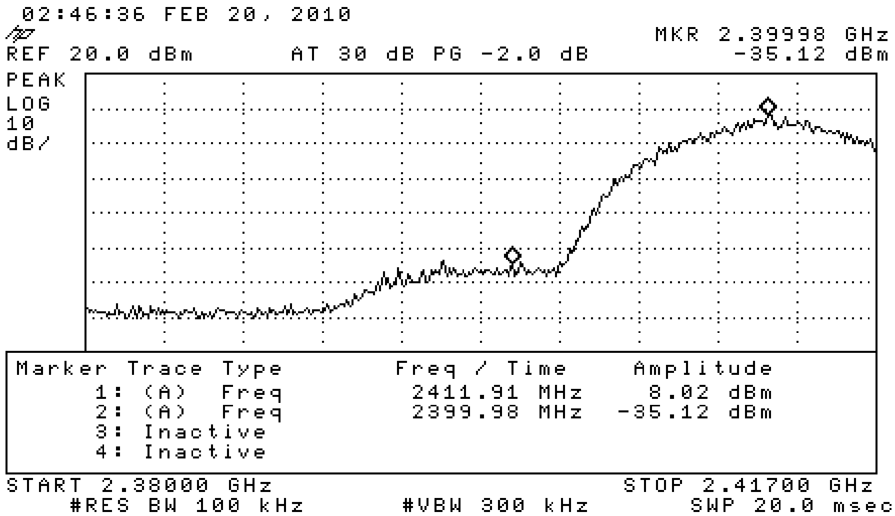


Figure 6.4(a) Conducted Spurrious Emissions (802.11 b mode).
(low, mid, and high channels)



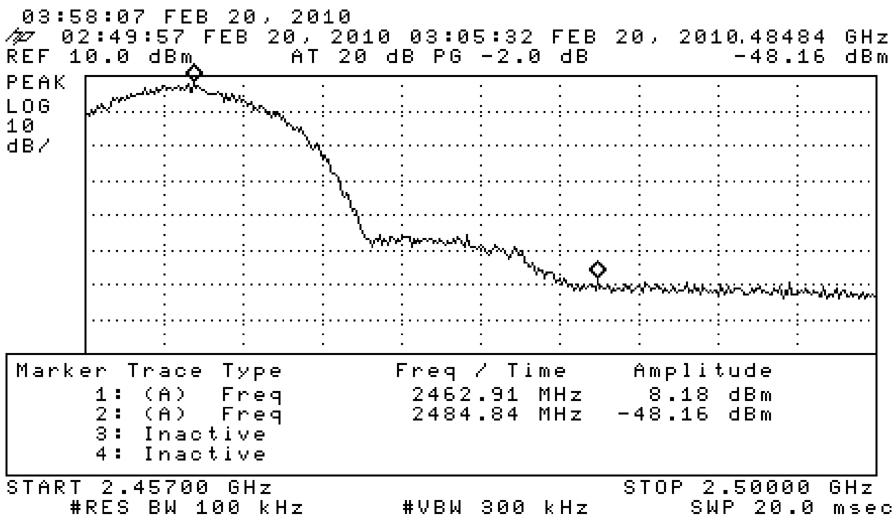
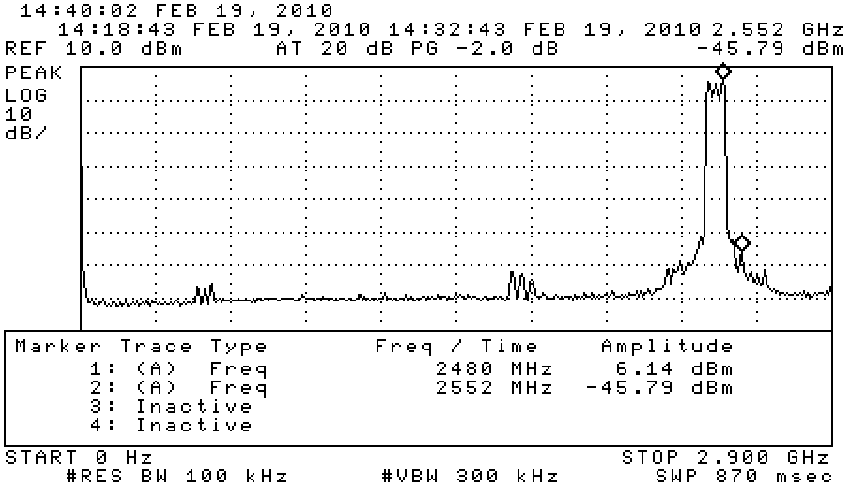
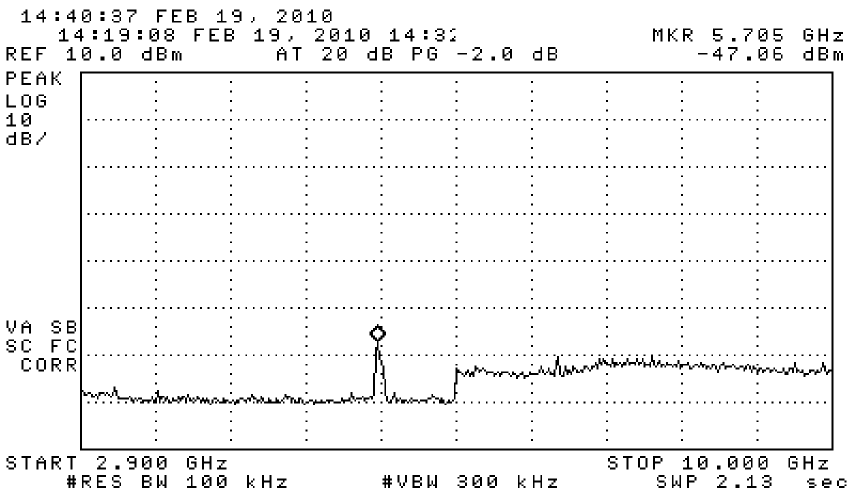


Figure 6.4(b) Conducted Band Edge Spurrious (802.11 b mode).
(low, mid, and high channels)





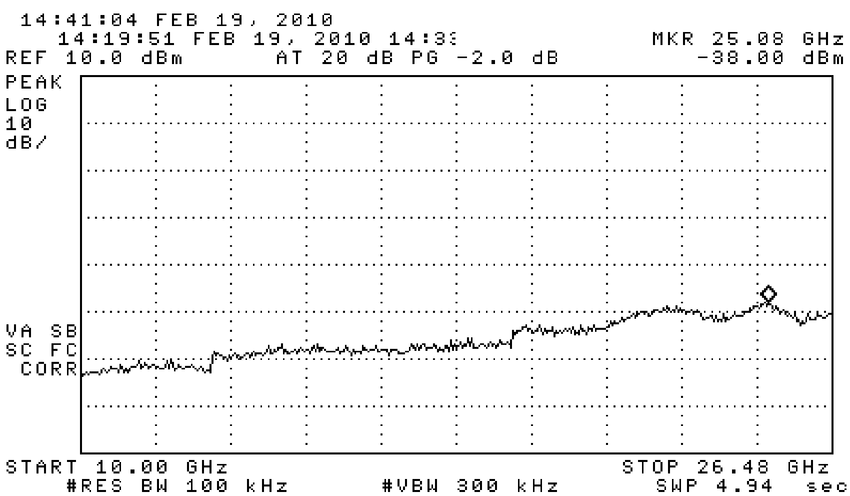
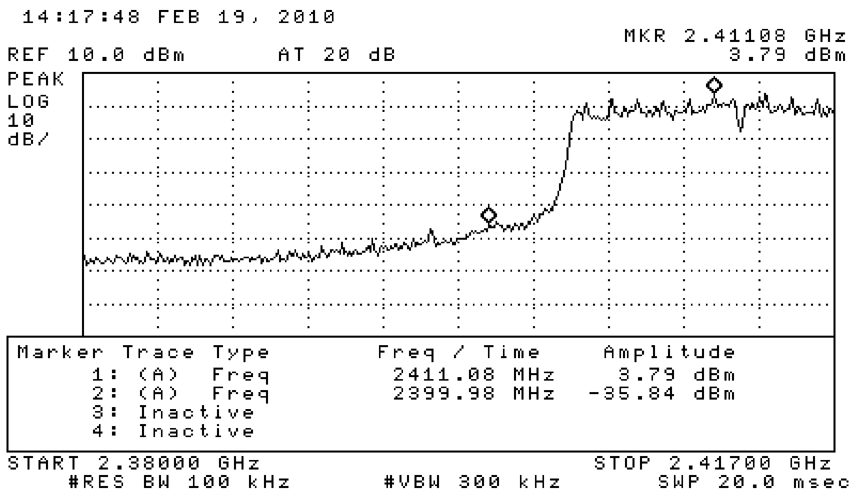


Figure 6.4(c) Conducted Spurrious Emissions (802.11 g mode).
(low, mid, and high channels)



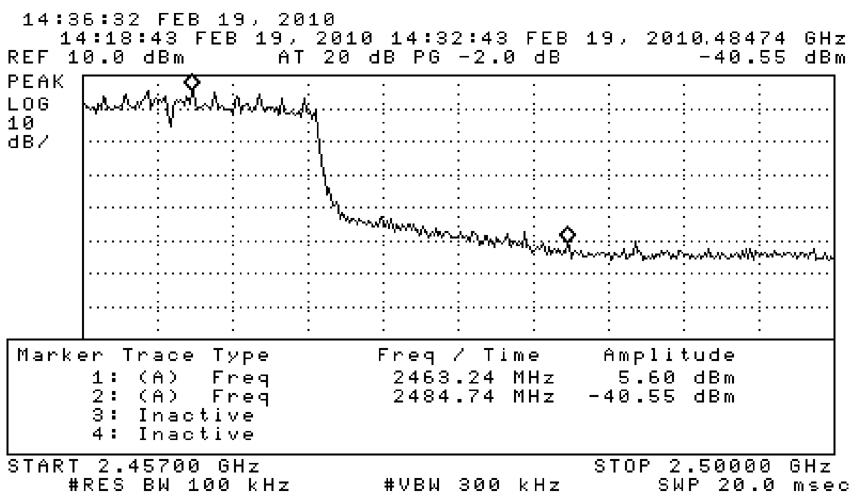
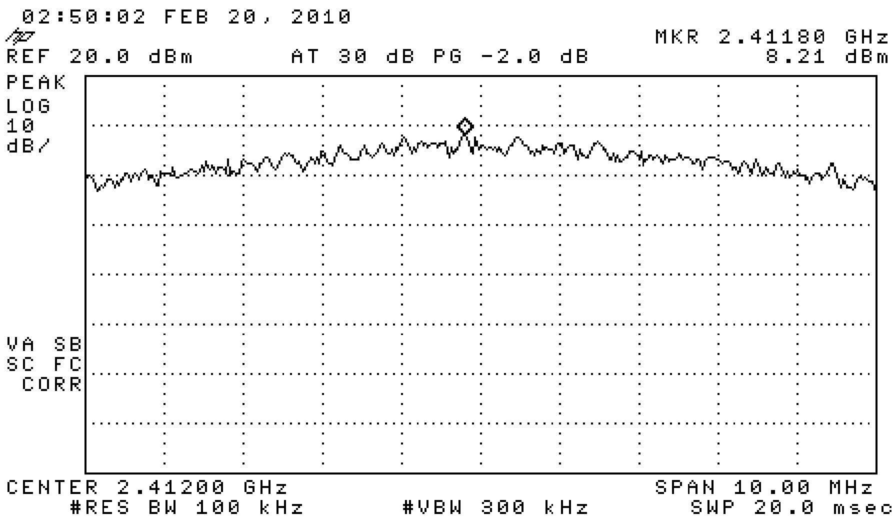
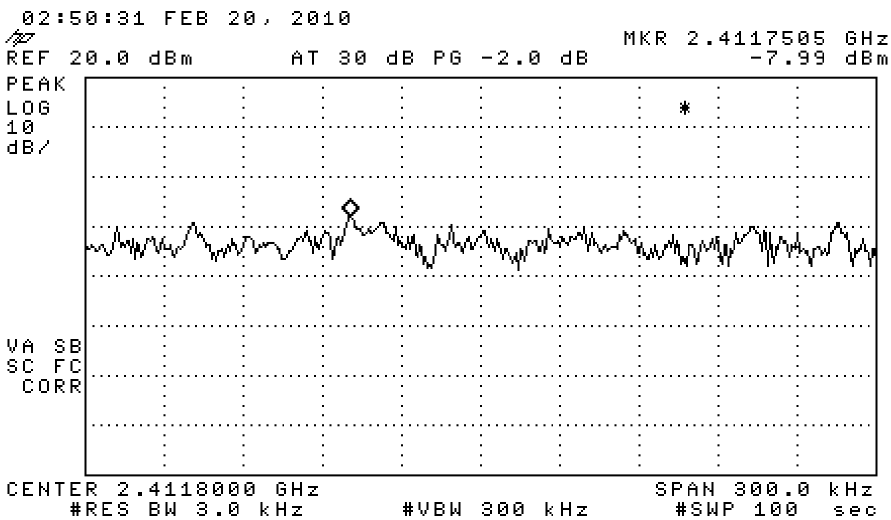


Figure 6.4(d) Conducted Band Edge Spurrious (802.11 g mode).
(low, mid, and high channels)





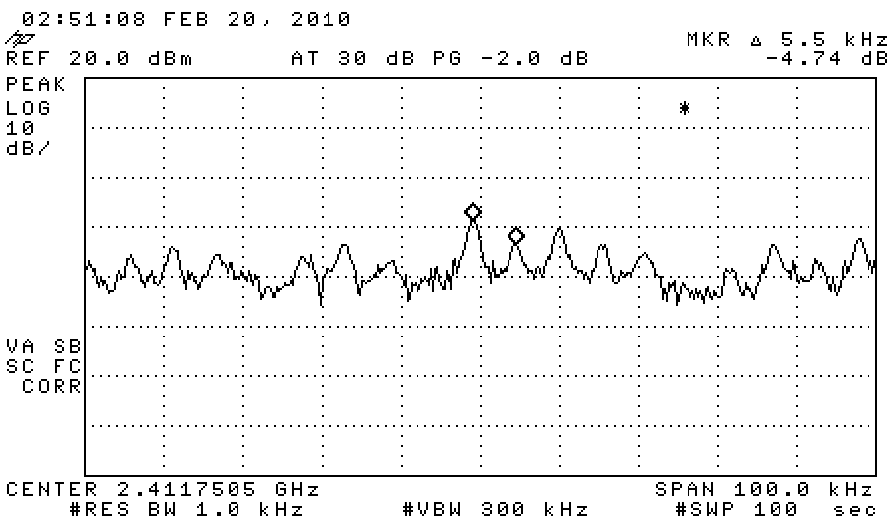


Figure 6.5(a) Power Spectral Density (802.11 b mode).
(only low channel plots shown)

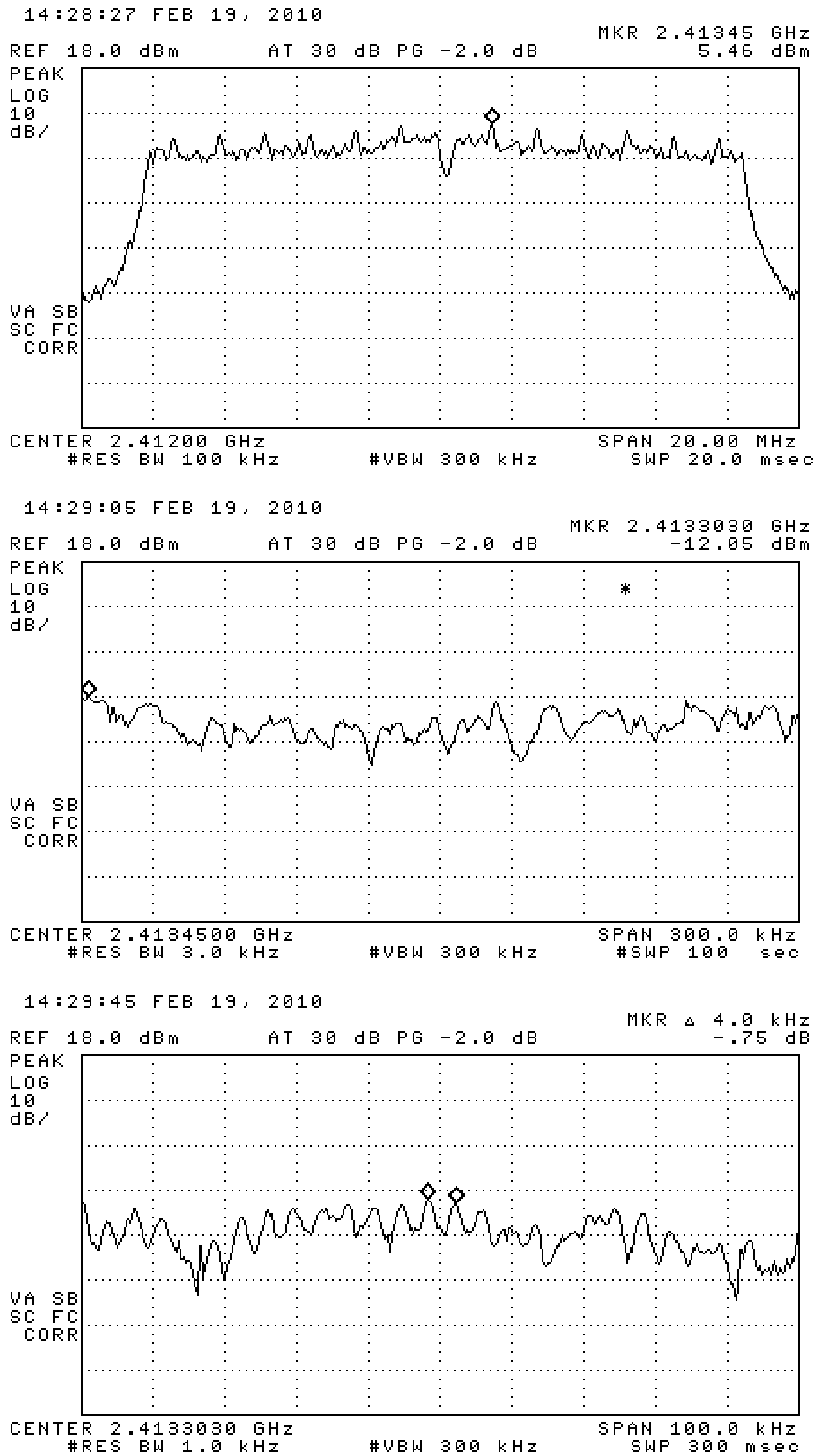


Figure 6.5(b) Power Spectral Density (802.11 g mode).
(only low channel plots shown)

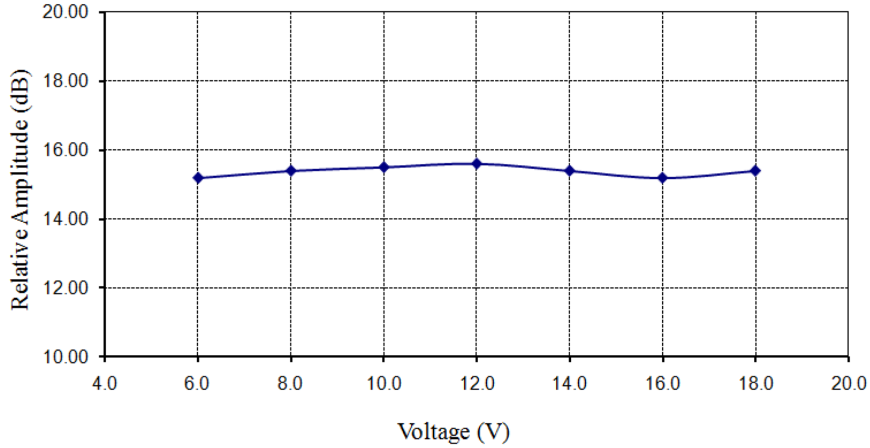
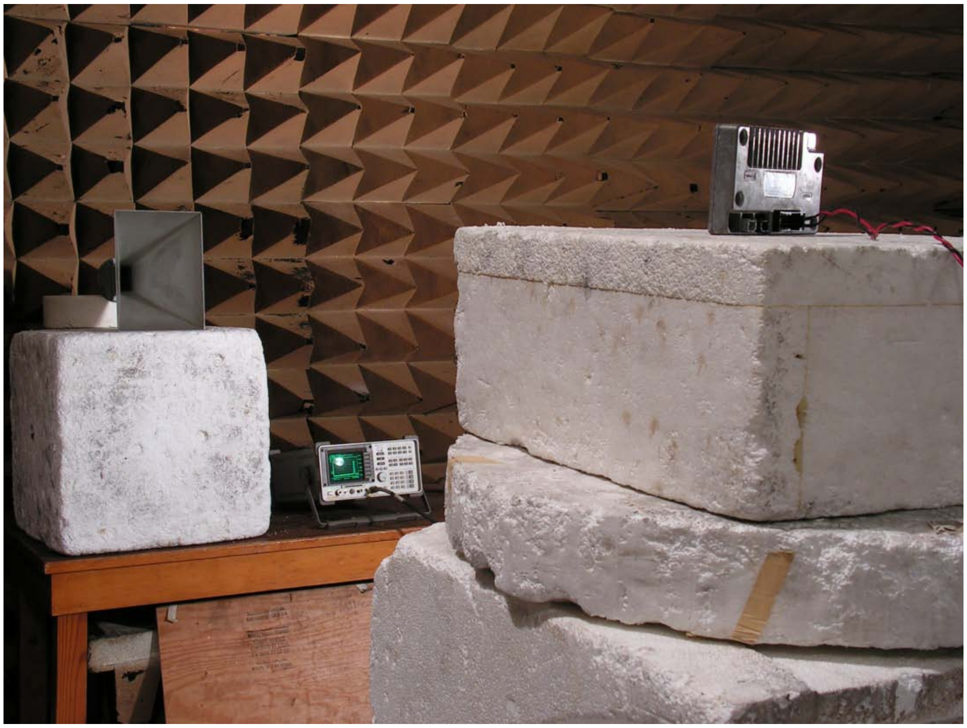
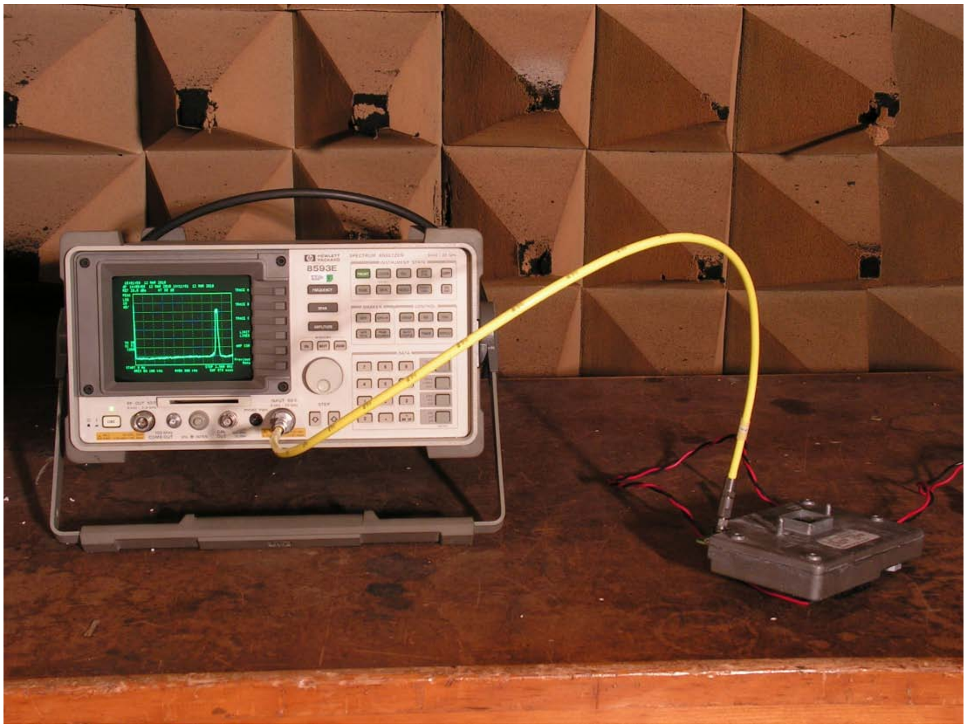


Figure 6.6 Relative output power vs supply voltage (802.11b mode).



Photograph 6.1: Test Setup



Photograph 6.2: Test Setup