EMI/EMC per 47CFR Part 15
Test Report

For

Fiberstars Inc.

On

Wireless Pool Controllers

Models

WPC-1, WPC-2, WPC-3, WPC-04R

Test data in this report include:

Emissions Test Methods per

47CFR15 Subpart B, Unintentional Radiators

47CFR15 Subpart C, Intentional Radiators

Report No.

20070604-01FCC

Judgement

Complies as Tested

Test Unit Provided for Evaluation by

Fiberstars, Inc.
32000 Aurora Road
Solon, Ohio 44139

Tests and Report by

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NVLAP®
Lab Code 200172-0

ISO 17025 Accredited Compliance Laboratory

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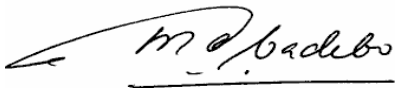
1 DOCUMENTATION

1.1 General Information

Product Type **Models**	Wireless Pool Controller WPC-1, WPC-2, WPC-3, WPC-04	
Manufacturer's Name	Fiberstars, Inc.	
Manufacturer's Address	32000 Aurora Road Solon, Ohio 44139	
Phone and Fax **Contact and Email**	440-715-1253 Sam Ciccone	Fax 440-715-1313 sciccone@fiberstars.com
Test Laboratory	ITC Engineering Services, Inc. 9959 Calaveras Road, PO Box 543 Sunol, CA 94586-0543 Email: itcemc@itcemc.com Web Site: http://www.itcemc.com	 Tel: +1(925) 862-2944 Fax: +1(925) 862-9013
Job Log and Report Numbers	20070604-01	20070604-01FCC
Test Date(s) & Issue Date	June 13-15,18/2007	
Test Engineer	John Caizzi	
Documentation	John Caizzi	
Test Results	☒ Complies as Tested	☐ Does not Comply
Total Number of Pages	39	

PREPARED BY:	REVIEWED BY:
	
John Caizzi	Michael Gbadebo, PE
Project Engineer	(California License # 11303) Chief Engineer

1.2 Summary of Test

ITC Engineering Services, Inc. as an independent testing laboratory, declares that the equipment specified above was tested to the requirements of:

1.2.1 Emissions Test Methods:

47CFR15, Subpart B: Unintentional radiators
47CFR15, Subpart C: Intentional radiators

1.3 Declaration/Disclaimer

It is the manufacturer's responsibility to assure that additional production units of these models are manufactured with identical electrical and mechanical characteristics. This report is the confidential property of the client. As a mutual protection to our clients, the public, and ourselves, extracts from the test report shall not be reproduced except in full without ITC Engineering Service's written approval. The applicant/manufacturer shall not use this report to claim product endorsement by NIST, NVLAP or any US or International Government agency.

1.4 EUT Ports and Connectors

The EUTs have none. The main boxes have knockouts for conduit, through which wiring from the house breaker panel and to the pool pump motors and lights are run. The cable connecting repeater to main box also runs through a knockout into which a strain relief has been inserted.

1.5 EUT Description

The WPC wireless pool controllers are devices used to control swimming pool peripherals; e.g., pumps, cleaners and lights. Control is effected by switching on and off relays connected to these peripherals. The relays are housed in water-tight boxes which are wired to the main breaker panel through conduit. There are two types of control, timer and wireless. The timers are in the box with the relays; they are manually set and switch the pump relays. Wireless control is used mainly for pool lighting, sometimes for smaller, secondary pumps. The models differ in their functionality.

WPC-1 One timer-controlled & two wireless-controlled relays.
WPC-2 One timer-controlled & two wireless-controlled relays, with provisions for internal circuit breakers and GFCI.
WPC-3 Two timer-controlled & three wireless-controlled relays, with provisions for internal circuit breakers.
WPC-04R One timer-controlled & one wireless-controlled relay.

Regardless of functionality, all models work in the same way. A 315 MHz carrier is gated on/off (ASK modulated) with a control code stored in the embedded processor, and transmitted to a receiver housed in a small plastic dome and connected by a 10 ft. wire to the main box containing the relays. Fiberstars calls the receiver a "repeater". The transmitter is powered by a 9V battery and the repeater gets DC power from the main box. The repeater demodulates the carrier & sends the recovered code by wire to what Fiberstars calls the "receiver" in the main box. The receiver is a microprocessor with associated circuitry which decodes this signal into the voltages which switch on & off the relays.

There is only one repeater, used in all models. Likewise, there is only one transmitter circuit; the transmitter models differ only in the number of control codes each can send. The receivers differ in the number of relays each has. Therefore, only one transmitter, and one repeater-receiver combination was tested.

1.6 List of Peripherals Used During Test

Description	Manufacturer	Model Name	Serial Number
100W incandescent light fixture	NA	NA	NA

1.7 General Test Remarks

The EUT and peripheral equipment were operated under the following conditions during testing:

WPC-3 transmitter. The device is designed for intermittent transmission, but will transmit continuously if the button is kept pressed. During testing a tie wrap and plastic washer was used to wedge the button down.

WPC-1. The device was wired to the 120 Vac mains and one of the wireless-controlled relays was wired to a light bulb load. During test, this gave a visual indication that the system was working while not contributing to RF emissions.

☐	Standby	☐	Test Program (H - Pattern)
☐	Test Program (Color Bar)	☐	Test Program (Customer Specific)*
☐	TV/VCR Signal Input	☐	Signal Generator Input
☐	Continuous Audio Tone (1kHz)	☐	Cycled Audio Tone (1kHz)
☐	Printer/Parallel Function	☐	Modem/Serial Function
☐	Serpentine Program with I/O	☐	Serpentine Program without I/O
☐	Practice Operation	☒	Normal Operating Mode
☐	Essential Operation (Functional Safety)	☐	Continuous Unmonitored Operation
☒	Continuous Monitored Operation	☐	Non-Continuous Operation

The requirements according to the technical regulations are:

☒	**Met**	☐	**Not Met**

The Equipment under Test does:

☒ Fulfill the general approval requirements
☐ Not fulfill the general approval requirements

2 Emissions Tests:

2.1 Unintentional Radiated Emissions per 47CFR15.109a

2.1.1 Test Description

The EUT was placed on a wooden turntable 80cm above the ground reference plane. The EUT was powered on and placed in an operational mode. Radiated emissions were monitored from 30 MHz to 2 GHz using antennas placed 3 meters from the EUT. The antennas were placed in both horizonal and vertical polarities and the EUT was rotated and the antennas were elevated from one to four meters while being monitored.

2.1.2 Administrative and Environmental Details

Site Used:	10 meter semi-anechoic chamber
Test Date:	June 18/2007
Test Engineer:	John Caizzi
Temperature	79 °F
Humidity:	40%
Test Voltage	120V/60 Hz

2.1.3 Test Equipment

Equipment Description	Manufacturer	Model Name	Serial Number	Calibration Due or Verification Date
EMC Analyzer	Hewlett-Packard	E7402A	US40240204	3/22/2008
Biconical Antenna (30-200 MHz)	EMCO	3104	9111-4463	1/25/2008
Log Periodic Antenna (200-1000 MHz)	EMCO	3146	9510-1001	1/25/2008
Horn Antenna (1-3 GHz)	A.H. Systems	SAS-571	887	12/12/07

2.1.4 Test Results

The EUT meets the requirements of the test for unintentional radiated emissions per 47CFR15.109a.

2.1.5 Test Data

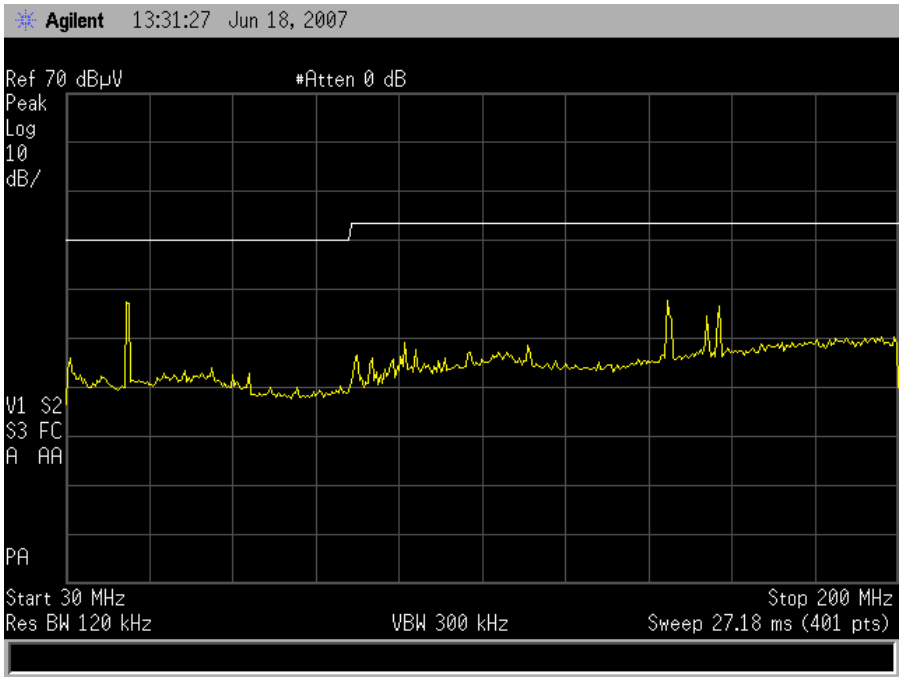


Figure 1. Ambient emissions, 30-200 MHz, horizontal polarization.

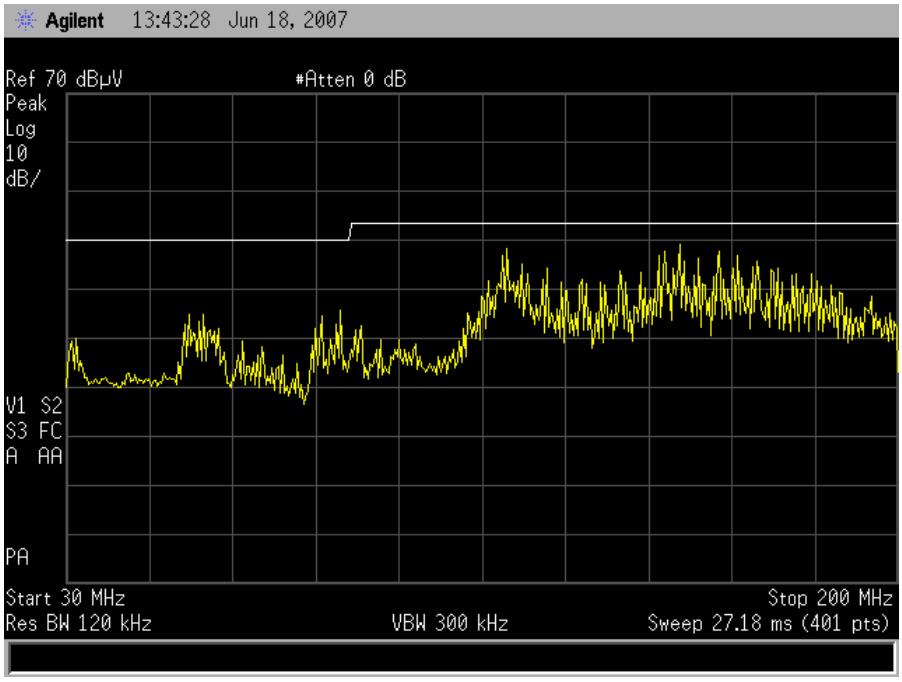


Figure 2. WPC emissions, 30-200 MHz, horizontal polarization.

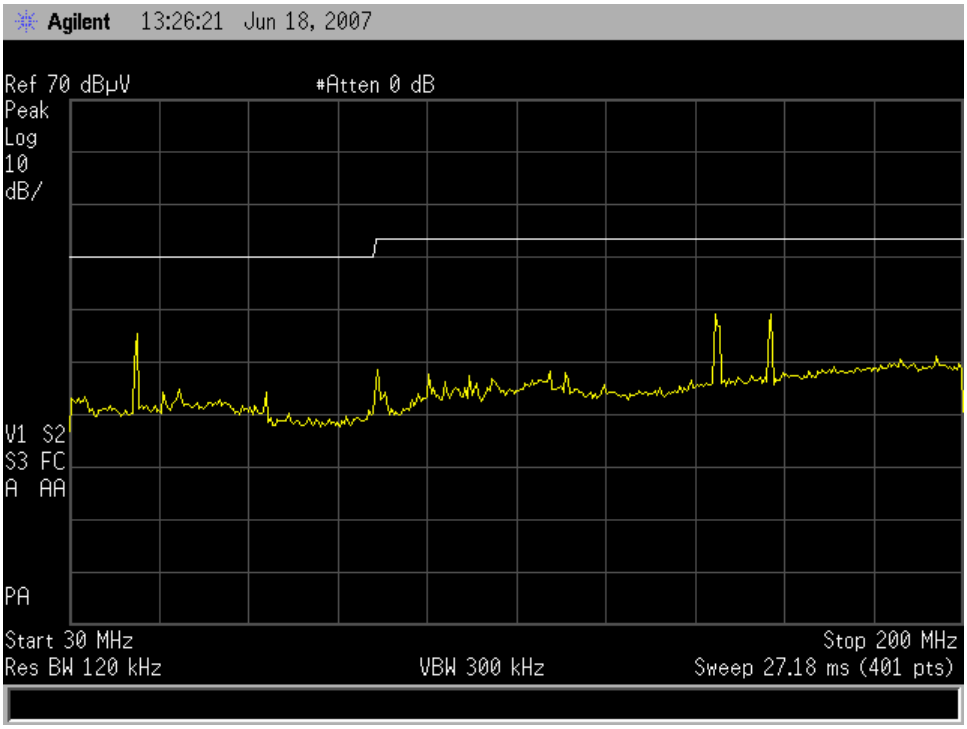


Figure 3. Ambient emissions, vertical polarization.

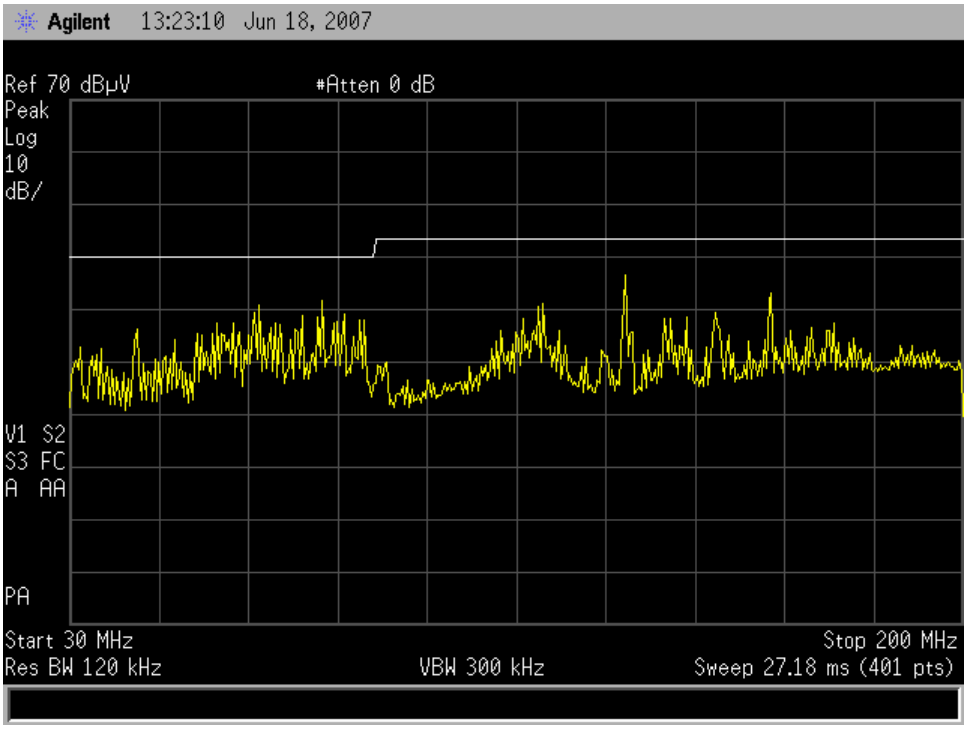


Figure 4. WPC emissions, 30-200 MHz, vertical polarization.

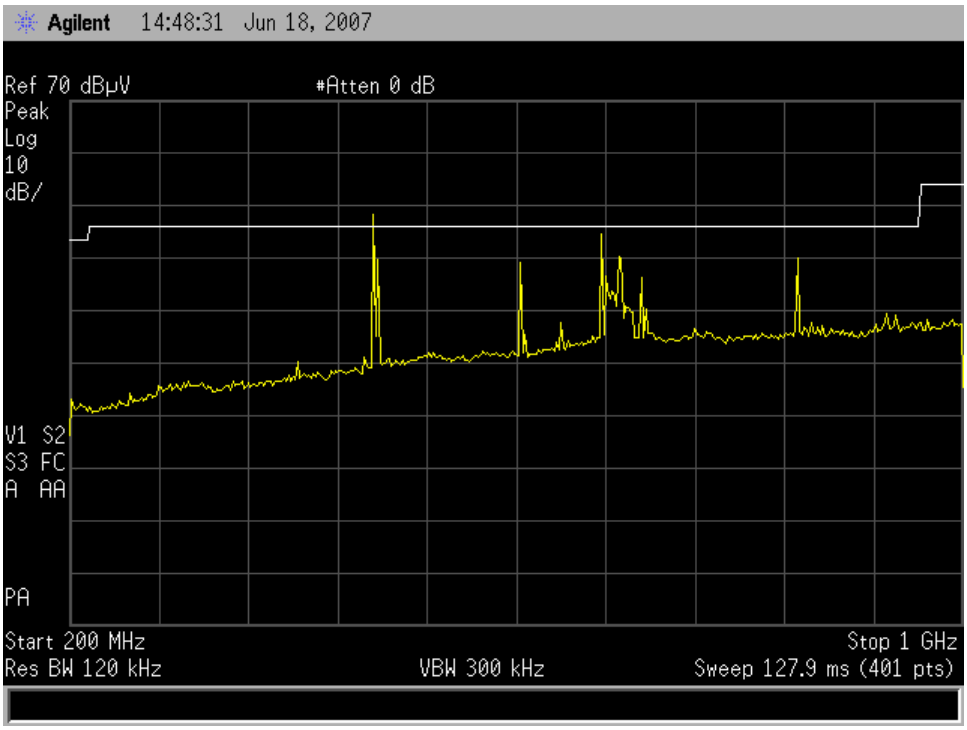


Figure 5. Ambient emissions, 200-1000 MHz, horizontal polarization.

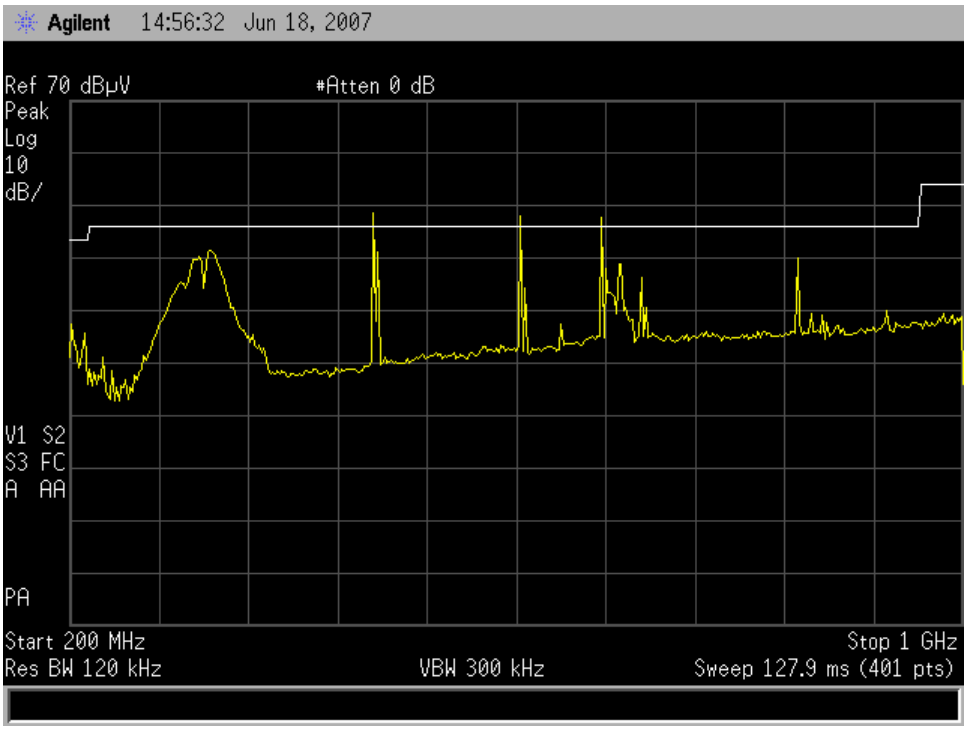


Figure 6. WPC emissions, 200-1000 MHz, horizontal polarization.

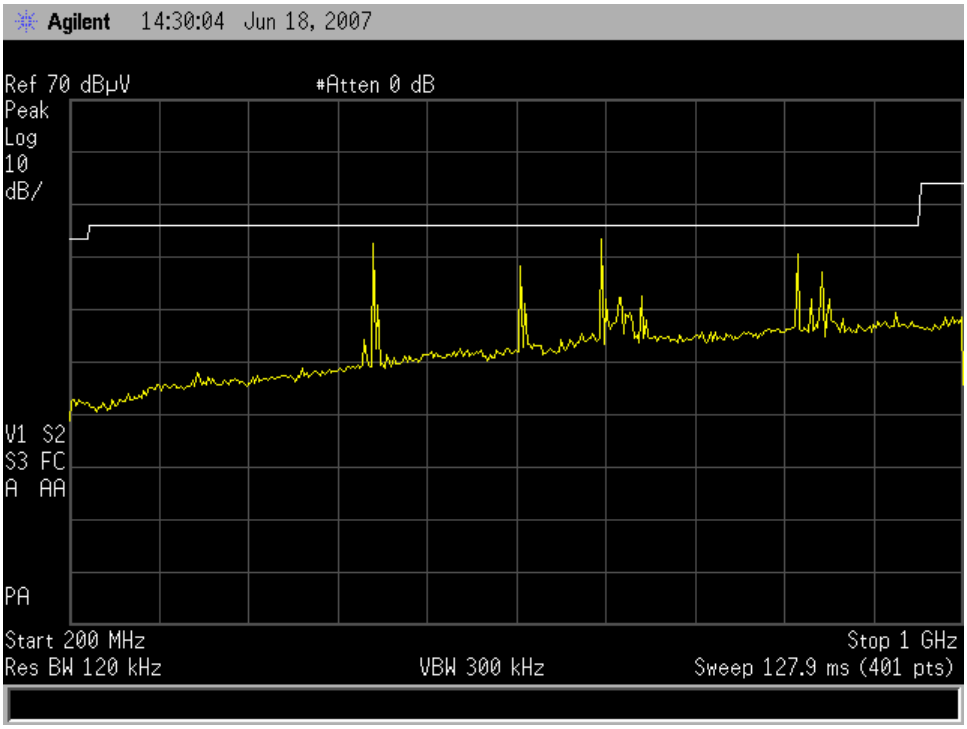


Figure 7. Ambient emissions, 200-1000 MHz, vertical polarization.

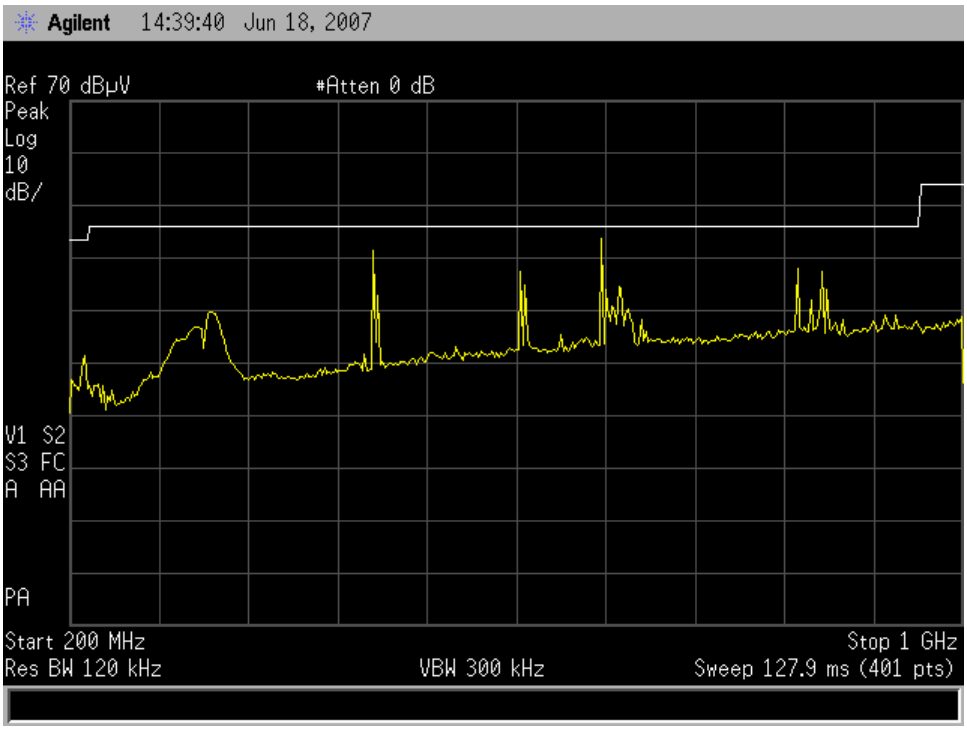


Figure 8. WPC emissions, 200-1000 MHz, vertical polarization.

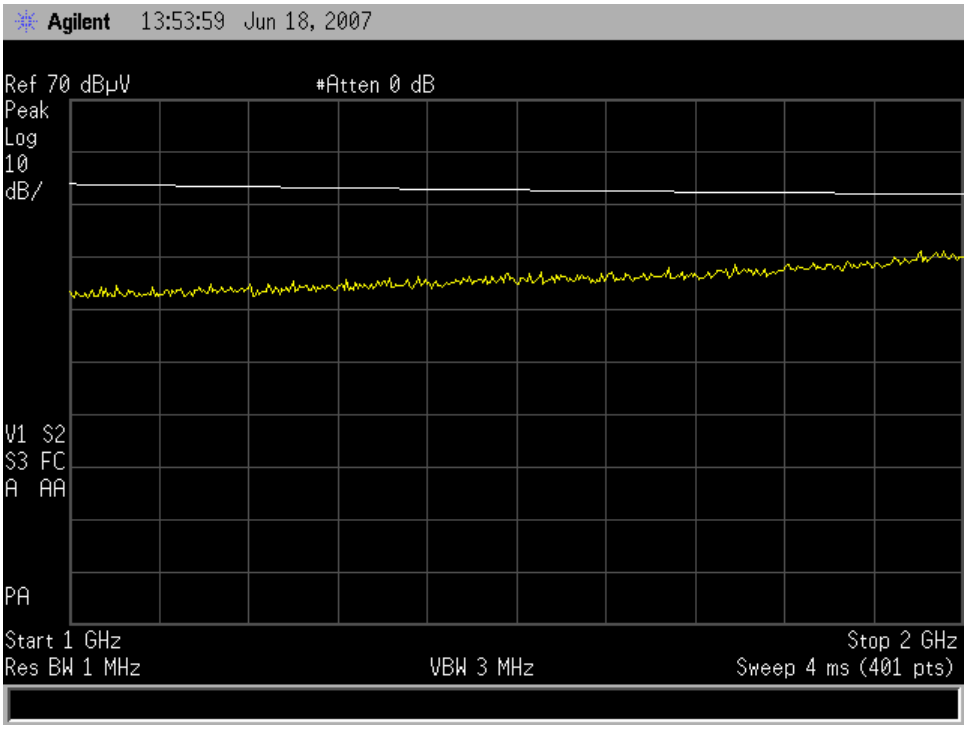


Figure 9. Ambient emissions, 1-2 GHz, horizontal polarization.

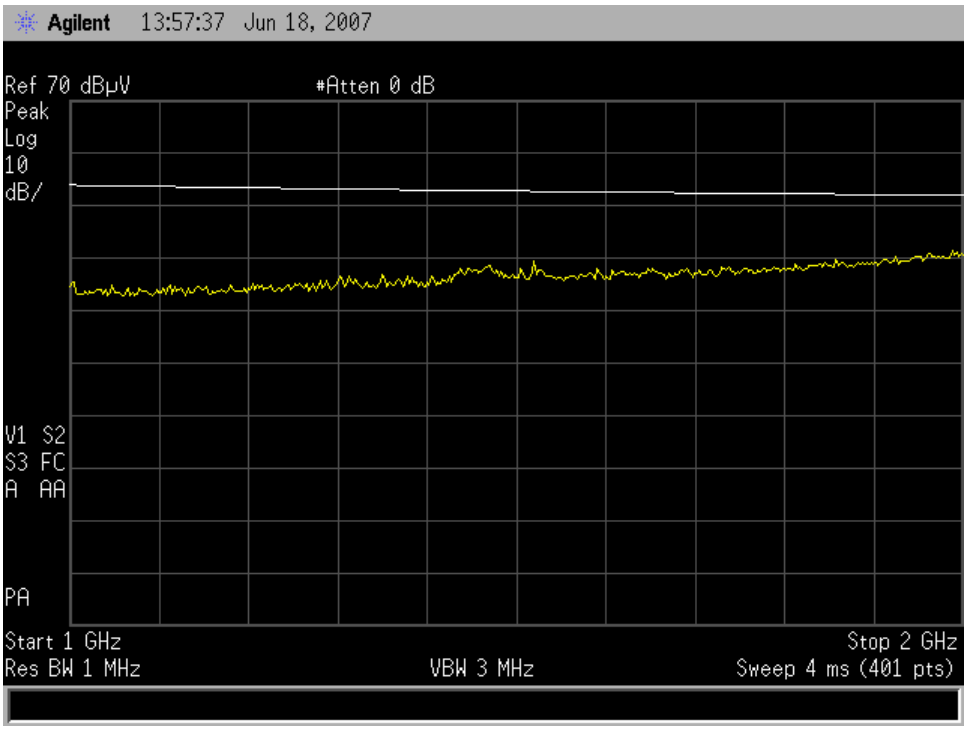


Figure 10. WPC emissions, 1-2 GHz, horizontal polarization.

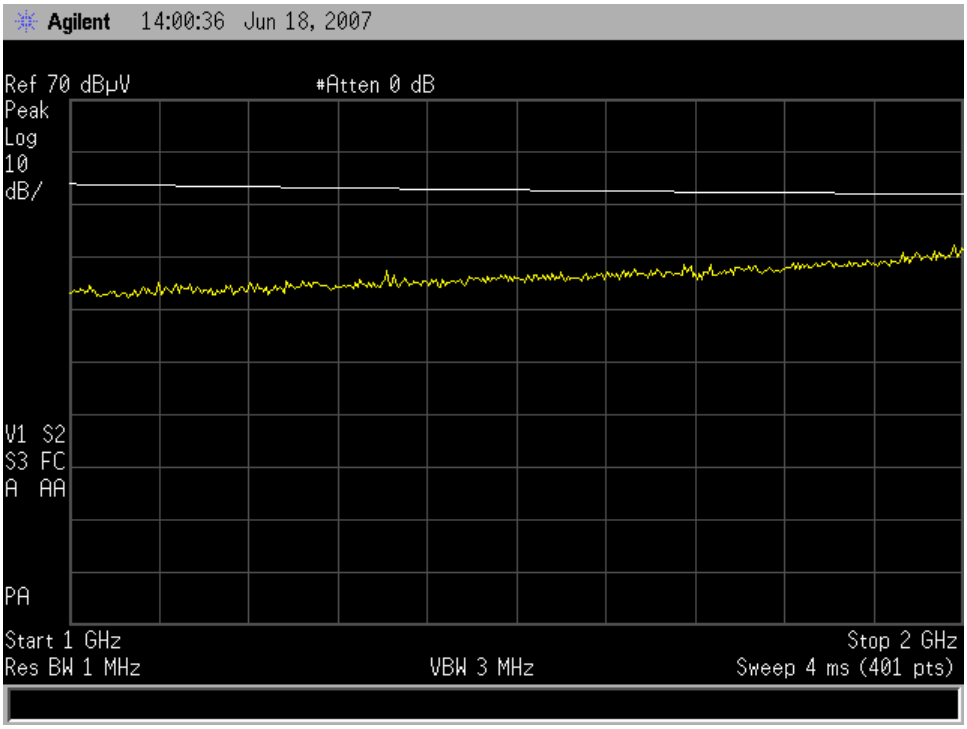


Figure 11. Ambient emissions, 1-2 GHz, vertical polarization.

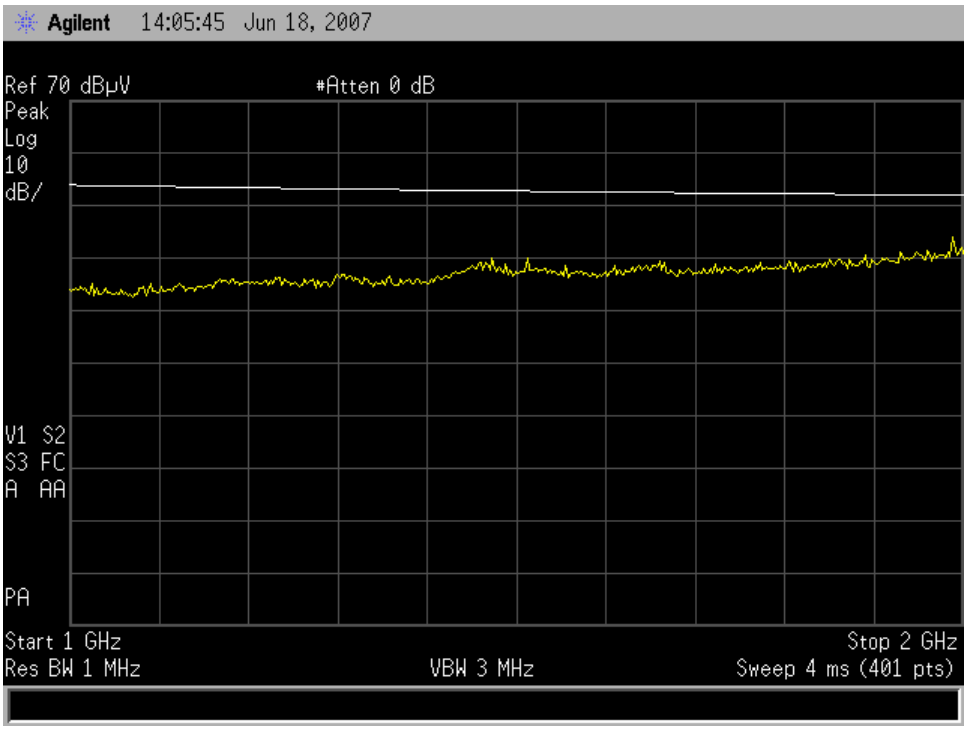


Figure 12. WPC emissions, 1-2 GHz, vertical polarization.

2.1.6 Test Setup Photos

Figure 13. EUT setup: repeater at left, relay box at right, lightbulb load.

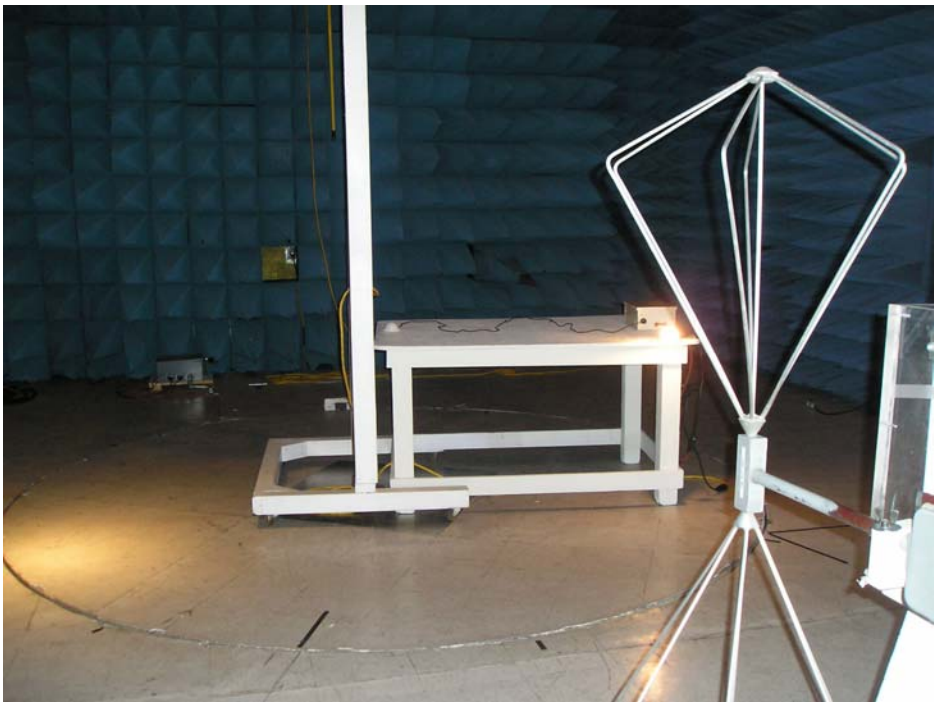


Figure 14. Radiated emissions setup, 30-200 MHz.

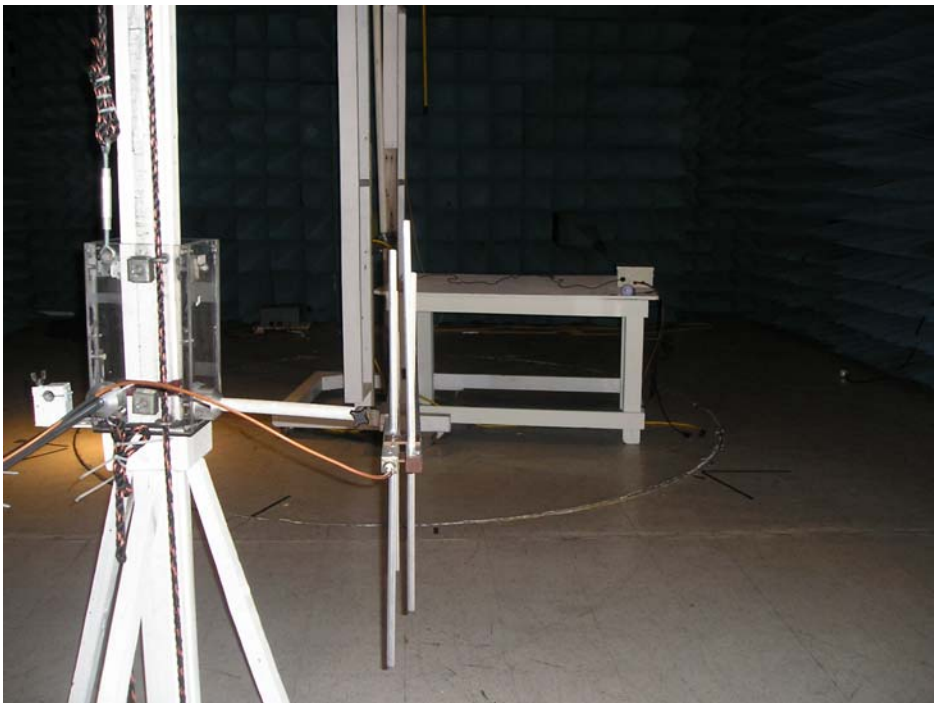


Figure 15. Radiated emissions setup, 200-1000 MHz.

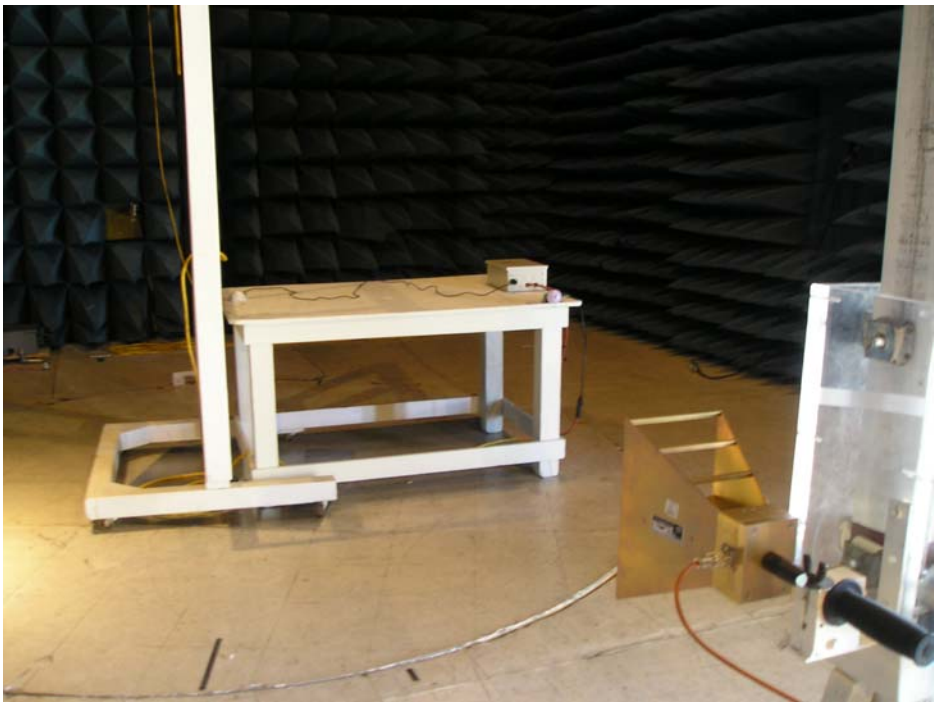


Figure 16. Radiated emissions setup, 1-2 GHz.

2.2 Intentional and Spurious Radiated Emissions per 47CFR15.231b

2.2.1 Test Description

The EUT was placed on a wooden turntable 80 cm above the ground reference plane. The EUT was powered on with a new battery and placed in an operational mode. Radiated emissions were monitored from 30 MHz to 3 GHz using antennas spaced 3 meters from the EUT. The antennas were placed in both horizonal and vertical polarities and the EUT was rotated and the antennas were elevated from one to four meters while being monitored.

Maximum field strength for the 315 MHz fundamental frequency of the WPC transmitter is 75.6 dBµV/m at 3 m, measured with an average detector. Maximum field strength for all other radiated frequencies is 55.6 dBµV/m, average detector.

2.2.2 Administrative and Environmental Details

Site Used:	10 meter semi-anechoic chamber
Test Date:	June 14, 15, 18/2007
Test Engineer:	John Caizzi
Temperature	80 °F
Humidity:	36%
Test Voltage	9 VDC

2.2.3 Test Equipment

Equipment Description	Manufacturer	Model Name	Serial Number	Calibration Due or Verification Date
EMC Analyzer	Hewlett-Packard	E7402A	US40240204	3/22/2008
Biconical Antenna (30-200 MHz)	EMCO	3104	9111-4463	1/25/2008
Log Periodic Antenna (200-1000 MHz)	EMCO	3146	9510-1001	1/25/2008
Horn Antenna (1-3 GHz)	A.H. Systems	SAS-571	887	12/12/2007

2.2.4 Test Results

The EUT meets the requirements of the test for intentional and spurious radiated emissions per 47CFR15.231b.

2.2.5 Test Data

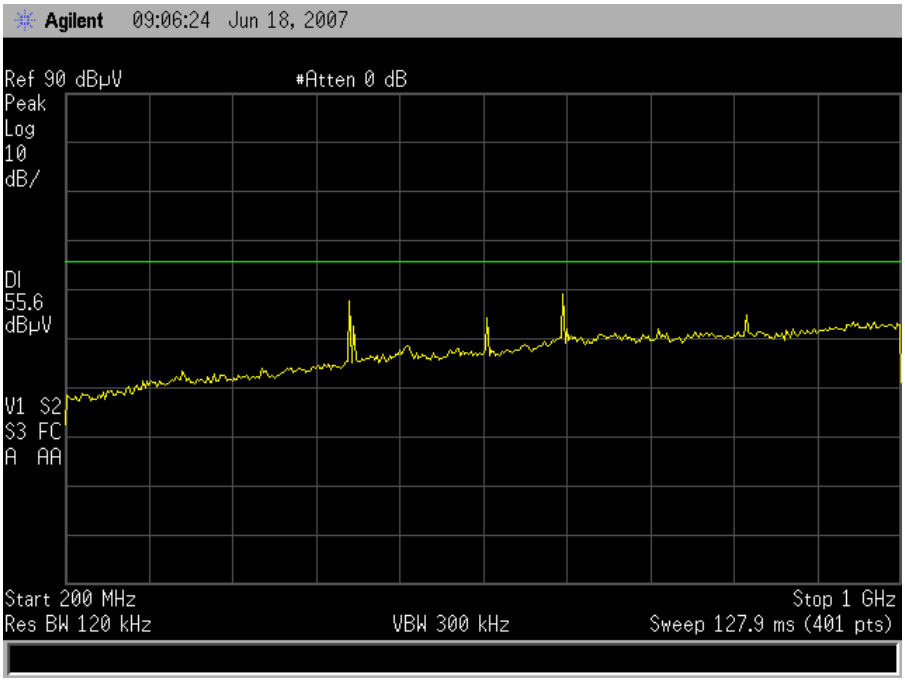


Figure 17. Ambient radiated emissions, 200-1000 MHz, peak detector, horizontal.

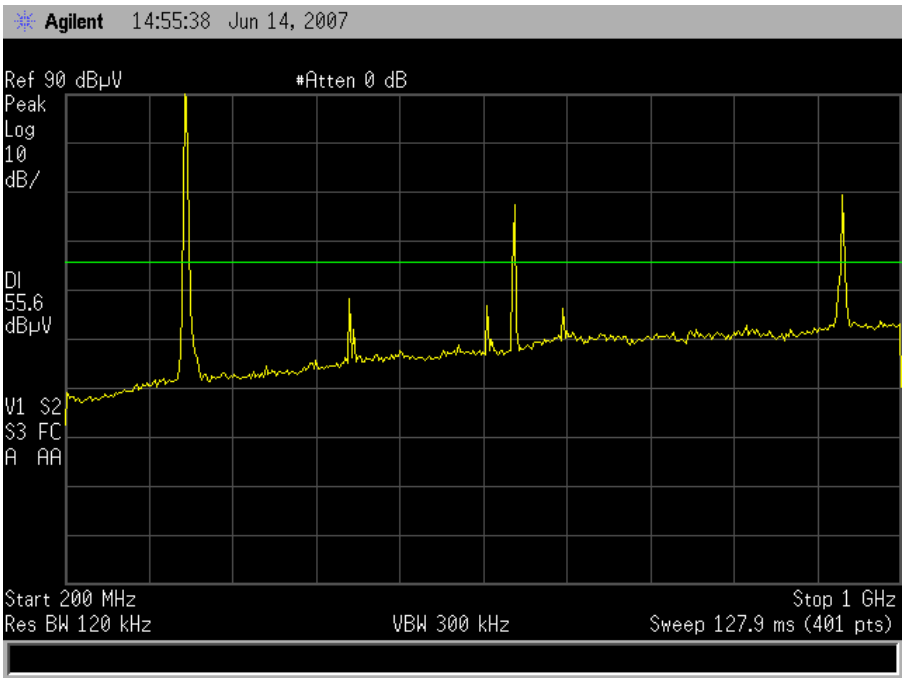


Figure 18. WPC transmitter radiated emissions, 200-1000 MHz, pk detector, horizontal

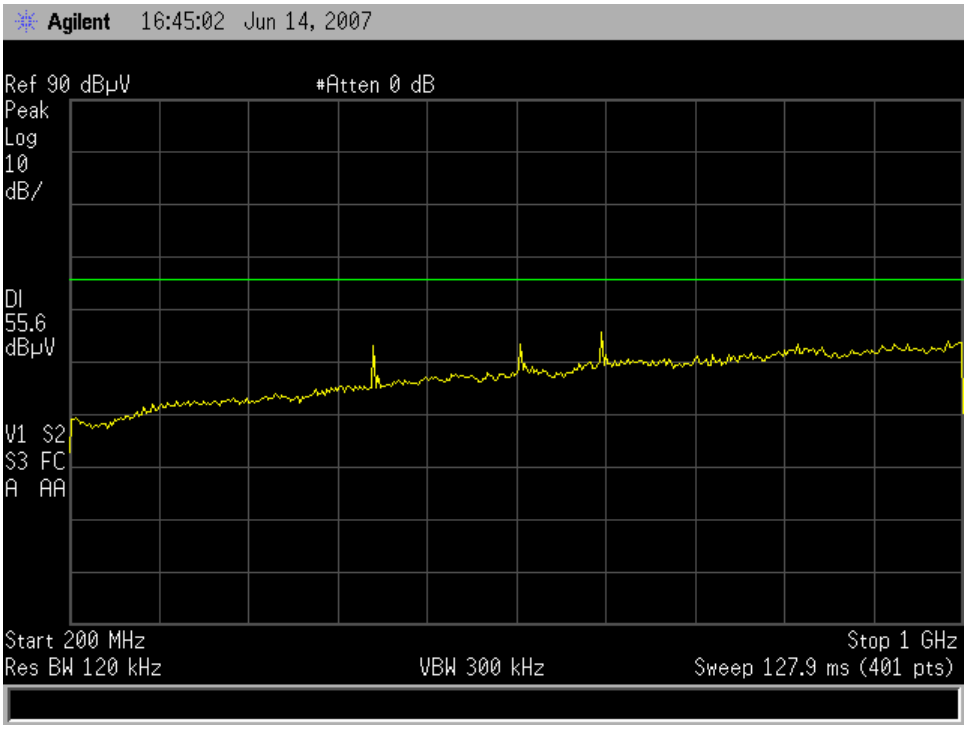


Figure 19. Ambient radiated emissions, 200-1000 MHz, peak detector, vertical.

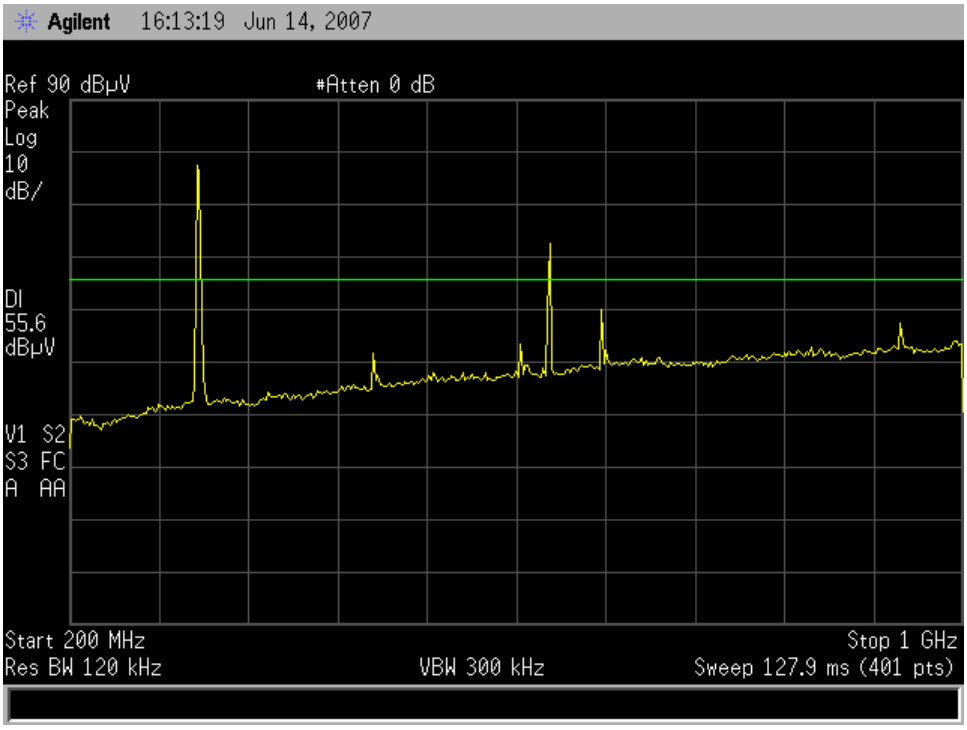


Figure 20. WPC transmitter radiated emissions, 200-1000 MHz, peak detector, vertical.

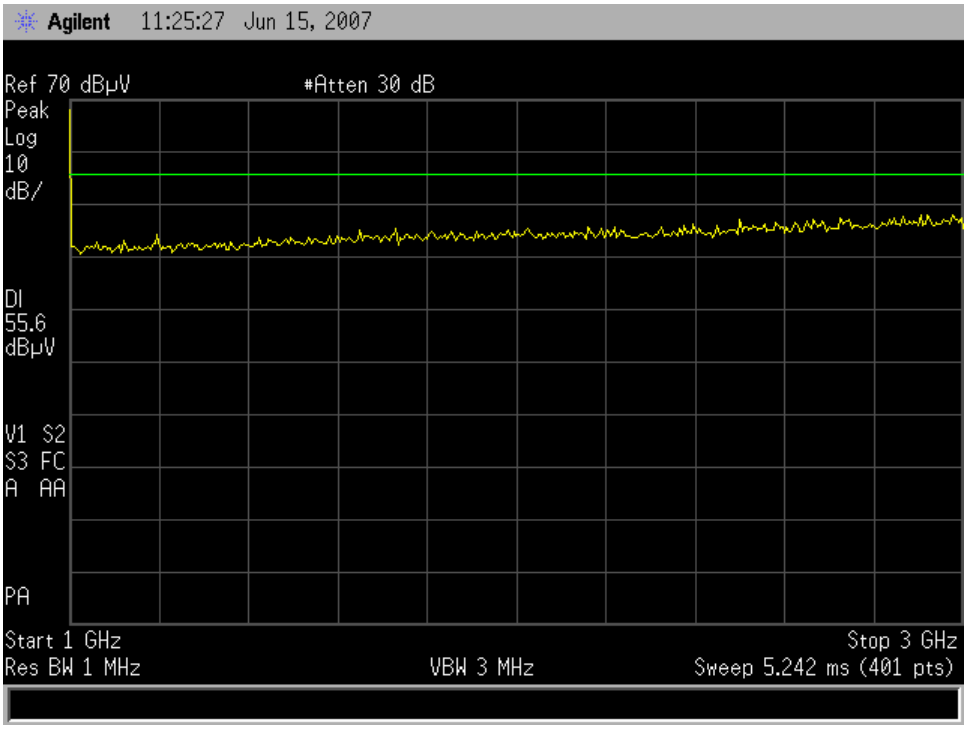


Figure 21. Ambient ratiated emissions, 1-3 GHz, peak detector, horizontal.

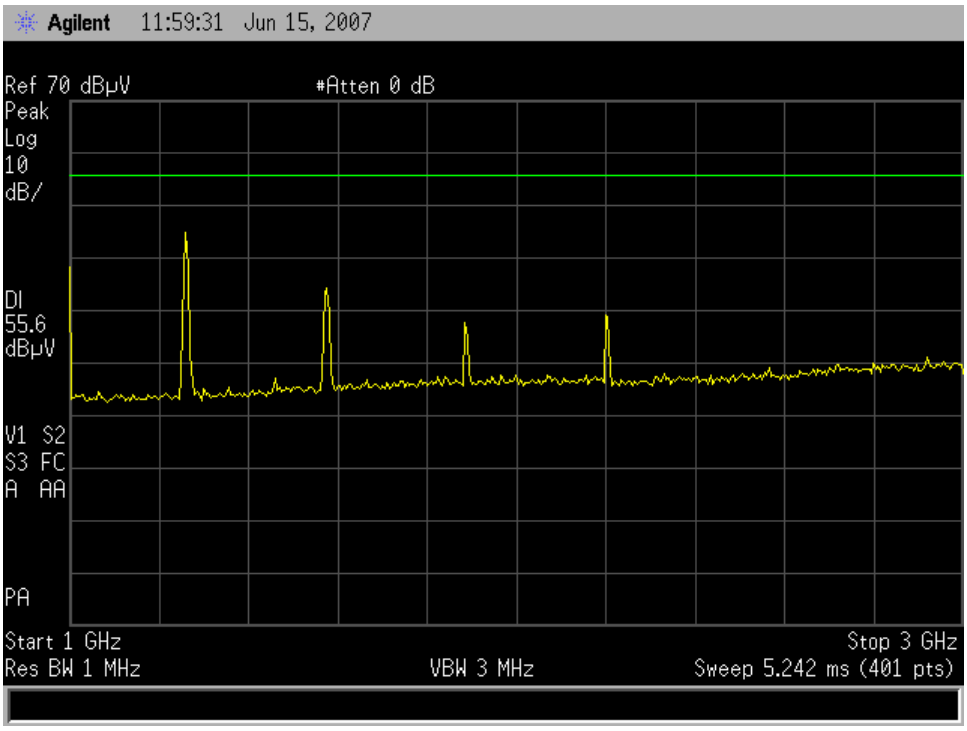


Figure 22. WPC transmitter radiated emissions, 1-3 GHz, peak detector, horizontal.

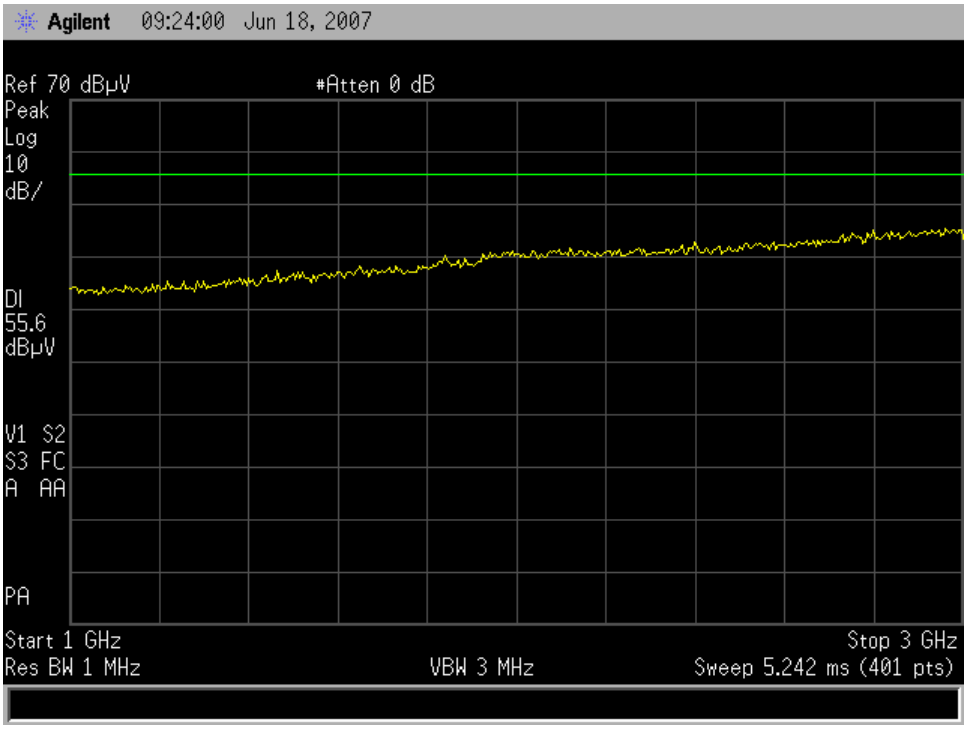


Figure 23. Ambient radiated emissions, 1-3 GHz, peak detector, vertical.

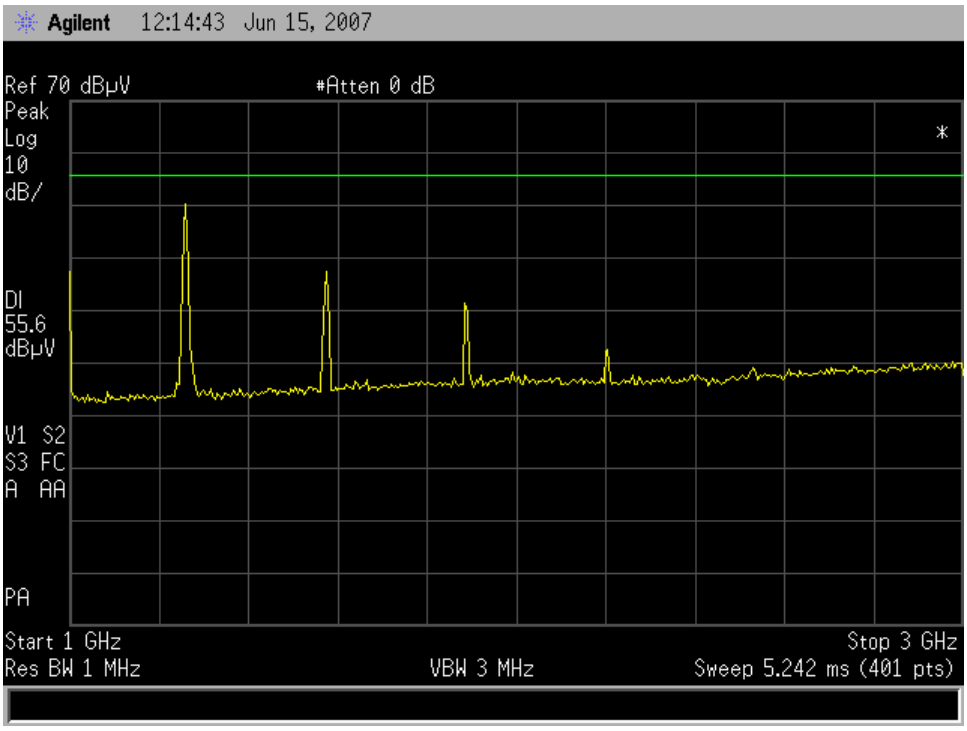


Figure 24. WPC transmitter radiated emissions, 1-3 GHz, peak detector, vertical.

Frequency (MHz)	Peak E Field (dBuV/m)	Avg E Field (dBuV/m)	Ant Polarization (H/V)	Avg Margin (dB)
314.3	90.5	74.1	H	-1.5
314.3	76.7	61.2	V	-14.4
628.6	69.6	51.9	H	-3.7
628.6	62.0	46.8	V	-8.8
942.9	69.1	52.1	H	-3.5
942.8	46.7		V	-8.9
1260	50.3		V	-5.3
1260	44.2		H	-11.4
1575	37.5		V	-18.1
1575	34.1		H	-21.5
1885	31.5		V	-24.1
1885	26.5		H	-29.1
2200	28.4		H	-27.2
2205	22.6		V	-33.0
2520	< 20.0		H & V	< -35.6
2835	< 20.0		H & V	< -35.6
3150	< 20.0		H & V	< -35.6

Table 1. WPC transmitter radiated emissions.

2.2.6 Test Setup Photos

Figure 25. WPC transmitter, configured for continuous transmission.

Figure 26. WPC transmitter test setup.

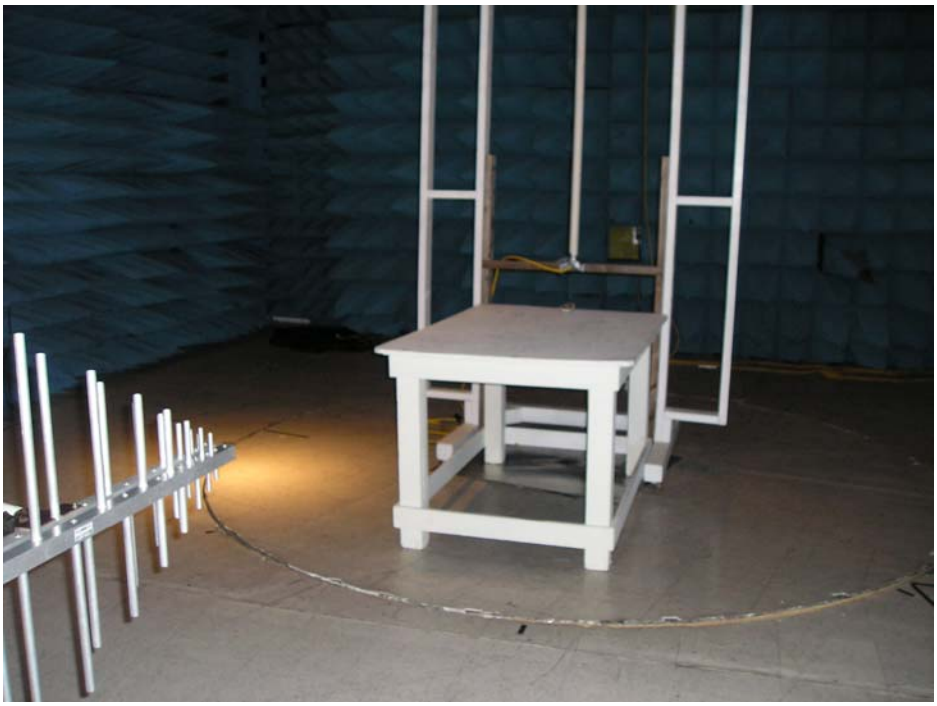


Figure 27. Radiated emissions setup, 200-1000 MHz.

Figure 28. Radiated emissions setup, 1-3 GHz.

2.3 Occupied Bandwidth per 47CFR15.231c

2.3.1 Test Description

The EUT was placed on a wooden turntable 80 cm above the ground reference plane. The EUT was powered on with a new battery and placed in continuous operational mode. Using a log periodic antenna in both horizontal and vertical polarizations at 3m from the EUT, the E field of the 315 MHz fundamental was maximized by rotating the EUT 360° and varying antenna height between 1 and 4 meters. Occupied bandwidth was then measured.

At 315 MHz, maximum bandwidth was 787.5 kHz.

2.3.2 Administrative and Environmental Details

Site Used:	10 meter semi-anechoic chamber
Test Date:	June 14/2007
Test Engineer:	John Caizzi
Temperature	80 °F
Humidity:	36%
Test Voltage	9 VDC

2.3.3 Test Equipment

Equipment Description	Manufacturer	Model Name	Serial Number	Calibration Due or Verification Date
EMC Analyzer	Hewlett-Packard	E7402A	US40240204	3/22/2008
Log Periodic Antenna (200-1000 MHz)	EMCO	3146	9510-1001	1/25/2008

2.3.4 Test Results

The EUT meets the requirements of the test for occupied bandwidth per 47CFR15.231c.

2.3.5 Test Data

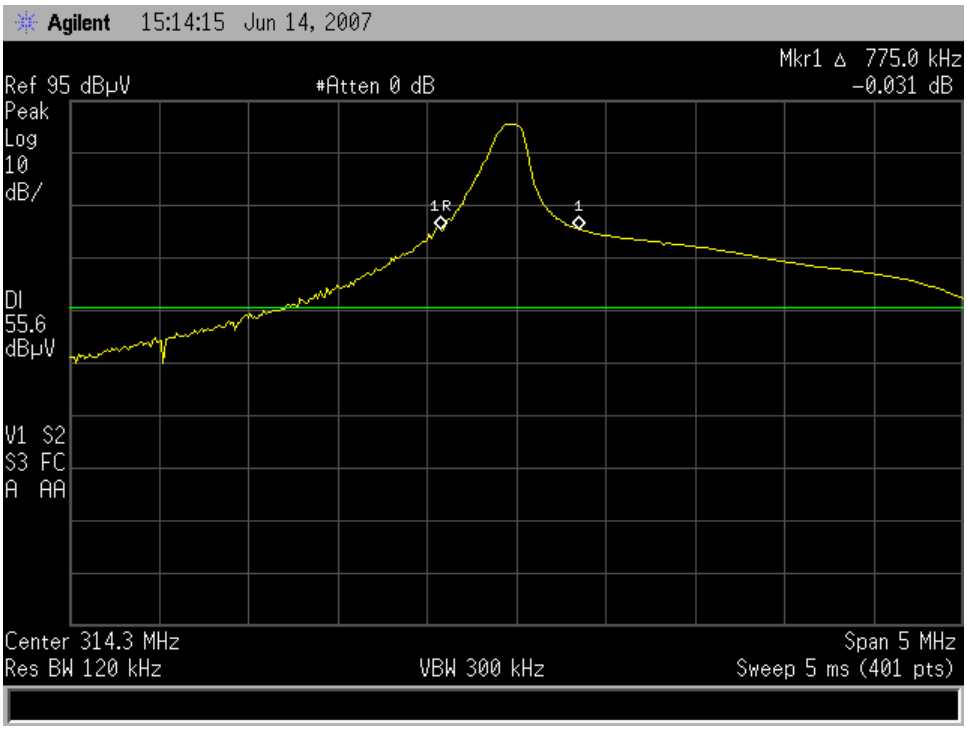


Figure 29. WPC transmitter occupied bandwidth, horizontal polarization.

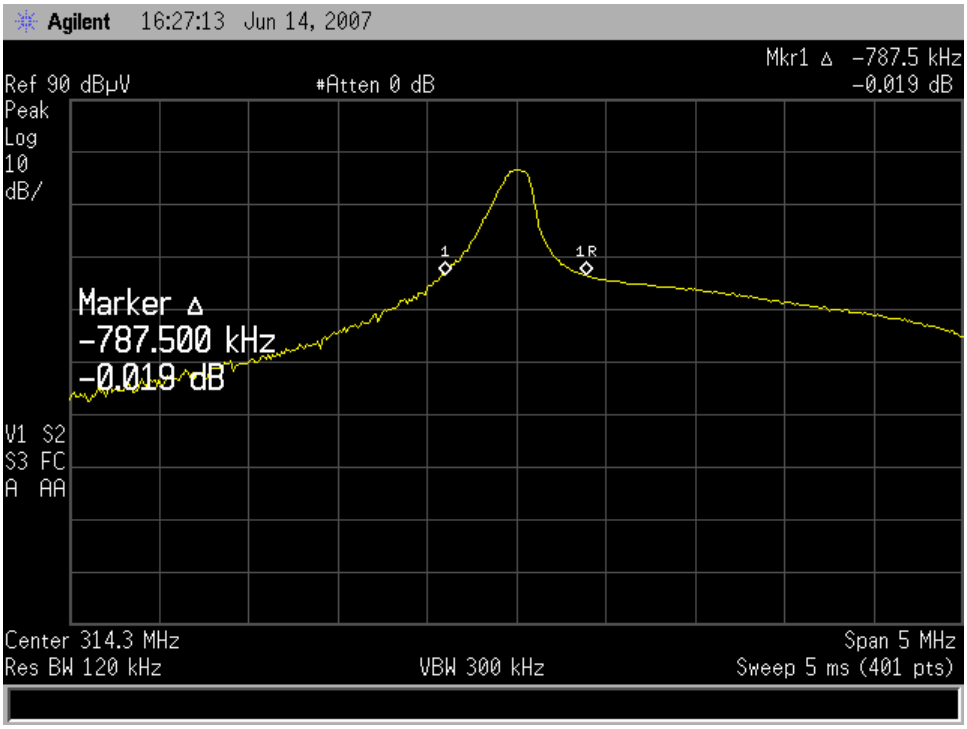


Figure 30. WPC transmitter occupied bandwidth, vertical polarization.

2.4 Power Line Conducted Emissions per 47CFR15.207a

The EUT was placed on a wooden table 80cm above the horizontal reference plane. The EUT was was plugged into a Line Impedance Stabilization Network (LISN) which was plugged into the 120V/60 Hz ac mains. The EUT was powered on and placed into a functional mode. Emissions on the mains, from 450 kHz to 30 MHz, were measured on an EMC analyzer connected to the LISN.

Maximum level of any emission in this frequency range is 48 dBµV.

2.4.1 Administrative and Environmental Details

Site Used:	EMC Lab 1
Test Date:	June 13/2007
Test Engineer:	John Caizzi
Temperature	81 °F
Humidity:	35%
Test Voltage	120 Vac/60 Hz

2.4.2 Test Equipment

Equipment Description	Manufacturer	Model Name	Serial Number	Calibration Due or Verification Date
EMC Analyzer	Hewlett-Packard	E7402A	US40240204	3/22/2008
LISN (25 Amp)	EMCO	3825/2	8901-1447	1/11/2008

2.4.3 Test Results

The EUT meets the requirements for 47CFR15.207a.

2.4.4 Test Data

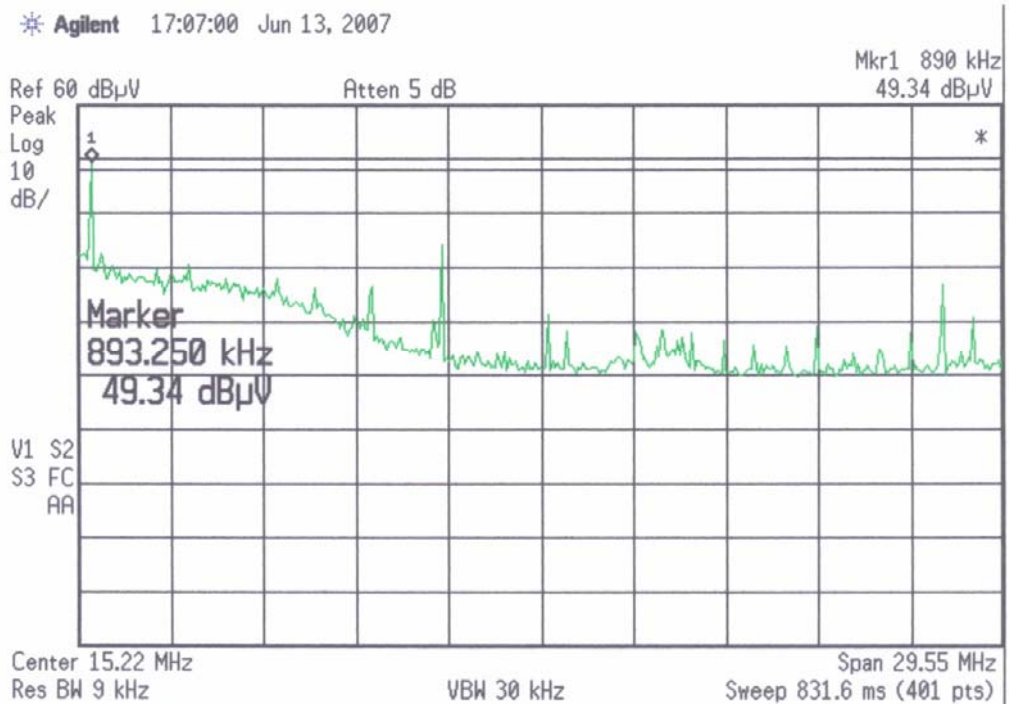


Figure 31. WPC conducted emissions, peak detector, hot line.

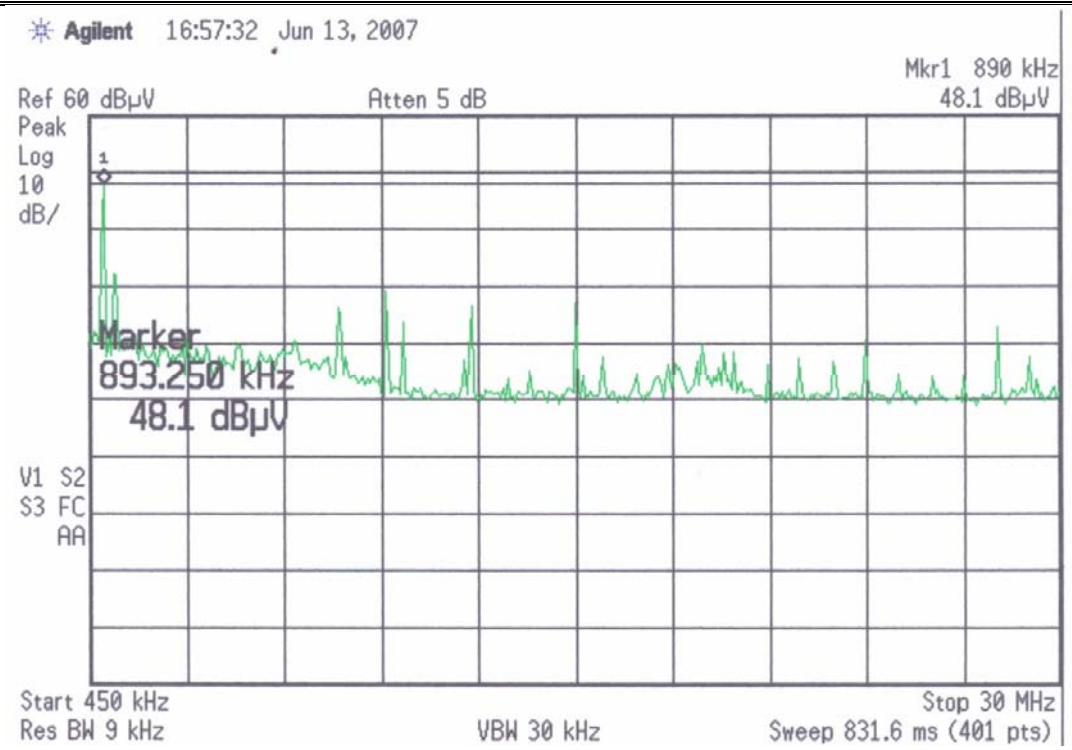


Figure 32. WPC conducted emissions, peak detector, neutral line.

Signal (2)	Freq	Peak Ampl dBµV	Qp Ampl dBµV	Avg Ampl dBµV	Avg Δ LL1 dB	Avg Δ LL2 dB
1	858.8 kHz	48.92	47.07	42.93	-5.07	
2	859.8 kHz	49.00	46.63	43.79	-4.21	

Table 2. WPC conducted emissions, hot and neutral lines, average detector.

2.4.5 Test Setup Photos

Figure 33. WPC conducted emissions setup.

3 APPENDICES

3.1 EUT Technical Specifications

Manufacturer	Fiberstars Inc.			
General Description	Wireless Pool Controllers			
	EUT Name:		**Models:** WPC-1 WPC transmitter WPC-2 WPC transmitter WPC-3 WPC3 transmitter WPC-04R Transmitter	**Serial Number:** 8306 0608 3580 0610 2583 0644 2851 0651
	Dimensions (HxWxD) in.	11.5 x 8.9 x 4.5 16.6 x 14.4 x 4.8 16.6 x 14.4 x 4.8 9.7 x 6.4 x 4 6.4 x 2.4 x 1.1	WPC-1 WPC-2 WPC-3 WPC-04R All transmitters	

	Weight (lb.)	8 16 18 2	WPC-1 WPC-2 WPC-3 WPC-04R All transmitters	
	Rated Voltage	120V/60 Hz & 240V/60 Hz 9 VDC	WPC-1, WPC-2, WPC-3, WPC-04R All transmitters	
	Output Voltage	120V/60 Hz & 240V/60 Hz	WPC-1, WPC-2, WPC-3, WPC-04R	
Cable Name	Power Cable	Length depends on installation.		Shielded ☒ Unshielded ☐
	Signal Cable	Length 10 ft.		Shielded ☐ Unshielded ☒

3.1.1 EUT Photos

Figure 34. WPC transmitter, front.

Figure 35. WPC transmitter, back.

Figure 36. WPC3 transmitter, front.

Figure 37. WPC3 transmitter, back.

Figure 38. WPC-04 transmitter, front.

Figure 39. WPC-04 transmitter, back.

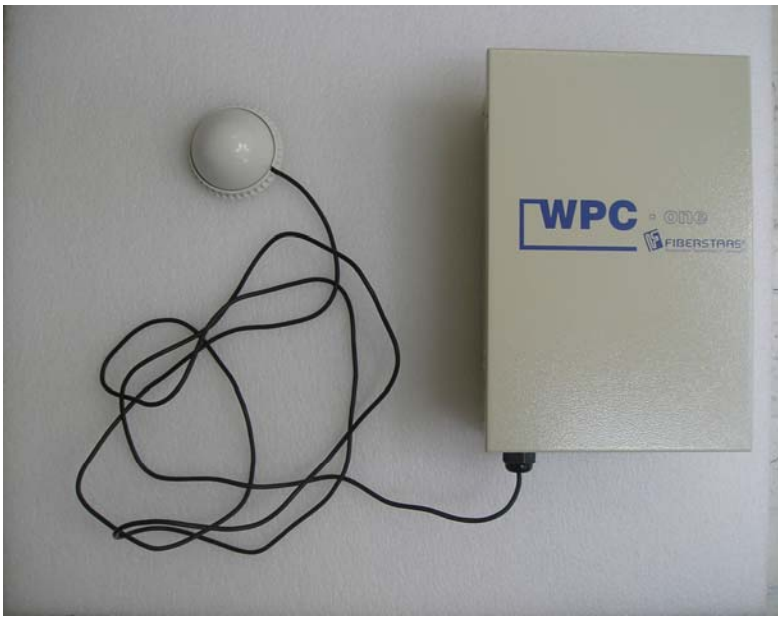


Figure 40. WPC-one relay controller and repeater.

Figure 41. WPC-one timer and remote control switches.

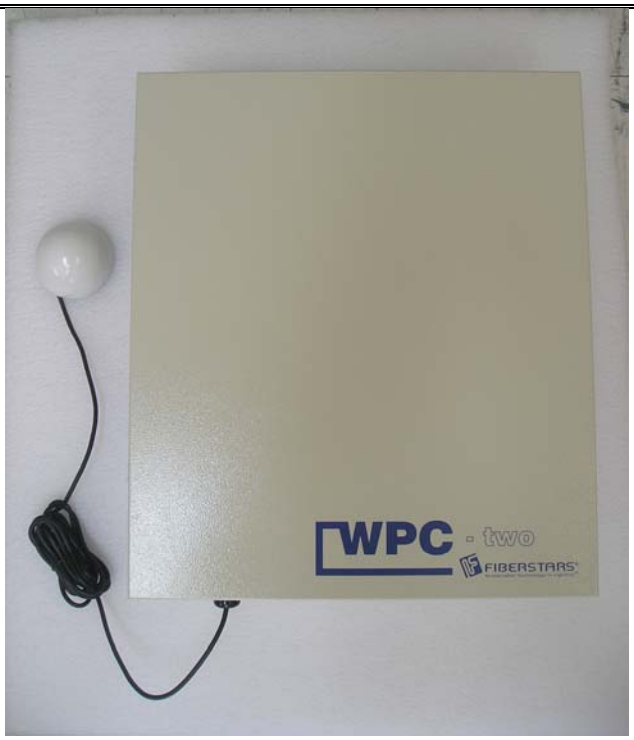


Figure 42. WPC-two repeater and relay controller.

Figure 43. WPC-two timer and remote control switches.

Figure 44. WPC-three repeater and relay controller.

Figure 45. WPC-three timers and remote control switches.

Figure 46. WPC-04 relay controller and repeater.

Figure 47. WPC-04 timer and remote control switch.

3.2 Modification Letter

To Whom It May Concern:

The EUTs described in this report, wireless pool controllers:
WPC-1 with included transmitter WPC
WPC-2 with included transmitter WPC
WPC-3 with included transmitter WPC3
WPC-04 with included transmitter
were tested to the requirements of the standards below.

Emissions Test Methods:

47CFR15 Subpart B, Unintentional Radiators
47CFR15 Subpart C, Intentional Radiators

For further information, please contact the manufacturer at:
Fiberstars Inc.
32000 Aurora Road
Solon, Ohio 44139

3.3 Revision History

Revision Date	Revision No.	Report No	Revision