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FCC CFR 47, Part 27 Type Acceptance Application

for

Metricom, Inc. WCS Wired Access Point

Prepared by:
Metricom, Inc.
980 University Ave
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408-399-8200
Tested: December 1999

1.0 Verification of Compliance

Description:	Metricom WCS Wired Access Point (WAP)
Serial Number(s):	Pre-production "beta" Models, SN #0001
Applicant:	Metricom Inc.
Type of Test:	FCC Part 27
Date(s) of test:	December 1999
Tested By	David Waitt, Metricom, Los Gatos Juan Martinez, Compliance Certification Services

The above equipment was tested by Metricom Inc. and Compliance Certification Services and found to be in compliance with the requirements set forth in Part 27 of the FCC rules and regulations governing WCS communications equipment.

2.0 General Information

Applicant: Metricom, Inc.
980 University Ave.
Los Gatos, CA. 95030

Contact Person: David Waitt
david@metricom.com
(Tel) 408-399-8126
(Fax) 408-354-1024

Equipment Under Test: Metricom WCS Wired Access Point (WAP)
Serial Number(s): 0001
Type of Test: FCC Part 27

Reason for testing: Type Acceptance of new equipment

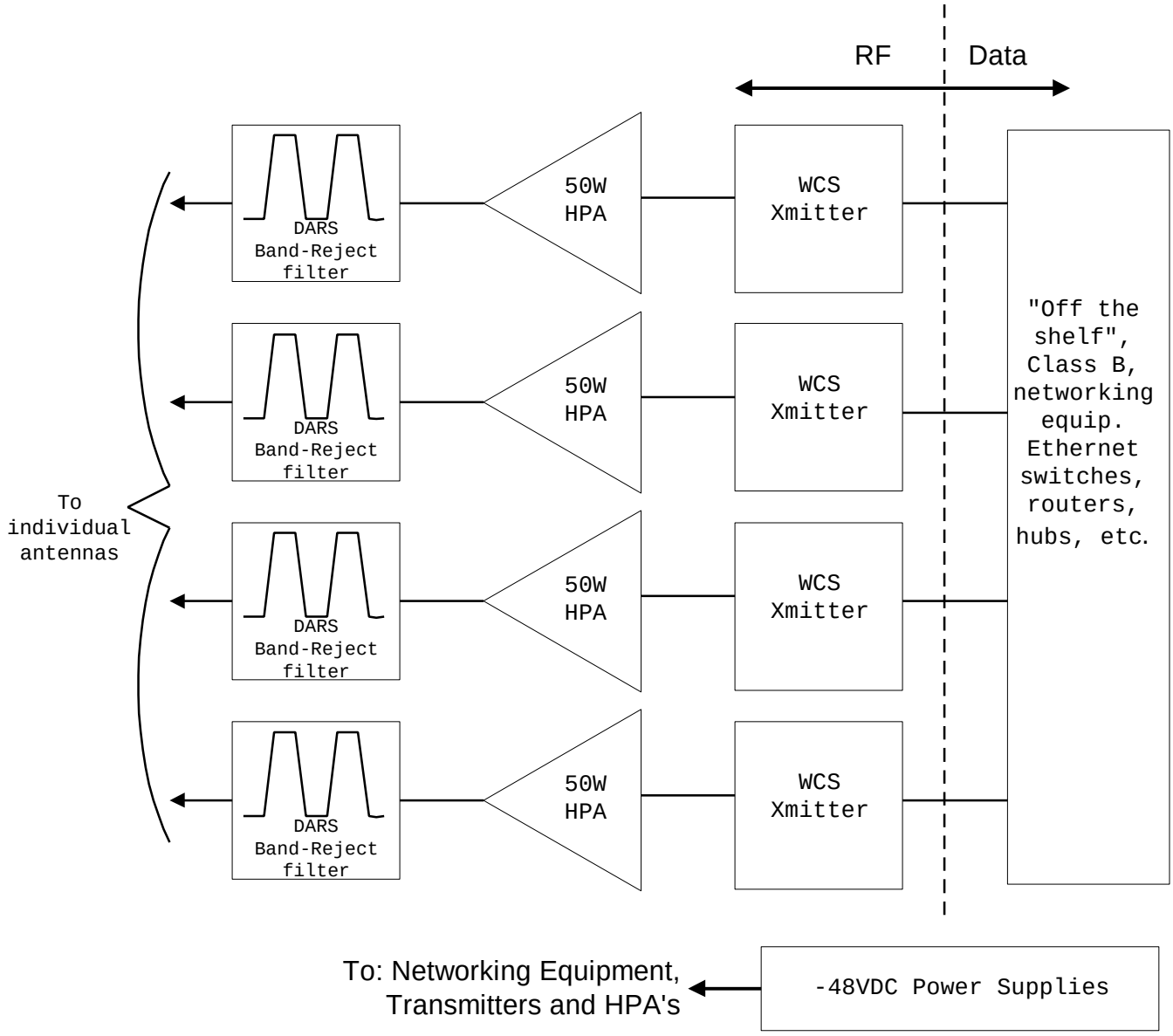
Metricom has developed the second generation of its Microcellular Data Network (MCDN). This network is made up primarily of Microcells and Wired Access Points (WAPs).

Brief description of Metricom's Microcellular Data Network (MCDN)
The MCDN Network is a wide-area wireless data network primarily using frequency-hopping spread-spectrum, packet data technology and Metricom's patented mesh architecture. The new network operates within the Part 15 (902-928 MHz and 2.4–2.4835 GHz) and the WCS (2.3 GHz) portions of the spectrum.

Microcells
The largest part of the of the MCDN consists of shoebox-sized radio transceivers, also called *microcells*, which are typically mounted to street lights or utility poles. They are strategically placed every quarter to half mile in a checkerboard pattern over a geographic area. Each microcell employs hundreds of hopping channels in the 900 MHz and 2.4 GHz band. These microcells serve as repeaters between a user with a portable wireless modem and a Wired Access Point. For the UPLINK, the data is relayed from the modem, through a microcell to a ISM WAP. For the DOWNLINK, the microcell receives data from a WCS WAP and then relays it to the user.

Wired Access Points (WAP)
Within a large "cluster" of microcells Metricom installs *Wired Access Points,* or *WAPS,* which convert the between RF packets and the wired IP network backbone. Each WAP and its associated cluster of microcells can support thousands of subscribers. There are two kinds of WAPS, ISM and WCS. The ISM WAPS primarily receive data from the microcells (though they are also capable of transmitting if need be) and the WCS WAPS transmit (only, no receive) data to the microcells.

The WCS WAP consists of 4 transmitter radios, 4 RF Power Amplifiers, 4 DARS band reject filters, some associated Class B, Part 15 networking equipment and a –48 VDC power supply. A basic block diagram is shown on the following page. The WCS WAPs are not frequency hopping like the microcells. Each RF "chain" within the WCS WAP is assigned a specific channel within Metricom's licensed band of operation. And each of the 4 antennas at a WAP installation will be pointing in different directions.



WCS WAP Basic Block Diagram

RF Power Budget:

PA Output:	50 W (16.9 dBW)
DARS Reject Filter passband Loss:	1.5 dB
Typical cable loss to antenna:	2 dB
Antenna Gain:	18 dBi

16.9 dBW – 1.5 dB – 2 dB + 15.85 dBD = 29.25 dBW ERP
= 841.4 Watts ERP

3.0 Results Summary

The following test were performed to demonstrate compliance with FCC Part 27

Part 27

Paragraph	Test	Result
27.53	Out of Band Emissions (Radiated)	.62 dB in Spec
27.53	Out of Band Emissions (Conducted)	5.3 dB in spec
27.54	Frequency Stability	Pass, 2.83kHz over temp

4.0 Test Facilities

The radiated out of band emissions test was performed at:

Compliance Certification Services
1366 Bordeoux Dr.
Sunnyvale, CA 94089
(Morgan Hill OATS, Site 'A')

A description of the sites located at Compliance Certification Services is on file at:

Federal Communications Commission
PO 429
Columbia, MD. 21045

All of the sites at Compliance Certification Services are constructed and calibrated to meet ANSI C63.4-1994 requirements.
The remaining tests described in this report were performed at:

Metricom, Inc.
980 University Ave
Los Gatos, CA. 95030

5.0 Test Equipment & General Test Methods

Equipment:

The following test equipment was used to perform the testing

Desc.	Manufacturer	Model
Horn Antenna	EMCO	3115
Pre Amp(1-26.5GHz)	HP	8449B
Plotter	HP	7470A
20 dB Pad	HP	NA
30 dB Pad (150W)	Narda	
Spectrum Analyzer	HP	8566B
4.0 GHz HPF	Laboratory Grade	NA
Diagnostic Software	Metricom, MFG_CMDS	NA
Spectrum Analyzer	HP	
Power Meter	HP	
Power Sensor	HP	

HP = Hewlett Packard

Method:

Many of the tests were performed at 4 different frequencies within the WCS bands that Metricom will be operating on. There are two of these bands, one on either side of the DARS band. Because of this, many of the WCS WAPs operating characteristics were checked at the low and high end of each of these two bands. The operating bands of the WCS WAP are:

Band #1 2315.0 to 2319.5 MHz
Band #2: 2345.5 to 2350 MHz

Out of band Emissions

FCC Specification **Paragraph 27.53**

(a) The power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (p) within the licensed band(s) of operation, measured in watts, by the following amounts:

(1) For fixed, land, and radiolocation land stations: By a factor not less than 80 + 10 log (p) dB on all frequencies between 2320 and 2345 MHz;

(2) For mobile and radiolocation mobile stations: By a factor not less than 110 + 10 log (p) dB on all frequencies between 2320 and 2345 MHz;

(3) For fixed, land, mobile, radiolocation land and radiolocation mobile stations: By a factor not less than 70 + 10 log (p) dB on all frequencies below 2300 MHz and on all frequencies above 2370 MHz; and not less than 43 + 10 log (p) dB on all frequencies between 2300 and 2320 MHz and on all frequencies between 2345 and 2370 MHz that are outside the licensed bands of operation;

(4) Compliance with these provisions is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or less, but at least one percent of the emission bandwidth of the fundamental emission of the transmitter, provided the measured energy is integrated over a 1 MHz bandwidth;

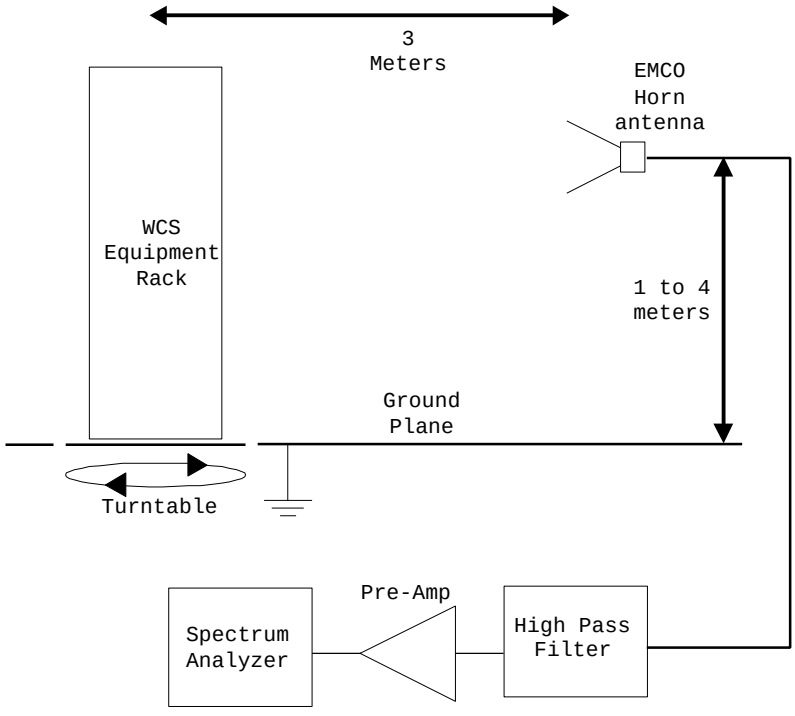
(5) In complying with the requirements in §27.53(a)(1) and §27.53(a)(2), WCS equipment that uses opposite sense circular polarization from that used by Satellite DARS systems in the 2320-2345 MHz band shall be permitted an allowance of 10 dB;

(6) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the edges, both upper and lower, of the licensee's bands of operation as the design permits;

(7) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power;

OVERVIEW

Two tests were performed to demonstrate compliance with the 27.53 specification. The first test was performed as a radiated emissions test at Compliance Certification Services on a three-meter OATS. The second test was a performed as a conducted emissions test at Metricom, Inc



Out of Band Emissions (Radiated) test setup.

Radiated Emissions Test Procedure:

The specification requires that the level of any spurious emissions be attenuated a specified level below the transmitter power (-dBc). Since this is a radiated test, the acceptable emission (in –dBc) levels must be converted into a field strength (dBuV/m) measured at 3 meters. The result of this conversion then becomes the radiated emission spec limit. The calculation for this conversion is below.

Using the relationship between field strength and RF Power into an isotropic antenna:

$$E(V/m) = \sqrt{\frac{30 * P * G}{D}}$$

P = Maximum Transmitter power (Watts)
G = Numeric gain of the antenna (Assume 1 for Isotropic)
D = Distance (Meters)

$$E(V/m) = \sqrt{\frac{30 * 50 * 1}{3}} = 12.91 \text{ V/m}$$

$20 * \log (12.91 * 10^{-6}) = 142.22$ dBuV/m @ 3 meters (Ref level of fundamental)

Emission Specs:
Freq > 2370 MHz 70 + 10*log(P) 70 + 10*Log(50) = 86.989 dBc

Therefore the Limit for the radiated setup is:

142.22 dBuV/m – 86.989dB = **55.23 dBuV/m @ 3 meters**

Resultant radiated field at 3 meters from a –40 dBm (-87 dBc) source feeding an isotropic antenna is 55.23 dBuV/m

The radiated emission test was performed on four frequencies. Two frequencies in each of the "passbands" , one at the high end and one at the lower end. The test frequencies were 2315.5 , 2319.0 , 2346.0 and 2350.0 MHz.

The WCS WAP antenna outputs were terminated with a 50-ohm load. The EUT was placed on the outdoor ground plane. The search antenna was placed 3 meters from the WCS WAP. With the transmitter operating at full power (47 dBm, 50 Watts) into the termination, the turntable was slowly rotated to locate the direction of maximum emission. Once maximum direction was determined the search antenna was raised and lowered in both vertical and horizontal polarization. This procedure was repeated for each of the test frequencies.

Test Results:
The unit passed the radiated emission requirements. The maximum readings obtained are recorded in the attached spreadsheet.

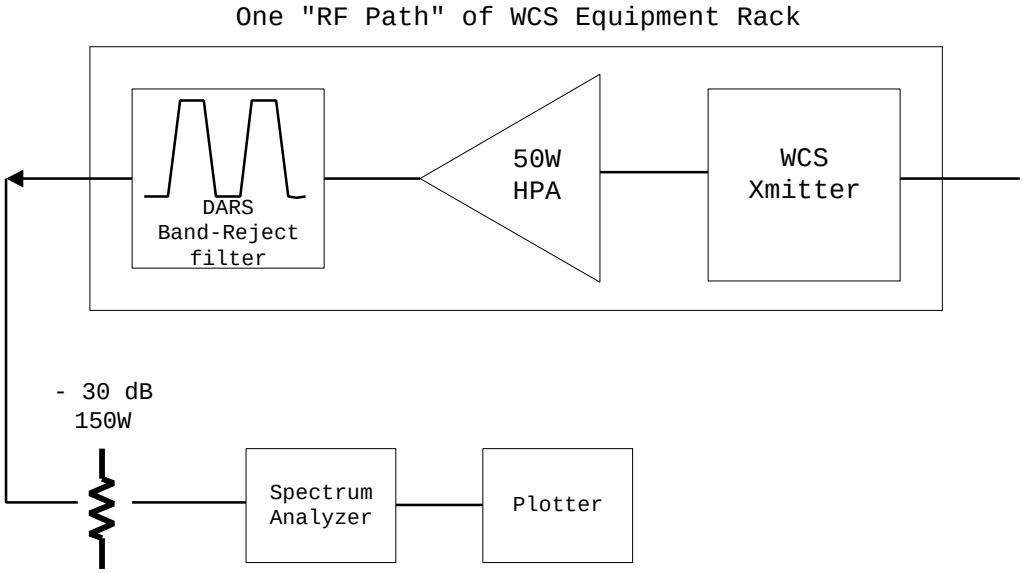
Conducted Emissions Test Procedure

A "typical" RF equipment chain of the WCS WAP was tested for out of band emissions being conducted out of the RF output of the rack. The WCS WAP was set to transmit at full power (47 dBm) and the frequency range of 1 to 24 GHz was examined for EACH test of the four test frequencies. The four fundamental test frequencies were 2315.2 , 2319.2 , 2345.76 and 2349.76 MHz.

Since the permitted emission level varies with respect to frequency, the table below shows the Part 27.53 emission limits in terms of dBm. Since there was a 30 dB pad at the input of the spectrum analyzer, all of the measured emissions must be below the level specified in the right-most column.

From (MHz)	To (MHz)	Spec	Spec (-dBc)	Xmit Pw (dBm)	Spec (dBm)	Spec, Test setup taking 30 dB pad into account (dBm)
DC	2300	70+10Log(P)	87	47	-40	-70
2300	2305	43+10Log(P)	60	47	-13	-43
2320	2345	80+10Log(P)	97	47	-50	-80
2345	2370	43+10Log(P)	60	47	-13	-43
2370	24000	70+10Log(P)	87	47	-40	-70

Out of Band conducted emissions test setup.



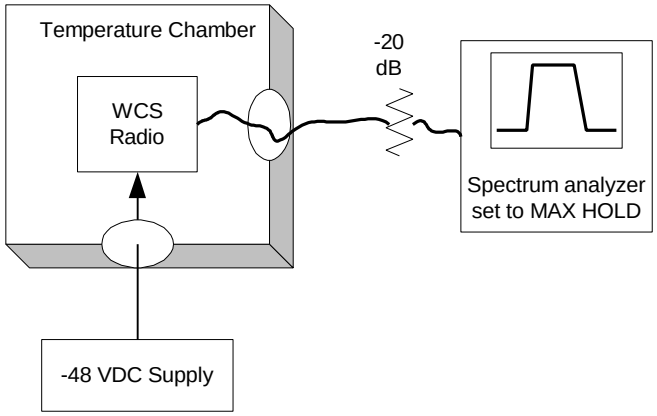
Test Results.
Plots of the test results are shown in the attached files.

Frequency Stability
FCC Specification **Paragraph 27.53**

Test Procedure:

The WCS radios were placed in a temperature chamber and the temperature was varied from the minimum to the maximum temperature, which the WCS WAP will be exposed to. The output of the radios was monitored with a spectrum analyzer set to "MAX HOLD" at the end for the temperature cycle, the amount of frequency drift could be read directly off the spectrum analyzer.

Frequency Stability Test Setup



Test Results:

The temperature of the chamber was varied from 5C to 45C. The worst frequency drift that was observed was 2.83 kHz maximum over the temperature range.

The highest and lowest center frequencies that Metricom will be operating on in either WCS band above or below the DARS band is given below. The channel bandwidth is 320 kHz.

The table below shows that under worst case conditions, (maximum temperature change and assuming that the drift is totally "one-sided" Vs. temperature) that the WCS radios will not drift out of band.

Below DARS

	Center	½ Chan BW	Drift	
MIN:	2315.2MHz	- 160kHz	– 2.83kHz	= 2315.037MHz (Limit: freq > 2315.00MHz)
MAX:	2319.2MHz	+ 160kHz	+ 2.83kHz	= 2319.362MHz (Limit: freq < 2320.00MHz)

Above DARS

	Center	½ Chan BW	Drift	
MIN:	2345.76MHz	– 160kHz	- 2.83kHz	= 2345.597MHz (Limit: freq > 2345.0MHz)
MAX:	2349.76MHz	+ 160kHz	+ 2.83kHz	= 2349.922MHz (Limit: freq < 2345.0MHz)

Metricom operation below and above DARS