

# **RF Measurement Report**

**Prepared by:**

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**In Support of:**

**FCC APPLICATION FOR CERTIFICATION**

**for**

**Winncom Technologies, Inc.**  
**30700 Carter Street, Suite A**  
**Solon, OH 44139**

**Model: Aironet BR500-E with AMP1000 Amplifier**  
**FCC ID: OQCWAF24-1000**

**Demonstration of Compliance with FCC Rules Part 15.247**

**February, 2000**

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*NCL PROJ.# WINCOMM-0526A*

### **1.0 Introduction**

This report has been prepared on behalf of Winncom Technologies,

Inc., to support the attached Application for Certification of a Part 15 Spread Spectrum Transmitter. The Equipment Under Test was the **Model Aironet BR500-E with AMP1000 Amplifier**.

Radio-Noise Emissions tests were performed according to **FCC Public Notice 54797, titled "Guidance on Measurements for Direct Sequence SST"**. The measuring equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

Testing was performed at National Certification Laboratory in Ellicott City, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch. FCC acceptance was granted on May 26, 1993.

## 1.1 Summary

The Winncom Technologies, Inc. **Model Aironet BR500-E with AMP1000 Amplifier** complies with the FCC limits (15.247) for a Direct Sequence SST.

## 2.0 Description of Equipment Under Test (EUT)

The Aironet BR500-E Wireless Bridge is actually the FCC Certified Model with FCC ID: LOZ102035. Winncom Technologies, Inc. has not modified this product in any manner except for the addition of high gain antennas, and an external amplifier.

The EUT Features:

Direct Sequence Spread Spectrum Transceiver  
+ 29 dBm RF Output Max.  
2412 to 2462 MHz Freq. Range  
10 MHz 6 dB Emission Bandwidth  
10 Available Channels  
5 MHz Channel Separation  
11 Mbps Data Rate (Radio Link)  
Differential DPSK Modulation

### **3.0 Test Program**

This report contains measurement charts and data as evidence for the following tests performed:

1. (15.247 b) Peak RF output power.
2. (15.247 d) Power Spectral Density (3kHz Bandwidth).
3. (15.247 c) Field strength of harmonics and spurious out-of-band emissions.
4. (15.247 c) RF Antenna Conducted of harmonics and spurious out-of-band emissions.
5. (15.247 a) 6 dB Emission Bandwidth.
6. (15.207) Power Line Conducted Emissions.

### **4.0 Test Configuration**

The BR500-E Wireless Bridge was connected via RS-232 port to a Pentium tower computer for testing. A Win98 Hyperterminal program is used to control the transmitter. The external amplifier is connected in-line between the wireless bridge and antenna via 10 feet of low loss cable. The 10 foot cable is the minimum length supplied with the system.

RF power output measurements were taken with an RF power meter at the amplifier output connector after the 10 ft. cable. RF antenna conducted output tests such as Bandwidth, Spurious/Harmonics, and Power Spectral Density were taken with the amplifier output feeding directly into the spectrum analyzer via the 10 ft. cable and external 30 dB attenuator. The analyzer's internal attenuator was adjusted to prevent overloading of the front end.

Field strength measurements were taken with the amplifier in-line, and feeding a 7dBi omni antenna.

## PEAK POWER TEST RESULTS

Limit: 0.800 watts (29 dBm)

Condition: Transmitter is set to a single modulated channel.  
Measurement taken at amplifier antenna connector.

Readings from RF Peak Power Meter:

BR500-E w/ 800 mW Amp	2412 MHz	-	+28.6 dBm
BR500-E w/ 800 mW Amp	2437 MHz	-	+28.8 dBm
BR500-E w/ 800 mW Amp	2462 MHz	-	+28.8 dBm

## **POWER SPECTRAL DENSITY**

Limit: 8 dBm

Resolution Bandwidth: 3 kHz

Average Time Interval: 1 second/3 kHz

Actual Time Interval used  
for testing: 1.5 seconds/3 kHz

Condition: Transmitter is modulated at 29 dBm RF power.  
Measurement taken at amplifier antenna connector.

Note: 30 dB front-end attenuator on analyzer

Readings from spectrum analyzer:

**2412 MHz - -4.6 dBm**

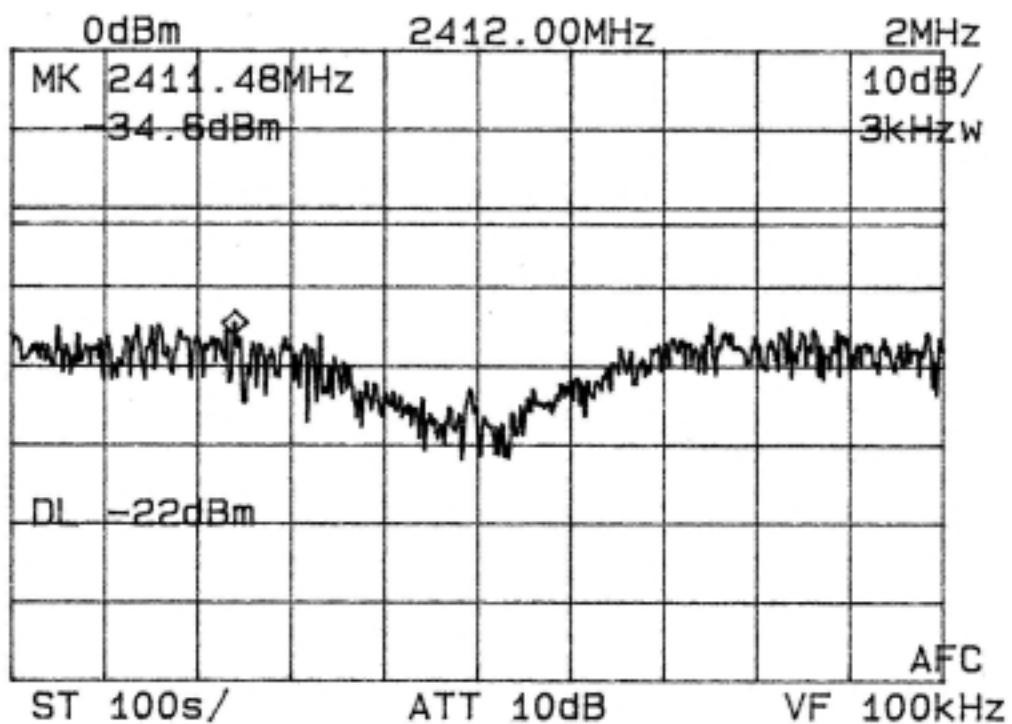
**2437 MHz - -5.2 dBm**

**2462 MHz - -8.8 dBm**

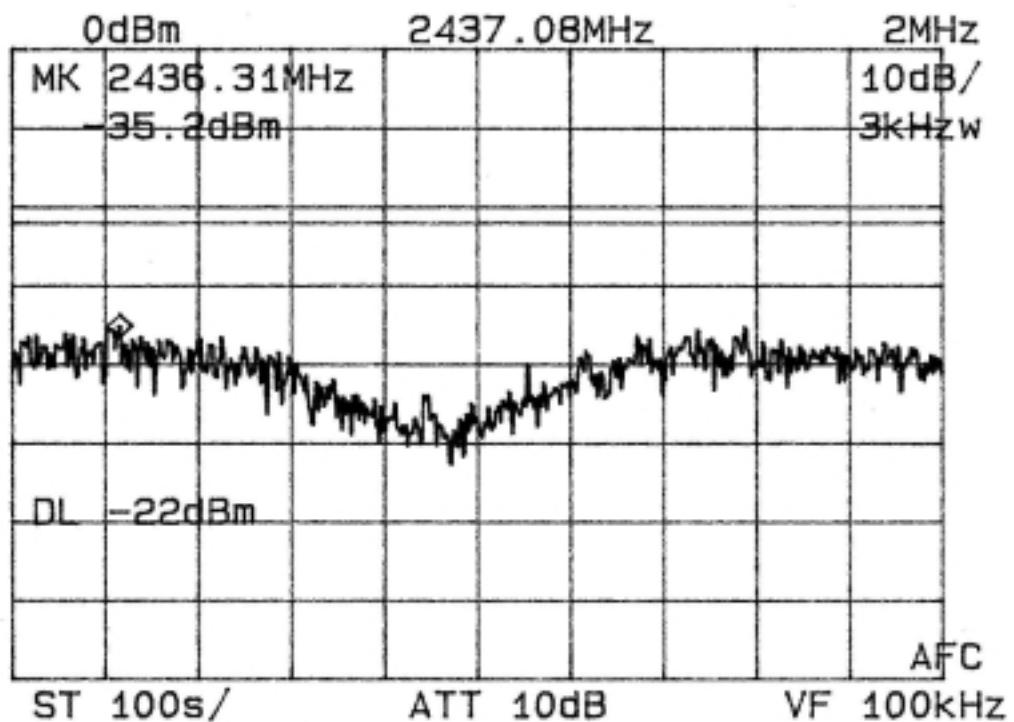
SEE FOLLOWING 3 PLOTS

LOW CHANNEL

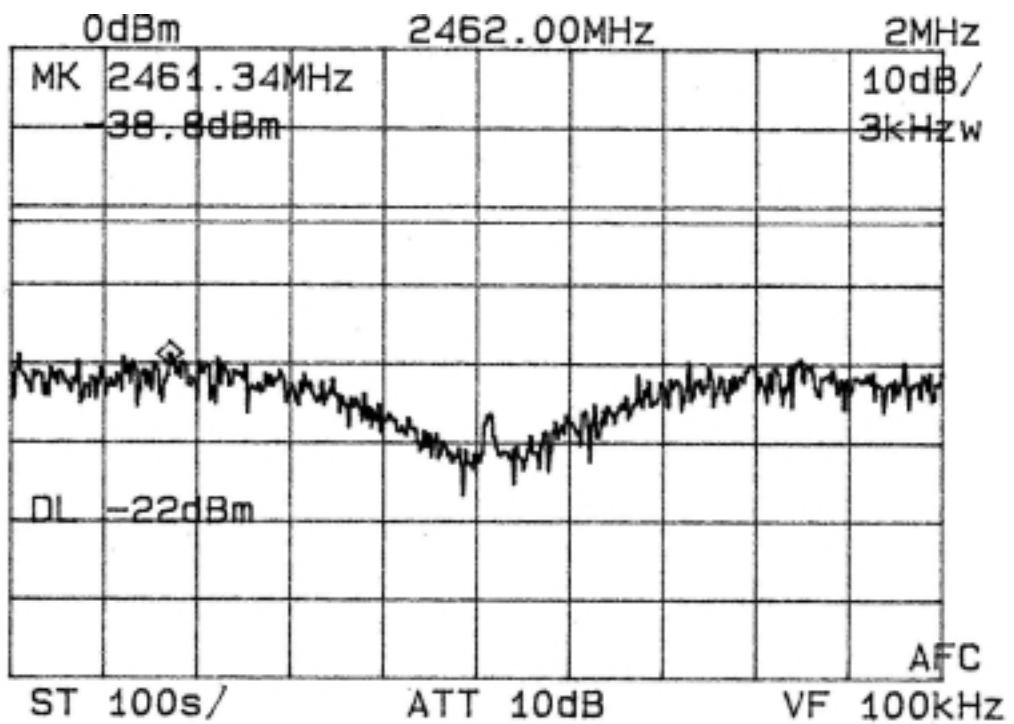
NOTE: 30dB EXT ATTENUATION



## MID CHANNEL



## HIGH CHANNEL



## 6 dB EMISSION BANDWIDTH

Minimum 6 dB BW: 0.5 MHz  
RBW Setting on S.A.: 100 kHz

Condition: Transmitter is set to a single modulated channel.  
Measurement taken at amplifier antenna connector.

Note: 30 dB front-end attenuator on analyzer

Readings from spectrum analyzer:

**2412 MHz - 12.6 MHz Occupied BW**

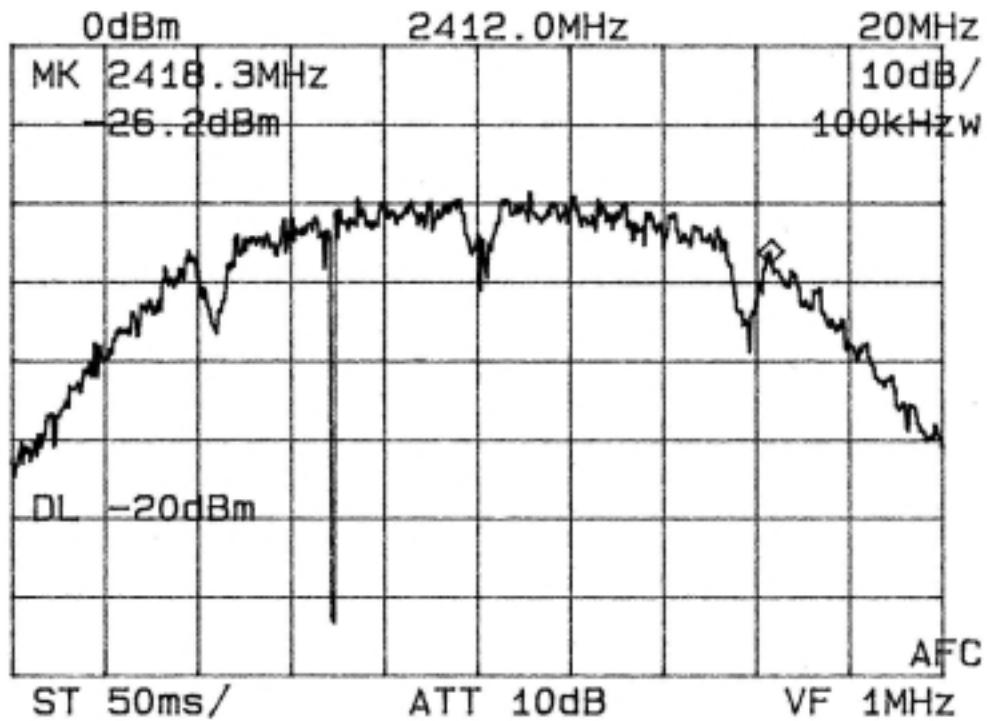
**2437 MHz - 12.4 MHz Occupied BW**

**2462 MHz - 12.4 MHz Occupied BW**

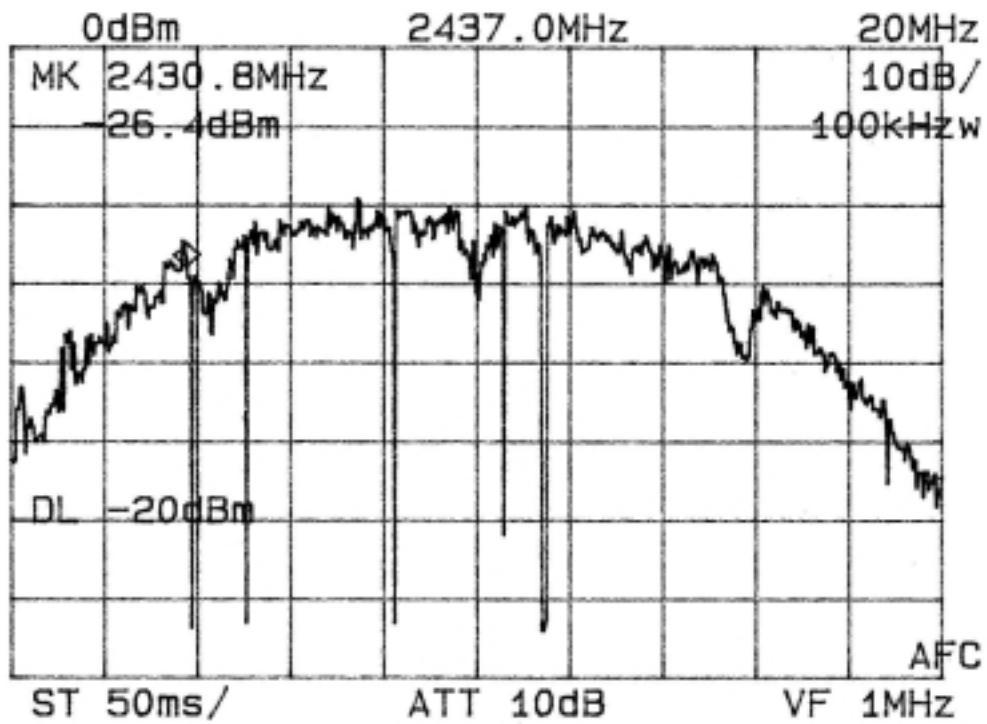
SEE FOLLOWING 3 PLOTS

LOW CHANNEL

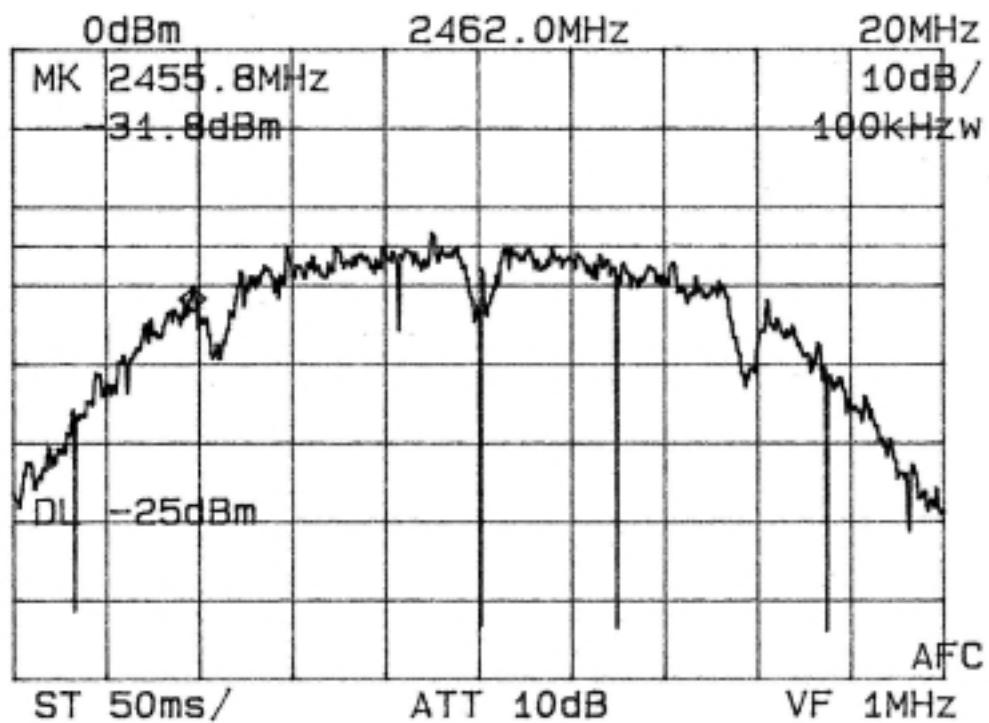
NOTE: 30 Db EXT. ATTENUATION



MID CHANNEL



HIGH CHANNEL



## RF ANTENNA CONDUCTED SPURIOUS/HARMONICS EMISSIONS

Limit: 20 dB below Carrier Level Measured with 100 kHz RBW  
RBW Setting on S.A.: 100 kHz

Condition: Transmitter is set to a single modulated channel.  
RF power = 29 dBm  
Measurement taken at amplifier antenna connector.

Three separate Measurements are performed to show harmonic and spurious emissions generated with the transmitter tuned to low, middle, and high parts of the spectral range.

SEE FOLLOWING 3 DATA TABLES

## FCC PART 15.247(c) - CONDUCTED SPURIOUS EMISSIONS

Frequency of Carrier = 2412 MHz

Limit = 20 dBc

Condition: Transmitter is set to a single modulated channel.

### TEST RESULTS

LIMIT: -20 dB FROM PEAK CARRIER

<u>COMPONENT</u>	<u>FREQUENCY (MHZ)</u>	<u>RESULT (dB FROM PEAK)</u>
HARMONIC	4824.00	- 42.0
HARMONIC	7236.00	- 48.0
HARMONIC	9648.00	- 59.0
HARMONIC	12060.00	- 66.0
HARMONIC	14472.00	- 65.0
HARMONIC	16884.00	- 70.0
HARMONIC	19296.00	- 72.0
HARMONIC	21708.00	- 75.0
HARMONIC	24120.00	- 77.0

## FCC PART 15.247(c) - CONDUCTED SPURIOUS EMISSIONS

**Frequency of Carrier = 2437 MHz**  
**Limit = 20 dBc**

**Condition: Transmitter is set to a single modulated channel.**

### TEST RESULTS

LIMIT: -20 dB FROM PEAK CARRIER

<u>COMPONENT</u>	<u>FREQUENCY (MHZ)</u>	<u>RESULT (dB FROM PEAK)</u>
HARMONIC	4874.00	- 43.0
HARMONIC	7311.00	- 49.0
HARMONIC	9748.00	- 61.0
HARMONIC	12185.00	- 66.0
HARMONIC	14622.00	- 67.0
HARMONIC	17059.00	- 70.0
HARMONIC	19496.00	- 74.0
HARMONIC	21933.00	- 77.0
HARMONIC	24370.00	- 77.0

## FCC PART 15.247(c) - CONDUCTED SPURIOUS EMISSIONS

**Frequency of Carrier = 2462 MHz**

**Limit = 20 dBc**

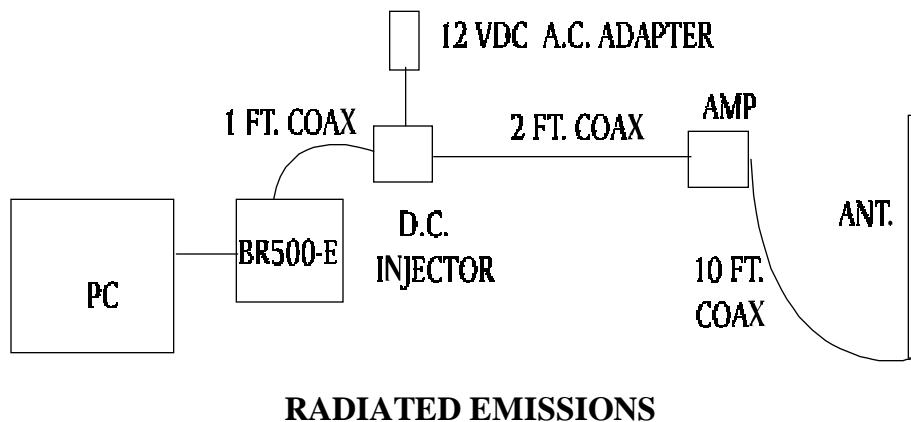
**Condition: Transmitter is set to a single modulated channel.**

### TEST RESULTS

LIMIT: -20 dB FROM PEAK CARRIER

<u>COMPONENT</u>	<u>FREQUENCY (MHZ)</u>	<u>RESULT (dB FROM PEAK)</u>
HARMONIC	4924.00	- 44.0
HARMONIC	7386.00	- 49.0
HARMONIC	9848.00	- 57.0
HARMONIC	12310.00	- 66.0
HARMONIC	14772.00	- 69.0
HARMONIC	17234.00	- 72.0
HARMONIC	19696.00	- 75.0
HARMONIC	22158.00	- 77.0

#### 4.0 Test Configuration



The EUT was set up on the center of the test table, in a manner which follows the general guidelines of ANSI C63.4, Section 6 "**General Operating Conditions and Configurations**". Two sets of measurements were taken: First set with amplifier, second set without amplifier.

This is described below:

#### 5.0 Conducted Emissions Scheme

The EUT is placed on an 80 cm high 1 x 1.5 m non-conductive table. Power to the RF modem is provided through a Solar Corporation 50  $\Omega$ /50

$\mu$ H Line Impedance Stabilization Network bonded to a 2.2 X 2 meter horizontal ground plane, and a 2.2 X 2 meter vertical ground plane. The LISN has its AC input supplied from a filtered AC power source. A separate LISN provides AC power to the peripheral equipment. I/O cables are moved about to obtain maximum emissions.

The 50  $\Omega$  output of the LISN is connected to the input of the spectrum analyzer and emissions in the frequency range of 450 kHz to 30 MHz are searched. The detector function is set to quasi- peak and the resolution bandwidth is set at 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth for final measurements. All emissions within 20 dB of the limit are recorded in the data tables.

#### FCC CLASS B CONDUCTED EMISSIONS DATA

CLIENT: Winncom Technologies, Inc.  
EUT: BR500-E WITH AMP1000

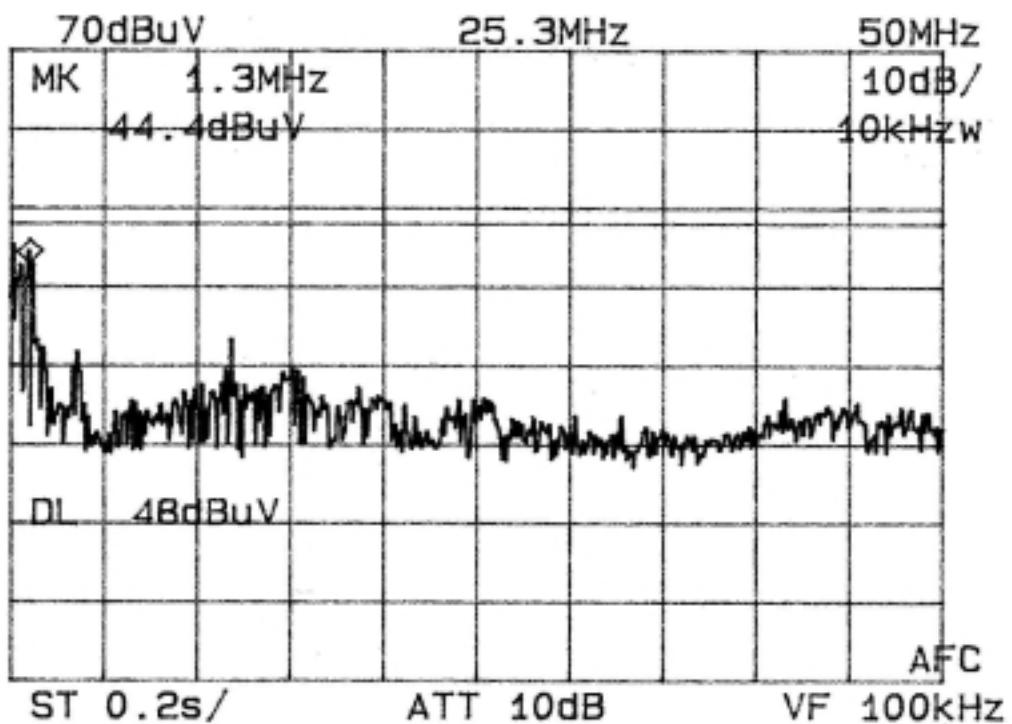
#### LINE 1 - NEUTRAL

FREQ MHz	VOLTAGE dBuV	VOLTAGE uV	FCC LIMIT uV	MARGIN dB
.854	42.6	135	250	-5.4
1.32	44.4	166	250	-3.6
3.82	31.6	38	250	-16.4
12.15	33.2	46	250	-14.8

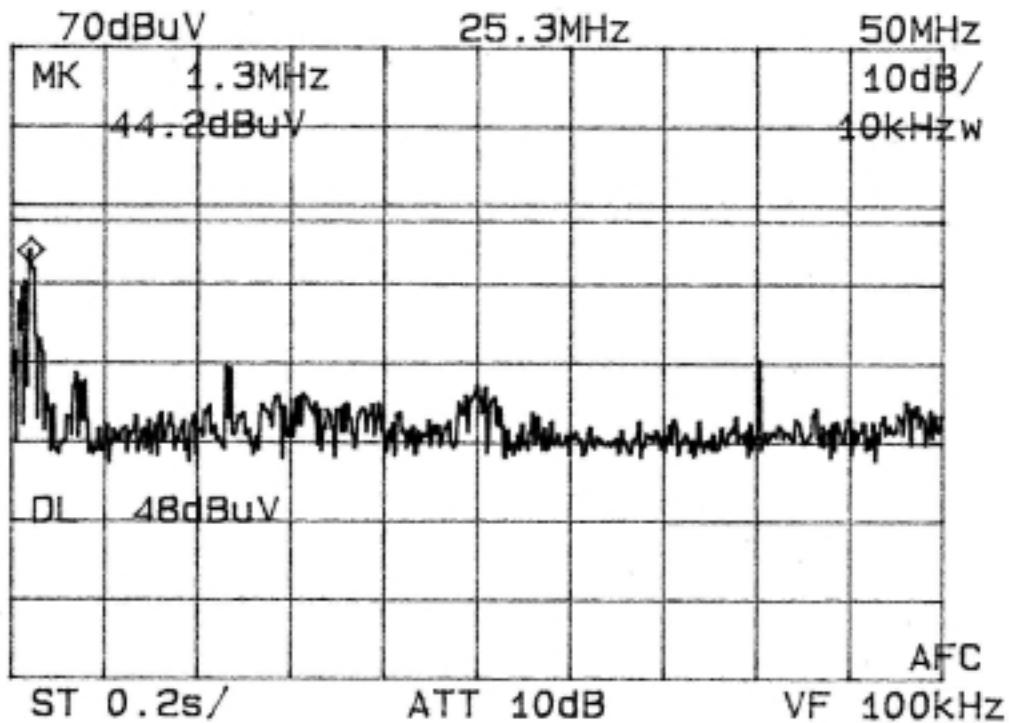
#### LINE 2 - PHASE

FREQ MHz	VOLTAGE dBuV	VOLTAGE uV	FCC LIMIT uV	MARGIN dB
.854	39.4	93	250	-8.6
1.32	44.2	162	250	-3.8
3.82	28.6	27	250	
-19.4	11.96	29.4	30	250
-18.6				

A.C. LINE-CONDUCTED - L1



A.C. LINE-CONDUCTED - L2



## 6.0 Radiated Emissions Scheme

The EUT is placed on an 80 cm high 1 X 1.5 meter non-conductive motorized turntable for radiated testing on the 3-meter open area test site. The emissions from the EUT are measured continuously at every azimuth by rotating the turntable. Guided horn and log periodic broadband antennas are mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna is varied between 1 and 4 meters. Both the horizontal and vertical field components are measured.

The RF spectrum is searched from 30 MHz - 25.000 GHz.

The output from the antenna is connected to the input of the preamplifier. The preamp out is connected to the spectrum analyzer. The detector function is set to **Peak**. The resolution bandwidth of the spectrum analyzer is set at 120 kHz, for the frequency range of 30-1000 MHz, and 1 MHz for the range of 1 GHz-25 GHz. A 10 Hz video BW setting is used to average readings above 1 GHz. All emissions within 20 dB of the limit are recorded in the data tables.

To convert the spectrum analyzer reading into a quantified E-field level to allow comparison with the FCC limits, it is necessary to account for various calibration factors. These factors include cable loss (CL) and antenna factors (AF). The AF/CL in dB/m is algebraically added to the Spectrum Analyzer Voltage in dB $\mu$ V to obtain the Radiated Electric Field in dB $\mu$ V/m. This level is then

compared with the FCC limit.

### Example:

Spectrum Analyzer Volt: VdBuV

Composite Factor: AF/CLdB/m

Electric Field:  $EdB\mu V/m = VdB\mu V + AF/CLdB/m$

Linear Conversion:  $\text{EuV/m} = \text{Antilog} \left( \text{EdB}\mu\text{V/m}/20 \right)$

4824.00	V	18.0	35.0	-25	28.0	25.1	500.0
12060.00	V	15.0	40.0	-25	30.0	31.6	500.0
14472.00	H	15.0	43.0	-25	33.0	44.6	500.0
19296.00	H	15.0	36.0	-25	26.0	19.9	500.0
		PEAK					PEAK
FREQ	POL	SPEC A	AF/CL	PREAMP	E-FIELD	E-FIELD	LIMIT
MHz	H/V	DBuV	dB/m	GAIN	DbuV/m	UV/m	uV/m
4824.00	V	39.0	35.0	-25	49.0	281.8	5000.0
12060.00	V	35.0	40.0	-25	50.0	316.2	5000.0
14472.00	H	30.0	43.0	-25	48.0	251.2	5000.0
19296.00	H	27.0	36.0	-25	38.0	79.4	5000.0
CARRIER:		2437 MHZ @ 800 mW					
ANTENNA :		7 DBi OMNI					
		AVRG					AVRG
FREQ	POL	SPEC A	AF/CL	PREAMP	E-FIELD	E-FIELD	LIMIT
MHz	H/V	DBuV	dB/m	GAIN	DbuV/m	UV/m	uV/m
4874.00	H	22.0	35.0	-25	32.0	39.8	500.0
7311.00	V	18.0	37.0	-25	30.0	31.6	500.0
12185.00	H	15.0	40.0	-25	30.0	31.6	500.0
19496.00	V	15.0	36.0	-25	26.0	19.9	500.0
		PEAK					PEAK



PEAK							
FREQ	POL	SPEC A	AF/CL	PREAMP	E-FIELD	E-FIELD	LIMIT
MHz	H/V	dBuV	Db/m	GAIN	DbuV/m	uV/m	uV/m
4924.00	V	40.0	35.0	-25	50.0	316.2	5000.0
7386.00	H	39.0	37.0	-25	51.0	354.8	5000.0
12310.00	H	32.0	40.0	-25	47.0	223.9	5000.0
19696.00	H	32.0	36.0	-25	43.0	141.2	5000.0
22152.00	V	28.0	37.0	-25	40.0	100.0	5000.0

#### FCC 15.209 RADIATED EMISSIONS DATA

##### UPPER BAND EDGE

CARRIER : 2462 MHz @ 800 mW  
 ANTENNA: 7 dBi OMNI

FREQ	POL	PEAK				AVRG	
		SPEC A	AF/CL	PREAMP	E-FIELD	LIMIT	MRGN
MHz	H/V	dBuV	dB/m	GAIN	dBuV/m	dBuV/m	dB
2483.5	H	27.0	34.0	-25	36.0	54.0	-18

## CONDUCTED BAND EDGE OUTPUT

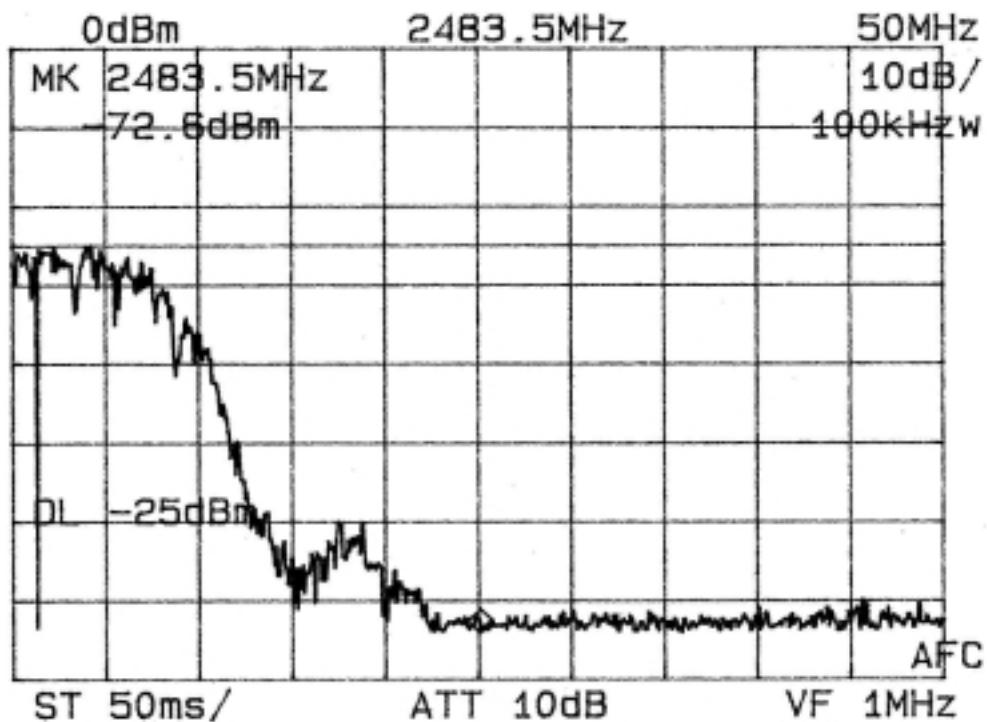


Table 1

### EUT Accessories

7 dBi Omni Antenna - Model WRO2400-70 - 2.4-2.5 GHz

Bidirectional amp module

D.C. power injector module

120 VAC adapter to 12 VDC

10 feet of low-loss flex coaxial cable used to connect the EUT to the antenna.

**Table 2**

**Support Equipment**

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MANUFACTURER	FCC ID #	SERIAL #
<b>MONITOR:</b>		
Relisys 1564ME SVGA	E80TE1564	30266672
<b>COMPUTER</b>		<b>WEX356-4432</b>
Lyrex Pentium Tower	<b>OIN3890BX1846S35</b>	
<b>KEYBOARD:</b>		
Fujitsu	C9S4D5KB4700	None
<b>MOUSE:</b>		
Logitech	DZL6QBC	<b>48ULTSL1901</b>

**Table 3**

**Measurement Equipment Used**

The following equipment is used to perform measurements:

HP 435A RF Peak Power Meter	- Serial No. 1527AO284
EMCO Model 3110 Biconical Antenna	- Serial No. 1619
Antenna Research MWH-1825B Horn Antenna	- Serial No. 1005
EMCO Model 3115 Ridged Horn Antenna	- Serial No. 3007
HP 8348A Preamplifier	- Serial No. 197-2564A
Solar 8012-50-R-24-BNC LISN	- Serial No. 924867
Bird 8306-300-N 30dB Attenuator	- S/N: 29198391515
Tektronix R3272 Spectrum Analyzer	- Serial No. 6-95-1124
4 Meter Antenna Mast	
Motorized Turntable	
Heliax FSJ1-50A 1/4" Superflex Coax Cable (12 Ft.)	