

# **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

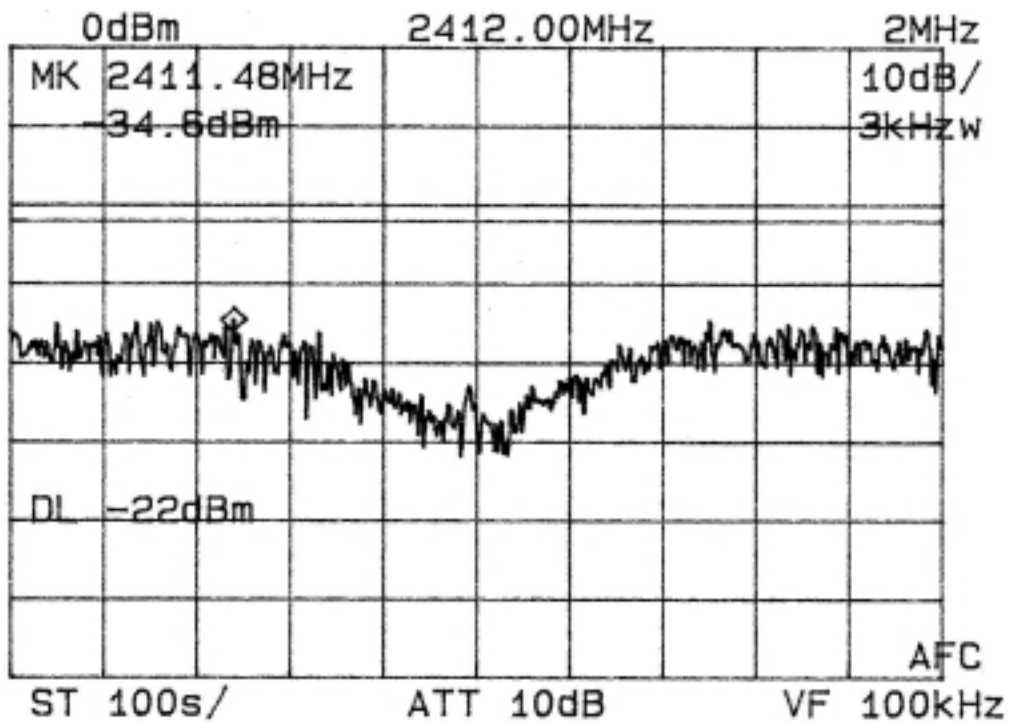
2437 MHz - -5.2 dBm

2462 MHz - -8.8 dBm

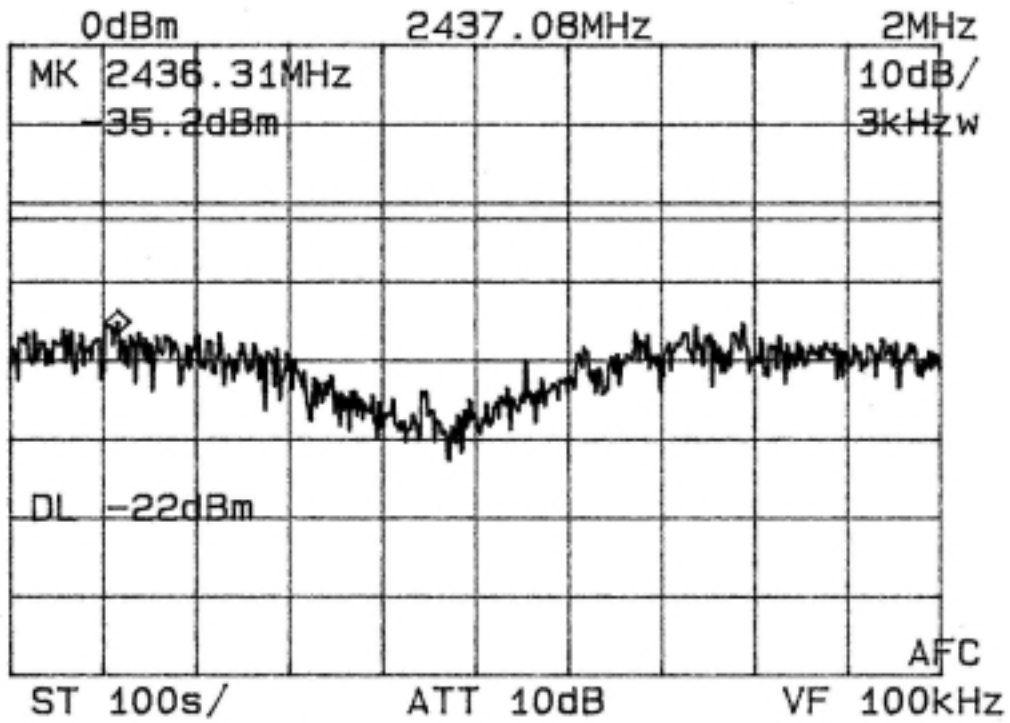
SEE FOLLOWING 3 PLOTS

LOW CHANNEL

NOTE: 30dB EXT ATTENUATION

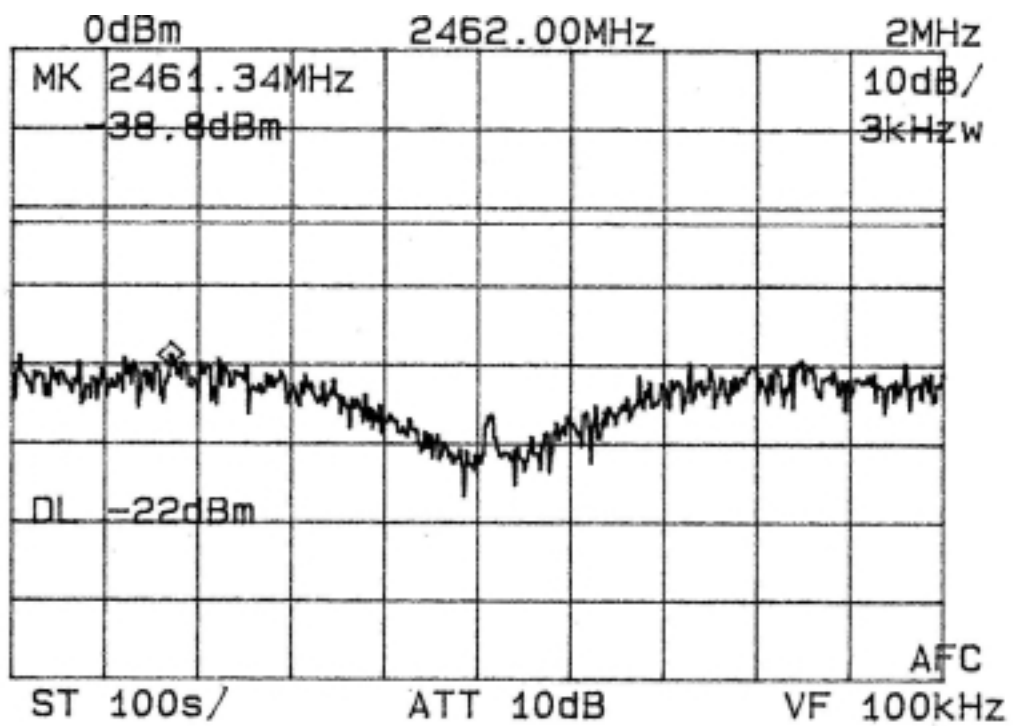


MID CHANNEL



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

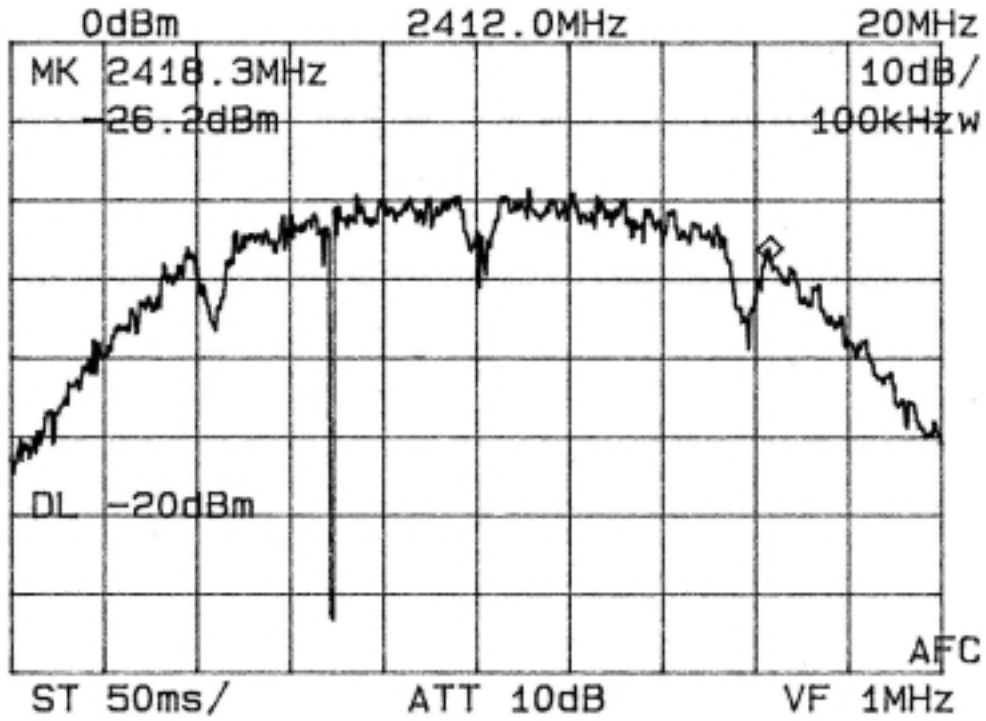
Readings from spectrum analyzer:

2412 MHz - 12.6 MHz Occupied BW  
2437 MHz - 12.4 MHz Occupied BW  
2462 MHz - 12.4 MHz Occupied BW

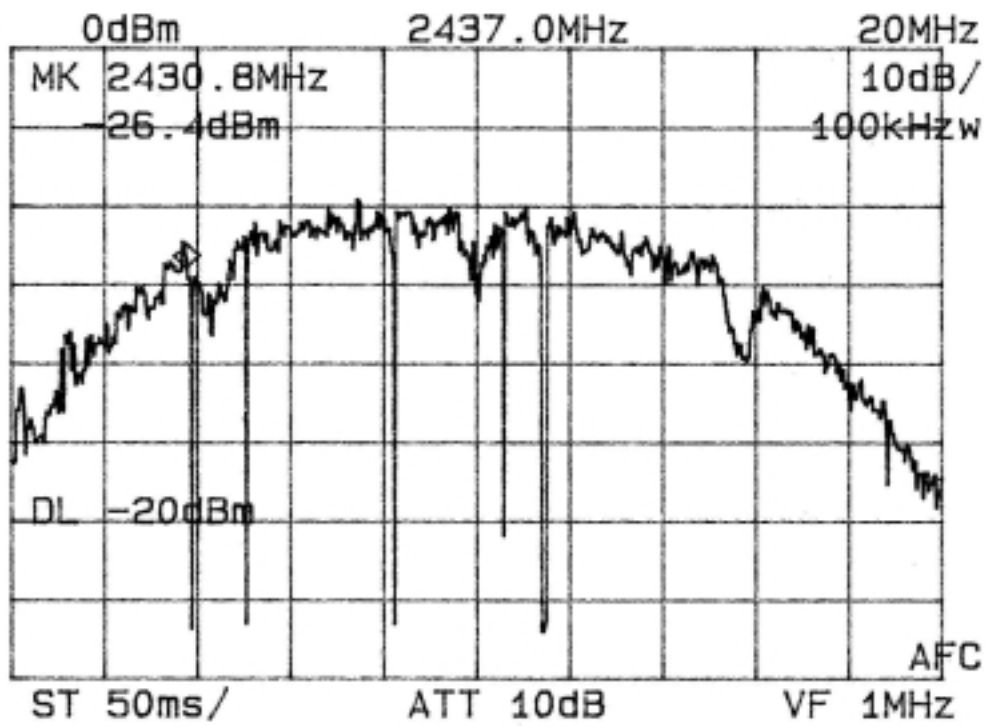
SEE FOLLOWING 3 PLOTS

LOW CHANNEL

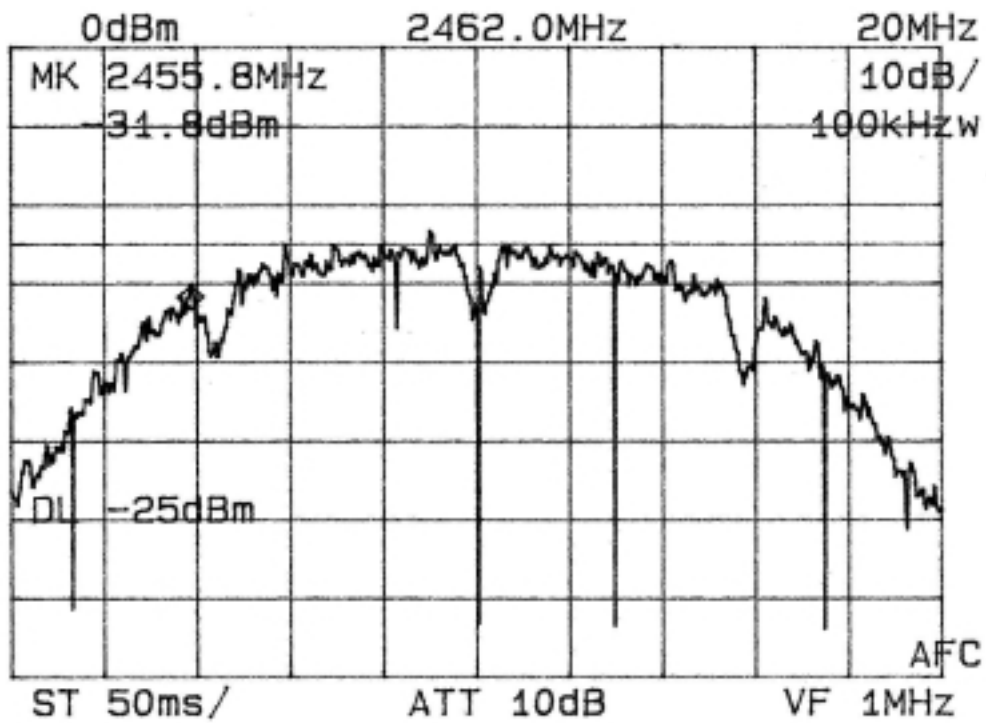
NOTE: 30 Db EXT. ATTENUATION



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

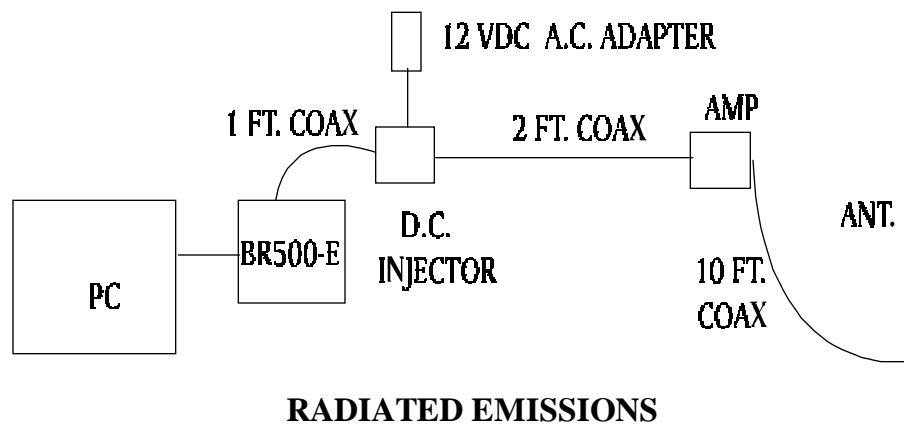
Condition: Transmitter is set to a single modulated channel.

### 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

μH 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 Ω 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

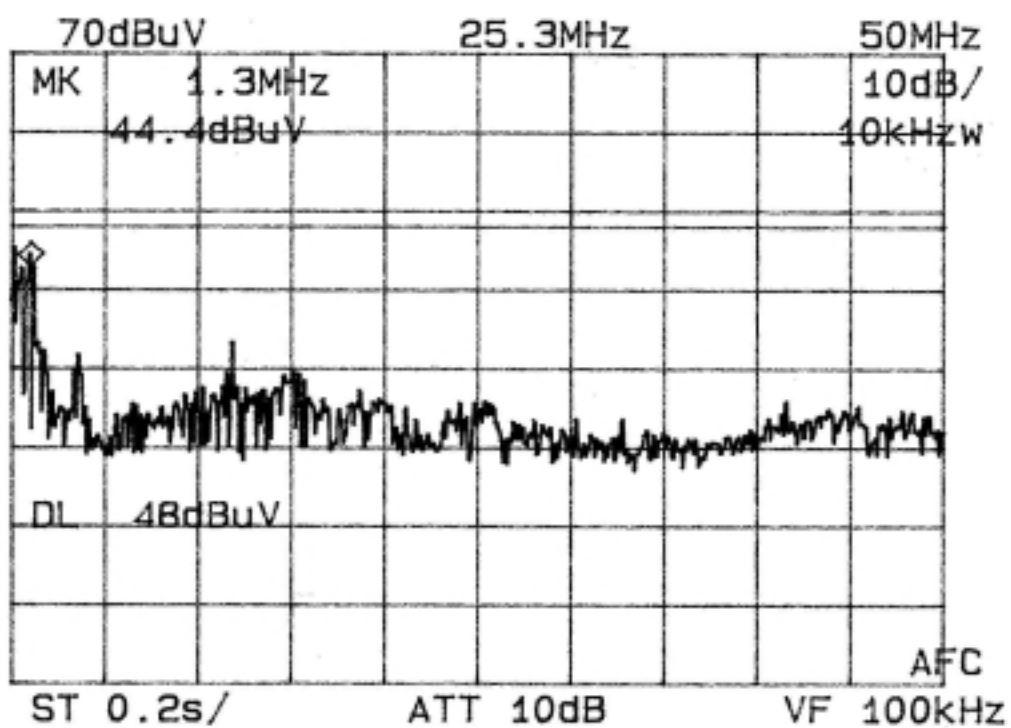
### LINE 1 - NEUTRAL

| FREQ<br>MHz | VOLTAGE<br>dBuV | VOLTAGE<br>uV | FCC LIMIT<br>uV | MARGIN<br>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        |

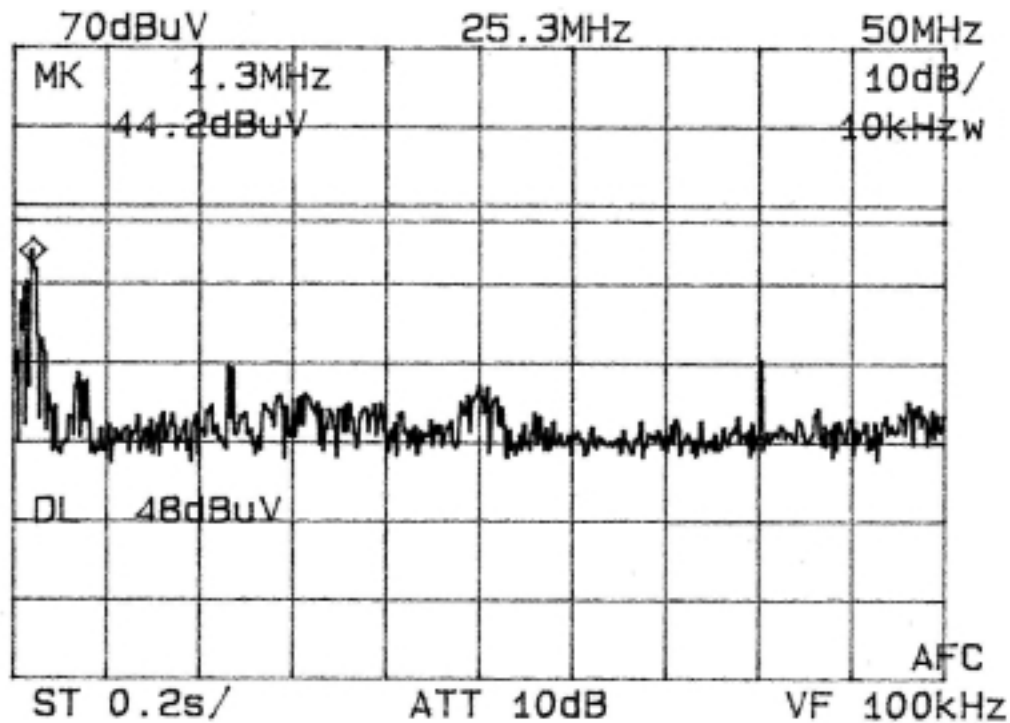
### LINE 2 - PHASE

| FREQ<br>MHz | VOLTAGE<br>dBuV | VOLTAGE<br>uV | FCC LIMIT<br>uV | MARGIN<br>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 dBμV to obtain the Radiated Electric Field in dBμV/m. This level is then

compared with the FCC limit.

**Example:**

Spectrum Analyzer Volt: VdBuV

Composite Factor: AF/CLdB/m

Electric Field:  $Ed_{\mu V/m} = VdB_{\mu V} + AF/CLdB/m$

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

|          |     |                                    |               |        |         |         |       |
|----------|-----|------------------------------------|---------------|--------|---------|---------|-------|
|          |     |                                    |               |        |         |         |       |
|          |     |                                    |               |        |         |         |       |
|          |     | FCC 15.209 RADIATED EMISSIONS DATA |               |        |         |         |       |
|          |     |                                    |               |        |         |         |       |
|          |     | FCC ID:                            | OQCWAF24-1000 |        |         |         |       |
|          |     |                                    |               |        |         |         |       |
| CLIENT:  |     | WINNCOM                            |               |        |         |         |       |
| EUT:     |     | BR500-E / AMP1000                  |               |        |         |         |       |
|          |     |                                    |               |        |         |         |       |
| CARRIER: |     | 2412 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  |
|          |     |                                    |               |        |         |         |       |



| 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   | 41.0              | 35.0  | -25    | 51.0    | 354.8   | 5000.0 |
| 7311.00  | V   | 37.0              | 37.0  | -25    | 49.0    | 281.8   | 5000.0 |
| 12185.00 | H   | 30.0              | 40.0  | -25    | 45.0    | 177.8   | 5000.0 |
| 19496.00 | V   | 30.0              | 36.0  | -25    | 41.0    | 112.2   | 5000.0 |
|          |     |                   |       |        |         |         |        |
|          |     |                   |       |        |         |         |        |
| CARRIER: |     | 2462 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   |
|          |     |                   |       |        |         |         |        |
| 4924.00  | V   | 20.0              | 35.0  | -25    | 30.0    | 31.6    | 500.0  |
| 7386.00  | H   | 18.0              | 37.0  | -25    | 30.0    | 31.6    | 500.0  |
| 12310.00 | H   | 15.0              | 40.0  | -25    | 30.0    | 31.6    | 500.0  |
| 19696.00 | H   | 15.0              | 36.0  | -25    | 26.0    | 19.9    | 500.0  |
| 22152.00 | V   | 15.0              | 37.0  | -25    | 27.0    | 22.3    | 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   |
|          |     |        |       |        |         |         |        |
| 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      |       | PREAMP | AVRG    |       | MRGN |
|--------|-----|-----------|-------|--------|---------|-------|------|
|        |     | SPEC A    | AF/CL |        | E-FIELD | LIMIT |      |
| MHz    | H/V | dBuVdB/m  | GAIN  | dBuV/m | dBuV/m  | dB    |      |
| 2483.5 | H   | 27.0 34.0 | -25   | 36.0   | 54.0    | -18   |      |

## CONDUCTED BAND EDGE OUTPUT

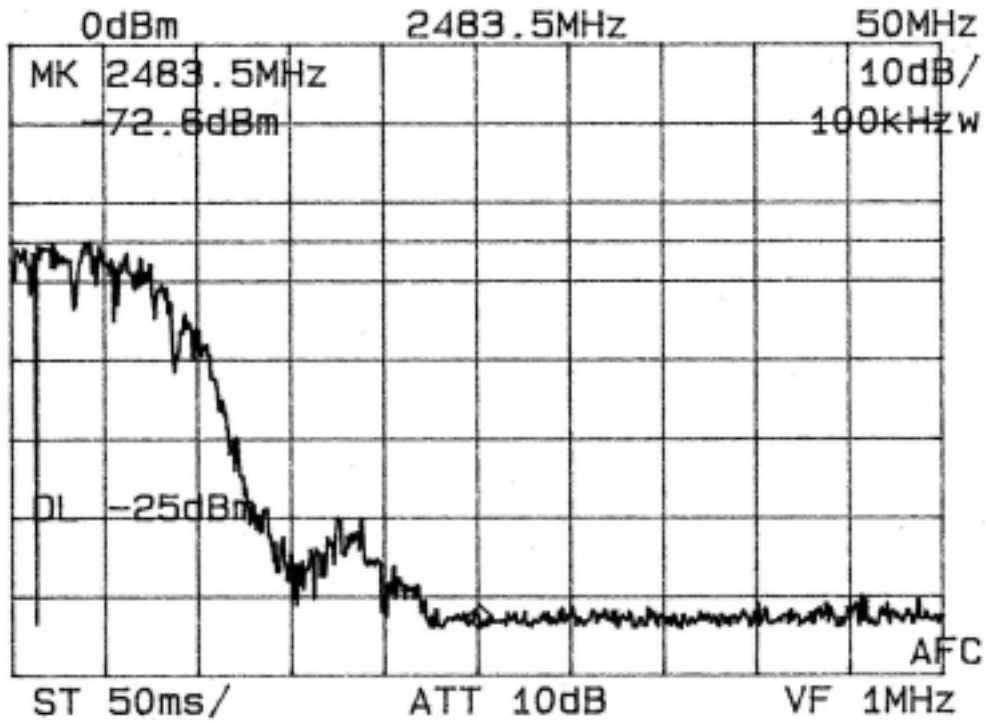


Table 1

### 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**

---

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

**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                                |                        |
| Heliac FSJ1-50A 1/4" Superflex Coax Cable (12 Ft.) |                        |