

# Wireless LAN Cards

## **WL2400-ISA** *Desktop ISA Bus Card*



## **WL2400-PCM** *Notebook Computer PCMCIA Card*



## ***Installation & Operation Manual***

US Rev 1.2

Sept 1999

### **NOTICE**

The WL2400-ISA and WL2400-PCM have been tested and found to comply with Part 15 of FCC regulations. Operation of these devices is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may induce undesired operation.

This device must be installed and implemented in strict accordance with the manufacturer's instructions. When installing the device with our AMP2440P amplifier and outdoor gain antennas, the installation must be professionally installed to ensure compliance with FCC regulation. YDI cannot guarantee that this device will not cause interference in a particular installation. In the case that this device does cause harmful interference, the user/operator shall promptly cease operation of the device until the threat of interference has been eliminated.

### **LIMITED WARRANTY**

Young Design, Inc. (YDI) insures your product against defects in material and workmanship for a period of **one year** after the initial purchase. In this period of time YDI will repair or replace any YDI product returned to the factory, freight prepaid.

The YDI warranty covers repairs or replacement (at the discretion of YDI) of the product alone. YDI is not responsible for the cost of removal, reinstallation, or shipping to the place of repair. YDI will not extend or modify its warranty period as a result of repair or replacement.

YDI reserves the right to void a warranty and/or make reasonable charges for repair of the unit if the serial number sticker is missing, or the unit displays evidence of misuse, abuse, tampering or water damage.

YDI is not responsible for damage to any other equipment or property, or any other consequential or incidental damages of any kind, whether based on contract, negligence, or strict liability. Maximum liability shall not in any case exceed the purchase price of the unit.

Warranties give you (the buyer) specific legal rights. You may also have other rights, which vary, from state to state. This warranty is only extended to purchases made in the United States of America or its possessions.

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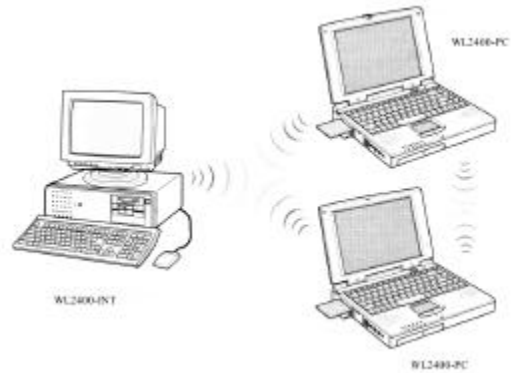
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## SECTION 1 Introduction

### 1.1 Wireless LAN Overview

The Wireless LAN models WL2400-ISA and WL2400-PCM are wireless LAN adapter cards that provide wireless connections between IBM compatible PCs, including desktop, laptop and notebook computers. These cards are capable of point-to-point networking or, with the AP-2 (Access Point) acting as an interface between the networks, connecting a wireless LAN to a wired LAN.

These cards operate in similar manner to Ethernet NICs (Network Interface Cards), but they have a wireless connection to the network or other computers equipped with these cards. Once installed properly, the Wireless LAN is invisible to most users. The **-ISA** version plugs into an ISA slot on a desktop computer. The **-PCM** has a built-in antenna version and plugs into a PCMCIA slot on either a laptop computer or an AP-2 Access Point. The **-PCM-J** is the same as the **-PCM** except it has an antenna jack for connection to an external antenna or the YDI AMP2440 pole mounted amplifier.



The WL2400 family of wireless LAN cards is a DSSS (Direct Sequence Spread Spectrum) radio data modem. This radio technique scrambles the data prior to transmission and uses a correlation technique on receive to improve the signal to noise ratio. This industry standard technique improves the receiver's sensitivity, making it possible to communicate in offices with walls and other obstacles. The cards use the CSMA/CA collision evasion protocol to prevent collisions on the network, allowing for high-speed data communication.

All the WL2400 models comply with the Wireless LAN International Standard IEEE 802.11. This makes these devices compatible with any other wireless LAN card or Access Point that also complies with the IEEE 802.11 DSSS standards.

The WL2400 products are also compatible with our remote mounted bi-directional amplifier, the Model AMP2440. Using our Model AMP2440 and high gain directional antennas, line-of-site ranges in excess of 30 miles are possible with these units!

The WL2400-ISA and WL2400-PCM cards support various network software. The network drivers and diagnostic programs included with the cards are supported by Microsoft Windows 3.1x, Windows 95 and Windows NT.

WL2400 wireless LAN products have been tested and passed FCC certification.

### 1.2 Specifications

#### Mechanical Specifications

| Model      | WL2400-ISA                                     | WL2400-PCM-J                                | WL2400-PCM |
|------------|--|---|------------|
| Type       | Half Size ISA Bus Card                         | PCMCIA II Card                              |            |
| Dimensions | 7.12" x 4.29" x .5"<br>(181mm x 109mm x 12mm)  | 4" x 2.12" x .196"<br>(104mm x 54mm x 5 mm) |            |
| Standards  | IEEE 802.11 Standard for Wireless LANs         |   |            |
| Antenna    | Left hand thread SMA jack for External Antenna |   | Internal   |
| Voltage    | 5V from ISA bus                                | 3.3 V                                       |            |

|                |        |                 |
|----------------|--------|-----------------|
| <b>Current</b> | 600 mA | 290 mA (normal) |
|----------------|--------|-----------------|

## Radio Specifications

| Model                       | WL2400-ISA   | WL2400-PCM-J | WL2400-PCM |   |   |   |   |   |   |    |    |
|-----------------------------|--|--------------|------------|---|---|---|---|---|---|----|----|
| <b>Frequency (MHz)</b>      | 2412, 2417, 2422, 2427, 2432, 2437, 2442, 2447, 2452, 2457*, 2462* |              |            |   |   |   |   |   |   |    |    |
| <b>Channels</b>             | 1  | 2            | 3          | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| <b>Data Rate</b>            | 2 Mbps over the air  |              |            |   |   |   |   |   |   |    |    |
| <b>Modulation</b>           | Direct Sequence Spread Spectrum, Differential DPSK                 |              |            |   |   |   |   |   |   |    |    |
| <b>Bit Error Rate</b>       | Better than 10 <sup>-8</sup>                                       |              |            |   |   |   |   |   |   |    |    |
| <b>Receiver Sensitivity</b> | -85 dBm or better  |              |            |   |   |   |   |   |   |    |    |
| <b>Transmit Power</b>       | 50 mW maximum  |              |            |   |   |   |   |   |   |    |    |

\*These frequencies cannot be used in the US with amplifiers due to signal levels in the restricted band above 2483 MHz.

## Range and Coverage Area

| Model  | WL2400-ISA  | WL2400-PCM-J | WL2400-PCM |
|--|---|--------------|------------|
| <b>Small indoor antennas:</b>                                      | Open Space: 1000 feet (300m) max<br>Semi Open Space: 200 feet (70m) max<br>Closed Space: 100 feet (30m) max |              |            |
| <b>External Roof/Tower antennas (no amplifier):</b>                | Up to 10 Miles (15 Km) with 24 dB gain grid dish antennas **  |              | N/A        |
| <b>External Roof/Tower antennas using Model AMP2440 amplifier:</b> | Up to 30 Miles (50 Km) with 24 dB gain grid dish antennas **  |              | N/A        |

\*\* Unobstructed line of sight is required between the antennas.

**NOTE:** Amplifiers cannot be used with the Indoor Patch antennas. Refer to the AMP2440P manual for more information.

| <b>Software</b>       |   |
|-----------------------|---|
| <b>Device Drivers</b> | NDIS for Windows95/98 and Windows NT<br>Source code for LINUX Drivers are available as an option. |

### 1.3 Drivers Available:

The following network drivers are provided:

- MS Windows for Workgroups 3.11
- Windows 95
- Windows NT

Also, the source code for the LINUX drivers are available free of charge. Call us for more information or visit the YDI web site at:

***www.ydi.com***

### 1.4 LED Indicators for the Model WL2400-ISA

**Power:** Steady red when system is powered up.

**TX:** Blinks orange when transmitting data.

**RX:** Blinks green when receiving data.

## SECTION 2. Network Applications

There are two types of networks used with the WL2400-ISA and WL2400-PCM: StructureNet and Instawave. The number of computers connected, Ethernet installation, and the desired network application determine the type of network.

### 2.1 Instawave™ Vs StructureNet™ Operation

The AP-2 Access Point gives you the option of operating in “Instawave” mode (default) or “StructureNet” mode. A description of these two modes follows, as well as an explanation of the advantages of each compared to the other. This information should enable you to decide which mode to use. Generally, it is not a good idea to mix modes. We recommend that all access points in your installation be set to the same mode.

IEEE802.11 defines two modes of operation: “ad hoc” mode and “infrastructure” mode. The concept behind “ad-hoc” mode is that several wireless stations such as laptops can get together in a local area such as a conference room and form a wireless network together. This would enable the sharing of documents and collaborative working using applications such as Microsoft’s NetMeeting. In ad-hoc mode all the operations are peer to peer, but cannot communicate with an access point.

Infrastructure mode requires the use of an access point. In Infrastructure mode, all wireless communication is between a station and an access point. There must be an operational access point in the vicinity for a station to communicate. Even if there are two wireless stations, they cannot communicate directly in the manner described for “ad-hoc” networks; they must communicate with each other via the access point.

The AP-2 has a mode that has the attributes of “ad-hoc” operation, but also allows you to use the Access Point to communicate with a wired LAN. This mode is called “Instawave™” and is the default mode of operation.

### 2.2 Advantage of Instawave

Instawave is very easy to set up. All the stations on a specific radio channel form a network if they are within range of each other. The channel can be specified in the access point and on the PCs or laptops. The default channel is 10.

Regardless of how many access points and stations there are in an area, they will automatically form a network. The access points may be attached to the same LAN or they may be on different LAN segments. The advantage of Instawave is that the most direct communication path is taken automatically. If two stations wish to communicate peer-to-peer they can do so. If the station wishes to communicate with a server on the LAN the correct access point will accept the data and forward it to the LAN. If there are two or more access points attached to the same LAN, the access points will determine which access point is used automatically — the user does not need to intervene.

Instawave is a good choice for small networks that need maximum flexibility and simplicity. To use Instawave you must configure the AP-2 with “**mode: Instawave**” and set the Channel on the remote stations to the same number as on the AP-2.

### 2.3 Advantage of StructureNet

When StructureNet is enabled each wireless station must associate with a single access point. That access point is responsible for receiving and sending all data to the station. A station cannot be associated with more than one access point at a time. The disadvantage of this is that peer-to-peer communication requires that a message be sent twice — once to the access point and a second time to

the destination station. However, the advantage of StructureNet is that the MIS manager can have more control over the connections because they pass through a single access point. Also because each station associates with only one access point at a time, it is possible for the station to dynamically change radio channels when switching from one access point to another. This is known as “multi-channel” roaming.

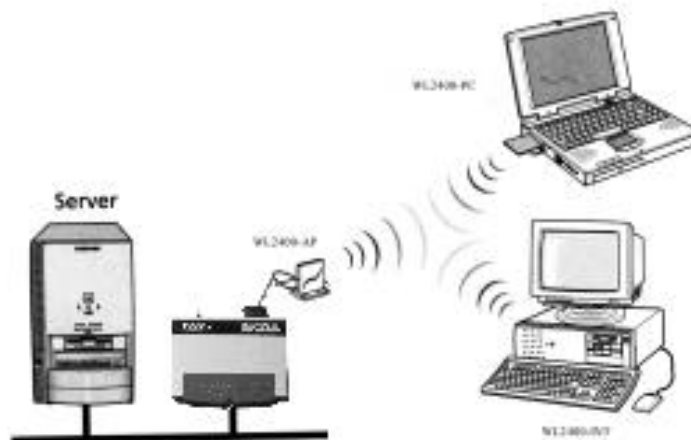
In larger networks where the manager wishes to have more control over connections and may wish to implement a radio cell organization in which each radio cell is on a different radio channel, StructureNet™ is a good choice.

If this is your first experience with the Access Point we recommend that you use Instawave for initial testing and, if required, change to StructureNet once you are satisfied with the operation of the wireless network.

To use StructureNet you must configure the AP-2 with “**mode: StructureNet**” and configure the mobile stations with the same ESSID value as on the AP-2.

## 2.4 Roaming

With multiple LAN Access Points installed, a user can roam from cell to cell and maintain a wireless connection to the server. For example, a user at location A will be served by cell site 1. At location B, either cell 1 or 2 will serve him. Likewise, when the user roams out of cell site 2, he will be picked up by cell site 3.



## SECTION 3. Hardware and Software Installation

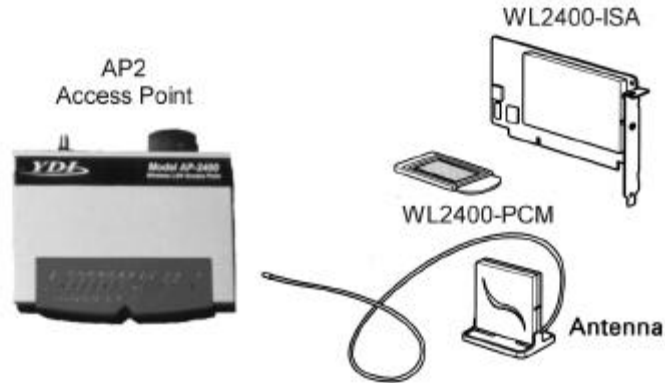
### 3.1 Unpacking and Inspection

After opening the box, verify that all components have been included and make sure there are no problems with your computer and network environment before the installation.

#### Package Contents:

1. WL2400-PCM or WL2400-ISA
2. External Antenna for WL2400-ISA or WL2400-PCM-J with antenna jack.
3. User's Manual
4. Network Driver





### 3.2 Hardware Installation

#### Desktop PC adapter card (WL2400-ISA)

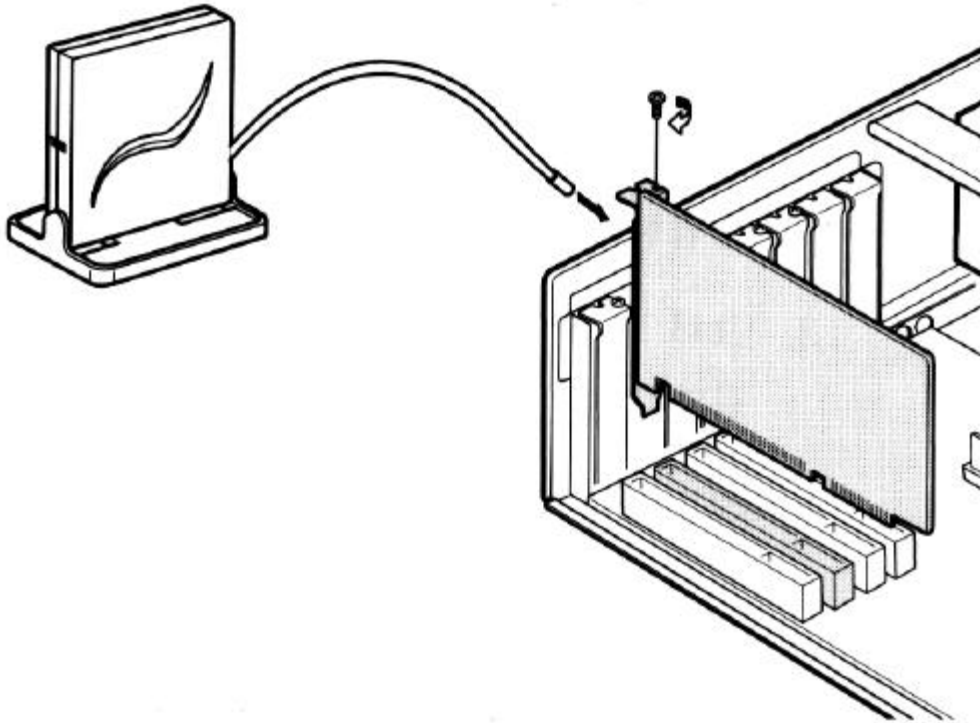
Before installing the ISA card, be sure that your system has a free IRQ available. If it does not, then one must be freed up in order for the card to work.

A. To find current IRQ assignments, follow this procedure:

1. On your Desktop, right click on "My Computer"
2. Select "Properties"
3. Select the tab labeled "Device Manager"
4. Double click on the "Computer" icon
5. View the IRQ list (default listing)
6. Under the "Setting" heading, verify that at least one IRQ is not being used.
7. If all of them (00-15) are taken, then you will have to disable one, for instance, one of your serial ports. Contact your hardware provider for information on how to do this.

**Next:**

1. Turn the PC off, remove the case, and take the Dummy Bracket off of an empty expansion ISA slot.
2. Carefully but firmly insert the Wireless LAN card into the PC slot and tighten the screw to mount the board into the PC case.
3. Now insert the antenna cable into the antenna port protruding from the back of the expansion card as shown in the diagram below.
4. Turn the PC on and confirm that the PC recognizes the adapter card by checking the 3 LEDs at the top left corner of the board, before you put the cover on the PC.



- Red LED: Power LED, lights when the computer turns on.
- Green LED: Blinks when receiving data.
- Orange LED: Blinks when transmitting data.

Note: Handle the card carefully! Be sure not to damage or break the surface mount LED's off the card when installing/removing the card!  
The card is operating normally when the green or orange LED blinks alternately, and the red LED stays steadily lit.

After inserting the card, install the device driver following the instructions in the Software Installation section. If a message that the PC failed to recognize the card appears, check the card by following the "Wireless LAN diagnostics" procedure.  
A WL2400-ISA supports ISA Plug and Play. The card is automatically recognized and installed in Windows 95/98 environment. If your system does not support the Plug and Play, you can use a utility for ISA PnP (not included in the package).



**WL2400-INT**



**WL2400-PC**

**card (WL2400-PCM)**

**Notebook-PC adapter**

You can insert the card into notebook-PC while the power is on or off.

1. Insert the adapter card into the PCMCIA slot.
2. If the notebook PC is not already on, power it up.

Normally, Windows will automatically detect the new hardware and prompt you for the drivers. Install the device driver following the instructions in the Software Installation section.



**3.3 Software Installation**

The following instructions should be used presuming that you have some networking experience. If not, you may have some trouble understanding and networking your computers.

**3.3.1 Windows 95/98 Driver Setup**

1. After you install the WL2400-PCM or -ISA, a wizard will appear to guide you through the installation process. Click "Next" and then "Have Disk" or "Specify Location".
2. Type "a:\win9598" at the Location prompt. Click "OK". If the driver is in the right location, click "Finish". The program may request files from the Windows 95/98 CD-ROM; make sure you have it nearby or already in the CD-ROM.
3. When a window appears requesting the location of the file "pcmbn3.sys" or "itcmd.vxd", type "a:\win9598".
4. Restart your computer when prompted.

**3.3.2 Windows NT Driver Setup**

1. Click "Start", "Settings", "Control Panel".
2. Double click the "Network" icon.

3. Click the “Adapters” tab, and click “Select Network Adapter”, then “Have Disk”.
4. Insert the provided disk, and specify the path “a:\windownt” then click “OK”.
5. When the program finds the driver, click “OK” at the next window.

### **3.3.3 Network Environment Setup**

1. Click “Start”, “Settings”, “Control Panel”.
2. Double click the “Network” icon.
3. Click on “WL2400 (IEEE 802.11)”, “Properties”.
4. Click on “Operating Mode”.
5. Select “Instawave”, and set the channel number to the one used by other wireless stations or Access Points that you want to communicate with.

### **3.3.4 TCP/IP Protocol Setup**

If you wish to use another protocol such as IPX/SPX, then skip this section.

#### **Installing TCP/IP**

1. Click “Start”, “Settings”, “Control Panel”.
2. Double click the “Network” icon.
3. You should see the line “TCP/IP -> WL2400 (IEEE 802.11)”.
4. If not, then click “Add...”, “Protocol”, “Microsoft”, “TCP/IP”, “Ok”.

#### **Manual TCP/IP configuration:**

If you have an access point that is attached to a LAN, which has a DHCP (Dynamic Host Configuration Protocol) server then you don’t have to do anything. Windows will automatically request configuration information from that server, such as an IP address, DNS server settings. The access point will forward DHCP messages and any broadcast messages.

If you don’t have a DHCP server, then you have to assign the configuration manually.

There are IP addresses that are reserved for private LAN use. No one in the Internet uses these addresses. They begin with 192.168.0.1 and end with 192.168.254.254. We will use them here.

If you have a gateway to the Internet, such as a stand-alone router, or a computer with a proxy server or modem sharing software, then you will need the gateway address of that computer. If you don’t have a gateway, then skip steps 5, 6 and 7.

To specify the configuration manually, do the following:

1. From Control Panel, Network, click on "TCP/IP -> WL2400 (IEEE802.11)", “Properties”.
2. Click on “IP Address”, “Specify IP Address”.

3. Enter the IP address 192.168.0.xxx, where xxx should be unused address, such as 1, 2, 3, up to 254. You should not use 0 and 255.
4. Enter the Subnet Mask 255.255.255.0
5. Click on "Gateway", add the gateway address. If you don't have a gateway, then skip steps 6 and 7. Proceed with step 8.
6. Click on DNS Configuration tab, Enable DNS, Enter "hostxxx", xxx should be the same as the IP address in step 3.
7. In "DNS Server Search Order" add the gateway address.
8. Click on Advanced tab; "Set this protocol to be the default protocol".
9. Click Ok.
10. Restart when prompted.
11. After restart. You need to make sure that you have correct settings. Go to "Start", "Run...", type "winipcfg". Select "WL2400 (IEEE802.11)". Click on "More Info>>", you should have the following settings:

|                 |                                      |
|-----------------|--------------------------------------|
| IP Address      | 192.168.0.xxx                        |
| Subnet Mask     | 255.255.255.0                        |
| Default Gateway | The gateway address entered or empty |
| DNS Servers     | The gateway address entered or empty |

12. If one is missing, it means that you did not press "Add" in one of the steps above.

### 3.4 System testing under Windows 95/98:

1. You need to setup file and printer sharing for Windows 95/98. You must use the same group name, and the same default protocol. Also, client for Microsoft Networks and File & Printer sharing must be installed and enabled.

To enable file and printer sharing under Windows, follow these steps:

1. Double-click on the **Network** icon from the Control Panel.
  2. Add "**Client for Microsoft Networks**" if it is not already listed.
  3. **Enable file and print sharing** by clicking on "File and Print sharing...".
  4. Click on the "**Identification**" tab.
  5. Type a **unique computer name**.
  6. The **workgroup must be the same** in all computers.
  7. Open "**Windows Explorer**", right click on any folder or the "C:" drive that you want to share.
  8. Click on "**Sharing...**", specify a share name, and the access type desired.
  9. Click **OK**.
  10. **Restart** your computer.
2. You should install the TCP/IP protocol if you did not do so already, and perform the procedure under section 3.3.4 "Manual TCP/IP configuration". You don't have to set a gateway address, or enable DNS at this time, but you can.

3. Open "MS-DOS Prompt" window, and type "ping 192.168.0.1" or "ping 192.168.0.2", this will send a request to the computer with address specified. It will send a response to your computer. If you see the message "Request timed out", then the other computer could be out of range or "TCP/IP -> WL2400 (IEEE802.11)" was not set as the default protocol.
4. Double click on "Network Neighborhood", you should see the other computer. If not, go to "Start", "Find", "Computer...", type the name of the other computer or any part of the name.

### 3.5 Antenna Installation

The WL2400 has been FCC Certified for use with the YDI Model AMP2440P and a variety of outdoor antennas.

Table (1) shows the FCC approved external antennas that can be used with and without the YDI AMP2440P. The AMP2440P and the YDI WL2400 WLAN cards must be professionally installed when used with an outdoor antenna or amplifier. It is the responsibility of the installer to ensure that when used in the United States (or where FCC rules apply) under Part 15 regulations, only these configurations are used.

Figure (1) shows the antenna cabling diagram for connection to an external antenna. Note that a special adapter cable is needed from the WLAN card to the transmission line to the antenna.

### 3.6 RF Exposure Safety Information

All antennas must be installed so that no person will be closer than the distances specified as outlined in the following table:

**TABLE (1)**  
**External Antennas Certified for use with the WL2400**

| <b>MODEL</b> | <b>DESCRIPTION</b>                  | <b>Minimum Safe Uncontrolled Exposure Distance</b> |
|--------------|-------------------------------------|--|
| Y2412        | 12 dB gain Yagi Antenna             | 20cm   |
| Y2414        | 14 dB gain Yagi Antenna             | 20cm   |
| A2.45 FP12   | 12 dB gain flat Panel Antenna       | 20cm   |
| A2.45 FP18   | 18 dB gain flat Panel Antenna       | 20cm   |
| A2.45 LP17   | 17 dB gain long Panel Antenna       | 20cm   |
| A2.45 LP15   | 15 dB gain long Panel Antenna       | 20cm   |
| A2408        | 8 dB gain Omni-directional Antenna  | 20cm   |
| A2412        | 12 dB gain Omni-directional Antenna | 20cm   |
| PT2421       | 21 dB gain Grid Dish Antenna        | 22cm   |
| PT2424       | 24 dB gain Grid Dish Antenna        | 32cm   |

Uncontrolled exposure distance is where the power density is  $1\text{mW}/\text{cm}^2$ . The antennas must be installed such that there will be no person closer than the specified distances in front of directional antennas or directly beside the Omni antennas. These distances apply only where ISA/PCM cards are used without the amp 2440 amplifier, since the RF output is only a maximum of 50mW to the antenna. When using an amplifier, refer to Table (1) in the AMP2440P Manual.

## APPENDIX A

### Brief Technical Description of the IEEE 802.11 Standard

802.11 is the standard for Wireless Local Area Networks (WLAN's) developed by the Institute of Electrical and Electronics Engineers (IEEE). It can be compared to the 802.3 standard for Ethernet wired LANs. The goal of this standard is to tailor a model of operation in order to resolve compatibility issues between manufacturers of WLAN equipment manufacturers. The YDI WL2400 models comply with standard for DSSS for use with BPSK modulation at a 2 Mbps data rate.

The Media Access Control (MAC) under 802.11 is composed of several functional blocks. These include mechanisms to provide contention and contention-free access control on a variety of physical layers. The functions within the MAC are independent of data rates or physical characteristics.

The fundamental access method of the 802.11 MAC is known as Carrier Sense Multiple Access with Collision Avoidance, or CSMA/CA. This technique works by a "listen before talk scheme". This means that a station wishing to transmit must first sense the radio channel to determine if another station is transmitting. If the medium is not busy, the transmission may proceed. The CSMA/CA scheme implements a minimum time gap between frames from a given user. Once a frame has been sent from a given transmitting station, that station must wait until the time gap is up to try to transmit again. Once the time has passed, the station selects a random amount of time (called a back off interval) to wait before "listening" again to verify a clear channel on which to transmit. If the channel is still busy, another back off interval is selected that is less than the first. This process is repeated until the waiting time approaches zero and the station is allowed to transmit. This type of multiple access ensures judicious channel sharing while avoiding collisions.

This scheme allows automatic medium sharing between several devices with compatible radio data link characteristics [i.e. the Physical Level (PHY)]. This access method is attractive because it provides spectral efficiency as well as asynchronous data transfer. Frequency Division Multiple Access (FDMA) and Code Division Multiple Access (CDMA) schemes would not be adequate because they require bandwidth used by the modulation scheme. Strict TDMA would not work well because it requires synchronization. Thus CSMA/CA, which may be thought of as a version of TDMA, is better suited to this application.

The Physical Level (PHY) under 802.11 includes diffused infrared (DFIR), Direct Sequence Spread Spectrum (DSSS), and Frequency Hopping Spread Spectrum (FHSS). Both spread spectrum techniques are used in the 2.4 GHz band because of wide availability in many countries and lower hardware costs in comparison to the higher microwave frequencies.