

# RADWIN 1000/2000



## Broadband Wireless Transmission System

### User Manual

Version 2.2a

# RADWIN 1000/2000

## User Manual

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# Regulatory Compliance

## General Note

This system has achieved Type Approval in various countries around the world. This means that the system has been tested against various local technical regulations and found to comply. The frequency bands in which the system operates may be “unlicensed” and in these bands, the system can be used provided it does not cause interference.

## FCC - Compliance

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications to this equipment not expressly approved by the party responsible for compliance (RADWIN Ltd.) could void the user's authority to operate the equipment.



**Warning**

It is the responsibility of the installer to ensure that when using the outdoor antenna kits in the United States (or where FCC rules apply), only those antennas certified with the product are used. The use of any antenna other than those certified with the product is expressly forbidden in accordance to FCC rules CFR47 part 15.204.



**Caution**

Outdoor units and antennas should be installed ONLY by experienced installation professionals who are familiar with local building and safety codes and, wherever applicable, are licensed by the appropriate government regulatory authorities. Failure to do so may void the product warranty and may expose the end user or the service provider to legal and financial liabilities. Resellers or distributors of this equipment are not liable for injury, damage or violation of regulations associated with the installation of outdoor units or antennas.



**Warning**

The antenna used for this transmitter must be installed to provide a separation distance of at least 200 cm from all persons and must not be co-located or operated in conjunction with any other antenna or transmitter.

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Indoor Units comply with part 15 of the FCC rules. Operation is subject to the following two conditions:



This product was tested with special accessories - indoor unit (IDU or PoE), FTP Cat 5e shielded cable with sealing gasket, 12 AWG grounding cable - which must be used with the unit to insure compliance.

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- (1) These devices may not cause harmful interference.
- (2) These devices must accept any interference received, including interference that may cause undesired operation.

### **Canadian Emission Requirements for Indoor Units**

This Class B digital apparatus complies with Canadian ICES-003.

*Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.*

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# Introduction

## Welcome!

Welcome to the RADWIN 1000/2000 radio series, designed for the IP and WiMAX Backhaul, Private Networks and Broadband Access global markets. The RADWIN 1000/2000 series is an innovation in high-capacity carrier-grade sub-6GHz radios, and designed to meet the requirements of current and next-generation markets and applications. RADWIN 1000/2000 also features software configurable antenna port activation enabling single (RADWIN 1000) or dual (RADWIN 2000) antenna port operation. The device configured as RADWIN 2000 has an advanced air-interface based on MIMO, antenna diversity.

The RADWIN 1000/2000 radio series offers unmatched performance and carrier-class quality with the following features:

- Superior spectral efficiency at 5, 10 and 20MHz channels
- High Ethernet capacity (up to 130Mbps at 20MHz channel bandwidth)
- Combo frequency products for maximum flexibility
- Advanced air-interface based on MIMO, built-in diversity and OFDM technologies
- Superior range performance
- Simple installation and management
- High Tx power

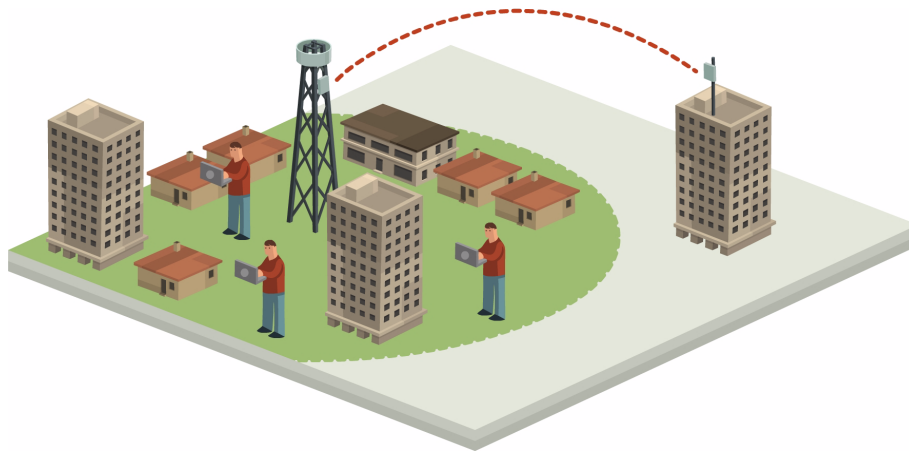
The RADWIN 1000/2000 radio series supports the 5.3, 5.4 and 5.8 GHz spectrum bands, and complies with international standards and regulations (FCC, IC Canada).

## Key Applications

### ***WiMAX and IP Backhaul***

The RADWIN 1000/2000 radio series offers WiMAX operators and ISPs a unique, highly scalable and cost-effective backhaul solution. Designed to suit a wide range of topologies, RADWIN 1000/2000 is easy to install and

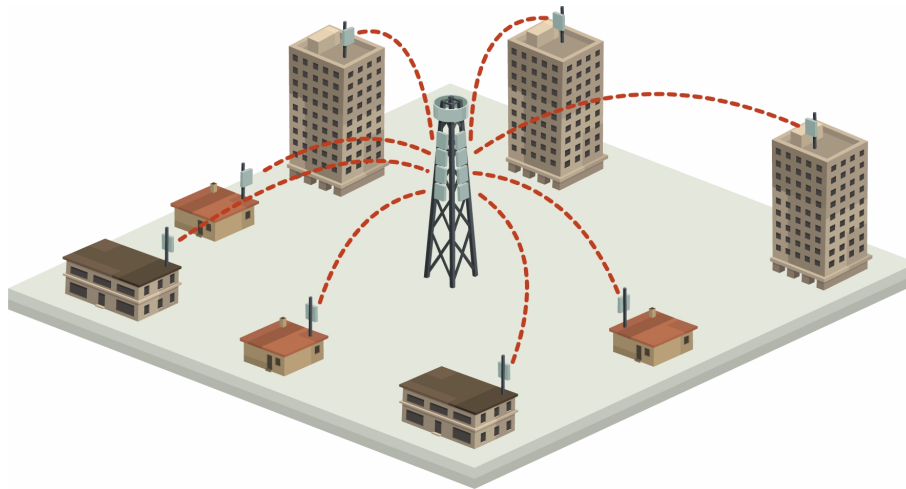
maintain, enabling operators to quickly and efficiently expand their networks and introduce new services to a growing subscriber base.



*Figure 1-1: Typical Wimax and IP Backhaul application*

## **Broadband Access**

With RADWIN 1000/2000, service providers can quickly and efficiently expand their networks, and provide high-capacity services that meet the increasing demand for high-quality, high-speed broadband.



*Figure 1-2: Typical Broadband Access application*

## **Private Networks**

RADWIN 1000/2000 is the ultimate solution for private networks such as enterprises, education, government and utility organizations that wish to own and manage their own networks and eliminate the costly recurring charges from service providers.

RADWIN 1000/2000's cost-effective solution enables a variety of organizations to connect geographically dispersed sites at ranges of up to 80km (50 miles).

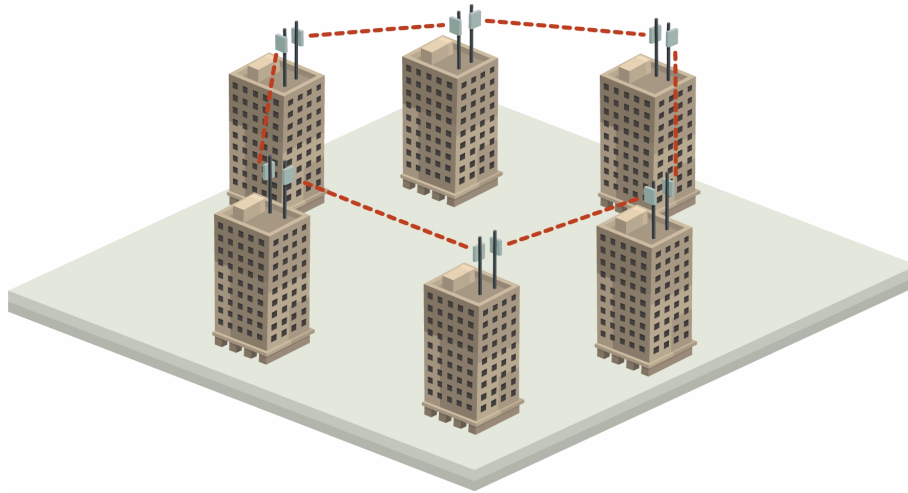


Figure 1-3: Private Network

## Key Features of RADWIN 1000/2000

Some of the outstanding features of the RADWIN 1000/2000 radio series are as follows:

⇒ **High Capacity**

The RADWIN 1000/2000 system provides a high-capacity link of up to 130Mbps at 20MHz channel bandwidth.

⇒ **Superior Spectral Efficiency**

Built on advanced MIMO and OFDM technologies, the RADWIN 1000/2000 system provides a high-capacity link at channel bandwidth of 20MHz. This channel bandwidth supports high robustness of the air interface under interference and harsh conditions. In countries where applicable, narrow channel bandwidth reduces the cost of the spectrum license.

⇒ **Advanced Air Interface**

The RADWIN 1000/2000 system provides an advanced air-interface based on MIMO, built-in diversity and OFDM technologies, resulting in an exceptionally robust air interface.

Using the following technologies, the RADWIN 1000/2000 air interface is designed to ensure nonstop, high quality transmission, even under interference and harsh conditions:

- Automatic Adaptive Rate (AAR) is a mechanism that dynamically adapts the air interface rate by changing both the signal modulation and coding.
- Automatic Channel Selection (ACS) chooses the best channel by monitoring the available radio channels and dynamically selecting a channel which is best suited for transmission at any given time.
- Automatic Repeat Request (ARQ) is a mechanism for error control during data transmission. When the receiver detects an error in the received information, it automatically requests the



transmitter to resend the information. This process is repeated until the transmission is error free or the error continues beyond a predetermined number of maximum transmissions. RADWIN 1000/2000's ARQ mechanism is optimized for time-critical traffic.

- Forward Error Correction (FEC) with very low overhead and algorithms specifically designed for the varying conditions of license-exempt frequency bands, ensuring fast, robust and error-free communications.

⇒ **High transmission (Tx) power**

The RADWIN 1000/2000 system supports high Tx power, compliant with radio regulations. High Tx power increases the system's availability and range, and enables the high performance with smaller antennas, thus reducing the total cost of the solution (lower CAPEX), installation and tower rent costs (lower OPEX).

⇒ **Superior range performance**

The RADWIN 1000/2000 system supports high capacity at superior ranges. The Link Budget Calculator (appendix D) is used to determine the capacity and range according to the choice of product, antenna, type of service and environmental conditions.

⇒ **Simple installation and management**

RADWIN 1000/2000 systems are extremely simple to install and maintain. They are typically up and running in less than an hour.

The RADWIN Manager application has full local and remote management capabilities. The user-friendly SNMP based management tool provides full end-to-end configuration, event logging, and performance monitoring capabilities.

⇒ **Enhanced Security**

The security features of RADWIN 1000/2000 include:

- RADWIN 1000/2000's AES 128-bit integrated advanced encryption support provides enhanced air interface security for carriers and private networks. It ensures user data protection with one of the most sophisticated commercially available combined encryption and authentication techniques, CCM/AES. This technique combines message authentication (preventing anti-spoofing and replay protection) with commercial encryption, and complies with the IEEE 802.11i (phase iii) security recommendations.

CCM/AES uses a symmetric 128-bit encryption key (EK), and a nonce, and provides both message encryption and authenticating signature. The nonce mechanism enables the receiver to remember already received genuine messages and reject all replayed messages.

- Initial encryption and authentication is based on a user-defined master key (Link Password). While standard Wireless LAN encrypts only the Ethernet Payload, the AES encrypts both the source and destination MAC addresses.

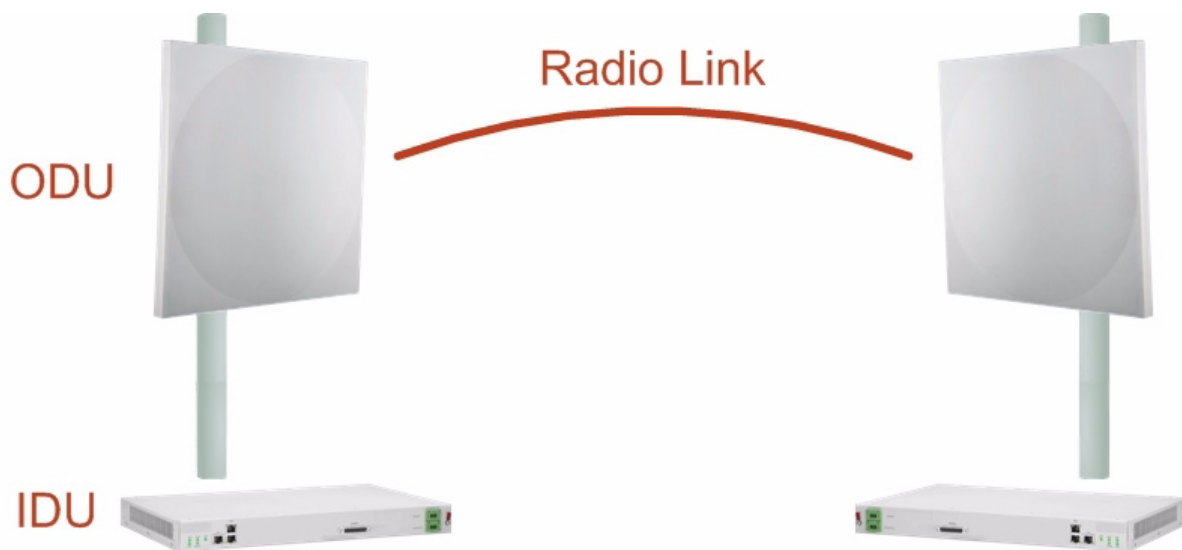
- In addition to normal login access, Read or Write Community access is available at login

## RADWIN 1000/2000 Link

The RADWIN 1000/2000 point-to-point solution is a wireless communication link. Typically each side of the link is comprised of an Outdoor Unit (ODU) and antenna and an Indoor Unit (IDU) or PoE device as shown in [figure 1-4](#) below.

The link is managed by the SNMP-based RADWIN Manager application.

The IDU and the ODU are connected by a CAT5e cable that carries the service traffic and power.



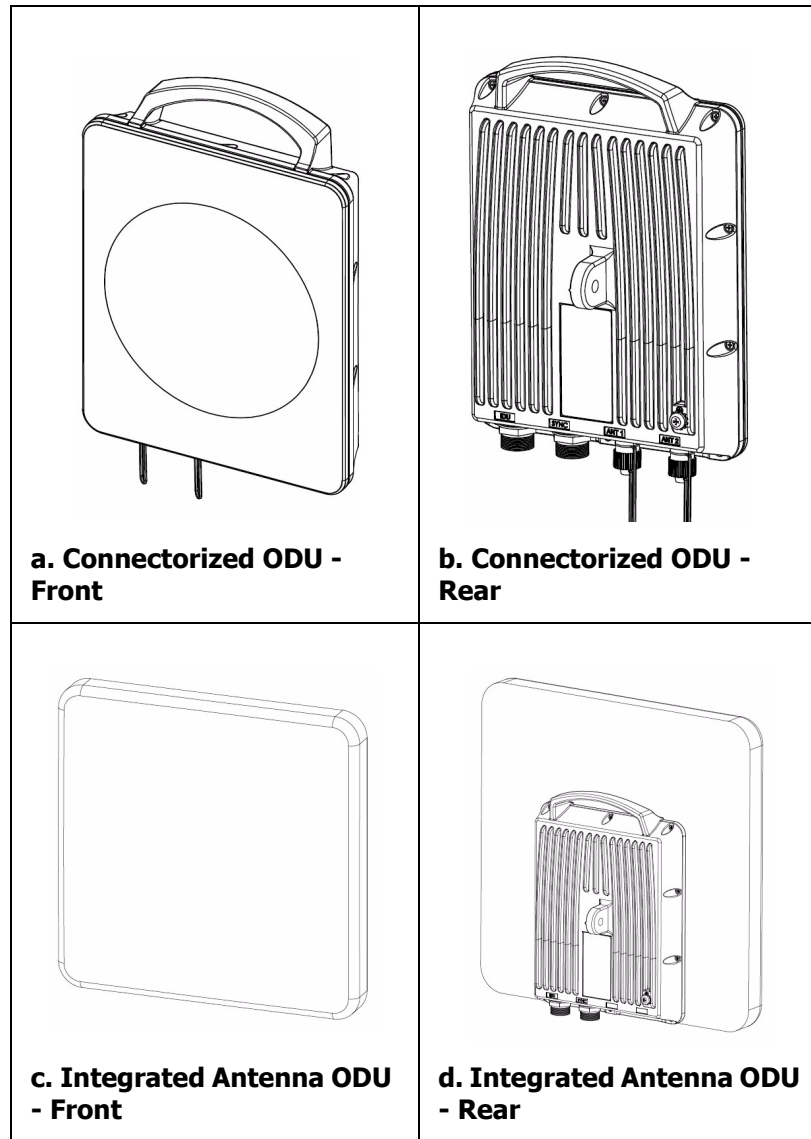
*Figure 1-4: Example of Link Architecture - System Components*

### **The Radio Outdoor Unit (ODU)**

The ODU is the radio transceiver of the RADWIN 1000/2000 system. It supports two radios for MIMO operation. It is available with an integrated antenna (***Integrated Antenna ODU***) or with connectors for an external antenna (***Connectorized ODU***).

The ODU may be mounted on a pole or a wall, and connects to the IDU or PoE device using a CAT5e cable.

The ODU comes in two form factors as shown in [figure 1-5](#) below:



*Figure 1-5: ODU Form Factors*

- **Integrated Antenna ODU**  
This ODU has an integrated 370mm (1.2ft) flat panel antenna, with a gain of 23dBi. The ODU contains both the radio and the antenna as a single unit housed in a weatherproof case.
- **Connectorized ODU**  
This ODU has 2x N-type connectors for connecting an external antenna.

The ODU products available in release 2.2a are shown below:

Table 1-1: Available ODU Products - Release 2.2a

Part Number	Description	
	Form Factor	Frequency Bands and Regulations
2050-0150	Integrated antenna	FCC/IC 5.725 – 5.850 GHz
2050-0250	Connectorized for external antenna (2x N-type)	FCC/IC 5.250 – 5.350 GHz
		FCC/IC 5.470 – 5.725 GHz

The only available external antenna is, single bipolar.

For further information, see [page 4-20, Installing the Link: Step 4, Tx Power and Antenna Settings](#).

### The Indoor Unit (IDU)

The IDU has the service ports and provides aggregation of these services towards the ODU that transports them over the air. The IDU also provides power to the ODU.

The IDU-C is a carrier-class 19 inch, 1U unit, providing two Ethernet ports, dry contact alarms and indication leds. It has two DC power feed connectors. An AC to DC converter is available for powering the IDU-C from an AC source. The IDU-C is designed to be rack mounted.

One IDU-C product is available in release 2.2a:

Table 1-2: Release 2.1 IDU-C Products

Part Number	Ethernet ports	Power	Form factor
7200-2000	2	Dual DC feed -20 to -60VDC	19" 1U



Figure 1-6: IDU-C Front Panel

## Power Over Ethernet (PoE) Devices

The PoE device provides Ethernet service only, with power for the ODU. The PoE device is extremely compact, having only two Ethernet ports and a standard 3 pin male AC power socket.



Figure 1-7: PoE device - showing the radio Ethernet port

## Antennas

An antenna is the radiating and receiving element from which the radio signal, in the form of RF power, is radiated to its surroundings and vice versa. The antenna gain and transmitting power may be limited by country regulations.

The RADWIN 1000/2000 may be operated with an integrated antenna that is part of the ODU unit, or with external antennas connected to the ODU via N-type connectors. All cables and connections must be connected correctly to reduce RF losses. The required antenna impedance is 50Ω.

The Integrated Antenna ODU is provided with 370 mm (1.2ft) flat panel antenna, with a gain of 23dBi. The radio and the antenna are housed in a weatherproof case as a single unit.



Figure 1-8: ODU with integrated Flat Panel antenna

External antennas are available for the RADWIN 1000/2000 radios, varying in operating frequencies, form factor, size and gain, dual or single polarization.


**Flat Panel Antennas**

The Flat Panel antenna shown in [figure 1-9](#) below has an integrated or external configuration:

	<b>Integrated or External 1.2ft Flat Panel Dual Polarization</b>	
	<b>Frequency</b>	4.9 - 5.875 GHz ( <b>Ext</b> ) 4.9 – 6.0 GHz ( <b>Int</b> )
	<b>Gain</b>	<b>External</b> 22.5 dBi at 4.9 – 5.25 GHz 23.5 dBi at 5.25 – 5.875 GHz  <b>Integrated</b> 21 dBi at 4.9 – 5.0 GHz 22 dBi at 5.0 – 5.15 GHz 23.5 dBi at 5.15 – 5.725 GHz 24 dBi at 5.725 – 6.0 GHz
	<b>Size</b>	1.2 x 1.2 ft / 371x371 mm
	<b>Beam Width</b>	H, V: 9° ( <b>Ext</b> ) H, V: 8° ( <b>Int</b> )

Figure 1-9: Flat Panel Antenna

## Parabolic Dish Antennas

	<b>External 2ft Dish Dual Polarization</b>	
	<b>Frequency</b>	5.150 - 5.875 GHz
	<b>Gain</b>	28 dBi
	<b>Diameter</b>	2 ft / 620 mm
	<b>Beam Width</b>	H,V: 5.6°

*Figure 1-10: External Antennas - Parabolic Dish*

See the RADWIN products catalog for RADWIN offering of external antennas. External antennas are also available from [authorized](#) antenna vendors.

### ***RADWIN Manager***

The RADWIN Manager is an SNMP-based management application which manages a complete link over a single IP address. It can also manage each side of the link separately.

The RADWIN Manager application facilitates installation and configuration of the link between the ODU units. The intuitive, easy-to-use RADWIN Manager has a graphical Microsoft Windows interface, and can be run locally and remotely.

The RADWIN Manager provides:

- Installation Wizard
- On-line monitoring of air interface quality allowing the administrator to monitor the service and status of each link
- On-line monitoring of equipment alarms and QoS
- Local and remote loopback testing
- Configuration settings
- On-line user manual and help files
- Link Budget Calculator for calculating the expected performance of the RADWIN 1000/2000 wireless link and the possible service configurations for a specific link range.

The RADWIN Manager can easily be integrated with any NMS system.

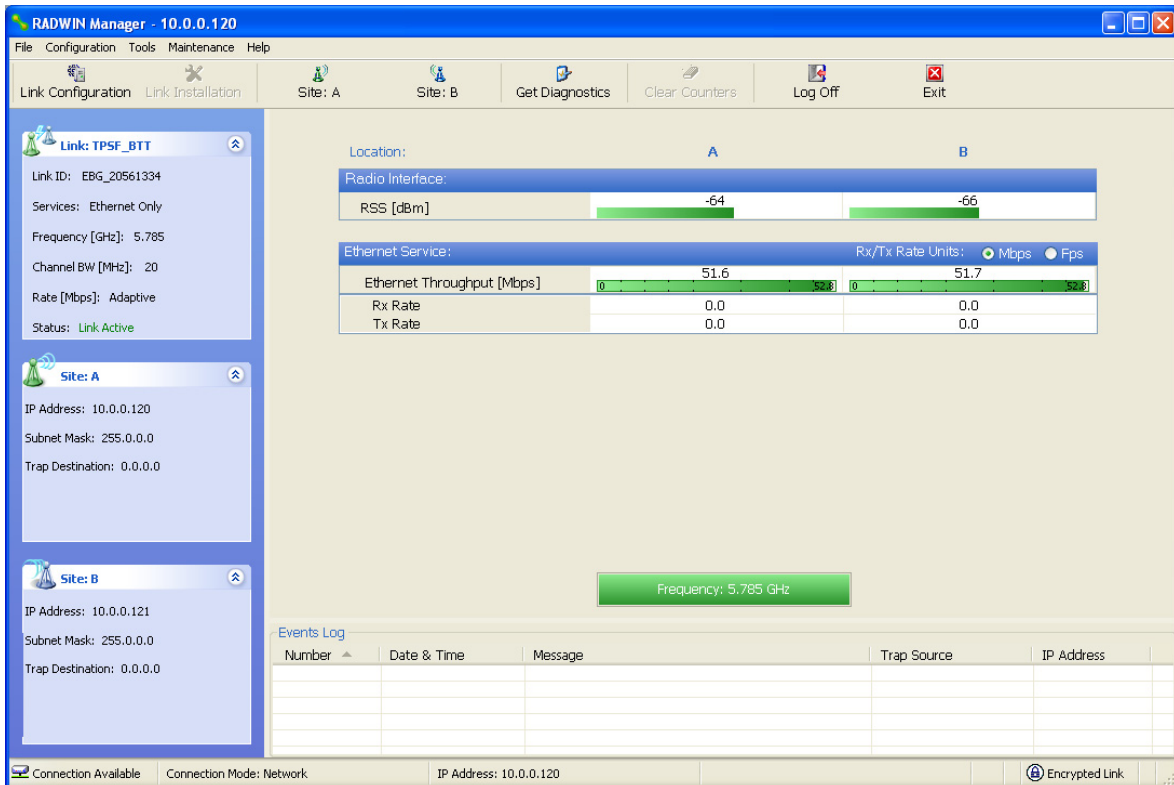


Figure 1-11: RADWIN Manager screen

## Accessories

RADWIN provides a variety of accessories to support the RADWIN 1000/2000 system:

- PoE devices
- AC Power Adaptor
- External Lightning Protection Unit
- Cables to connect the various system elements

## Documentation set supplied with RADWIN 1000/2000

The technical documentation supplied with a RADWIN 1000/2000 includes the following items:

- A Quick Start Guide for experienced installers
- A full User Manual - the document which you are reading



## How to Use this Manual

This User Manual is divided into functionally distinct chapters reflecting the activities required to set up a RADWIN 1000/2000. The division is shown in the following table:

Chapter/ Appendix	Subject	Audience
<b>2</b>	<b>Site Preparation</b>	Site survey team
<b>3</b>	<b>Hardware Installation</b>	Field technician
<b>4</b>	<b>Link Installation: The RADWIN Manager</b>	Installation technician
<b>5</b>	<b>Configuring the Link</b>	Installation technician, System manager
<b>6</b>	<b>Site Configuration</b>	Installation technician, System manager
<b>7</b>	<b>Monitoring and Diagnostics</b>	Installation technician, System manager
<b>A</b>	<b>Technical Specifications</b>	Installation technician, System manager
<b>B</b>	<b>Wiring Specifications</b>	Installation technician
<b>C</b>	<b>Pole and Wall Installation</b>	Installation technician
<b>D</b>	<b>Link Budget Calculator</b>	Installation technician
<b>E</b>	<b>Lightning Protection and Grounding Guidelines</b>	Field technician
<b>F</b>	<b>MIB Reference</b>	System manager
<b>G</b>	<b>External Alarms Specification</b>	Installation technician, System manager, Field technician
<b>H</b>	<b>Combo Configuration Tool</b>	Installation technician

## A Little Terminology

In the field, a link typically has a local or headquarters site as for example in [figure 1-2](#) above. Here the service provider is the local or headquarters site. The service recipient is the remote site.

Where the link is completely internal to a corporation, the choice of the local and remote is just a matter of convenience.

A *link* then, consists of two *sites*.

In Broadband Wireless terminology, the local and remote sites are sometimes referred to as "near" and "far", "HQ" and "remote" and so on.

The site which is closer to the network core (often the local site) will be referred to as *site A*, and the opposite side of the link, usually closer to the end user, as *site B*.

This choice is application-neutral and will be used throughout the manual both to describe the sites and their names as in the examples.

The link is configured and managed using a PC, the *managing computer* connected to site A. (The precise requirements for the managing computer are set out in [chapter 3, Hardware Installation](#)).

RADWIN 1000/2000 supports three connection methods for the managing computer:

- **Local** - a direct peer to peer connection between the Ethernet ports on the managing computer and the IDU or PoE device. Local connection is always read-write.
- **Network** - the managing computer and the site A IDU or PoE device belong to a LAN and communicate through a router or hub
- **Over-the-air** - the managing computer connects to site B via the air interface

The managing computer may be connected to the link through an IDU or a PoE device. In what follows, where ever we refer to an IDU it includes PoE devices unless stated otherwise. Typically, if we need to refer to an IDU as such, we will use a model name such as IDU-C.

## Conventions Used in this Manual

### **Notifications**

Notifications consist of Notes, Cautions and Warnings.



The purpose of a **Note** is to

- Draw your attention to something that may not be obvious or counter-intuitive
- Emphasize a special feature or peculiarity of the RADWIN 1000/2000
- Offer an external reference for additional information
- Add a caveat that would not qualify as a full Caution or Warning (see below)
- Provide additional background to what follows
- Offer a recommendation
- Highlight an indication of something to watch out for
- Advise you if an action has "side effects" i.e. it may disturb something else that would be best left undisturbed
- Remind you of something that should be kept in mind



A **Caution** is a notification of risk of damage to equipment or of service degradation



A **Warning** is a notification of risk of danger to persons operating near the equipment

### **Typographical conventions**

#### **General**

Where a term is defined or introduced for the first time, it is shown in Bold-face. You will have noticed this usage in the Terminology section above.

#### **Software**

The RADWIN Manager is a Microsoft Windows application following the user interface conventions of familiar Microsoft Windows programs.

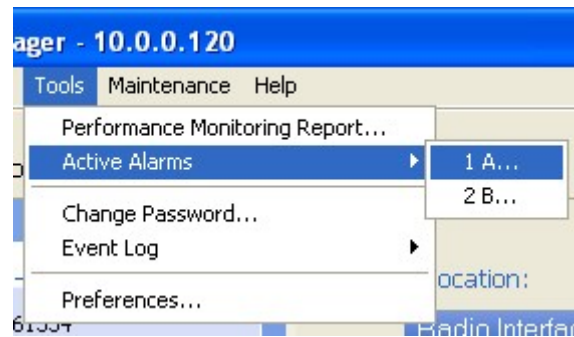
We would describe the chain of menu commands indicated in the following screen shot, like this:

#### **Tools | Active Alarms | 1 A**

using Boldface for the menu labels and vertical bars to separate them.

Similarly, mouse click items will be referred to like this:

“Click **Next** to continue.”



(A mouse click always uses the left mouse button unless stated otherwise.)

## **Windows Terminology**

Look at [figure 1-11](#) above. The main application display which you see consists of a frame-window with a menu bar, system icons and content. It will be referred to as a **window**, the **main window** or the Manager window depending on context.

The top line of icons is the **tool bar**, and provides part of the menu bar functionality with a mouse click.

At the bottom of the window is the **status bar**, a line of icons and text boxes.

The central part of the main window consists of several **panes**: On the right, there are Radio Interference, Ethernet Service and the Frequency panes. The left hand pane (with the blue background) is split into three sub-panes.

If you click Site A or Site B in the tool bar, you will be offered another window, which in turn displays one of several **panels** depending on which function you choose.

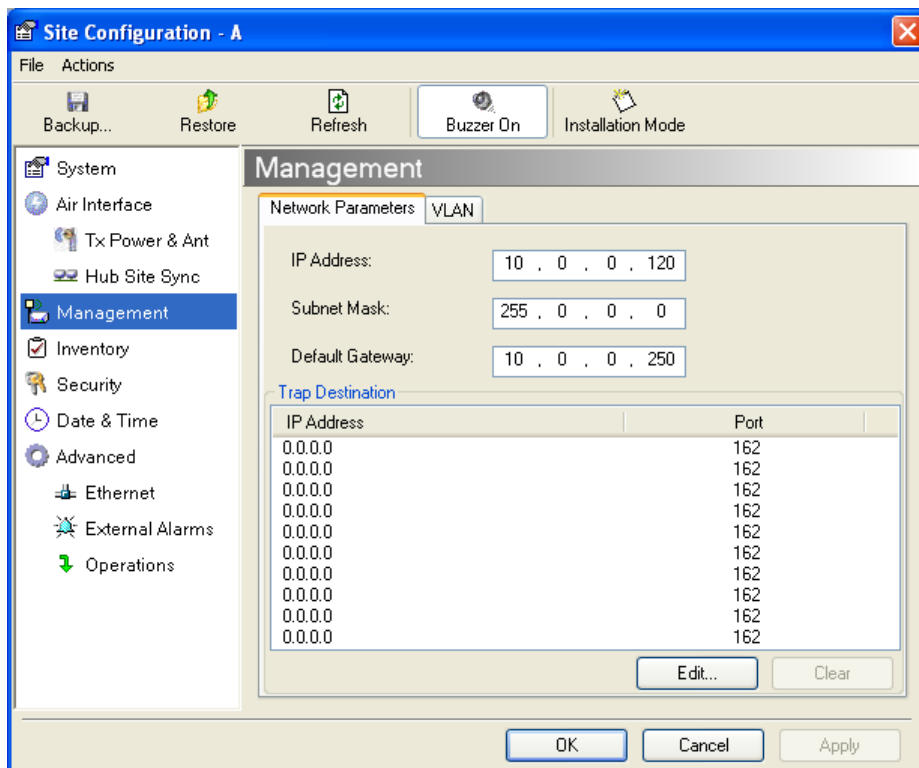


Figure 1-12: Site Configuration window with open Management panel

# Site Preparation

## Planning the Link Site

### *Overview*

Link site planning consists of a set of surveys, which must be carried out before any equipment is brought to the site. If for some reason, the outcome of any of these surveys is negative, site re-location will need to be considered.

A Site Survey consists of three stages:

1. Preliminary survey - The proposed link is analyzed **in the office** using a topographic map.
2. Physical survey - The locations of the RADWIN 1000/2000 indoor and outdoor equipment are determined **on-site**.
3. Radio Frequency (RF) survey - It is recommended that the installation area be scanned with a spectrum analyzer, to identify RF interference so as to determine a clear channel for RADWIN 1000/2000 installation (**on-site**).

## The Site Survey

### *Introduction*

RADWIN 1000/2000 wireless links must be planned before installation. The designated installation site must be appraised to determine that the wireless system is able to operate efficiently and provide connectivity without signal degradation.

RADWIN 1000/2000 offers a wide operating frequency range. A free frequency channel must be determined within the operating range, for optimum performance.

### *Recommended Equipment*

#### *Stage 1: Preliminary Survey*

- Topological map of the area

- Urban map of the area
- Compass

**Stage 2: Physical Survey**

- 100 meter tape measure
- Ohmmeter, to check ground connection
- Binoculars
- Map
- Digital camera
- Paper, pencil, and a clipboard
- GPS device (optional)
- Compass (optional)

**Stage 3: RF Survey**

- Spectrum Analyzer with Max Hold function and screen capture facility that can store multiple images, for documentation purposes
- RF accessories (connectors and cables)
- Communication devices (for example, cellular phones, or a set of walkie-talkies)

## Stage 1: Preliminary Survey

A preliminary survey is necessary before visiting potential installation sites. As much detail as possible should be obtained about the two designated ODU installation sites and the area between them.

➤ **To perform a preliminary survey:**

1. Mark the two designated installation sites on a topographic map of the area.
2. Measure the distance between the sites; check that it is within the specified range of the RADWIN 1000/2000.
3. On the urban map, check for developed areas situated between the two installation sites. Pay attention to these areas when performing the physical site survey; there may be tall buildings, RF towers, or transmitters, which could cause interference to the link.
4. Check the area between the two sites for obstructions such as:
  - High ground - hills or mountains
  - Lakes or large bodies of water. Water has a reflection effect on RF signals like a building. This type of reflection causes the received amplitude to be reduced. As a rule of thumb, the presence of a large body of water between the link sites may double the required antenna height.
5. Determine and record the compass bearings between both ODUs, relative to north.
6. If there are obstructions between the two sites, calculate the Fresnel Zone (see appendix **D** for details).

7. If the site chosen does not meet requirements, consider alternative sites.
8. Use the Link Budget Calculator (on the CD supplied with the RADWIN 1000/2000 or using the RADWIN Manager) to determine the expected performance.

## Stage 2: Physical Survey

The physical site survey reviews the environment of the proposed RADWIN 1000/2000 installation location, to ensure that the link sites are suitable for the wireless network. The results of the physical site survey should be recorded.



### Note

It is advisable to go on a clear day, so you can more easily see any obstructions between the two sites.

### ➤ To perform a physical survey:

1. From the compass readings taken in the preliminary survey, find the azimuth (horizontal position) that the ODU should face towards the second ODU.
2. Using binoculars, locate any obstructions such as tall trees, high buildings, hills or mountains. Look for other RF towers between the two sites. Mark the locations of the obstructions on the map.
3. Determine the location for the ODU (having regard for existing rooftop installations and tower space). It should be above any obstructions, considering the Fresnel zone (see appendix D).
4. If you need to install the ODU on a tower, make sure that the tower is far away from overhead electric power lines.
5. Determine a location for the indoor equipment; it should be as close as possible to the ODU. At an existing site, there is probably an equipment room with cable-routing channels.



### Note

The IDU - ODU cable length limit is 100m, in accordance with IEEE 10/100BaseT standards.

6. Measure and record the path length of the cable from the ODU position to the indoor equipment room.
7. Determine the ground and lightning connection points of the installation. The RADWIN 1000/2000 ODU and IDU must both be grounded.
8. Using the Ohmmeter, measure and record the resistance of the required installation to the grounding point. The resistance must be less than 10 ohm.



9. Review the results of the physical site survey. Decide if the site is suitable for the RADWIN 1000/2000 wireless network installation.
  - If the site is suitable, continue with stage 3, the RF survey
  - If the site is not suitable, survey another site

### ***Additional Outdoor Site Requirements***

The ambient outdoor operating temperature should be -35 to 60°C (-31 to 140°F).

### ***Additional Indoor Site Requirements***

The following requirements guarantee proper operation of the system:

- For IDU-C units, allow at least 90 cm (36 ") of front clearance for operating and maintenance accessibility. Allow at least 10 cm (4 ") clearance at the rear of the unit for signal lines and interface cables
- The ambient operating temperature should be 0 to 50°C (32 to 122 °F) at a humidity of up to 90%, non condensing

## **Stage 3: RF Survey**

The RF survey examines the wireless environment of the RADWIN 1000/2000 installation site, to determine whether there are available channels within the RADWIN 1000/2000 operating frequency band. An RF survey is performed using a spectrum analyzer.

It is advisable to familiarize yourself with the spectrum analyzer before going out on site, specifically the Max Hold and Marker functions.

You should perform the RF survey at both proposed link sites.

The survey should be carried out during a busy time of day, to best judge the worst-case radio interference. Allow 2-4 hours duration for a good RF survey.



#### ***Note***

---

It is possible to install the RADWIN 1000/2000 link and use the RADWIN Manager to find a clear channel. Each frequency channel can be evaluated in turn. Achievement of a clear channel is indicated by the Quality bar on the Channel Setting window (see [figure 4-13](#)) becoming green.

---