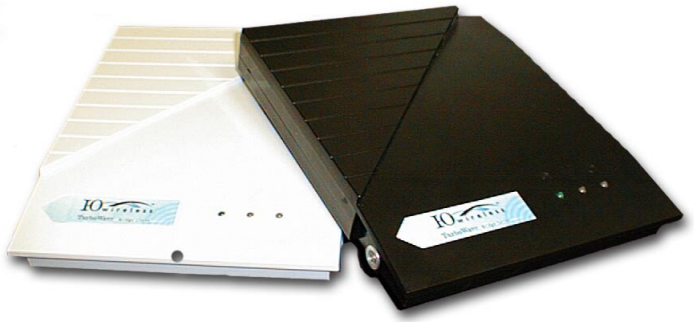

LAN to LAN Bridge
User's Guide

Models WBS11 & WBC11

Version 1.0 October 2001

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TABLE OF CONTENTS

1 Introduction

Thank you for purchasing the I-O Wireless LAN to LAN Bridge. This manual will assist you with the installation and use of the bridge.

1.1 Product Introduction

A wireless LAN to LAN bridge is used to create either a point-to-point or a point-to-multipoint link between two or more local area networks.

Due to the complexity of installing a wireless bridge, *always make sure a professional installs the bridge link.* A professional installer not only provides you with an optimized link; he also supplies you with a professional mechanical installation.

The professional installer covers the following areas:

- Network link installation
- Mechanical installation
- Weather resistant installation
- Lightning proof installation

By covering all these areas the installer will provide you with a link that has the highest possible uptime. He will also take away every possible chance of damaging your network.

In order to establish a link between two or more networks, it is essential that the antenna of the server and the antenna of the client be in line of sight. Chapter 2 will define line of sight in depth and explains the installation of the antennas.

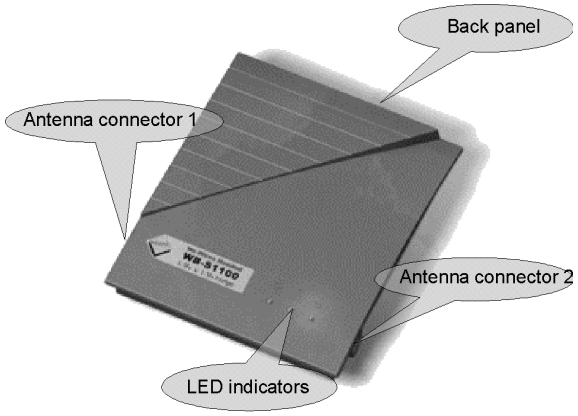


Figure 1.1:The bridge, the connectors and indicators

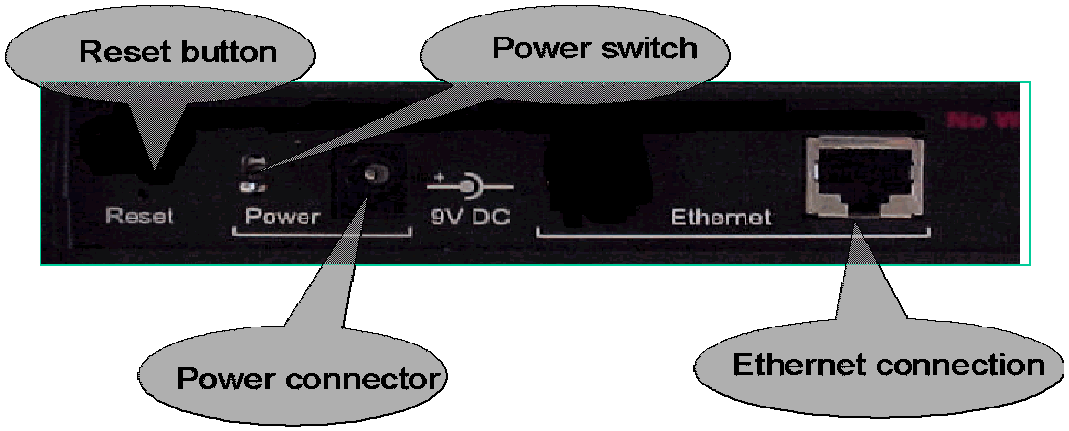


Figure 1.2: The back panel of the wireless bridge

HINT: Before you start, write down the MAC addresses of all bridge units. These addresses are located on the backside of the unit and are difficult to access after installation.

1.2 What is Included

The package you have received contains the following items:

- Bridge server unit and/or Bridge client unit
- Antenna adapter cable
- Power supply
- CD-ROM containing the bridge configuration software and user's guide
- Antenna (if ordered)

It is the customer's responsibility to perform site surveys and supply all mounting hardware, antenna cabling, lightening protection devices, etc. that may be required to effect a secure, reliable and successful installation.

1.3 Installation Overview

The steps involved in installing the I-O Wireless LAN to LAN Bridge are:

1. Review this user's guide – pay specific attention to Chapter 2.
2. Determining the location for the antennas and bridge units.
3. Determining the availability of power and access to the Ethernet LAN.
4. Installing the antennas and running the antenna cable to the bridge units.
5. Connecting the bridge units to the antenna cable, Ethernet LAN and power.
6. Installing the bridge configuration software.
7. Configuring the bridge server unit.
8. Configuring the bridge client unit(s).
9. Tuning the antenna alignment.
10. Fine tune the bridge communication values (if needed)

1.4 Hints for a Successful Installation

- Have your wireless bridge installed by a professional.
- Thoroughly test all antenna and network cables before connecting the bridges.
- Make certain to keep the antenna cable as short as possible and use "low noise" cable such as LMR-400.
- Make certain that the SSID is entered exactly the same in all bridge units.
- Make certain that the IP address, sub-net masks and gateway address coincide with your network addressing plan.

This user's guide is designed to provide you with information necessary to accomplish a successful installation of your I-O Wireless LAN to LAN Bridges.

2 Hardware Installation

This chapter describes:

- The installation of the antennas
- The installation and configuration of the bridge units
- Connecting the antennas to the bridge units

Before starting the installation, some understanding of antennas and their behavior is necessary. In the following chapter the most important characteristics are explained. If you are not familiar with antenna technology please take a few minutes to read this information and understand more about antenna installation.

***Note**: Detached antennas, whether installed indoors or out, should be installed ONLY by experienced antenna 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 I-O Product Warranty and may expose the end user to legal and financial liabilities. I-O and its resellers or distributors are not liable for injury, damage or violation of government regulations associated with the installation of detached antennas.

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

2.1 The Antenna Installation

2.1.1 Radiation Diagram

The bridge units are supplied with a choice of two different antennas.
The type of antenna used depends on the type of link (point-to-point or point-to-multipoint) and the required range. All antennas are directional by nature; they cannot be made to radiate uniformly in all directions. Therefore, antennas are designed with controlled properties to guide available RF energy in the desired direction. This directivity multiplied by antenna efficiency is gain. Gain is expressed in decibels relative to a hypothetical isotropic source that radiates uniformly over a spherical surface. Figure 1.1 displays the radiation pattern of an antenna with the gain referenced to an equivalent isotropic source. The gain of the isotropic source is the unity or zero decibels. Depending on the directive behavior of an antenna and the site requirements, the type of antenna is chosen.

This diagram displays the radiation power versus the direction. Figure 2.1 displays the radiation diagram of a Stub Loaded Helix (SLH) antenna.

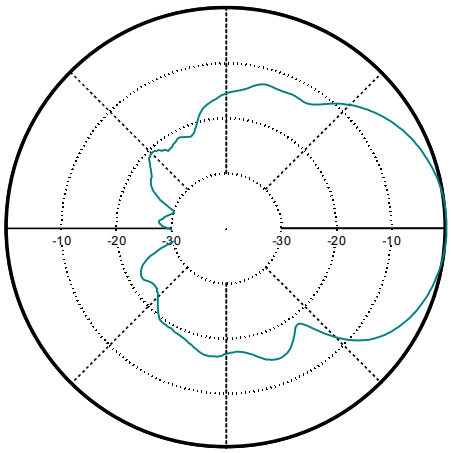


Figure 2.1 The radiation diagram of a Stub Loaded Helix (SLH) antenna

The more directive an antenna is, the more gain an antenna has in one specific direction. Installing an omni directional antenna for a point-to-point link is inefficient, unless the range between the two antennas is short. In such a case the choice for an omni-directional antenna is a purely economical.

2.1.2 Multi path

2.1.2.1 Polarization

Direct Sequence technology is more sensitive for multi-path effects than the traditional Frequency Hopping. Multi-path effects can be explained as coherent signals (signals from the same source) arriving at the antenna at different times due to the difference in path length. Several signals from the same source meeting at the receiving antenna can arrive in phase, out of phase or in between. When the level of each incoming signal is included, the effects can be any of the following:

Level	**Phase**	**Result**
Equal	In	Strong reception
Unequal	In	Good results
Equal	Out	Possible loss of reception
Random	Random	Variable levels

The conductivity of the reflector and polarization of the wave before reflection primarily affect the level of the signal. Horizontal polarized signals, which are parallel to the reflecting surface, will reflect almost totally without appreciable loss at the point of bounce.

Vertically polarized signals are perpendicular to the reflecting surface, and will either be totally reflected from a conductor, or will propagate along the surface (depending on the angle of the arriving energy). Since radiated waves penetrate loose materials, energy can be lost to heat generation.

Circularly polarized signals are composed of a combination of vertically and horizontally polarized signal which are in phase quadrature (offset 90°) with each other. Depending on their phasing, the sense of circularly polarized signals are described as right-handed or left-handed. Circularly polarized signals have the unique property that the sense changes upon reflection. Thus, a right-hand circularly polarized signal becomes left-handed upon reflection. A circularly polarized antenna will only respond to one sense, either right or left, depending on its design.

By using circular polarization, the effect of multipath interference can be greatly reduced. This makes setting up wireless links easier and more reliable than when using horizontal or vertical polarization. I-O bridge products use circularly polarized antennas exclusively.

2.1.2.2 Refraction

The velocity of RF energy is slower in dielectric materials that are denser than dry air. The result is refraction, or the change of direction of propagation as radio waves pass through these materials. The time spent in the denser material controls the degree of refraction and the resulting direction of the emerging wave.

2.1.2.3 Diffraction

Perfect shadows that are cast by RF-opaque structures or objects are rare at wireless system frequencies. Because of diffraction, energy scatters at the edges of the obstruction. Diffraction is more pronounced in sharp or knife edged corners. According to field theory, edges cause secondary radiation when illuminated. This is generally independent of polarization when the scatterer is much longer than the impinging signal's wavelength.

Diffraction forms a fuzzy signal source at the edges, which tends to fill in the shadowed regions. The signal levels are low but often usable. These edges can be corners of a building, window frames or large vehicles. Diffraction also figures significantly in scattering at hilltops lying in the propagation path.

2.1.2.4 Locating the Antenna

Free space radiation patterns are the baseline performance criteria before installation in the real world environment. Since sites are located on rooftops, or on the side of buildings; many opportunities exist for interference from chimneys, walls, masts, towers and other antennas. Although it is difficult to predict level changes you can take steps to minimize pattern distortion.

Obstructions are either conducting or non-conducting. Conducting objects create the most severe disturbances. Those near the resonant length of the antennas, such as other antennas, behave as the parasitic elements of an uncontrolled array, producing random nulls and lobes. Larger conducting structures causes severe shadowing. The closer the spacing, the larger the shadow.

Locate the antenna as far from other conducting objects as feasible. In particular, avoid placing the antenna where obstructions are within the view of the antenna main beam. For highly directional antennas, the presence of conductive objects in the rear lobe of the antenna is not critical.

2.1.3 Free space losses

Spreading is the principal contributor to signal loss for line of sight propagation. As a signal radiates it spreads or expands into a spherical surface. The available RF power is distributed over this surface and weakens with increasing range. The signal is reduced by 6 dB for every doubling of distance from the source. The loss path between the source radiators with spherical patterns is computed using the following equation:

$Lp(dB)= 92.45 + 20*\log_{10}(F)+20*\log_{10}(d)$

Lp = Path loss
F= frequency in GHz
dB = decibels
d= Distance in kilometers

Example:
A distance of 6 kilometers provides a free space loss of 115.67 dB at 2.4 GHz.

2.1.4 Line of sight

Radio signals generally require a clear path between antennas. It is necessary to know the requirements of a clear path (known as ‘line of sight’).

Line of Sight (LOS) means a bit more than the words say. Of course the first condition for a LOS link is that the two antennas can be connected with an imaginary straight string. There should never be any object blocking this line. Achieving this with a short link is fairly easy. Long links, however, can cause problems. As well as binoculars and a compass, a large calibrated tether balloon can be used for determining line of site. Letting this balloon up on one side until it is visible from the other side will tell you exactly the required height for this link. Repeat this for both sides.

Besides the LOS there is the Fresnel zone. This zone is an elliptical area immediately surrounding the visual path. It varies in thickness depending on the length of the signal path and the frequency of the signal. The necessary clearance for the Fresnel zone can be calculated, and must be take in account when determining the height of the antennas.

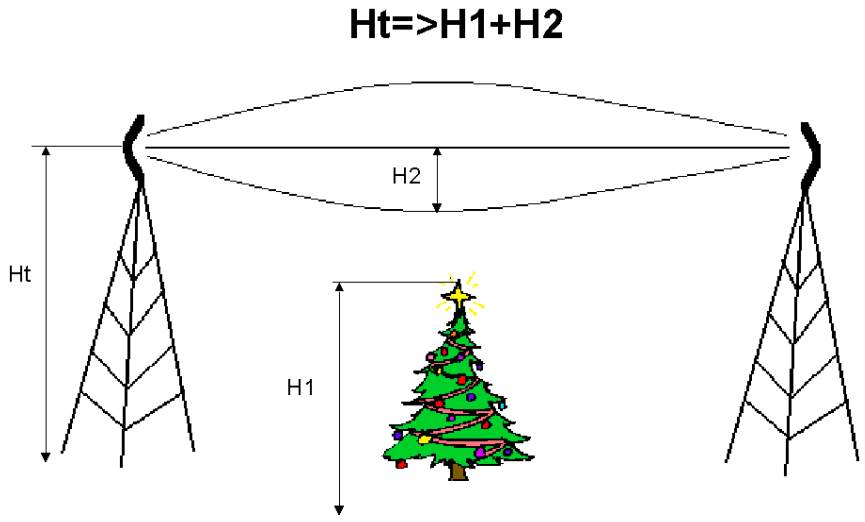


Figure 2.2 Line of Sight and the Fresnel Zone

A rule of thumb for the clearance needed above and below the signal path (H2) is that for every 1.5 km, a clearance of 4 meter is necessary. A result of this rule is that large distances need great heights.

2.1.5 The link budget

For each link, a 'link budget' needs to be made. The link budget will calculate the signal level through the link, and predicts the signal level at the receiver's side. Within the 'link budget' there are a few parameters that are influenced by the location of the link. These are humidity and terrain roughness. The length of the link also has a major influence on the 'link budget'.

An example:
We want to bridge a point-to-point distance of 2.5 Km over average terrain in a dry climate. The bridge must perform at 11Mbps.

To be able to do this, we first select the components we need. This is the long-range bridge and a high gain helix array antenna.

The output power of the long-range bridge is (Pout): 10 dBm
Antenna gain is (Gt): 16 dBic
Cable loss and connector loss is (Cr): 4.5 dB

Therefore, the EIRP (effective isotropic radiated power) is:

EIRP= Pout + Gt - Cr
EIRP= 10 + 16 – 4.5
EIRP= 21.5 dBm

The free space loss is the attenuation of the signal power travelling through air.

$FSL= 20*\log_{10}(F) + 20*\log_{10}(d) + 92.45$

Where:
FSL= Free space loss
F= Frequency (Ghz)
d = Distance between antenna (Km)

Our example gives
$FSL= 20*\log_{10}(2.4) + 20*\log_{10}(2.5) + 92.45$
FSL= 108.01 dB

Then the antenna on the other side of the bridge will receive the signal. This antenna has the same gain (16 dBic) as the transmitting antenna. The signal received by the antenna will suffer the same attenuation on the cable, (4.5dB). So the signal strength at the receiver can be calculated as follow:

Pin= EIRP – FSL + Gr - Cr

This results in:

Pin = 21.5 – 108.0 + 16 – 4.5

Pin = -75.0 dBm

This signal is a calculation under ideal circumstances, however, the radio path can be disturbed by weather conditions, or antennas can suffer degradations. For this there is a safety margin included. This margin is called the FADE margin. Many factors can influence the fade margin; it is safer not to be optimistic about it. A valid value is approximately 5dB.

This results in a signal level of –80 dBm. The receiver requires a minimal level of –84.1 dBm to perform at the highest bitrate. Therefore, we can conclude that this link will work.

2.1.6 Mechanical Installation of the Antenna

A solid mechanical installation of the antenna is the base of a quality link. An outdoor mounted antenna is exposed to extreme weather conditions. Metal brackets oxidize, and vibrations will cause slack on connections. Therefore, the mechanical connection between the antenna and its carrier needs to be solid. Use locktite on screws. The connector between the cable and the antenna needs to be sealed with threading tape. Corrosion on the connector will cause signal losses due to changing impedance of the connection.

Outside mounted antennas are lightning strike sensitive. Lightning strikes always are common at highest and smallest point, typically an antenna. The antenna cable will then conduct the enormous amount of energy towards the bridge. If no lightning arrestor is placed in-between the antenna cableand the bridge, the bridge unit will be damaged, or worse, set on fire. Therefore, always use a lightning arrestor.

When placing the antennas the following points should be kept in mind:

- Place the antenna above conducting objects and in the clear
- Place the antenna always on the edge of a roof or mounted on a wall
- With an outdoor installation of the antenna, always use a lightning arrestor
- Make sure that the mounting of the antenna can handle high forces. Wind can cause misalignment or even permanent damage
- Keep the cable length between the antenna and the bridge limited to the minimum. Every meter of cable causes signal loss
- Antenna cable should be a low noise cable such as LMR-400

2.1.7 Antenna Installation Hints

1. Contract with a professional for antenna installation

2. Determine the antenna location

    - Line of sight
    - Make sure your antenna fits the range
    - No large conducting objects in the area
    - No other antennas close
    - When mounting on a pole: Let the antenna rise above the pole
    - Remember that trees grow!

3. Mount the antenna

    - It can never be too solid
    - Use Locktite with screws
    - Seal connectors with threading tape
    - Use a lightning arrestor
    - User low noise cable such as LMR-400, LMR-200, or LMR-195.

4. After installation

    - Double check

2.1.8 Lighting protection

Lightning strikes can cause major damage on equipment and buildings. An antenna placed on a roof is often the place of strike. Dish antennas mounted against a wall are less risky. The cable conducts the lighting into the building. Due to this behavior an antenna installation requires dual protection. The antenna needs to be grounded, and the cable requires a surge protector.

Contact a local lightning specialist for advice on grounding. Below are some general hints on lighting protection:

- Never mount an antenna though the roof, only on the roof
- Keep the antenna cable as much as possible out doors
- The cable shield needs to be grounded on the highest possible point, and at the point of entering the building.
- Place a surge protector on the antenna connection at the bridge, and also on the power supply of the bridge

Lightning protection is a profession. A specialist supplies a professional installation that reduces the risks of damage caused by lightning strikes.
I-O advises always use a professional lightning specialist.

2.2 Basic Alignment of the Antenna

Due to its directive behavior, an antenna needs to be aligned. Alignment is done by maximizing the antenna signal and by minimizing phase noise. The phase noise directly influences bit error rate. The alignment is essential because certain weather conditions can degrade the signal strength. Also essential to obtaining the strongest signal is the use of a low noise antenna cable. To avoid link dropouts with bad weather, the antennas need to receive the strongest signal possible with the lowest possible phase noise. In most situations a high signal level means a low bit error rate, but it does not go without saying. In some cases the lowest Bite Error Rate is reached at a signal strength level that is not the highest possible.

The bridge has a Radio Signal Strength Indicator (RSSI) and a SQ2 indicator. These indicators need to be used during alignment. Both indicators are displayed at the same time.

To be able to read the RSSI and SQ2 the bridge needs to be connected to a computer via a small hub. This computer needs to be equipped with an Ethernet card. The set-up depicted in figure 2.3 needs to be made.

NOTE: The bridge unit is equipped with two antenna connectors (1 & 2). Always use connector 1, Connector 2 is only used in special cases by an experienced installer. For information about using the second antenna option, please contact I-O.

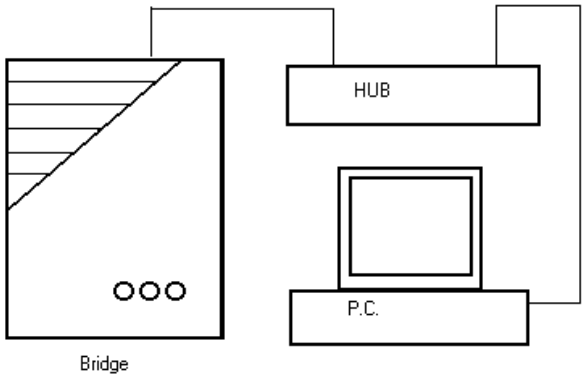


Figure 2.3 Interconnection during installation

Picture 2.4. The power connector

Picture 2.5. The Ethernet connector

At the remote location, connect the antenna and bridge unit the regular way. Only the antenna needs to be connected, the network does not have to be connected. If you have a directive antenna, aim it at the other antenna.

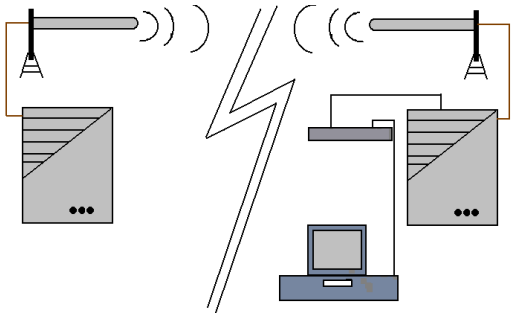


Figure 2.6 Basic setup of two bridge units.

This diagram is based on a 10Base-T (RJ-45) connection. This connector is located on the backside of the bridge unit. Picture 2.4 shows the Ethernet connector. After interconnecting the units, they can be powered up. The power switch is next to the power connector. See picture 2.3.

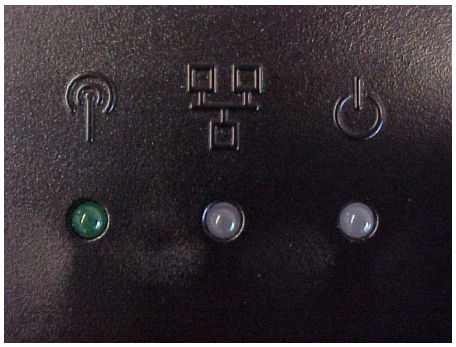


Figure 2.7. The led indicators

The LED indicators (figure 2.7) display the status of the bridge. The power LED, on the right, displays the power status. Green means a correct power feed, red indicates wrong firmware or power failure.

The LED in the middle displays the network status. If the bridge is connected to a network it will light-up green, otherwise it will be red or off.

The left-hand side LED displays the radio link status. The client bridge unit function of this LED differs from the server bridge unit. **The radio link LED of the server will blink as soon as it is transmitting a beacon, approximately 10 times per second, even if there is no connection to the client. The client will blink as soon as it receives a beacon.** It is this function that is used for the first alignment.

First, install the server side of the bridge. Aim the server antenna (unless it is an omni antenna) towards the client side of the bridge. Then power up the server side.

Secondly, the client side needs to be installed. Aim the client antenna towards the server side and power-up the client unit. This should result in a blinking radio link LED at the client side. Please remember the server radio link LED will always blink, while the client LED blinks only when it receives a beacon. If the client radio link LED is not blinking, realign the antennas (both server and client side).

2.3 Configuration of the Bridge Units

This section describes the configuration of the bridge during alignment. This means that certain settings or parameters are not mentioned because they do not effect the alignment of the antennas. Chapter 3 will give a clear description of the meaning of each option, and when to change or use that option.

Start the Bridge Configuration program. (See Chapter 3 to install the configuration program.) First, the MAC address of the bridge unit connected to the antenna needs to be entered. The MAC address can be found on the backside label.

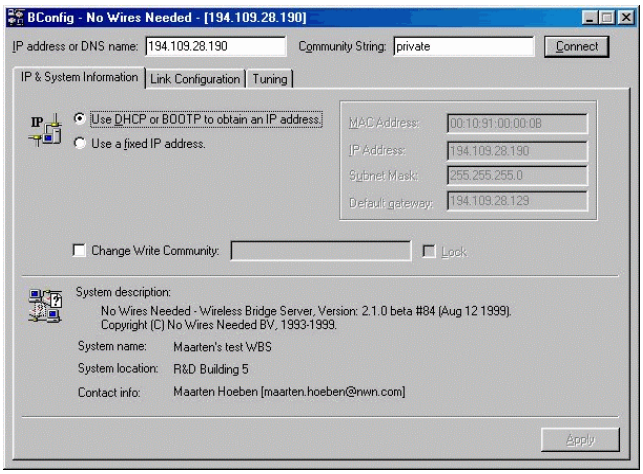


Figure 2.8 IP & System Information Screen

When the bridge is powered up for the first time, the top IP address field is empty. To set an IP address select ‘Set a fixed IP address’; then enter the MAC address, IP address, Subnet mask, and finally the default gateway. Make certain that the IP address, sub-net mask and gateway coincide with your network addressing plan. If you have a DHCP server within your network you can select the DHCP option, an IP address is then automatically assigned. If you prefer to use DHCP because of its centralized administration, but want a fixed IP address for the bridge unit, you can make a reservation for the MAC address in the DHCP server.

After this information is entered press the ‘Connect’ button. Then the system description will display the bridge name and firmware version.

After entering this information select the ‘Device’ tab. The following screen will be displayed:

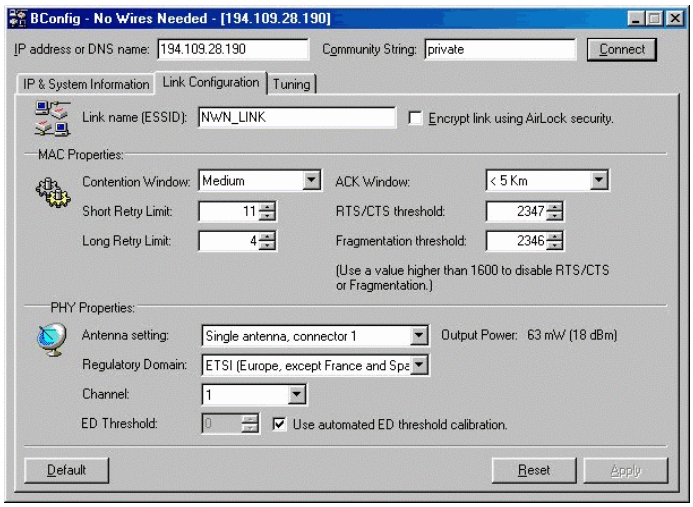


Figure 2.9 Link Configuration Screen

In this menu the radio settings can be set. It contains the following options:

- SSID or ESSID (name of the wireless link between the bridge units, all bridge units in the same link need the same name)
- Encrypt using AirLock™
- MAC properties
  - Contention window (use if more data goes upstream than downstream)
  - ACK window (use when large distances need to be covered)
  - Short retry limit
  - RTS/CTS threshold
  - Long retry limit
  - Fragmentation threshold
- Physical properties
  - Antenna settings
  - Regulatory domain
  - Channel
  - ED threshold

Most of these settings do not require any changes for normal operations. Point-to-point links up to 3 km / 1.875 miles do not need any changes from the default MAC settings. If the distance exceeds 3 km / 1.875 miles, increase the minimum of the ACK window to 10.

A new installation does require the SSID, Regulatory domain and Channel to be set.

SSID or ESSID – This is the name of the wireless link between the bridge units. The server and all clients need to have the exact same name in this field (the only restriction for this setting).

Regulatory Domain – This is the organization which controls radio frequency use (such as ETSI in Europe, or FCC in the USA). Some counties have the ETSI rules applied with some minor changes. These changes are often made on the channels that are allowed.

Channel – This setting also needs to be the same on both sides of the bridge. This setting becomes important if multiple bridge links are installed. It could be that one bridge link will interfere with the other bridge link. By choosing another channel, interference can be avoided. Within ETSI the available channel settings are channel 1, 7, and 13. These channels are not interfering and need to be used when bridges are co-located.

The other settings are described in Chapter 3. These do not need to be changed for normal use. If you do, however, change the settings and it has a negative effect on the link quality, the settings can be changed back to the original values without damaging the bridge.

Antenna settings – Make sure the antenna options selected match your set-up. The diversity option will influence the performance if only one antenna is connected.

2.4 Fine Tuning of the Bridge Link

The link quality is measured via the Tuning tab. Two quality indicators are displayed. These are:

- RSSI (radio signal strength indicator)
- SQ2 (indication for quality of received signal)

The tuning selection looks like this:

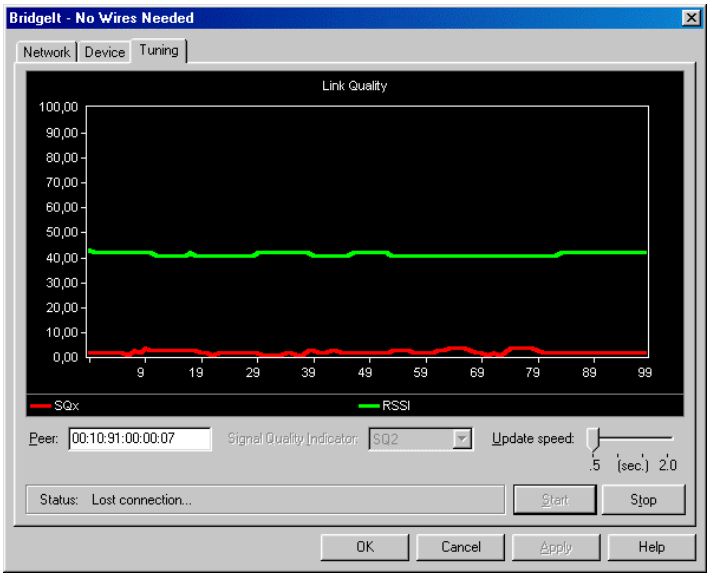


Figure 2.10 Tuning Screen

Two lines are displayed. The top one (green) represents the radio signal strength indicator (RSSI); the other (red) represents the signal quality (SQ2).

Before the signal quality measurement can be started, the MAC address of the other bridge unit needs to be entered in the PEER field.

It is also possible to change the update speed of the measurements.
Remember: If this measurement is activated, no normal IP traffic is possible. So this mode can only be used during trouble-shooting and installation.

The status bar at the bottom of the screen shows the current status of the link.

The alignment is done by maximizing the radio signal strength and minimizing the SQ2 indicator. Slowly turning the antenna left and right, up and down, will affect the RSSI.

After finding the peak level, monitor the SQ2 indicator. This indicator displays the multipath effects. Turn the antenna very slowly in all directions to find the SQ2 signal peak. Once you have found the SQ2 signal peak, monitor the RSSI indicator again and verify that it is still at an acceptable level.

Repeat this procedure on both bridge units several times.

The chart below displays the signal level versus the RSSI, SQ2, and the speed. Speed is displayed as a percentage of the maximum. If SQ2 displays 100%, the red line in the tuning screen displays 0. You can use this graph to determine if the throughput fits the RSSI and SQ-2 value the tuning function displays.

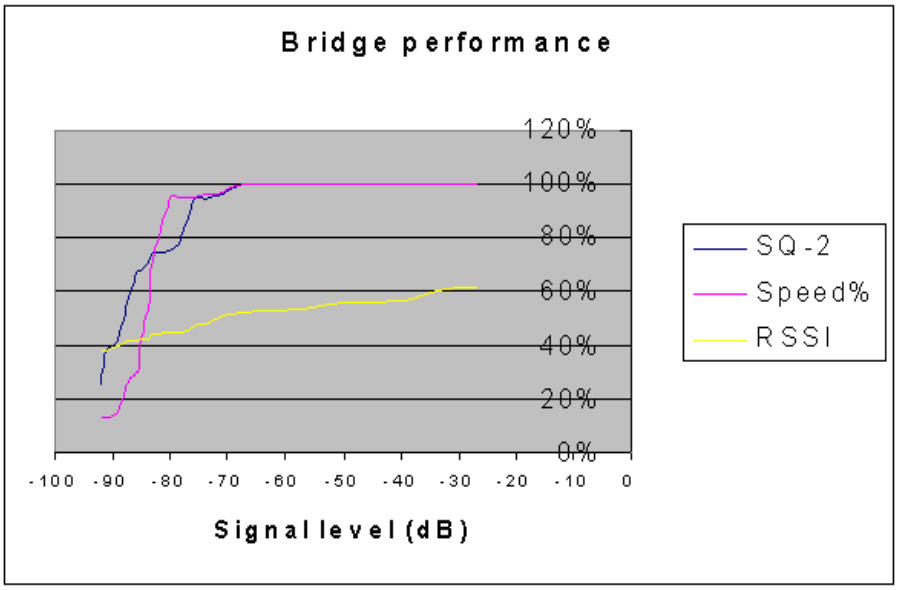


Figure 2.11 Bridge Performance

2.5 Installing the Bridge Unit

The bridge unit should be installed in a dry and temperature controlled location. The bridge unit should not be exposed to hostile environments; temperature should not drop below zero or exceed 50 degrees Celsius / 122 degrees Fahrenheit. Preferably mount the unit inside; if that is not possible use an outdoor housing.

The bridge is supplied with an antenna adapter cable. Use this cable with your installation. If for some reason this cable is too short, consult I-O for another cable. If the cable is too long, do not cut the cable or roll the cable. Changing the length of the cable determines changes the characteristics of the system.

Note: If you cut the antenna adapter cable, the system will not perform according to the specifications. Modifying the adapter cable will void the warranty. If for some reason changing the antenna adapter cable is unavoidable please contact I-O.

3 Bridge Configuration Program

This chapter describes the configuration program of the bridge units. This program allows you to install and maintain your bridge link. It contains an excellent performance monitor for fine-tuning and troubleshooting.

Within this chapter all options in the program are described together with the circumstances in which it is useful to use these setting.

3.1 Installation

The Bridge Configuration software runs on any Windows 95/ 98 or Windows NT machine with TCP/IP installed.

To install the configuration program, insert the I-O Wireless Bridge Configuration Utility CD into your CD-ROM drive. The Bridge Setup Menu will appear. If it does not appear after a few seconds, click *Start* | *Run*, enter “d:\setup.exe” (d:\ is the location of your CD-ROM drive), and click *Ok*. The set-up wizard will guide you through the installation process.

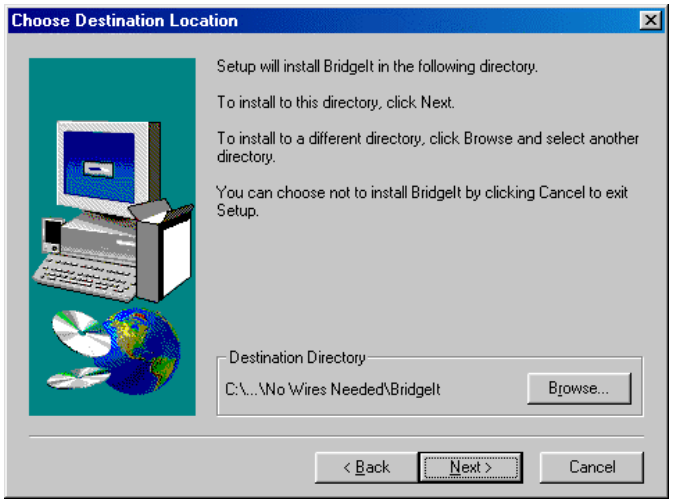
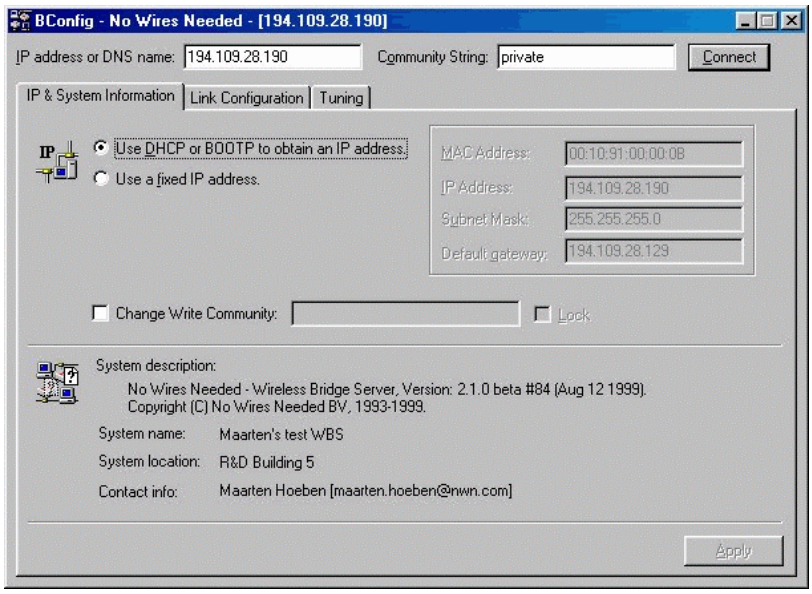


Figure 3.1

After installation is finished you can start the Bridge Configuration program. It will start at the network screen. The network screen allows you to enter the MAC address or the IP number of the bridge. It also allows you to set or change the community string.


BConfig - No Wires Needed - [194.109.28.190]
IP address or DNS name:
194.109.28.190
Community String:
private
Connect
IP & System Information
Link Configuration
Tuning
Use DHCP or BOOTP to obtain an IP address.
Use a fixed IP address.
MAC Address:
00:10:91:00:00:0B
IP Address:
194.109.28.190
Subnet Mask:
255.255.255.0
Default gateway:
194.109.28.129
Change Write Community:
Lock
System description:
No Wires Needed - Wireless Bridge Server, Version: 2.1.0 beta #84 (Aug 12 1999).
Copyright (C) No Wires Needed BV, 1993-1999.
System name:
Maarten's test WBS
System location:
R&D Building 5
Contact info:
Maarten Hoeben [maarten.hoeben@nwn.com]
Apply
Figure 3.2

3.2 The Network Configuration

The bridge can be configured before it is actually installed. The configuration consists of two parts, the wireless settings and the network settings.

The network settings contain the following parameters:

- IP address (DHCP or manual set)
- Sub-net mask
- Default router / gateway
- Community string (password)
- Lock (remote management on/off)

If an IP address has already been setup in the bridge, only the IP address needs to be entered at the top field (a DNS name may also be entered). Click the *Connect* button to continue. The system description will then show the MAC address, etc.

If the bridge is being connected for the first time, two IP addressing processes are possible. The first is when you have the bridge connected to a network without a DHCP server, and the second is where there is a DHCP server installed in the network.

If a DHCP server is used in the network where the bridge is installed, first check the IP address it has been assigned (see the system administrator for this IP address). Then enter that IP address at the network screen and press *Connect*. This will display the MAC address, sub-net mask, and default gateway.

If no DHCP server is running select ‘Set an fixed IP address’. Then enter the MAC address and the IP address manually. Also, the sub-net mask and default gateway has to be entered. Press *Connect*. The network side of the bridge unit is now configured. Repeat this procedure on all bridge units.

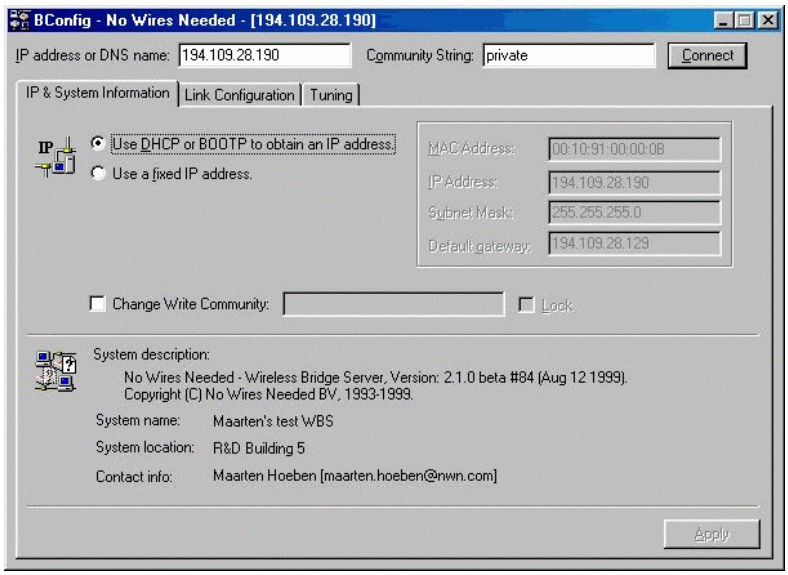


Figure 3.3

Below you find a summary of all settings in the network settings part.

IP address or DNS name of WBS/WBC – The configured bridge can be accessed via this field.

Community string – This is the password protection on the bridge settings.

Use DHCP or BOOTP to obtain an IP address – If a DHCP server is installed, an IP address can automatically be assigned to the bridge.

Set a fixed IP address – With this option an IP address can be manually set. First the MAC address needs to be entered. If an IP address is already configured, it will appear after entering the MAC address. Sub-net mask and default gateway can also be entered in to this field.

Change write community – This option allows you to change the password of the bridge unit. If the LOCK field is flagged, the bridge can not be accessed via the network. It can only be configured directly.

3.3 The Device Settings

The radio setting can influence the performance of the link. After installation it is essential to go through each parameter and determine the best settings. Some parameters are related to each other, this means that the best combination needs to be found. Pay special attention during fine-tuning to the ED threshold, the ACK window, and the contention window.

In the Device tab the following parameters can be set:

- SSID or ESSID (name of the wireless link)
- Security algorithm used (AirLock™ or none)
- Radio channel (preferred 1, 7 or 13)
- Antenna settings
- MAC properties
- Access control setting

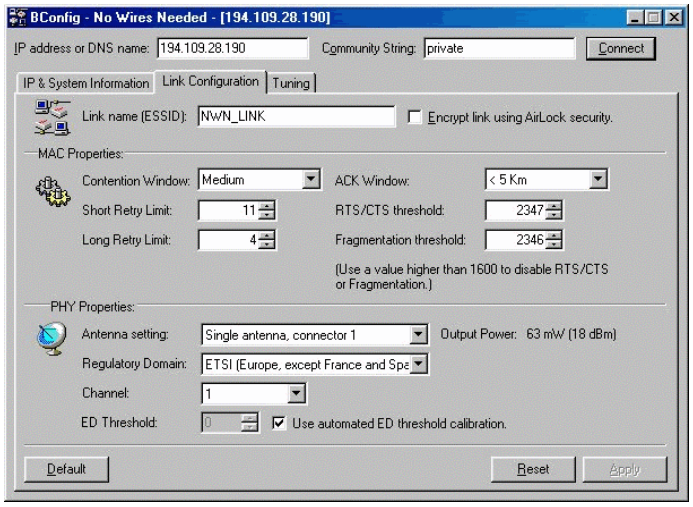


Figure 3.4

Fine tuning a link requires knowledge of the IEEE 802.11. For every link there can be an optimal configuration found. Understanding the influence of each parameter is essential to find this optimal configuration. Experiment and monitor each change to reach this configuration.

The following is a description of each of the various parameters and their settings.

Link Name (SSID or ESSID) – The link name is the link ID. All bridge units that are connected together need to have exact the same name. This name can be considered the general link name.

Encrypt link using AirLock™ security – This option allows you to switch the security on or off. It is advised to have AirLock™ always switched on. Airlock™ provides you superior security and protects you against eavesdrops, hacking, etc.

Contention window – This is the back-off window expressed in slot time. 1 means 1slot time, which equals 20 microseconds. This parameter may need to be manipulated when the traffic is out of balance or if the link is set to point-to-multipoint. Out of balance means more data upstream then downstream, or vice versa. Having the diversity option selected within the antenna field will also creates some extra requirements for the contention window. Diversity makes the radio listen to both antennas. This does not happen at the same time; it will constantly switch between the two antennas. So it will listen 1 slot time to antenna 1 and the next slot time to antenna 2. Use medium and high when the traffic is out of balance or in a point to multipoint. Short will work on standard point to point links.

ACK window, – This is the waiting time for the acknowledgement. Select the setting that corresponds with the length of the actual link. For a point to multipoint situation use the longest link as a reference. It will not harm the link if the ACK window is larger than the corresponding distance. To fine tune the throughput, increase the number, measure the throughput, and then start to decrease the ACK window while monitoring the throughput.

Short retry limit – The short retry limit sets the number of retries for packets smaller than the number defined in the RTS/CTS threshold field.

RTS/CTS threshold – Packages longer than this value will be transmitted via ‘request to send/ clear to send’ routine. This method of transmitting provides an extremely secure and reliable link, but will slow it down significantally. Since the reliability of the link without RTS/CTS communication is already outstanding it is advised to use this option only in complex and hostile environments.

Long retry limit – The long retry limit sets the number of retries for packets longer than the number defined in the RTS/CTS threshold field.

Fragmentation threshold – This value sets the threshold where above which the packets will be fragmented.

Antenna settings – The bridge contains two antenna ports. With this option you can select the following options:

- Receive and send on antenna 1
- Receive and send on antenna 2
- Receive on 1 send on 2
- Antenna diversity

Be very careful selecting the right antenna setting. Having diversity switched on while only one antenna is connected will harm the performance of the link.

Note: Having an unconnected antenna port selected could harm the device.

Regulatory domain – A few countries have adapted the ETSI regulations with some changes. Examples are France and Spain. In these countries some channel settings are not allowed.

Regulatory Domain	Area	Permissible Channels	Bridge Predefined channels
FCC	United States	1 – 11	1, 6, 11
DOC	Canada	1 – 11	1, 6, 11
ETSI	Europe except Spain and France	1 – 13	1, 7, 13
SPAIN	Spain	10	10
FRANCE	France	10	10
MKK	Japan	14	14

Channel – The options displayed in this field are the allowed channels with in the chosen regulatory domain. Use this option if multiple bridges are co-located or an indoor wireless network is installed. With the channel settings, interference of other equipment working in the same frequency band can be avoided.

ED Threshold – ED threshold allows you to kill background noise. If there is interference from other weaker signals on the same frequency, the ED threshold can be used for reducing the influence of this noise. If it is set to 0 or if the check box is selected, the unit will adjust itself dynamically. 99 represents the highest sensitivity possible. 1 represents the lowest sensitivity. It is suggested that the ED threshold be set to a value of 99.

The tuning tab of the Bridge Configuration program displays the RSSI. The RSSI parameter displays the signal strength, which corresponds with the ED Threshold.

3.4 Resetting the Bridge

You can reset the wireless bridge unit's settings to factory defaults by pushing a paperclip in the little hole, next to the power switch, while switching the bridge unit on.

When you push a paperclip in the reset hole while the bridge unit is switched on, only the lock (password) set by the Bridge Configuration program is deactivated.

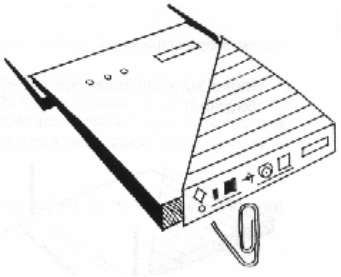


Figure 2.5 Reset the Bridge

4 Troubleshooting

This chapter displays the common problems that can occur while setting up a bridge link. If your problem is not related to any of the below mentioned problems please contact your reseller.

Problem: No connection between the networks

If the radio LED of the client is not blinking:

- Make sure both bridges are powered up.
- Make sure the bridges are within the valid range for the antennas.
- Make sure that the channel settings for both bridges are the same.
- Make sure that the antenna is connected or cable is not broken.
- Make sure that the antennas are in line of sight (NO obstacles!).
- Make sure no other device is transmitting on the same frequency. You can do this by changing the frequency settings on both bridge units.
- Bring the ED threshold down.

If the radio LED of the client is blinking or the Bridge Monitor's signal strength indicator (on the Tuning screen) shows a good signal):

- Make sure that the SSID/ESSID of all bridge units is exactly the same.

Problem: Can not access the bridge settings via network

- Check if sub-net mask and default gateway is set according the network the bridge is connected to. (To do this you need to connect directly to the unit)
- Check if the unit has been reassigned another IP address. (To do this you need to connect directly to the unit.)

Problem: Low throughput on the link

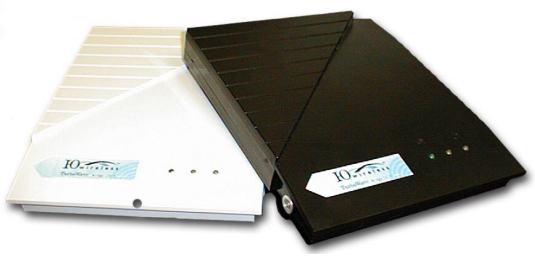
- Check if the average of SQ2 is below 10. (Go to monitor screen in the Bridge Configuration program.)
- Check if the ACK time fits the range.
- Check if the network card of the PC you are measuring with can handle the throughput.

Problem: Link drops off every now and then

- Check the antenna alignment
- Check the line of sight for obstacles
- Check antenna mounting
- Check if ED threshold is set to 99, if not do so.

5 Specifications

5.1 LAN to LAN Bridge



Standards compliance:

- IEEE 802.11 standard for wireless LAN
- Compliant with ETS 300 328 and ETS 300 826 (CE marked)
- Compliant with FCC (47 CFR) Part15C, Section 15.247
- All major networking standards (including IP, IPX)

Security:

- AirLock™ Access control, 128 bit encryption, no key management
- IEEE standard WEP 40

Radio/ modem:

- Frequency range:
  2.4 - 2.483 GHz (US, Canada)
  2.4 - 2.497 GHz (Japan, ETSI)
- Supported bit rates: 11 Mbps / 5.5 Mbps (as well as interoperable with IEEE 802.11 Direct Sequence Spread Spectrum compliant devices that support 1 Mbps and 2 Mbps)
- Modulation:
  1.0 Mbps DBPSK
  2.0 Mbps DQPSK
  5.5 / 11 Mbps CCK
- Number of Channels:
  Europe: 13 (3 non-overlapping)
  US: 11 (3 non-overlapping)
  France: 4 (1 non-overlapping)
- Transmit power: Bridge base output 18 dBm
- ASBF™ Automatic link speed optimizer.

Wireless LAN interface:

- Standards: IEEE 802.11 CSMA/CA

Network Interfaces:

- Standards: IEEE 802.3 CSMA/CD Supports 1024 Mac addresses
- Mobility: Seamless roaming across cell boundaries

Mechanical:

- Dimensions: 180 x 220 x 40 mm
- Weight: 260g
- LEDs:
  Ethernet connection
  RF activity
  Power
- Connection types:
  Antenna connection: SMA male right-angle with modified shield
  Ethernet connection: RJ-45 for 10Base-T
- Power Supply
  AC 110-240V 50-60 Hz to 9VDC converter Included

Environmental:

- Temperature Range: 0 - 40°C / 122° F operating
  Temperature 95% humidity (non-condensing)

Management and configuration

- Network: SNMP agent with support for MIB-II and IEEE 802.11 MIB
- Configuration utility software included (Win95,Win98/Me & WinNT 4.0)

5.2 SLH 10 Helix Antenna

Features

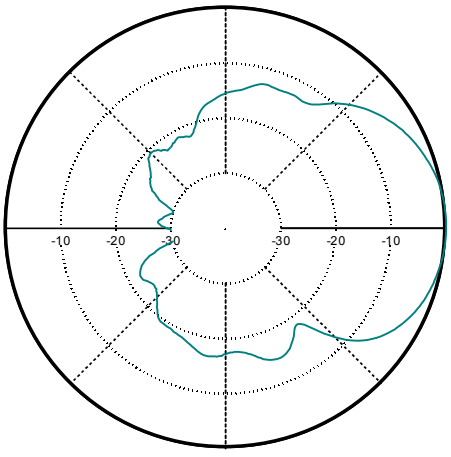
- Light weight – slim profile
- Patented reduced size design
- Watertight Ultrasonic and O-ring sealed
- Circular polarization

Description

The SLH 10 Stub Loaded Helix is a compact helix antenna with performance characteristics similar to conventional helix but only about one-quarter the size. This significant size reduction is obtained through a unique patented antenna geometry that maximizes antenna performance and efficiency while minimizing size. The SLH 10 utilizes circular polarization to minimize the effects of multipath interference. It is housed in a rugged radome that protects the antenna from the weather as well as providing an aesthetically pleasing appearance. A variety of mounting options are available.

Specifications

Frequency	2.3 – 2.6 GHZ
Gain	10 dBic typical (11 dBic average)
Beamwidth	60° (– 3dB)
Polarization	Right-hand circular
Connector	Reverse-thread TNC
Nominal impedance	50 Ohm
VSWR	1.7:1 Max
RF power average	10 W
Length	6.5”
Weight	< 1 lb.



Radiation Pattern of SLH 10
Stub Loaded Helix

5.3 SLH 12 Stub Loaded Helix Antenna

Features

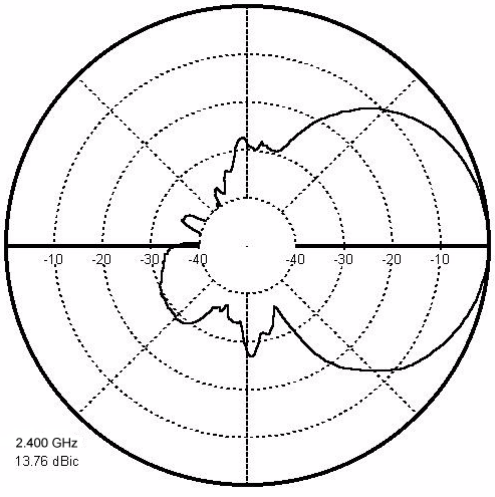
- Light weight – slim profile
- Patented reduced size design
- Watertight Ultrasonic and O-ring sealed
- Circular polarization

Description

The SLH 12 Stub Loaded Helix is a compact helix antenna with performance characteristics similar to conventional helix but only about one-quarter the size. This significant size reduction is obtained through a unique patented antenna geometry that maximizes antenna performance and efficiency while minimizing size. The SLH 12 utilizes circular polarization to minimize the effects of multipath interference. It is housed in a rugged radome that protects the antenna from the weather as well as providing an aesthetically pleasing appearance. The SLH 12 uses a cupped reflector to provide greater gain and a higher front-to-back ratio than the standard SLH 10 helix for those installations where additional gain is needed or more directivity is required to reduce interference. A variety of mounting options are available.

Specifications

Frequency	2.3 – 2.6 GHZ
Gain	12 dBic typical (13 dBic average)
Beamwidth	40° (– 3dB)
Polarization	Right-hand circular
Connector	Reverse-thread TNC
Nominal impedance	50 Ohm
VSWR	1.7:1 Max
RF power average	10 W
Length	6.5”
Weight	<1 lb.



Radiation pattern of SLH 12 Stub Loaded Helix

5.4 Power Supply Specifications

- AC input range 90~264VAC/0.5A
- Inrush current cold start,<60A peak @ 230VAC
- Hold up time 10ms @ full load, nominal line
- Overload protection pulsing mode, auto recovery
- Over voltage protection 110%~145%
- Operating temperature 0-30°C @ 100%, 40°C @ 50% load
- Withstand voltage I/P-O/P:3KVAC, I/P-FG:1.5KVAC, 1min.
- Safety standards UL 1950, CSA 22.2, TUV EN60950
- EMC standards EN55022, EN50082-1
- Humidity 20%~90% RH
- Length of output cable 120cm (typical)
- Plug of DC output 5.5φx2.1φx11mm, center “+”
- Type No. MA15-090,
- Output 9V, 1.67A,
- Tol. ±5%,
- R&N 90mV
- Eff. 70%,
- P.p. 6

5.5 Cable Specifications

The bridge units are shipped with a short adapter cable that can be used to attach the SLH10/12 antennas directly to the bridge unit.

Adapter Cable Supplied with the Bridge:

To connect to the bridge:	RFS-2006 SMA Male Right Angle Crimp with Modified Shell by RF Industries
To connect to the antenna:	RFT-1202-c TNC Male Reverse Threaded as manufactured by Times
Cable type	LMR-195, maximum length 3 feet (multiple manufacturers such as Belden, Times, etc.)

If the antenna must be located further away from the bridge unit, then a new adapter cable and an extension cable must built. Under no circumstances should the antennas be mounted more than 50 feet away from the bridge units as the loss of signal strength and increased noise are substantial.

Adapter Cable for use with an Extension Cable:

To connect to the bridge:	RFS-2006 SMA Male Right Angle Crimp with Modified Shell by RF Industries
To connect to the Extension Cable	RFN-1005-3C N Type Male Crimp as manufactured by RF Industries or similar
Cable type	LMR-195, maximum length 3 feet (multiple manufacturers such as Belden, Times, etc.)

Extension Cables:

To connect to the Adapter Cable	RFN-1028-S1 N Type Female Crimp as manufactured by RF Industries or similar
To connect to the antenna:	TN-400-TM-RT TNC Male Reverse Threaded as manufactured by Times
Cable type	LMR-400, maximum length 50 feet (multiple manufacturers such as Belden, Times, etc.)

Sources for Connectors and Cables

Many different manufacturers can supply the LMR400 and LMR195 cable as well as the Type N connectors. At the time of this printing, the following sources are available for these products:

Electro-Comm Distributing
Denver, Colorado
800-525-0173
303-371-8182

Kimball Electronics
Salt Lake City, Utah
801-466-0569

RF Industries
San Diego, California
800-233-1728

Glossary

10/100BaseT: An IEEE standard (802.3) for operating at either 10 Mbps or 100 Mbps Ethernet networks (LANs) with twisted pair cabling and a wiring hub.

Access Point (AP) - An internetworking device that seamlessly connects wired and wireless networks together.

Ad-Hoc - An Ad-Hoc wireless LAN is a group of computers each with wireless cards, connected as an independent wireless LAN. You can immediately begin communicating between the various stations as soon as the hardware and drivers are installed. An Ad-Hoc network is not attached to a wired network (which uses an access point in an infrastructure mode). An alternative set-up is where computers communicate with each other through an access point where there is a connection with a wired network. (See Access Point and Infrastructure.)

Backbone - The core infrastructure of a network, the portion of the network that transports information from one central location to another central location. The information is then off-loaded onto a local system.

Base Station - In mobile telecommunication, a base station is the central radio transmitter/ receiver that maintains communication with the mobile radio telephone sets within range. In cellular and personal communications applications, each cell or microcell has its own base station; each base station in turn is interconnected with other cells' base.

BSS - Stands for "Basic Service Set." An Access Point associated with several wireless stations.

Client – Any computer connected to a network that requests services (files, print capability) from another member of the network.

DSS – Direct-Sequencing Spread-Spectrum. DSSS uses a radio transmitter to spread data packets over a fixed range of frequency band.

ESS - Stands for "Extended Service Set." More than one BSS can be configured as an Extended Service Set. An ESS is basically a roaming domain.

Ethernet - A popular local area data communications network, originally developed by Xerox Corp., which accepts transmission from computers and terminals. Ethernet operates on 10 Mbps baseband transmission over shielded coaxial cable or over shielded twisted pair telephone wire.

Fresnel zone – This zone is an elliptical area immediately surrounding the visual path. It varies in thickness depending on the length of the signal path and the frequency of the signal.

Gateway – A network point that acts as an entrance to another network.

Hz (Frequency or Hertz) – The international unit for measuring frequency, equivalent to the older unit of cycles per second. One megahertz (MHz) is one milling hertz. One gigahertz (GHz) is one billion hertz. The standard US electrical power frequency is 60 Hz, the AM broadcast radio frequency band is 0.551.6 MHz, the FM broadcast radio frequency band is 88103 MHz, and wireless 802.11 LANs operate at 2.4 GHz.

IEEE - Institute of Electrical and Electronics Engineers, New York, www.ieee.org. A membership organization that includes engineers, scientists, and students in electronics and allied fields. It has more than 300,000 members and is involved with setting standards for computers and communications.

IEEE 802.11 - IEEE 802.xx is a set of specifications for LANs from The Institute of Electrical and Electronic Engineers (IEEE). Most wired networks conform to 802.3, specification for CSMA/CD based Ethernet networks. 802.11 defines the standard for wireless LANs encompassing three incompatible (non-interoperable) technologies: Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS), and Infrared.

Infrastructure - An integrated wireless and wired LAN is called an Infrastructure configuration. As compared to Ad-Hoc Mode where computers communicate directly with each other, clients set in Infrastructure Mode all pass data through a central access point. The AP not only mediates wireless network traffic in the immediate neighbourhood, but also provides communication with the wired network. (See AD-Hoc and Access Point.)

IP - The Internet Protocol (IP) is a method or protocol by which data is sent from one computer to another on a network, i.e. the Internet. Each computer on the Internet has at least one address that uniquely identifies it from all other computers on the Internet. When you send or receive data (for example, an e-mail note or a Web page), the message gets divided into little chunks called packets. Each of these packets contains both the sender's Internet address and the receiver's address. Any packet is sent first to a gateway computer that understands a small part of the Internet. The gateway computer reads the destination address and forwards the packet to an adjacent gateway that in turn reads the destination address and so forth across the Internet until one gateway recognises the packet as belonging to a computer within its immediate neighbourhood or domain. That gateway then forwards the packet directly to the computer whose address is specified. Because the data is divided into a number

of packets, each packet can, if necessary, be sent by a different route across the Internet. A packet is treated as an independent unit of data so packets can arrive at their destination in a different order than they were sent in. Another protocol, the Transmission Control Protocol, (TCP) then reassembles the packets in the right order.

IP Address - An IP address is a 32-bit number that identifies each sender or receiver of information that is sent across the Internet. An IP address has two parts: the identifier of a particular network on the Internet and an identifier of the particular device (which can be a server or a workstation) within that network.

LAN (Local Area Network) - A communications network that serves users within a defined geographical area. The benefits include the sharing of Internet access, files and equipment like printers and storage devices. Special network cabling (10BaseT) is often used to connect the computers together. Wireless LANs use wireless communications, in a home or office, to network all computers together so there is no need to run an extra set of cables.

Line of Sight (LOS) – Radio signals generally require a clear path between antennas. Basically this means that the two antennas can be connected with an imaginary straight string. There should never be any object blocking this line.

Multi-path - Multi-path effects can be explained as coherent signals (signals from the same source) arriving at the antenna at different times due to the difference in path length.

PCI - A local bus standard for connecting peripherals to a personal computer. Within a computer, the bus is the transmission path on which signals and data transfers occur between the CPU, system memory, and attached devices such as a network card, sound card, or CD-ROM drive.

PCMCIA - Personal Computer Memory Card International Association, which develops standards for PC cards, formerly known as PCMCIA cards, are available in three “types” which are about the same length and width as credit cards, but range in thickness from 3.3 mm (Type I) to 5.0 mm (Type II) to 10.5 mm (Type III). These cards can be used for many functions, including memory storage, as landline modems and as wireless LAN.

Roaming - A function that allows one to travel with a mobile end system (wireless LAN mobile station, for example) through the territory of a domain (an ESS, for example) while continuously connected to the infrastructure. As a wireless computer moves from an area served by one AP to another AP, the connection is automatically switch from the first AP to the second AP. When the change of connection occurs, there may appear to be a loss of connection at the wireless station.

RTS Threshold – Transmitters contending for the medium may not hear each other. RTS/CTS mechanism can solve this " Hidden Node Problem".

Spreading – Spreading is the principal contributor to signal loss for line of sight propagation. As a signal radiates it spreads or expands into a spherical surface. The available RF power is distributed over this surface and weakens with increasing range.

SSID – An acronym for Service Set Identifier, SSID is the unique name shared among all clients and Access Points in a wireless network. The SSID must be identical for all clients or Access Points participating in the same network. The SSID is case sensitive and must not exceed 30 characters.

TCP (Transmission Control Protocol) - A protocol used along with the Internet Protocol (IP) to send data in the form of individual units (called packets) between computers over the Internet. While IP takes care of handling the actual delivery of the data, TCP takes care of keeping track of the packets that a message is divided into for efficient routing through the Internet. For example, when a web page is downloaded from a web server, the TCP program layer in that server divides the file into packets, numbers the packets, and then forwards them individually to the IP program layer. Although each packet has the same destination IP address, it may get routed differently through the network. At the other end, TCP reassembles the individual packets and waits until they have all arrived to forward them as a single file.

WEP (Wired Equivalent Privacy) - WEP data encryption is defined by the 802.11 standard to prevent (i) access to the network by "intruders" using similar wireless LAN equipment and (ii) capture of wireless LAN traffic through eavesdropping. WEP allows the administrator to define a set of respective "Keys" for each wireless network user based on a "Key String" passed through the WEP encryption algorithm. Access is denied by anyone who does not have an assigned key. The key, either 40 or 104 bits in length, is added to a 24-bit initialization vector resulting in a 64-bit or 128-bit key size. Each station and access point in the network must be set-up the same.

Agency Compliance Notices

FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with the minimum distance between your body and the antenna as shown in the table below:

Low gain indoor antennas (≤6dBi)	4.5cm (1.8 inches)
High gain outdoor antennas (>6dBi)	30cm (12 inches)

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

***Note**: Detached antennas, whether installed indoors or out, should be installed ONLY by experienced antenna 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 to legal and financial liabilities. I-O, its licensors, and its resellers or distributors are not liable for injury, damage or violation of government regulations associated with the installation of detached antennas.

CE 0122 ⓘ	Important Notice This device is a 2.4 GHz low power Wireless Bridge transceiver intended for use in all EU member states, except for France where restrictive use applies. Please refer to page 7 of this manual for further details.

R&TTE Compliance Statement

This equipment complies with all the requirements of the DIRECTIVE 1999/5/EC OF THE EUROPEAN PARLIAMENT AND THE COUNCIL of 9 March 1999 on radio equipment and telecommunication terminal Equipment and the mutual recognition of their conformity (R&TTE).

The R&TTE Directive repeals and replaces in the directive 98/13/EEC (Telecommunications Terminal Equipment and Satellite Earth Station Equipment) As of April 8, 2000.

Explanatory Notes related to RTTE

The equipment included in the RTTE statement are representative for the following transceivers below:

Type	Features
BS11	programmed to operate as an Wireless Bridge Server (WBS) otherwise identical internal and external hardware as BC11.
BC11	programmed to operate as an Wireless Bridge Client (WBC) otherwise identical internal and external hardware as BS11.

Programming the flash memory to enable the EUT to operate as Wireless Bridge Server (WBS) or Wireless Bridge Client (WBC) has no effect on the RF parameters. The difference in programming is in the way the EUT handles the data, while the radio and modem controls are common.

The external antennas are connected to the transceiver by unique **non-standard** antenna connectors. The following antenna assemblies are included :

Antenna assembly description	Antenna assembly type	Manufacturer's declared gain (dBi)
medium gain helix antenna	SLH-12	12
standard helix antenna	SLH 10	10

The EU and UK versions only differ in the connector of the power cord of the mains adapter.

EU Countries intended for use
The ETSI version of this device is intended for home and office use in Austria, Belgium, Denmark, Finland, France (with Frequency channel restrictions), Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden and United Kingdom.

The ETSI version of this device is also authorized for use in EFTA member states Iceland, Liechtenstein, Norway and Switzerland.

EU Countries Not intended for use

None.

Potential restrictive use
France: Only channels 10,11,12, and13

Safety

This equipment is designed with the utmost care for the safety of those who install and use it. However, special attention must be paid to the dangers of electric shock and static electricity when working with electrical equipment. All guidelines of this manual and of the computer manufacturer must therefore be allowed at all times to ensure the safe use of the equipment.

Restriction of use
The channel use of this Wireless Bridge differs by regulatory domain. Please check if the regulatory domain fits your country. Please refer to Section 4.5 for reading regulatory domain in the Wireless Bridge and to chapter 4.9 for the list of regulatory domains.

Using a Wireless Bridge with illegal regulatory setting creates a possibility of transmitting on channels that are not allowed by the government. If for some reason the regulatory domain is not correct, do not install your Wireless Bridge and immediately contact your Reseller.

Intended use
This product is a low power 2.4 GHz WLAN Wireless Bridge transceiver intended for home and office use.

Hardware Warranty

I-O Wireless (I-O) warrants the hardware product against defects in material and workmanship for a period of one (1) year commencing from date of purchase by the original customer, when operated and maintained in accordance with I-O's published specifications. I-O's liability shall be limited, at its option and expense, to refund to buyer the actual amount paid by buyer or to repair or replace any defective or non-conforming product or part thereof, F.O.B. I-O's authorized repair depot. Buyer will pay reasonable labor and handling charges for each product returned for repair which is found to have no defect.

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Product Support and Warranty Administration Policy

Contact I-O Wireless™ if . . .

- You have questions about the installation or operation of your I-O Wireless product, or
- You believe your I-O Wireless product may not be working properly.

How to contact I-O Wireless

Web site address: www.iowireless.com

- Frequently asked questions, installation guides, and technical information are available for reference and assisting with self-help.
- Questions or requests may be submitted via e-mail in the "Contact Us" section.

Telephone: 1.877.471.9933 (toll-free) or 1.801.972.1446

- Hours of support are 7:00 a.m. to 4:00 p.m. MST, Monday - Friday.
- Voice mail messages may be left outside normal hours of operation

Support

You must have your product serial number to qualify for I-O Wireless telephone support.

Telephone support is provided at no charge for one (1) year from date of purchase.

No telephone support will be given without first verifying your I-O Wireless product serial number. This number was activated when your product was shipped. The product serial number is found on the label attached on the bottom side of the product.

Please have your product serial number noted before calling I-O Wireless.

Self-help assistance or e-mail inquiries via the I-O Wireless web site are always free.

Returning a product

The I-O Wireless Customer Service Representative will assist you in determining the nature of your problem. If the I-O Wireless Customer Service Representative determines that your product should be replaced under the manufacturer's terms of warranty, you will be issued a Return Merchandise Authorization (RMA) number.

I-O will then ship to you a replacement unit. Reuse the packing materials to return the original unit. Return the original product freight prepaid. Make sure that the RMA number on the outside of the package.

Replacement units are shipped from I-O's stock of refurbished units, subject to availability. Replacement units carry the same warranty as remaining on the original product. As the buyer, you are responsible for payment for non-warranted product repairs or replacement.

Changes in this Policy

I-O reserves the right to change the terms and conditions of this policy without notice.