SkyGateway/SkyExtender
Installation and Setup
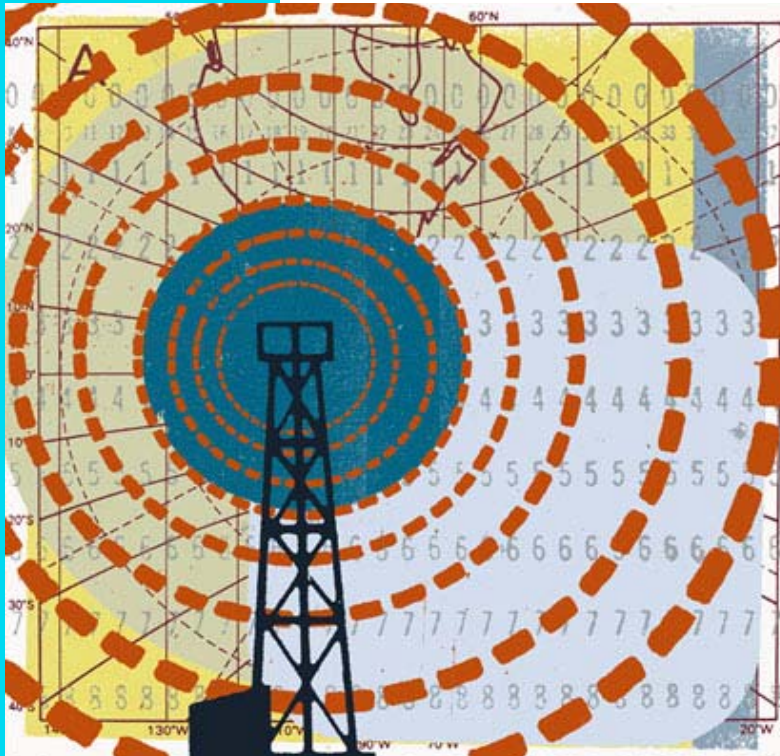
SkyPilot™
NETWORKS

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EMS Firmware 1.5
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Contents

About This Guide

This guide explains how to install and set up a SkyPilot™ SkyGateway™, SkyExtender™, SkyExtender DualBand, or SkyExtender TriBand device to provide wireless network access to users of a SkyPilot wireless mesh network. It assumes administrator-level knowledge of IP networks and a familiarity with configuring wireless devices.

Chapter Highlights

- Audience and purpose

- How this guide is organized

- Conventions used in this guide

Audience and Purpose

This guide provides directions for installing and setting up a SkyPilot SkyGateway, SkyExtender, SkyExtender DualBand, or SkyExtender TriBand device that can provide access to users of a SkyPilot wireless mesh network.

This guide assumes administrator-level knowledge of IP networks and a familiarity with configuring wireless devices.

How This Guide Is Organized

This guide is organized as follows:

- Chapter 1, "Introduction," provides an overview of the SkyPilot Networks solution, describes the SkyPilot devices, and then illustrates how they combine to form a mesh network.

- Chapter 2, "Your SkyGateway/SkyExtender Kit," provides the information you need before you begin your installation.

- Chapter 3, "Installing and Configuring the SkyGateway/SkyExtender," provides instructions for the physical installation of the SkyGateway or SkyExtender as well as background information about configuration and references to associated procedures.

- Appendix A, "Grounding Guidelines," provides direction on protecting your SkyPilot device with proper grounding and surge protection.

- Appendix B, "FCC Statements," provides the FCC radio frequency interference statements for the SkyGateway and SkyExtender devices.

- Appendix C, "Specifications," provides technical specifications for the SkyGateway and SkyExtender devices.

- Appendix D, "Pinouts," provides pinouts for connectors and adapters to connect to the Ethernet interface port labeled "CPE" on the SkyGateway/SkyExtender power injector and the device's serial interface.

Conventions Used in This Guide

This section describes the text and syntax conventions used throughout this guide.

Text Conventions

This guide uses the following text conventions:

- *Italic* is used to introduce new terms.

- **Bold** is used to indicate what you click or type in a graphical user interface (for example, commands names or text being entered). In examples showing user interaction with the command-line interface, bold is used to indicate user input as opposed to command output.

- A `monospace` font is used for code elements (variable names, data values, function names, and so forth), command lines, scripts, and source code listings.

- *`Italic-monospace`* is used for replaceable elements and placeholders within code listings.

Syntax Conventions

This guide uses the following conventions when showing syntax:

- Angle brackets, "<" and ">", enclose mandatory elements. You must enter these elements. For example:
  ```
  ping <IP-address>
  ```

- Square brackets, "[" and "]", enclose optional elements. You can omit these elements. For example:
  ```
  show filter [filter-table-number]
  ```
  Square brackets are also used to show the current value of parameters in the output of some commands.

- A vertical bar, "|", separates choices. For example:
  ```
  show bridge [cache | port]
  ```

Introduction

This chapter provides an overview of the SkyPilot Networks solution, describes the SkyPilot devices, and then illustrates how they combine to form a mesh network.

Chapter Highlights

- Solution overview
- Mesh network
- SkyGateway
- SkyExtender devices
- SkyConnector

Solution Overview

SkyPilot Networks delivers a wireless, end-to-end broadband solution that seamlessly supports high-capacity, high-coverage mesh networks. Designed for managed-access networks and service providers, the SkyPilot network takes broadband wireless the "last mile" with a cost-effective, robust infrastructure solution.

Based on a high-performance architecture that deploys intelligent antenna arrays, the SkyPilot network delivers a dynamic broadband solution with significant advantages for business and home users.

SkyPilot wireless devices are simple to install and easily fit into any type of wireless environment—metropolitan, business, or home.

The auto-discovery and rapid provisioning features of a SkyPilot wireless mesh network can greatly reduce deployment and maintenance costs. Multiple topology options and network scalability create intriguing options for rapidly expanding a metro Wi-Fi customer base.

Mesh Network

The typical configuration for a SkyPilot network is a mesh topology, which uses SkyExtenders to extend range and add network flexibility. In a mesh configuration, subscribers can either connect directly to the SkyGateway or connect indirectly via SkyExtenders (see Figure 1-1). In addition to adding range, a mesh network allows connections from locations where obstructions prevent line-of-sight access to a SkyGateway.

Mesh networks are ideal for dense subscriber environments, for filling in coverage "holes," and for reaching subscribers in areas where RF communication is obstructed by hills, trees, buildings, or other obstacles.

Figure 1-1. SkyPilot wireless mesh network

SkyExtender DualBand
A SkyExtender DualBand adds a Wi-Fi access point, providing 802.11 wireless access to mesh network subscribers in metropolitan "hot" zones.

Wi-Fi zone

SkyAccess DualBand
A SkyAccess DualBand adds a Wi-Fi access point, providing 802.11 wireless access to mesh network subscribers in metropolitan "hot" zones.

Wi-Fi zone

SkyExtender
SkyExtenders increase the coverage footprint by extending the wireless mesh network beyond the range of the SkyGateway.

SkyExtender

SkyGateway
The SkyGateway serves as a base station for a wireless mesh network and provides an interface with wired infrastructure.

Internet

SkyConnector
SkyConnectors link subscribers to the wireless mesh network via an Ethernet port that allows connection from a PC or a local area network.

SkyGateway

The SkyGateway operates as a base station for a wireless mesh network. It provides an interface between wired infrastructure and a wireless network of subscribers who enjoy secure, high-speed access to the Internet or to wide area networks.

A SkyPilot wireless network requires at least one SkyGateway for operation. If necessary, you can add additional SkyGateways to increase network capacity or provide redundancy.

The SkyGateway typically resides at a location with easy access to wired infrastructure—usually a POP (point of presence) or data center.

For optimal performance, install the SkyGateway on an elevated site such as a cell tower or the top of a tall building.

SkyExtender Devices

SkyExtenders, SkyExtender DualBands, and SkyExtender TriBands provide a cost-effective way to add capacity and balance network loads by operating as "repeaters" to extend the wireless range of a SkyGateway (see Figure 1-1). You can add any SkyExtender device to your network to expand your coverage footprint and provide redundancy through SkyPilot's mesh networking features. SkyExtender devices (except DualBands) can provide subscribers with a direct connection to the wireless network via the device's Ethernet port.

SkyExtender DualBand is a dual-radio solution that combines SkyPilot's long-range, high-capacity 5 GHz mesh backhaul with a high-powered 2.4 GHz 802.11b/g access point that allows service providers and municipalities to offer standard Wi-Fi services over great distances—for targeted hot zones or dense, ubiquitous coverage patterns.

SkyExtender TriBand integrates a 5.8 GHz mesh backhaul with the DualBand's access point and adds a third radio accessible through a second access point. The second access point leverages the 4.9 GHz Public Safety band, using 802.11a

communication protocol. Each access point uses a single antenna, and these antennas have similar coverage patterns, providing a cost-effective solution for municipal networks.

For optimal performance, install the SkyExtender in an elevated location such as a roof, tower, or utility pole.

SkyConnector and SkyAccess DualBand

SkyConnectors link your subscribers to the SkyPilot wireless network. An Ethernet port on the device allows a connection to a subscriber's computer, or to a local area network (LAN) via a data switch or router. Designed for installation by the service provider, the SkyConnector attaches to an external structure such as an eave, roof, or pole.

The SkyAccess DualBand offers the same features as a SkyConnector, plus a Wi-Fi access point that enables service providers and municipalities to provide standard 802.11 wireless access over great distances, for targeted hot zones, or for dense coverage patterns.

Your SkyGateway/SkyExtender Kit

Your SkyPilot SkyGateway/SkyExtender kit provides the basic equipment you need to install the device and configure it for operation on a SkyPilot wireless mesh network. This chapter describes that equipment and lists additional items you should have on hand before starting installation.
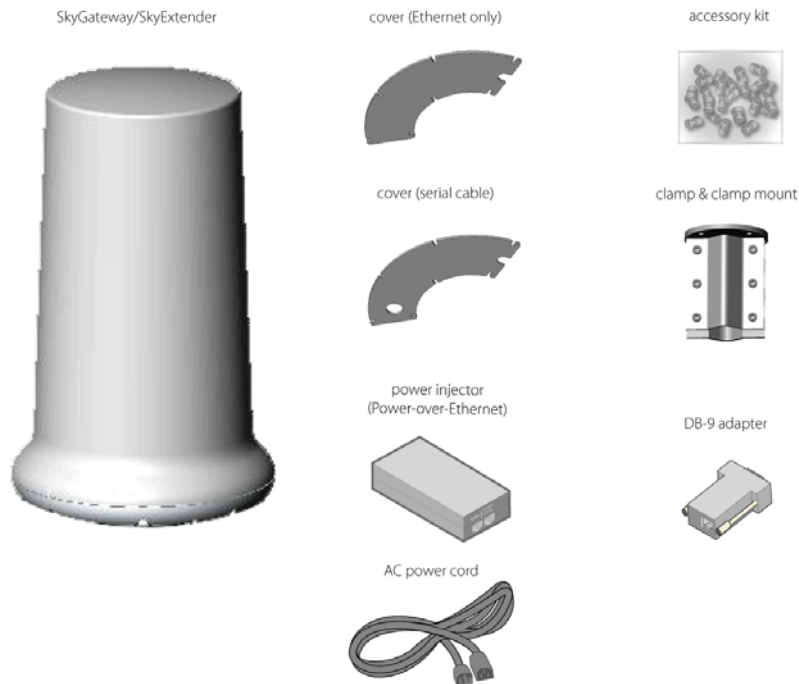
Chapter Highlights

- Kit contents

- What else you need

Kit Contents

Figure 2-1 shows the contents of the SkyGateway/SkyExtender kit.

Figure 2-1. What the basic kit provides

Additionally, DualBand kits contain two 2.4 GHz (white tipped) omnidirectional antennas.

And TriBand kits contain the following items in addition to the basic SkyExtender kit:

- One 2.4 GHz (white tipped) antenna
- One 4.9 GHz (black tipped) antenna

SkyPilot separately offers accessories for different types of installation, including a surge suppressor, a tilt mount kit, and an all-in-one mount kit for light poles that includes a power supply and surge suppressor. For more information, visit the SkyPilot website at www.skypilot.com/support/.

What Else You Need

Before starting installation, you also need the following:

- For basic mounting:
  - 7/16" wrench
  - Phillips screwdriver
- For pole mounting:
  - Magnetic level
  - Steel pole between 1 1/4" and 2 1/8" in diameter
- For network cabling:
  - Spool of CAT-5 network cable (shielded cable is recommended)
  - RJ-45 straight through cable for a serial connection to a console (standard CAT-5 patch cable will work)

    NOTE   SkyPilot strongly recommends always running a serial cable from SkyGateways and SkyExtenders to facilitate troubleshooting.

  - Crossover cable (for connecting to a an access point, switch, or router)
  - RJ-45 connectors (connectors without a protective "boot" are recommended)
  - RJ-45 crimping tool
  - Surge protection device (strongly recommended)
- For configuration:
  - Computer with a serial port, a terminal emulation program, a network interface card, and a Web browser (laptop recommended for convenience)

Installing and Configuring the SkyGateway/SkyExtender

This chapter provides instructions for planning and performing the physical installation of the SkyGateway or SkyExtender and then configuring it.

Chapter Highlights

- Planning your installation

- GPS and the SkyGateway/SkyExtender

- Mounting

- Cabling

- Attaching antennas

- Powering up

- Configuring the SkyGateway/SkyExtender

- Accessing the command-line interface

- Troubleshooting

Planning Your Installation

When choosing a site for the SkyGateway or SkyExtender, consider the radio frequency (RF) environment and the physical layout of the area.

Trees, buildings, and hills can attenuate or block a wireless signal. When assessing a site, examine the overall topology of the wireless path for possible obstructions—both existing and planned—as well as seasonal changes of foliage and tree growth. The RF environment is dynamic, and can deteriorate over time as structures appear or are relocated.

Plan to use test signals to determine the suitability of the link topology for target applications. Interference on your desired frequency results in overlapping signals, causing outages or intermittent drops in throughput.

Once you've identified a potential site, use a topographic map or path profile software to ensure that terrain or obstacles will not interfere with the links.

Your site survey should include an RF scan to identify available frequencies. You should also check your preferred frequency at all locations. A frequency that's clear at one location may be crowded at another. Frequency planning is a critical factor in planning and implementing a wireless network. (For device operating frequencies, see Appendix C, "Specifications.")

The site survey process should be ongoing. To verify that a site is relatively free of interference, make site audits every six to twelve months, scheduling regular maintenance visits to coincide with the site audits.

For TriBand installations, operators should review laws and regulations regarding the registration and use of the 4.9 GHz frequency in the area of deployment. For example, 4.9 GHz is used in the US for public safety information.

IMPORTANT Plan to configure the SkyGateway or SkyExtender before mounting it. Some steps, such as those requiring serial console access, are easier if the device is more accessible. For information about configuration, see "Configuring the SkyGateway/SkyExtender" on page 30.

SkyGateway Installation

In a typical wide area wireless mesh network, you'll install a SkyGateway on a tower or the roof of a tall building. The direct coverage area of the SkyGateway is usually proportional to the height of the installation.

You can also set up a SkyGateway for use in smaller-scale networks—for example, a high-capacity business, an academic campus interconnection, or a local access network. For smaller networks, you can install the SkyGateway on the roof of a medium-height building or on a utility pole.

SkyExtender Installation

You can install a SkyExtender in any location where a strong signal from a SkyGateway (or another SkyExtender) is available: home rooftops, tall buildings, or light and utility poles. Having fewer obstructions means greater signal strength, a higher signal-to-noise ratio, and more throughput.

GPS and the SkyGateway/SkyExtender

The SkyGateway or SkyExtender uses a GPS (Global Positioning System) signal to synchronize itself with other devices on the network. The strongest GPS signal is available outdoors, where the device has an unobstructed view of the sky. (For indoor installations, such as for configuration and testing, the optimal location is on a windowsill or other opening with access to the sky.)

Upon startup, a SkyGateway or SkyExtender searches for a GPS signal, and if the device can't detect a signal, it will be unable to complete startup and won't establish wireless connections with other devices.

You can configure a SkyGateway or SkyExtender even if the device can't detect a GPS signal. While the device is searching for the GPS signal, press the TILDE key (~) to bypass the search; the device will then proceed through the startup sequence.

NOTE The GPS search should be bypassed only for device configuration, not for standard operation. Without a GPS signal, data will not be reliably transmitted between devices.

The LEDs on the base of the device will confirm availability of a GPS signal. For more information on the LEDs and GPS signal acquisition, see "Monitoring the Power-On Sequence" on page 27.

Mounting

The first step of physically installing the SkyGateway or SkyExtender is to mount the device as described below.

NOTE   The figures in this section show the SkyGateway. For SkyExtender, DualBand, and TriBand installations, your view will differ slightly, allowing for antenna access through the cable covers.

To mount the SkyGateway/SkyExtender:

1   Attach a magnetic level to the 1.25" to 2.0" diameter steel mounting pole to verify that the pole is plumb (straight).

IMPORTANT   It is the installer's responsibility to verify that the support pole and its installation method are of sufficient strength to withstand onsite weather conditions. (The supplied mounting bracket and screws are certified to withstand a 125 mph wind force.)

2   Use the provided mounting bracket and appropriate length 1/4" Number 28 screws (provided in the accessory kit) to attach the SkyGateway or SkyExtender to the mounting pole (see Figure 3-1). The 1" screws accommodate a pole diameter of 1 1/2", and the 2" screws accommodate a pole diameter of 2 1/8".

Before clamping down the bracket, check that the mounting pole is still plumb and that the SkyGateway or SkyExtender is level.

NOTE   If the device is not level, performance may be degraded.

Figure 3-1. Attaching the SkyGateway/SkyExtender

Figure 3-1. Attaching the SkyGateway/SkyExtender
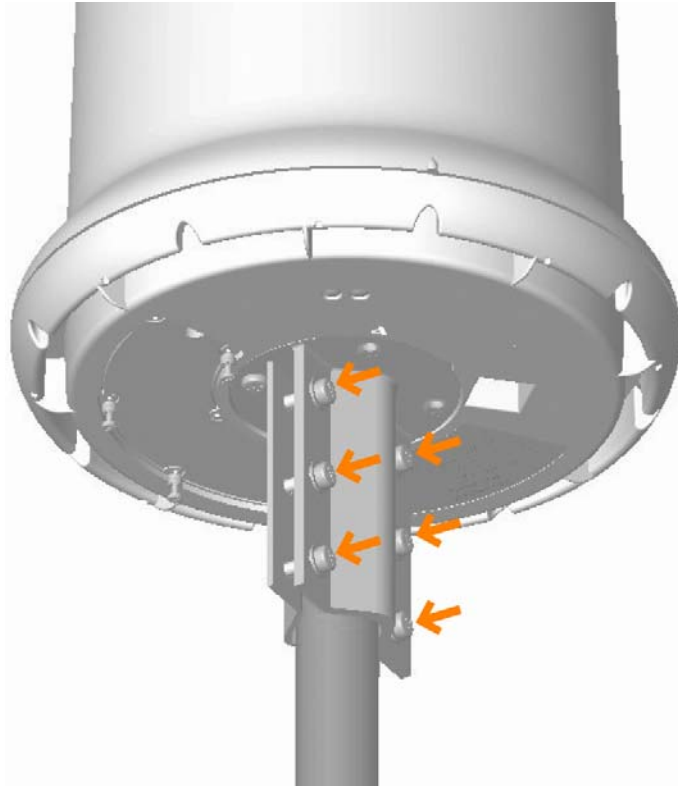
Cabling

Ethernet cabling provides power and data connectivity for the SkyGateway or SkyExtender. Serial cabling provides connectivity for troubleshooting and local configuration—connectivity that's beneficial and cost-effective for locations where access to the device is difficult, such as cell towers. To cable the device for both Ethernet and serial connections (recommended), see the procedure on page 16; to cable the device for Ethernet only, see the procedure on page 19.

IMPORTANT For DualBand and TriBand installations, make sure to route and secure the cables such that they will not interfere with the external antennas.

To install cabling for both Ethernet and serial connections:

1 Connect the Ethernet cable.

Run the CAT-5 cable under the gasket and plug it into the Ethernet port in the cavity on the device base (see Figure 3-2).
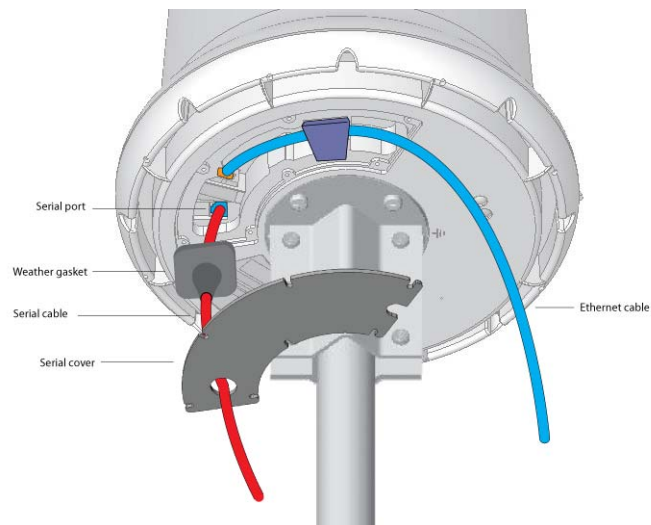
Figure 3-2. Connecting the Ethernet cable
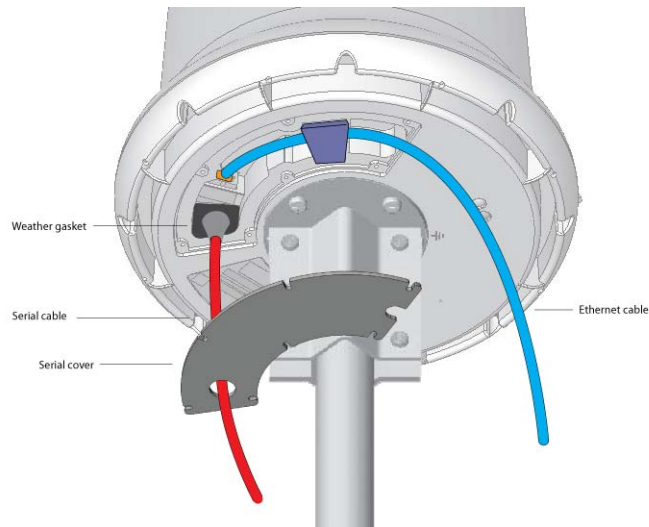

Ethernet cable
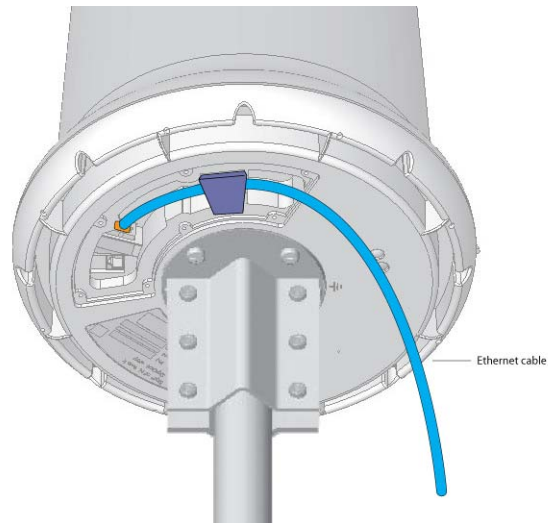
2 Connect the serial cable.

a Thread the serial cable through the serial cable cover and weather gasket, and then plug the connector into the serial port.

Figure 3-3. Connecting the serial cable

Serial port

Weather gasket

Serial cable

Serial cover

Ethernet cable

b Press the weather gasket into the recessed area around the serial port.

Figure 3-4. Fitting the weather gasket

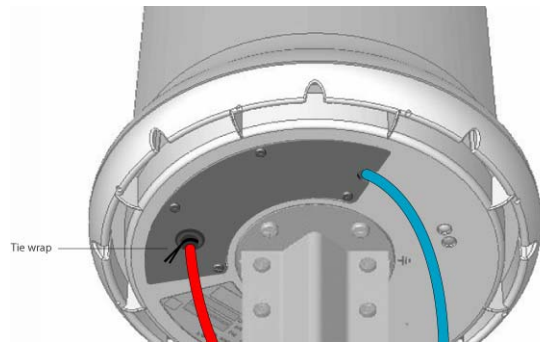**3** Attach the cover.

a Slide the port cover over the weather gasket and secure it to the base of the unit with the provided screws, making sure the Ethernet cable passes through the cutout in the cover.

Figure 3-5. Attaching the cover to the base
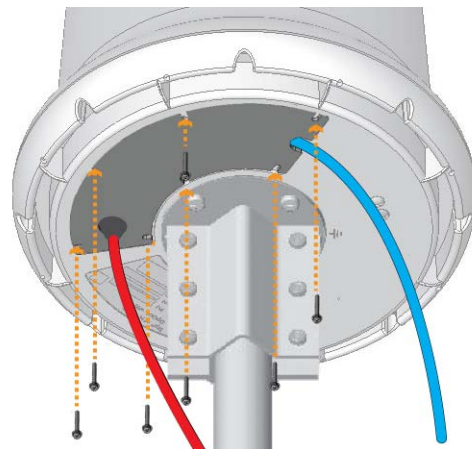
b Use a tie wrap (provided in the accessory kit) to ensure a tight seal for the weather gasket. Cut off any excess tie wrap.

Figure 3-6. Sealing the weather gasket

4   Secure the cabling.

Use sturdy cable ties or Velcro wraps (not included) to secure all the cabling against strain, especially if the installation is subject to high winds.

Figure 3-7. Secured cabling

To install cabling for Ethernet only:

1 Connect the Ethernet cable.

Run the CAT-5 cable under the gasket and plug it into the Ethernet port in the cavity on the device base (see Figure 3-8).

Figure 3-8. Connecting the Ethernet cable

Ethernet cable

2 Attach the cover.

Slide the Ethernet cable cover over the gasket and secure it to the base of the unit with the provided screws, making sure the Ethernet cable passes through the cutout in the cover.
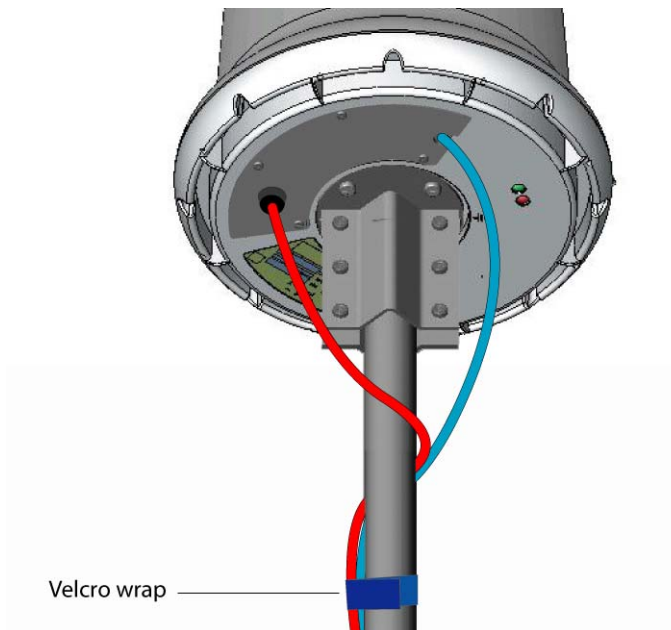
Figure 3-9. Attaching the cover to the base
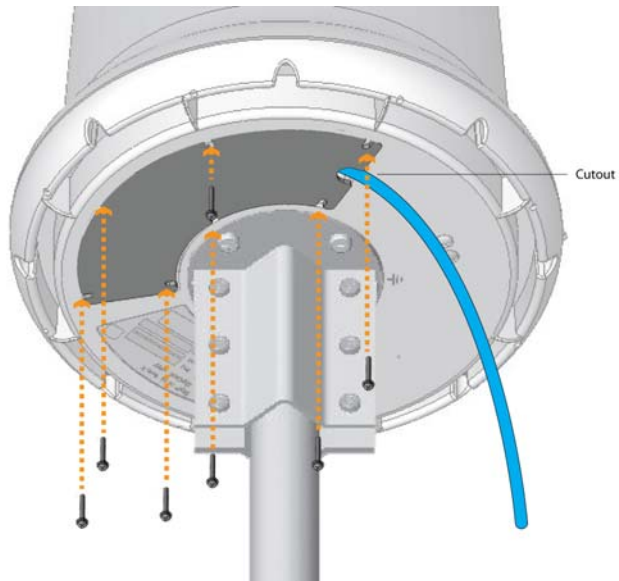
3 Secure the cabling.

Use sturdy cable ties or Velcro wraps (not included) to secure all the cabling against strain, especially if the installation is subject to high winds.
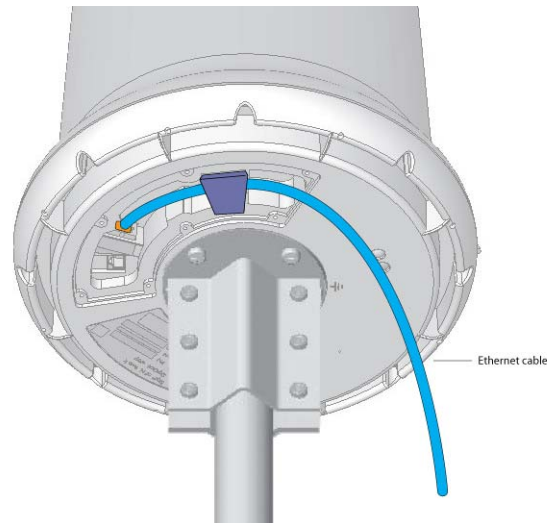
Figure 3-10. Secured cabling
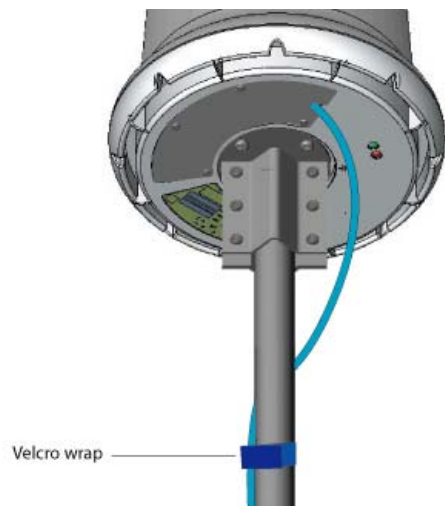
Attaching Antennas

Unless you're installing a DualBand or TriBand, you can skip this section. To to attach the DualBand antennas, see the procedure on page 21; to attach the TriBand antennas, see the procedure on page 22.

To attach the DualBand antennas:

● Connect the 2.4 GHz antennas.

> **IMPORTANT** If installing anything other than the included antennas, it is the operator's responsibility to ensure the antenna EIRP falls within FCC specifications.

Screw the antennas onto the standard N-connectors on the bottom of the DualBand.

Figure 3-11. Attaching the DualBand antennas
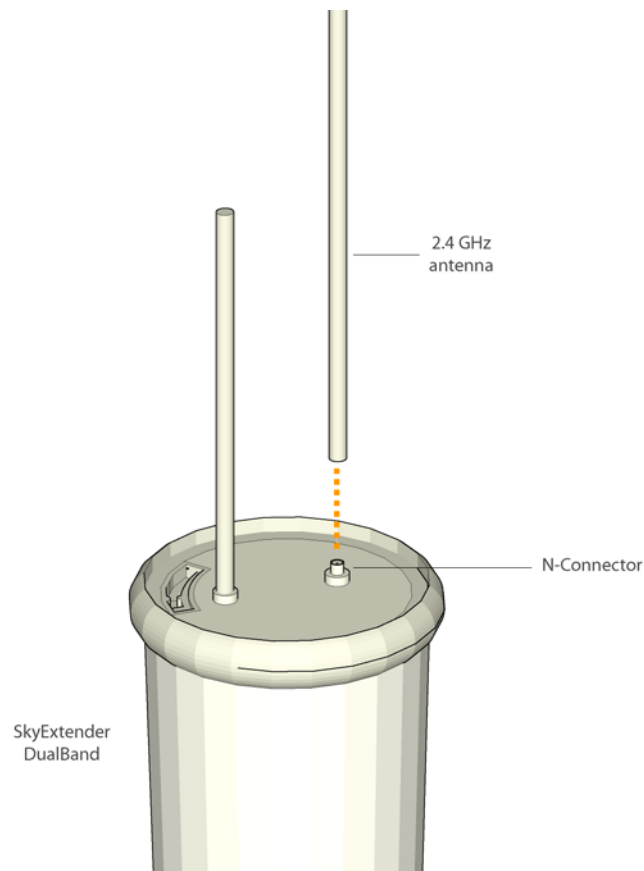
To attach the TriBand antennas:

● Connect the 2.4 GHz and 4.9 GHz antennas.

Each TriBand access point requires attachment of one of the antennas provided with the device. Screw the 2.4 GHz (white tipped) antenna onto the N-connector marked "ant 1" and the 4.9 GHz (black tipped) antenna onto the N-connector marked "ant 2".

Figure 3-12. Attaching the TriBand antennas
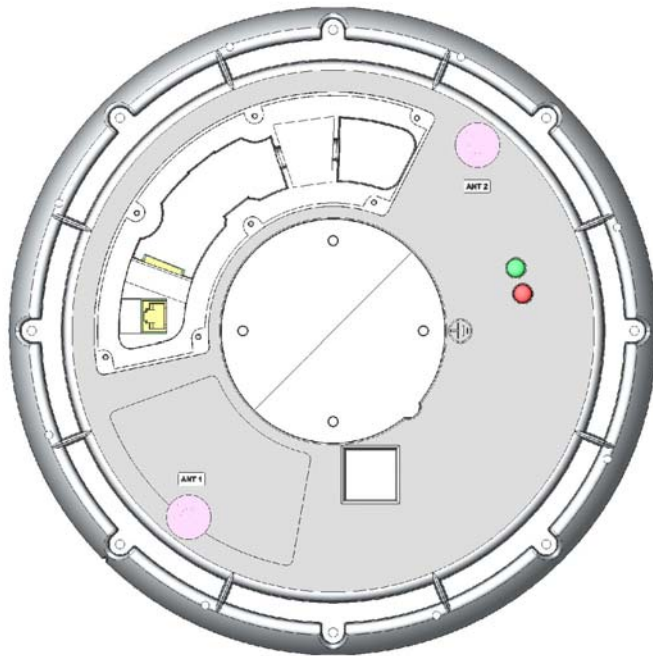
Powering Up

To supply power to the SkyGateway or SkyExtender, perform the procedures described in this section.

Making Power and Network Connections

To make connections:

1   Attach the power supply for the SkyGateway or SkyExtender.

    a   Connect the AC power cord to the AC adapter, and plug it into an AC outlet.

    b   Connect the Ethernet cable to the port labeled "CPE" on the power injector.

        IMPORTANT   Be careful not to plug the Ethernet cable connected to the SkyGateway or SkyExtender into the port labeled "Computer."

    c   Plug the AC adapter into the power injector.

Figure 3-13. Providing power to the SkyGateway/SkyExtender

SkyGateway/SkyExtender

Ethernet cable

Power injector

AC adapter
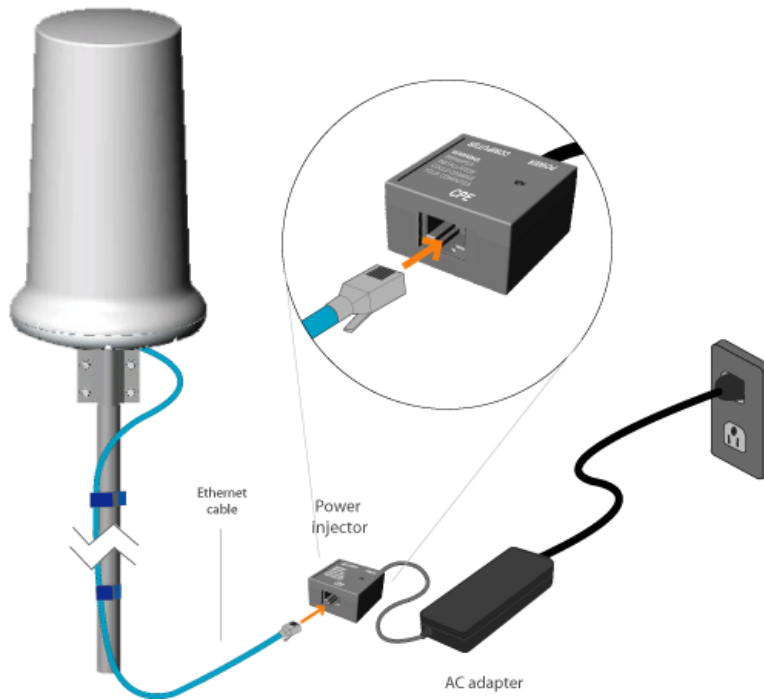
2   If you're connecting a DualBand, skip this step. Likewise, if you're connecting a SkyExtender that will operate solely as a repeater on the wireless mesh network, skip this step as a data connection is not required.

Otherwise, connect the device to a WAN (for a SkyGateway) or a PC/LAN (for a SkyExtender that's also providing local access to the wireless network).

NOTE   DualBands don't contain an Ethernet interface and can't detect any device connected to the power injector port labeled "Computer".

For a SkyGateway, connect a second Ethernet cable from the power injector port labeled "Computer" to a router or data switch that connects to the WAN or Internet (see Figure 3-14).

Figure 3-14. Connecting a SkyGateway to a router or data switch

SkyGateway

Internet

Router/access point

Ethernet port

Ethernet cross-over cable (router/access point) or Ethernet straight-through cable (data switch)

Power injector

AC adapter
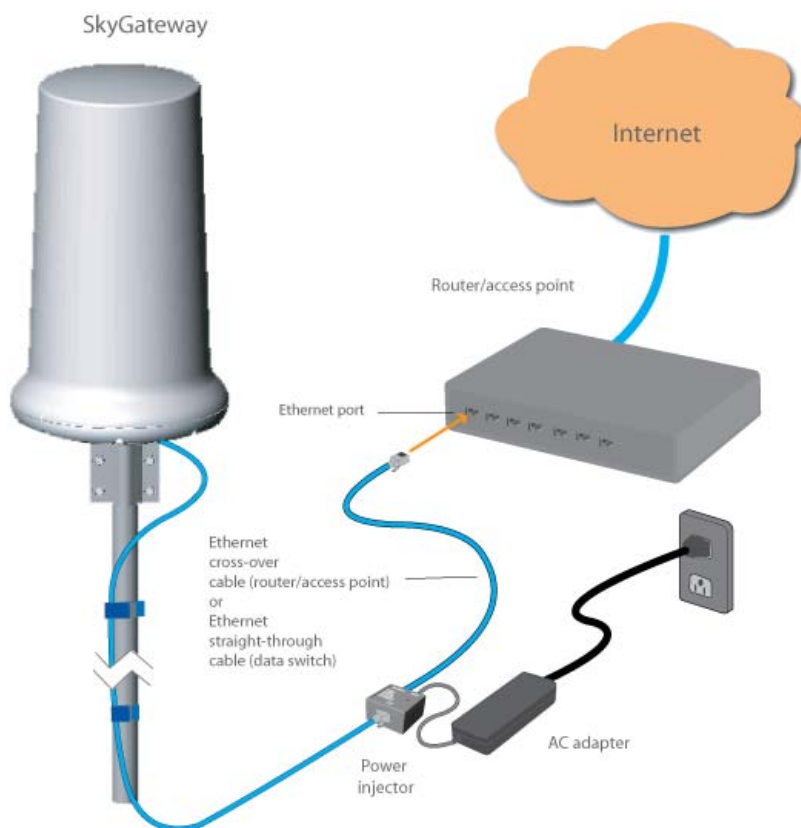
For a SkyExtender (or TriBand, but not DualBand) that also gives subscribers access to the wireless mesh network, connect a second Ethernet cable from the power injector port labeled "Computer" to a personal computer (see Figure 3-15) or to a router or data switch providing a connection to a LAN (see Figure 3-16).

Figure 3-15. Connecting a SkyExtender/TriBand to a computer

SkyExtender

Ethernet port

Ethernet
cross-over cable

Power
injector

AC adapter
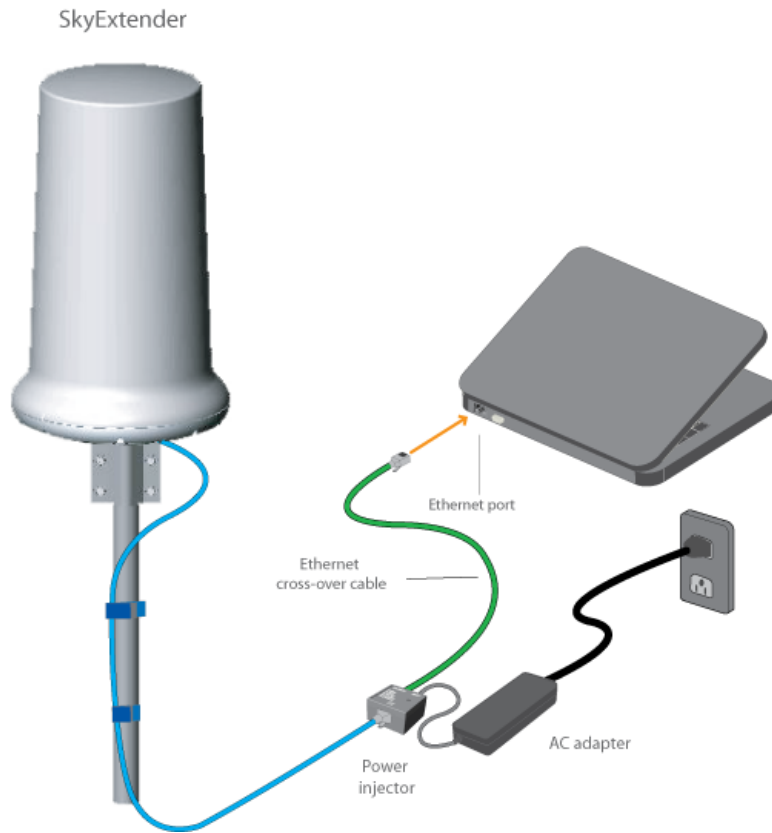
Figure 3-16. Connecting a SkyExtender/TriBand to a LAN

SkyExtender

Access point

Ethernet port

Ethernet cross-over cable

AC adapter

Power injector
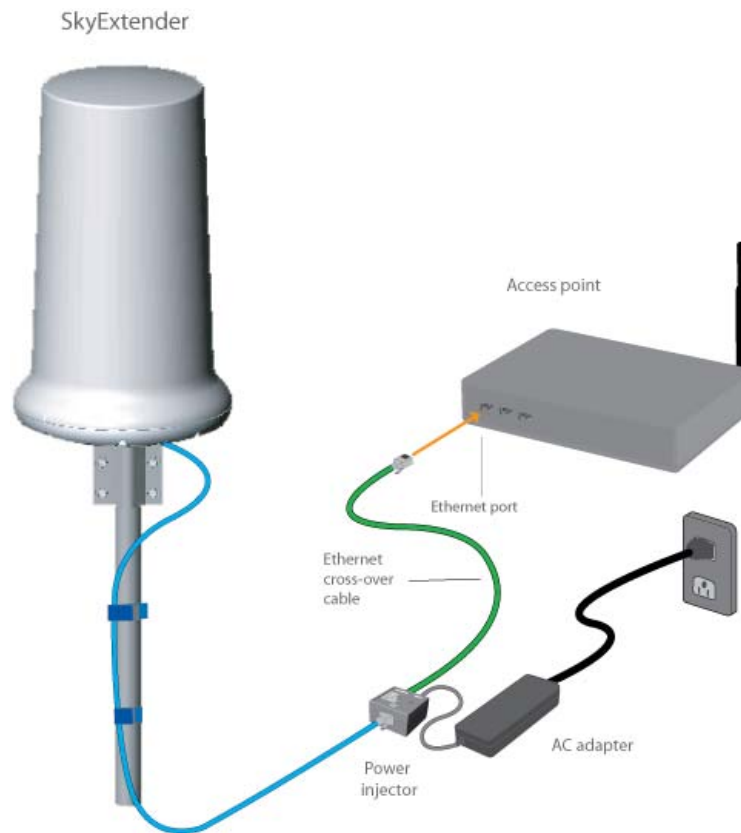
Monitoring the Power-On Sequence

When power is supplied to the SkyGateway or SkyExtender, it starts a routine power-on sequence which you can monitor by observing the pair of LED lights on the underside of the device.

The power-on sequence takes up to 15 minutes, depending on how quickly the device can acquire a GPS signal.

NOTE   The SkyGateway or SkyExtender must have access to a GPS signal to complete its power-on sequence and start making wireless network connections. And depending on your SkyPilot network configuration, the device may be unable to connect to the network until the device has been fully configured as described in "Configuring the SkyGateway/SkyExtender" on page 30.

Figure 3-17. LED lights on the SkyGateway/SkyExtender base
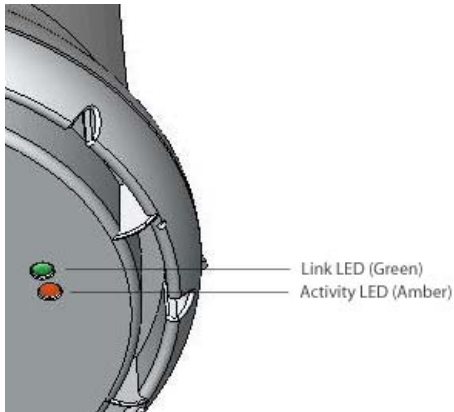
The tables that follow provide detailed descriptions of device states indicated by the LED lights. When both LED lights are lit and steady, the SkyGateway or SkyExtender is successfully connected to the wireless network.

You can observe the startup progress by attaching a laptop to the device's serial port, starting a terminal emulation program, and rebooting the device. For more information about accessing a SkyGateway or SkyExtender via a serial connection, refer to the *SkyPilot Command-Line Interface Reference*, available from the SkyPilot website at www.skypilot.com/support/.

Table 3-1. SkyGateway LED Status Lights (Page 1 of 2)

Device state	Link LED (green)	Activity LED (amber)
Startup in progress	Slow staggered blinking of both LEDs	
Startup failure	Off	On
Initializing image [†] (and acquiring GPS signal)	Blinks 4 times; repeats cycle	Blinks 4 times; repeats cycle

[†] The blink sequence will be different for SkyGateways running firmware version 1.1 or earlier.

Table 3-1. SkyGateway LED Status Lights (Page 2 of 2)

Device state	Link LED (green)	Activity LED (amber)
Initialization failure	Fast, synchronized blinking of both LEDs	
Successful initialization, but authorization failure	On	Off
Connected	On	On

† The blink sequence will be different for SkyGateways running firmware version 1.1 or earlier.

Table 3-2. SkyExtender/DualBand/TriBand LED Status Lights (Page 1 of 2)

Device state	Link LED (green)	Activity LED (amber)
Startup in progress	Slow staggered blinking of both LEDs	
Startup failure	Off	On
Initializing image † (and acquiring GPS signal)	Blinks 4 times; repeats cycle	Blinks 4 times; repeats cycle
Initialization failure	Fast, synchronized blinking of both LEDs	
Successful initialization, but failure to locate hello	On	Off
Successful initialization; heard hello on RSSI	Off	Blink (RSSI rate-based)

† The blink sequence will be different for SkyExtenders running firmware version 1.1 or earlier.

Device state	Link LED (green)	Activity LED (amber)
Successful initialization; link is not optimized, or is in pre-authorization	Slow blink	Blink (RSSI rate-based)
Successful initialization; link is in standby state on RSSI	Fast blink	Blink (RSSI rate-based)
Connected	On	On

† The blink sequence will be different for SkyExtenders running firmware version 1.1 or earlier.

Configuring the SkyGateway/SkyExtender

To operate on the wireless mesh network, the SkyGateway or SkyExtender requires a network configuration.

A SkyGateway will not transmit a wireless signal until it is configured, and it will not be able to connect to other network devices without a configuration.

SkyPilot offers two modes for provisioning devices with a configuration:

- **Automatic**—Requires the use of SkyPilot EMS software to create configurations that an unattended central server can distribute to devices on the wireless mesh network. Although automatic provisioning requires more setup time than manual provisioning, it greatly simplifies the administration of a growing network.

  Detailed procedures for using EMS software are provided in *SkyPilot Network Administration*, available from the SkyPilot website at www.skypilot.com/support/.

- **Manual**—Usually performed in the field, manual provisioning permits the configuration of only a single device at a time, creating the minimum settings required for a wireless link and storing them in the device's flash (nonvolatile) memory. Manual provisioning is a logical choice if you're installing a test network or rolling out a small-scale installation that isn't expected to expand.

For more information about provisioning modes, refer to *Getting Started with the SkyPilot Network*, available from the SkyPilot website at www.skypilot.com/support/.

Accessing the Command-Line Interface

SkyPilot devices include a command-line interface which you can use for manual provisioning and troubleshooting.

You can connect to a device and access its command-line interface through Telnet over an Ethernet connection or via a terminal session from a console connected to the device's RJ-45 serial port. After logging in (by supplying a password), you can enter commands at the command prompt.

For detailed cabling and access instructions for the command-line interface, refer to the *SkyPilot Command-Line Interface Reference*.

Troubleshooting

After making an Ethernet or serial connection to the SkyGateway or SkyExtender, you can manage and troubleshoot the device using a wide range of commands available through the command-line interface.

For detailed troubleshooting procedures, refer to the "Troubleshooting" section in *SkyPilot Network Administration*. There you'll find troubleshooting procedures for:

- Power-on problems
- Ethernet connectivity problems
- IP connectivity problems
- SkyGateway Transmission problems
- Link failure problems

Grounding Guidelines

This appendix provides some guidelines for properly grounding the SkyPilot Gateway/SkyPilot Extender.

Proper grounding protects both your SkyPilot device and equipment connected to it. For the surge protection circuitry built into the SkyPilot equipment to be effective, proper grounding of the unit is necessary. This is especially true if you're installing devices on tall structures, or in areas subject to lightning.

NOTE   The techniques described in this appendix are intended as general guidelines only and do not constitute a comprehensive guide covering all installation scenarios. For maximum protection, contact a qualified installation specialist who is familiar with your operating environments. If lightning is a threat in your area, consider a consultation with a lightning and transient protection specialist.

General Grounding Strategy

To ensure optimal reliability, properly ground the metal base of the SkyPilot device. The most efficient way to ground the device is to use an 8 GA or larger wire to connect it to a ground point on the structure or tower.

The three most common ground points are:

- A cold-water pipe. Make sure it is well connected to earth.

- The primary grounding point of the AC electrical system of the building.

- A 10-foot or longer copper-clad ground rod driven into the earth. For a tower with multiple legs, you need one ground rod per leg and a ground wire loop connecting each of the rods; see Figure 12.

Figure 12. Ground wire loop
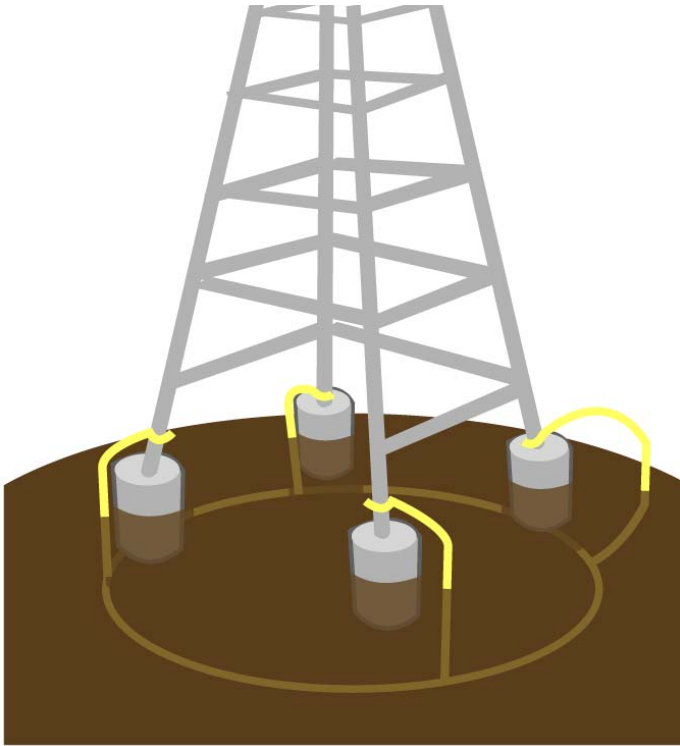
Making Connections "Gas-Tight"

Regardless of the grounding point you use, make sure the connections are "gas-tight"—capable of retaining low resistance and integrity over time and with exposure to the elements.

Use of an antioxide compound and proper sealing is essential. For protection against corrosion, wrap all connections with Scotch® 130C tape.

Checking Cold-Water Pipe Integrity

If you're using a cold-water pipe for grounding, verify the integrity of the ground. In some cases, sections of metal cold-water pipes may have been repaired or extended with PVC material. PVC material or a dielectric union will render a cold-water pipe ground unacceptable for grounding.

Measuring Resistance

Verify that there is no more than 5 ohms of resistance between any two ground points in the entire system. Also make sure that all ground points on a structure are tied together. For example, if you use a ground rod and a cold-water pipe as grounding points at different locations on the same structure, you must tie them together.

Adding Surge Protection

If you're installing a SkyPilot device in an area that's subject to lightning storms, SkyPilot recommends installing a surge protection device (SPD) at both ends of the Ethernet cable—one at the SkyPilot device and one at the point of entry to a building or enclosure.

SkyPilot offers SPDs with bracket and cabling designed for use with SkyPilot equipment. For more information, visit SkyPilot customer support at www.skypilot.com/support/ to view accessory guides for SkyPilot-branded surge protection solution. (You may also purchase SPDs from third-party vendors.)

Grounding Checklist

When grounding a SkyPilot device, use the following checklist to confirm that your installation is adequately protected from power surges and lightning.

- Connect a ground wire from the SkyPilot device to a ground system on the building or tower.

- Use shielded CAT5 cabling and connect the drain wire of the shield to ground at the SkyPilot device. (Leave the other end of the drain wire unconnected.)

- Use the proper size down lead to connect a SkyPilot device on a roof or tower to the ground system of indoor equipment.

- Verify that all points of the ground system are tied together with less than 5 ohms resistance between any two points.

- Run the CAT5 cable inside the tower structure, tying the cable to the tower leg at every 4 feet of length. For increased protection, run the CAT5 cable through metallic conduit installed on the tower.

- Bleed off any static charge by installing a streamer-delaying, static-dissipation array above the SkyPilot device.

- Install all lightning and surge protection devices in accordance with UL 96A installation requirements for lightning protection systems and the NFPA 780 standard for lightning protection.

FCC Statements

FCC Radio Frequency Interference Statement

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to part 15/90 of the FCC Rules. These limits are designed to provide reasonable protection against 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 and correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the distance between the equipment and the receiver.

- Connect the equipment to 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.

This equipment has been certified to comply with the limits for a class B computing device, pursuant to FCC Rules. In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of manufacturer could void the user's authority to operate this equipment.

Maximum Permissible Exposure

In order to meet Industry Canada, FCC and other regulatory requirements for RF
Exposure, the SkyGateway and SkyExtender units must be located a minimum of
40 cm (16 inches) from all persons.

FCC 15.203 statement

Because DualBands and TriBands use standard RF connectors for the external
removable antennas, professional installation is required.

FCC Radio Frequency Interference Statement

IC RSS-210 statement

DualBands have been designed to operate with the external antennas for the
2.4 Ghz band listed below, and having a maximum gain of 7.4 dBi. Antennas not
included in this list or having a gain greater than 7.4 dBi are strictly prohibited for
use with this device. The required antenna impedance is 50 ohms.

Approved antennas:

Manufacturer	Model
Comet	SF245
Comet	SF245+12
Comet	SF245+12x

Specifications

This appendix provides technical specifications for the SkyPilot SkyGateway and SkyExtender (Table C-1), SkyExtender DualBand (Table C-2), and SkyExtender TriBand (Table C-3).

Table C-1. SkyGateway/SkyExtender Specifications (Page 1 of 3)

Wireless specifications

Frequency band	4.940–5.150, 5.150–5.450, 5.450–5.725, or 5.725–5.850 GHz
EIRP	44.5 dBm/28.2W peak, 36 dBm/4W average, 33 dBm/2W average, 30 dBm/1W average, or 36 dBm/4W peak (EIRP selected for country-specific regulations)
Media access	Time Division Duplex (TDD)
Modulation technique	OFDM with adaptive modulation
Modulation rates	6–54 Mbps
Throughput	UDP: Up to 20 Mbps
	TCP: Up to 10.5 Mbps
Latency	10–12 ms round trip per hop
Antennas	8-antenna array (360° coverage), each antenna 45° horizontal x 6° vertical, 18 dBi
Channel width	5, 10, or 20 MHz, depending on product version
Channel resolution	5 MHz frequency control
Receive sensitivity	-90 dBm at 6 Mbps modulation
Connectivity	SkyGateway connects with SkyExtenders, DualBands, TriBands, and SkyConnectors.
	SkyExtender connects with SkyGateways, SkyExtenders, DualBands, TriBands, and SkyConnectors.

Table C-1. SkyGateway/SkyExtender Specifications (Page 2 of 3)

Authentication	MD5-based certificates
Encryption	128-bit AES on all wireless links

Product Specifications

Connectors	RJ-45: Ethernet connection (10/100Base-T) and power (Power over Ethernet)
	RJ-45: RS-232 serial for local management
Mounting	Tower, utility pole, building, or other infrastructure, outside pole diameter up to 2.0"
Range	Up to 10 miles (16 km)
LEDs	Wireless activity, wireless link
Dimensions	18.0" (45.7 cm) H x 12.2" (31.0 cm) diameter
	25.0" (63.5 cm) H with mounting bracket
Weight	14.0 pounds (6.3 kg)
Operating temperature	-40° to 131° F (-40° to 55° C)
Wind loading	Up to 150 mph (240 km/h)
Enclosure/humidity	NEMA-4X
Power	110–230 VAC, 50–60 Hz input, 16 watts maximum
Certifications	FCC Part 15, FCC 47 CFR Part 15, Class B USA; compliance with UL safety standards, CE, C-Tick, IC RSS210 Issue 5
EMI and susceptibility	FCC Part 15.107 and 15.109
Warranty	One-year limited warranty on hardware and software

Security

Authentication	MD5-based certificates
Encryption	AES
Filtering	Based on protocol type, IP port ID, and configurable IP address list

Table C-1. SkyGateway/SkyExtender Specifications (Page 3 of 3)

Network management

Command-line interface	Console via RS-232 serial port or SSH
NMS Integration	SNMP v2c
GUI configuration	SkyProvision™ software and Web interface
GUI EMS	SkyControl™ software
IP address	DHCP or static
Firmware	Multiple versions of firmware stored in nonvolatile memory; updated via FTP
Configuration file	XML over HTTP

QoS (Quality of Service)

Prioritization	802.1p-based; based on protocol type, IP address, port ID, and configurable IP address list
Traffic shaping	Per-device rate limits upstream and downstream

Monitoring and MIB support

Supported MIBs	MIB-II (RFC 1213); EtherLike (RFC 2665); Bridge (RFC 1493); SkyPilot private MIB
Local management	RS-232 Serial Console Port
Remote management	Command-line interface via Telnet, SNMP 2c, Web interface

Topology

Configurations	Mesh, point-to-multipoint, point-to-point

Table C-2. SkyExtender DualBand Specifications (Page 1 of 3)

Wireless specifications	5 GHz wireless backhaul (mesh, point-to-multipoint, or point-to-point)	802.11b/g AP (Wi-Fi subscriber access)
Frequency band	4.940–5.150, 5.150–5.450, 5.450–5.725, or 5.725–5.850 GHz	2.400–2.497 GHz
EIRP	44.5 dBm/28.2W peak, 36 dBm/4W average, 33 dBm/2W average, 30 dBm/1W average, or 36 dBm/4W peak	35.0 dBm/3.2W or 29.0 dBm/800mW
Media access	Time Division Duplex (TDD)	802.11b/g CSMA/CA
Modulation technique	OFDM with adaptive modulation	802.11b: DSSS 802.11g: OFDM with adaptive modulation
Modulation rates	6–54 Mbps	802.11b: 1–11 Mbps 802.11g: 6–54 Mbps
Throughput	UDP: Up to 20 Mbps TCP: Up to 10.5 Mbps	UDP: Up to 20 Mbps TCP: Up to 10.5 Mbps
Latency	10–12 ms round trip per hop	10–12 ms round trip per hop
Antennas	8-antenna array (360° coverage), each antenna 45° horizontal x 6° vertical, 18 dBi	2 external 7.4 dBi omnidirectional antennas with transmit and receive diversity
Channel width	5, 10, or 20 MHz, depending on product version	20 MHz
Channel resolution	5 MHz frequency control	5 MHz frequency control
Receive sensitivity	-90 dBm at 6 Mbps modulation	-98 dBm at 1 Mbps modulation

Table C-2. SkyExtender DualBand Specifications (Page 2 of 3)

Connectivity	Connects with SkyGateways, SkyExtenders, DualBands, TriBands, and SkyConnectors.	Connects with 802.11b/g Wi-Fi clients
Authentication	MD5-based certificates	RADIUS support for multiple servers, 802.11b/g
Encryption	128-bit AES on all wireless links	AES, WPA (EAP-TTLS, EAP-PEAP/MSCHAPv2 with TKIP), MIC, and dynamic WEP

Product specifications

Connectors	RJ-45: Power over CAT-5
	RJ-45: RS-232 serial for local management
Mounting	Tower, utility pole, building, or other infrastructure, outside pole diameter up to 2.0"
Range	Up to 10 miles (16 km)
LEDs	Wireless activity, wireless link
Dimensions	33.0" (83.8 cm) H x 12.2" (31.0 cm) diameter
Weight	15.0 pounds (6.75 kg)
Operating temperature	-40° to 131° F (-40° to 55° C)
Wind loading	Up to 150 mph (240 km/h)
Enclosure/humidity	NEMA-4X
Power	110 VAC, 50–60 Hz input,20 watts maximum
Certifications	FCC Part 15, FCC 47 CFR Part 15, Class B USA; compliance with UL safety standards, CE, C-Tick, IC RSS210 Issue 5
EMI and susceptibility	FCC Part 15.107 and 15.109
Warranty	One-year limited warranty on hardware
	90-day limited warranty on software

Security

Authentication	MD5-based certificates

Table C-2. SkyExtender DualBand Specifications (Page 3 of 3)

Encryption	AES
Filtering	Based on protocol type, IP port ID, and configurable IP address list

Network management

Command-line interface	Console via RS-232 serial port or SSH
NMS Integration	SNMP v2c
GUI Configuration	SkyProvision™ software and Web interface
GUI EMS	SkyControl™ software
IP address	DHCP or static
Firmware	Multiple versions of firmware stored in nonvolatile memory; updated via FTP
Configuration file	XML over HTTP

QoS (Quality of Service)

Prioritization	802.1p-based; based on protocol type, IP address, port ID, and configurable IP address list
Traffic shaping	Per-device rate limits upstream and downstream

Monitoring and MIB support

Supported MIBs	MIB-II (RFC 1213); EtherLike (RFC 2665); Bridge (RFC 1493); SkyPilot private MIB
Local management	RS-232 Serial Console Port
Remote management	Command-line interface via Telnet, SNMP 2c, Web interface

Topology

Configurations	Mesh, point-to-multipoint, point-to-point

Table C-3. SkyExtender TriBand Specifications (Page 1 of 3)

Wireless specifications	5.8 GHz wireless backhaul (mesh, point-to-multipoint, or point-to-point)	802.11b/g access point (Wi-Fi subscriber access)	802.11a access point
Frequency band	4.940–4.990 or 5.725–5.850 GHz	2.400–2.483 GHz	4.940–4.990 GHz
EIRP (Effective Isotropic Radiated Power)	44.5 dBm/28.2W peak	26.0 dBm/400mW radio: 33.4 dBm/2.2W	26.0 dBm/400mW radio: 35 dBm/3.2W
Media access	Time Division Duplex (TDD)	802.11b/g CSMA/CA	802.11a CSMA/CA
Modulation technique	OFDM	802.11b: DSSS 802.11g: OFDM	OFDM
Modulation rates	6–54 Mbps	802.11b: 1–11 Mbps 802.11g: 6–54 Mbps	6–54 Mbps
Throughput	UDP: Up to 20 Mbps TCP: Up to 10.5 Mbps	UDP: Up to 20 Mbps TCP: Up to 10.5 Mbps	UDP: Up to 20 Mbps TCP: Up to 10.5 Mbps
Latency	10–12 ms round trip per hop	10–12 ms round trip per hop	10–12 ms round trip per hop
Antennas	8-antenna array (360° coverage), each antenna 45° horizontal x 6° vertical, 18 dBi	1 external 7.4 dBi omnidirectional antenna	1 external 9.5 dBi omnidirectional antenna
Channel width	5, 10, or 20 MHz, depending on product version	20 MHz	5, 10, or 20 MHz
Channel resolution	5 MHz frequency control	5 MHz frequency control	5 MHz frequency control
Receive sensitivity	-90 dBm at 6 Mbps modulation	-98 dBm at 1 Mbps modulation	-94 dBm at 6 Mbps modulation
Wireless Connectivity	SkyGateways, SkyExtenders, DualBands, TriBands, and SkyConnectors	802.11b/g Wi-Fi clients	802.11a Wi-Fi clients

Table C-3. SkyExtender TriBand Specifications (Page 2 of 3)

Authentication	MD5-based certificates	RADIUS support for multiple servers, 802.1x	RADIUS support for multiple servers, 802.1x
Encryption	128-bit AES on all wireless links	WEP, Dynamic WEP, and WPA (EAP-TTLS, EAP-PEAP/MSCHAPv2 with TKIP)	WEP, Dynamic WEP, and WPA (EAP-TTLS, EAP-PEAP/MSCHAPv2 with TKIP)

Product specifications

Connectors	RJ-45: Ethernet connection (10/100Base-T) and power (Power over Ethernet)
	RJ-45: RS-232 serial for local management
Mounting	Tower, utility pole, building, or other infrastructure, outside pole diameter up to 2.0"
LEDs	Wireless activity, wireless link
Dimensions	33.0" (83.8 cm) H x 12.2" (31.0 cm) diameter
Weight	15.0 pounds (6.75 kg)
Operating temperature	-40° to 131° F (-40° to 55° C)
Wind loading	Up to 100 mph (160 km/h)
Enclosure/humidity	NEMA-4X
Power	110 VAC, 50–60 Hz input,10 watts maximum
Certifications	FCC Part 15, FCC 47 CFR Part 15, Class B USA; compliance with UL safety standards
EMI and susceptibility	FCC Part 15.107 and 15.109
Warranty	One-year limited warranty on hardware
	90-day limited warranty on software

Security

Authentication	MD5-based certificates
Encryption	AES
Filtering	Based on protocol type, IP port ID, and configurable IP address list

Table C-3. SkyExtender TriBand Specifications (Page 3 of 3)

Network management

Command-line interface	Console via RS-232 serial port or SSH
NMS Integration	SNMP v2c
XML	
GUI Configuration	SkyProvision™ software and Web interface
GUI EMS	SkyControl™ software
IP address	DHCP or static
Firmware	Multiple versions of firmware stored in nonvolatile memory; updated via FTP
Configuration file	XML over HTTP

QoS (Quality of Service)

Prioritization	802.1p-based; based on protocol type, IP address, port ID, and configurable IP address list
Traffic shaping	Per-device rate limits upstream and downstream

Monitoring and MIB support

Supported MIBs	MIB-II (RFC 1213); EtherLike (RFC 2665); Bridge (RFC 1493); SkyPilot private MIB
Local management	RS-232 Serial Console Port
Remote management	Command-line interface via Telnet, SNMP 2c, Web interface

Topology

Configurations	Mesh, point-to-multipoint, point-to-point

Pinouts

This appendix provides pinouts for connectors and adapters to connect to the Ethernet interface port labeled "CPE" on the SkyGateway/SkyExtender power injector and the device's serial interface.

RJ-45 Pins

Table D-1 lists the RJ-45 pin assignments.

Table D-1. RJ-45 Pin Assignments

Pin	Assignment
1	Ethernet
2	Ethernet
3	Ethernet
4	Power
5	Power
6	Ethernet
7	Power
8	Power

DB-9 Adapter

Table D-2 lists connecting pins between the SkyGateway/SkyExtender "CPE" port (RJ-45 connector) and a standard computer DB-9 serial port.

Table D-2. RJ-45 Pin Assignments

SkyGateway/SkyExtender "CPE" port		Computer serial port	
Signal	Pin	Pin	Signal
TxD	3	2	RxD
GND	4	5	GND
RxD	6	3	TxD

The following figures show the connection between the SkyGateway or SkyExtender "CPE" port and a standard computer DB-9 serial port, the DB-9 pinouts, and the cable-pin correspondence.

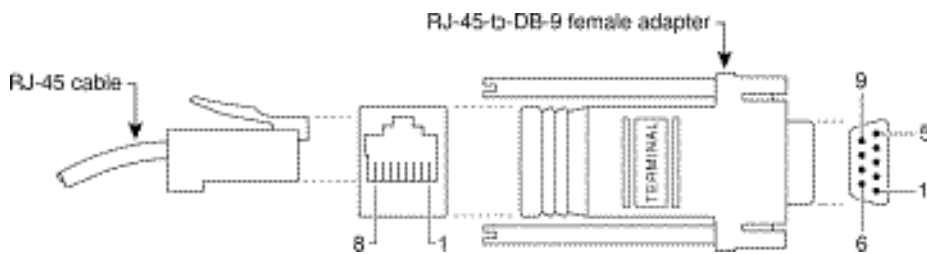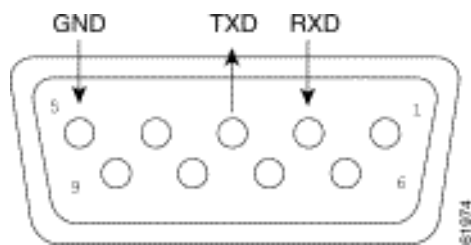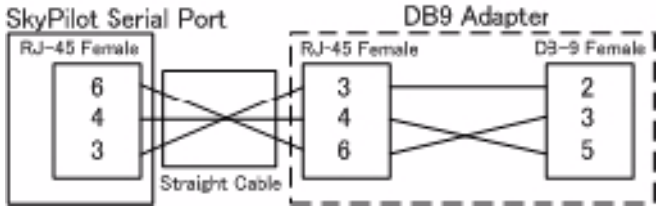Figure D-1. RJ-45 to DB-9 physical connectors

Figure D-2. DB-9 pins

If you're using a straight through cable, the connection can be visualized as shown in Figure D-3.

Figure D-3. Straight through cabling

Although there is no official standard, the connector wire colors typically are as described in Table D-3.

Table D-3. Typical RJ-45 DB-9 Wire Colors

Color	RJ-45 pin	DB-9 pin
Black	3	2
Yellow	6	3
Red	4	5