SkyPilot
SkyConnector Outdoor

Installation

Contents

About This Guide

This guide explains how to install and set up a SkyPilot™ SkyConnector™ Outdoor 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 SkyConnector Outdoor 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**," 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**," provides the information you need before you begin your installation.

- Chapter , " **3**," provides instructions for the physical installation of the SkyConnector Outdoor as well as background information about configuration and references to associated procedures.

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

- Appendix , " **Error! Reference source not found.**," provides the FCC radio frequency interference statements for the SkyConnector Outdoor.

- Appendix , " C" provides technical specifications for the SkyConnector Outdoor.

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.

SkyPilot devices' multiple antenna configurations work within mixed-use environments of municipal applications and broadband Internet access, supporting public-private partnerships such as public safety services.

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   ). In addition to adding range, a mesh network allows connections from locations where obstructions prevent line-of-sight access to a SkyGateway hub.

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. SkyPilot wireless mesh network
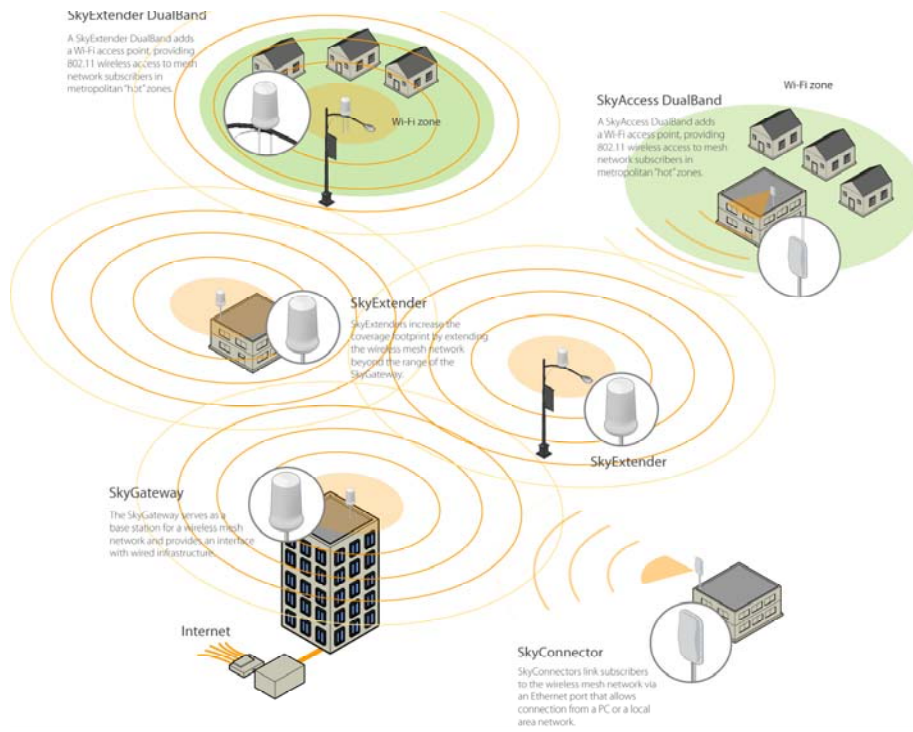
SkyGateway

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   ). 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.

The SkyConnector Outdoor Installation Kit

Your SkyPilot SkyConnector Outdoor installation 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.
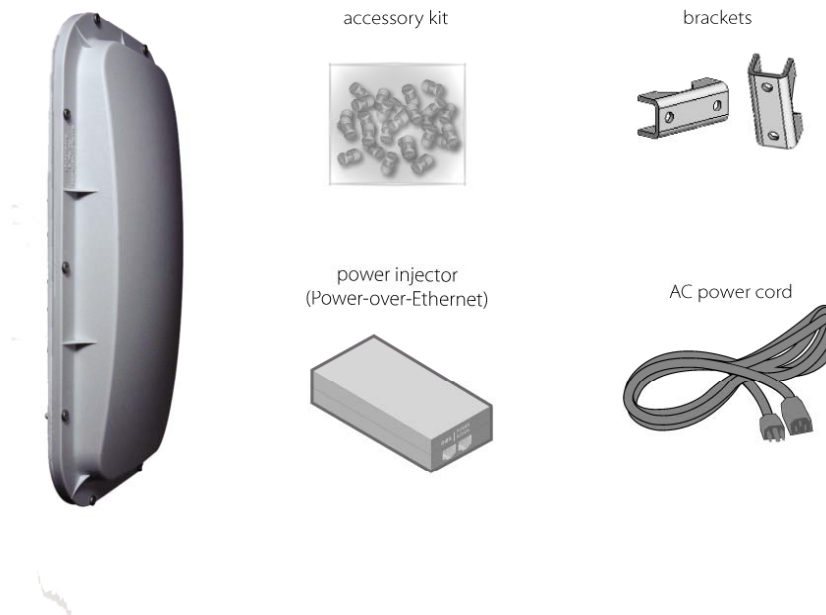
Chapter Highlights

- Kit contents

- What else you need

Kit Contents

Figure 2-1 shows the contents of the SkyConnector Outdoor installation kit.

Figure 2-1. SkyPilot Outdoor installation kit

SkyConnector (Outdoors)

SkyPilot separately offers accessories for different types of installation, including a surge suppressor and a tilt mount kit. 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:

    o Phillips screwdriver

- For pole mounting:

- o Magnetic level

- o Steel pole between 1 1/8" (2.87 cm) and 1 3/8" (3.48 cm) in diameter

- For network cabling:

  - o A spool of CAT5 network cable (shielded cable is recommended)

  NOTE Ethernet cabling must comply with NEC/CEC requirements for outdoor CAT-5 cables. The cabling's outer jacket must be clearly marked as CAT-5e per ANSI/TIA/EIA-568-B.2.

  - o Crossover cable (for connecting to a an access point, switch, or router)

  - o RJ-45 connectors (connectors without a protective "boot" are recommended)

  - o RJ-45 crimping tool

- For configuration:

  - o Computer with a serial port, a terminal emulation program, a network interface card, and a Web browser (laptop recommended for convenience)

Installing a SkyConnector

This chapter provides instructions for planning and performing the physical installation of a SkyConnector Outdoor.

Chapter Highlights

- Planning your installation

- Cabling

- Powering up the SkyConnector

- Optimizing location

- Monitoring SkyConnector status

- Mounting

- Configuring the SkyConnector

- Accessing the command-line interface

- Troubleshooting

Planning your Installation

In a typical wide area wireless mesh network, you'll install a SkyConnector on a utility pole or the roof of a building. The effective range of a SkyConnector is usually proportional to the height of the installation.

When choosing a site for a SkyConnector Outdoor, 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**.")

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.

NOTE Plan to configure the SkyConnector Outdoor 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 SkyConnector" on page 20.

Cabling the SkyConnector

Ethernet cabling provides power and data connectivity for the SkyConnector. This section provides instructions for attaching CAT5 cable to the device.

To install CAT-5 cabling:

1   Terminate the appropriate grade and length of CAT-5 cable with an RJ-45 connector, and plug it into the RJ-45 port on the back of the SkyConnector.

     Make sure the fit is snug so that the cable doesn't interfere with the weather gasket.

Figure 3-1. Connecting CAT5 cable to the SkyConnector
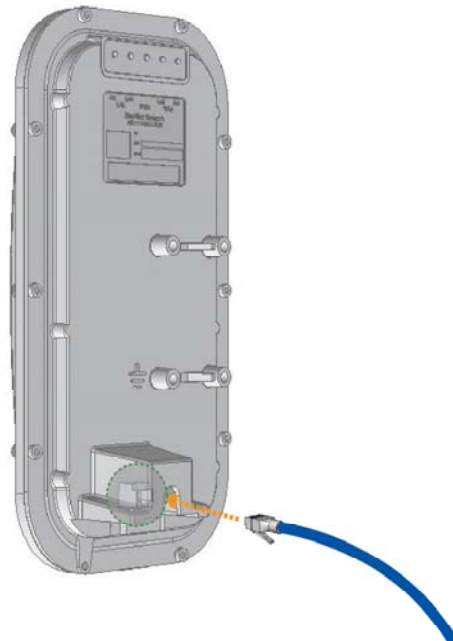
2   Insert the weather gasket and secure the metal cover.

a. Press the CAT5 cable into the gasket and insert the gasket into the housing, taking care not to twist or place unnecessary force on the RJ-45 connector.

b. Fit the metal cover over the weather gasket and secure it with the four machine screws supplied in the accessory kit (Figure 3-2).

Figure 3-2. Attaching weather gasket and metal cover
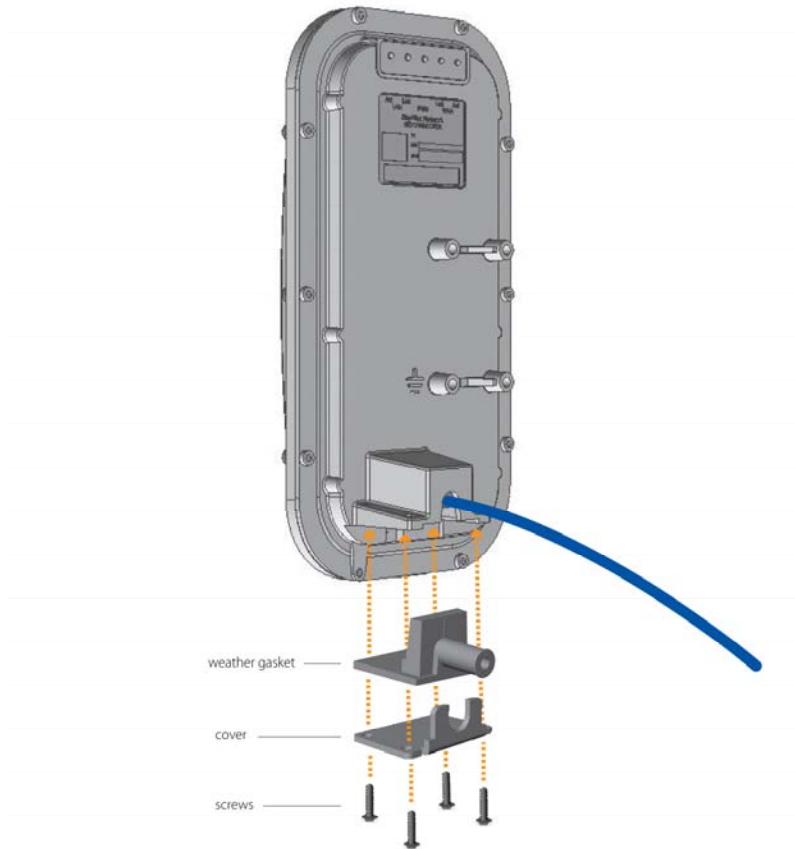
3. Attach the tie wraps to the neck of the weather gasket and tighten them so that they slightly depress the neck (Figure 3-3).

The tie wraps provide relief from cable strain and ensure a fully weatherproof seal.

Figure 3-3. Attaching tie wraps to the gasket neck

Powering on the SkyConnector

Before mounting the SkyConnector, first power on the unit so that you can use the onboard LEDs to determine optimal placement.

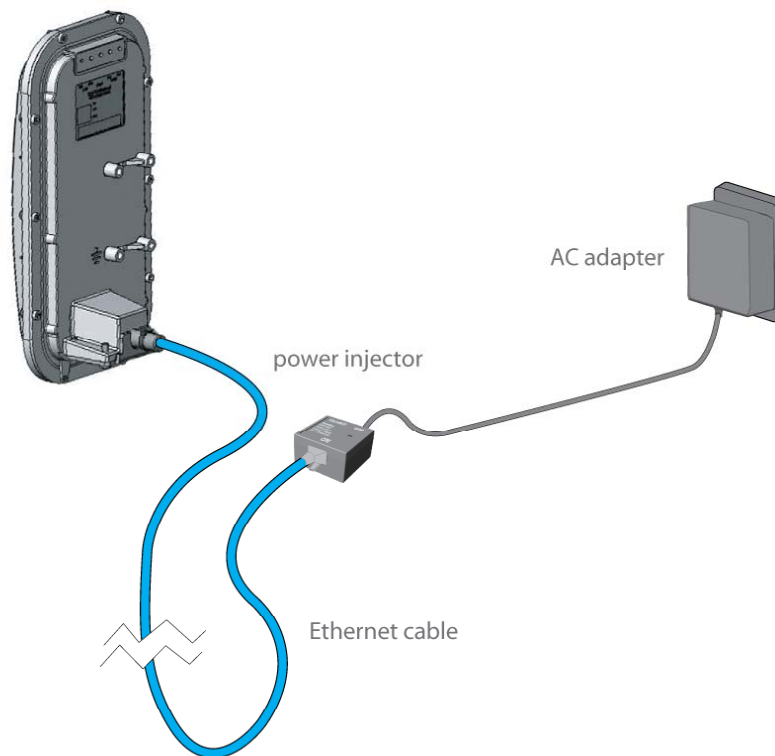**To power on the SkyConnector:**

1 Attach the power supply

   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.

NOTE Be careful not to plug the Ethernet cable connected to the SkyConnector into the port labeled "Computer."

c. Plug the AC adapter into the power injector.
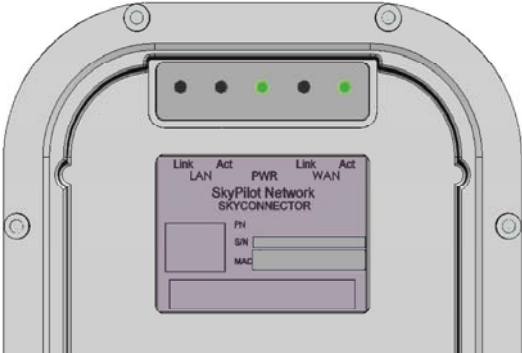
Figure 3-4. Providing power to the SkyConnector

2   Check the LEDs on the SkyConnector.

If the connections are correct, the SkyConnector's power LED (labeled "PWR") should illuminate and the WAN activity LED (labeled "WAN Act") should blink on and off. (For details about the LED status lights, see Table 3-1 on page 18.)

Figure 3-5. Checking the SkyConnector LEDs

Optimizing Location

After powering up the SkyConnector, use the device's LEDs to identify the optimal location for mounting. (For details about the LED status lights, see Table 3-1 on page 18.)

To power on the SkyConnector:

1 Confirm signal acquisition.

   a. Position the SkyConnector near the intended mounting location and watch the "WAN Act" LED for activity. The LED starts blinking when it acquires a signal from the network and is attempting to make a connection.

   If the LED doesn't start blinking within 30 seconds, try changing the orientation of the SkyConnector or walk to a new location. Repeat the process until the LED starts blinking.

   b. When the LED starts blinking, make minor adjustments to find the location where the signal is strongest. (The faster the LED blinks, the stronger the signal.)

   When the LED blinks steadily at a high rate, you have an optimal signal.

2 Verify network connection.

   a. Watch the "WLAN Link" LED for activity. Within 90 seconds of locating a signal, the LED should start to blink—first slowly, then more quickly, and finally it should remain steadily lit.

   When the "WAN Link" LED is steadily lit and the "WAN Act" LED is blinking, SkyConnector has established an authorized connection to the network, indicating that the current location is suitable for mounting.

   If both the "WAN Link" LED and the "WAN Act" LED continue blinking, a signal is available but isn't strong enough for reliable service. Keep trying different locations until you can confirm a network connection.

NOTE To optimize your SkyConnector installation, ask your network administrator (at the Network Operations Center) to measure signal strength on the node to which SkyConnector has established a link.

Monitoring SkyConnector Status

Table 3-1 provides detailed descriptions of SkyConnector states indicated by the LED lights. When both LED lights are lit and steady, the SkyConnector is successfully connected to the wireless network.

Table 1. SkyAccess LED states

LED	LED state	Device state
LAN Link	Steady illumination	SkyConnector is connected to another device via its Ethernet port.
LAN Act	Blinking	Device is transmitting or receiving data via its Ethernet port.
PWR	Steady illumination	Device is powered on.
WAN Link	Blinking (fast blink when device is in standby mode)	Device is attempting to establish an authorized connection on the wireless network. If both WAN Link and WAN Act continue to blink, the signal is not strong enough to support reliable service or there is a provisioning problem that's preventing the device from coming online. Contact your network administrator.
	Steady illumination	Device is connected to the wireless network.
WAN Act	None	Device cannot detect a wireless network.
	Blinking	Device is within the coverage area of a wireless network. Blink rate communicates signal strength: • Fast (8x per second) = excellent • Medium (4x per second) = good • Slow (<1x per second) = poor • None = no reception

Mounting the SkyConnector

After determining an optimal location for your SkyConnector, you can mount the device and run the appropriate cables.

To mount the SkyConnector:

1   Disconnect the CAT-5 cable from the power injector.

2   Power down the SkyConnector.

3   Attach a magnetic level to the 1 1/8" (2.87 cm) and 1 3/8" (3.48 cm) 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.)

4   Use the provided clamps and screws (provided in the accessory kit) to attach the SkyConnector to the mounting pole (see Figure 3-6).

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

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

Figure 3-6. Attaching the SkyConnector
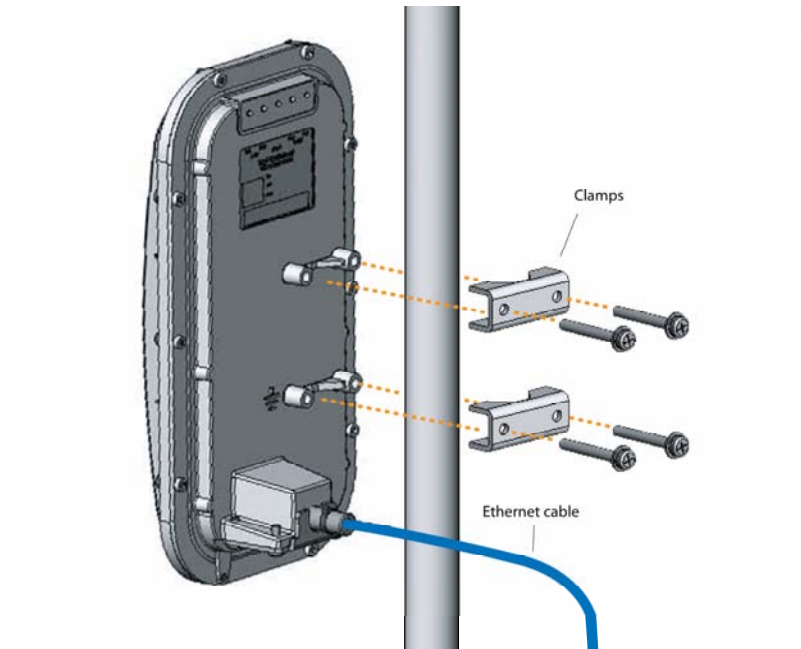
5   Reconnect the CAT-5 cable to the port labeled "CPE" on the
    SkyConnector power injector.

Configuring the SkyConnector

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

A SkyConnector will not transmit a wireless signal until it's 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.

- **Manual** - Usually performed in the field, manual provisioning permits the configuration of 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 and procedures, refer to Getting Started with the SkyPilot Network and SkyPilot Network Administration, 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 SkyConnector, 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 Connector.

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 A1-1. Attaching the SkyConnector
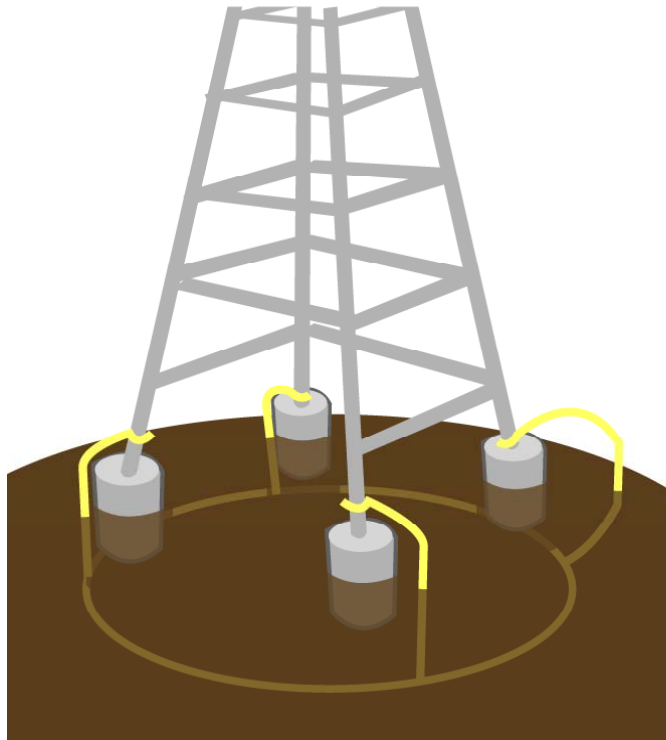
Making Connections "Gas-Tight"

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

- Reorient or relocate the receiving antenna.

- Increase the 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.

FCC Radiation Exposure Limits

To comply with FCC RF exposure requirements in section 1.1307, a minimum separation distance of 40 cm (16 inches) is required between the antenna and all persons.

Specifications

This appendix provides technical specifications for the SkyPilot SkyConnector.

Wireless Specifications

Frequency bands capable US & Canada	
SP 4100	5.5GHz to 5.725GHz
SP 4304	5.26 GHz to 5.32 GHz
For other countries check with sales representative	
EIRP	29 dBm/0.9 W peak,
Media access	Time Division Duplex (TDD)
Modulation technique	OFDM with adaptive modulation
Modulation rates	6–54 Mbps
Throughput	Up to 20 Mbps UDP, up to 10 Mbps TCP
Latency	8–10 ms roundtrip per hop
Antennas	28° horizontal x 9° vertical panel, 16.5 dBi
Channel width	20 MHz

Channel resolution	5 MHz frequency control
Receive sensitivity	-90 dBm at 6 Mbps modulation
Connectivity	SkyConnector connects with SkyGateways, SkyExtenders, and SkyExtender DualBands
Authentication	MD5-based certificates
Encryption	128-bit AES on all wireless links

Product Specifications

Connectors	RJ-45: Ethernet connection (10/100bT) and power (Power-over-Ethernet)
Mounting	Eave, roof, or chimney; outside pole diameter up to 2.0"
Range	7.5 miles (12 km)
LEDs	Wireless activity, wireless link, LAN activity, LAN link, and power
Dimensions	12.6" (32 cm) H x 6.6" (16.8 cm) W x 4.2" (10.7 cm) D
Weight	3.8 pounds (1.7 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; 8 W
Certifications	FCC Part 9, 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 and software

Security

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

Network Management

Command-line interface	Console via Telnet
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

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 v2c, Web interface

Topology

Configurations	Mesh, point-to-point