> *Note:* *There are alternative 2.4 GHz channel layouts, such as one for four channels using 1, 4, 8 and 11 and another using channels 1, 5, 9 to counter interference from microwaves, which tend to cause interference in the high end of the spectrum. Aerohive recommends alternative channel layouts only for the most challenging radio environments.*

Designing a channel pattern is easier for the 5 GHz spectrum. Depending on the country and the device being used, there are between 4 and 14 channels available for Wi-Fi use. However, in most countries there are at least 8 to work with. To simplify the layout of more than 3 channels most use a 7-to-1 pattern, as is shown on the right in Figure 6 on page 21. This channel layout is much more flexible than the 3-channel system and allows for much better capacity over all channels.

The last topic to cover is the concept of multipaths. When a client receives a transmission from an access point (or vice versa), the RF signal reaches the client first through a "direct path," but then shortly thereafter by the "indirect paths" reflected off other objects. The direct path combined with the indirect paths make up multipaths (see Figure 7). RF signals can bounce off of almost anything—walls, people, plants, and so on—but they bounce the greatest off of metal. As the RF signals bounce about while propagating, one or more of the secondary paths can interfere with the primary path, causing the signal strength of the direct path to diminish. In doing so, multipath can greatly decrease signal to noise ratio.

Figure 7   Multipath Radio Waves
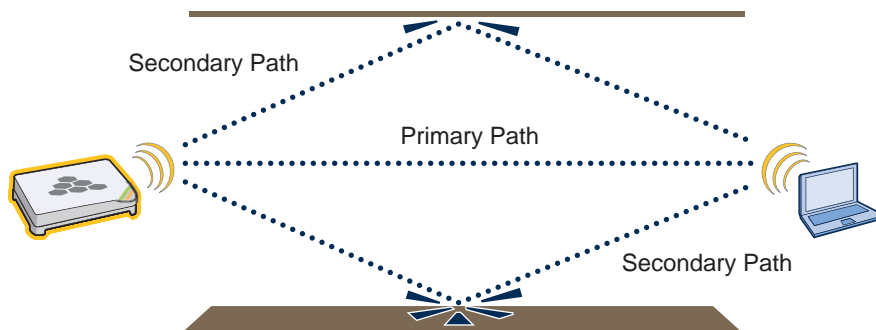
> *Note:* *If you would like to learn more about how radio frequency propagation works or the details of 802.11, Wikipedia provides excellent background information under the entries "IEEE 802.11", "radio propagation", and "multipath". Additionally, spending a few hours with a site survey tool such as AirMagnet Surveyor and a few test APs can increase both your familiarity with Wi-Fi propagation and your confidence about how it behaves.*

Chapter 2   The HiveAP 20 ag Platform

The Aerohive HiveAP 20 ag is a new generation wireless access point. HiveAPs have the unique ability to self-organize and coordinate with each other, creating a distributed-control WLAN solution that offers greater mobility, security, quality of service, and radio control.

This guide combines product information, installation instructions, and configuration examples for both the HiveAP and HiveManager platforms. This chapter covers the following topics relating to the HiveAP:

HIVEAP 20 PRODUCT OVERVIEW

The HiveAP 20 ag is a multi-channel wireless AP (access point). It is compatible with IEEE 802.11b/g (2.4 GHz) and IEEE 802.11a (5 GHz) standards and supports a variety of Wi-Fi (wireless fidelity) security protocols, including WPA (Wi-Fi Protected Access) and WPA2.

You can see the hardware components on the HiveAP in Figure 1. Each component is described in Table 1.
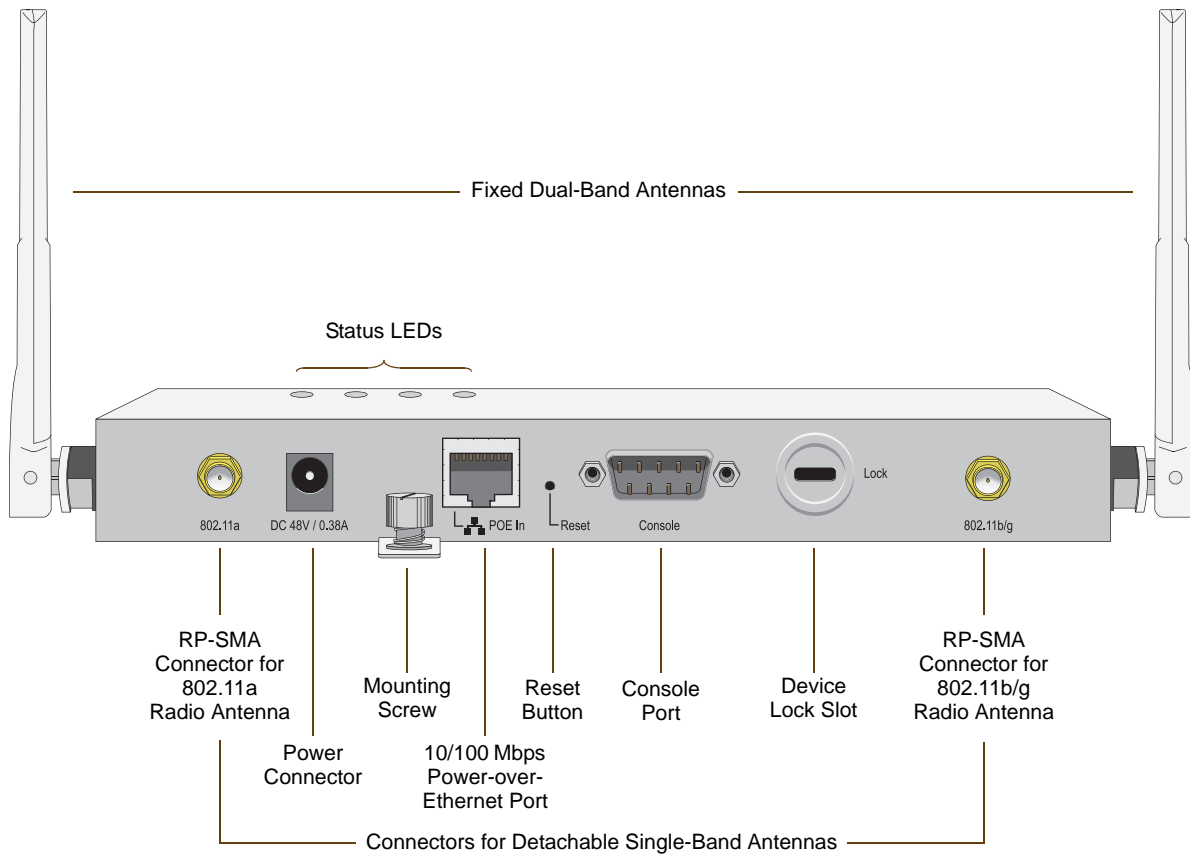
Figure 1   HiveAP 20 Hardware Components

Table 1   HiveAP 20 Component Descriptions

| Component	Description
Fixed Dual-Band Antennas	The two fixed omnidirectional dipole antennas can operate at two radio frequencies: 2.4 GHz (for IEEE 802.11b/g) and 5 GHz (for IEEE 802.11a). For details, see "Antennas" on page 28.
Status LEDs	The status LEDs convey operational states for system power, and the LAN, Access, and Mesh interfaces. For details, see "Status LEDs" on page 27.
802.11a RP-SMA Connector	You can connect a detachable single-band antenna, such as the Pulse W1028 dipole antenna for the 5 GHz band, to the male 802.11a RP-SMA (reverse polarity-subminiature version A) connector. Note that doing so disables the adjacent fixed antenna.

Component	Description
Power Connector	The 48-volt DC power connector (0.38 amps) is one of two methods through which you can power the HiveAP 20. To connect it to a 100 – 240-volt AC power source, use the AC/DC power adaptor that is available as an extra option. Because the HiveAP does not have an on/off switch, connecting it to a power source automatically powers on the device.
Mounting Screw	To mount the HiveAP 20 on a surface, attach the mounting plate that ships with the product to the HiveAP by inserting the two pins on the underside of the chassis into slots in the plate and tightening the mounting screw. For details, see "Mounting the HiveAP 20" on page 29.
10/100 Mbps PoE Port	The 10/100-Mbps Ethernet port supports IEEE 802.3af PoE (Power over Ethernet) and receives RJ-45 connectors. The HiveAP can receive its power through an Ethernet connection to power sourcing equipment (PSE) that is 802.3af-compatible. (If you connect the HiveAP to a power source through the power connector and PoE port simultaneously, the device draws power through the power connector and automatically disables PoE.) The HiveAP can also connect to the wired network or to a wired device (such as a security camera) through this port. It is compatible with 10/100Base-T/TX and automatically negotiates half- and full-duplex connections with the connecting device. It is autosensing and adjusts to straight-through and cross-over Ethernet cables automatically. It also automatically adjusts for 802.3af Alternative A and B methods of PoE. For details, see "Ethernet and Console Ports" on page 26.
Reset Button	The reset button allows you to reboot the device or reset the HiveAP to its factory default settings. Insert a paper clip, or something similar, into the Reset pinhole and press the reset button. To reboot the device, hold the button down between 1 and 5 seconds. To return the configuration to the factory default settings, hold it down for at least 5 seconds. After releasing the button, the Power LED goes dark, and then glows steady amber while the firmware loads and the system performs a self-test. After the software finishes loading, the Power LED glows steady green. To disable the reset button from resetting the configuration, enter this command: `no reset-button reset-config-enable` Pressing the button between 1 and 5 seconds will still reboot the HiveAP, but pressing it for more than 5 seconds will not reset its configuration.
Console Port	A male DB-9 serial port to which you can make a console connection using an RS-232 (or "null modem") cable. The management station from which you make a serial connection to the HiveAP must have a VT100 emulation program, such as Tera Term Pro© (a free terminal emulator) or Hilgraeve Hyperterminal® (provided with Windows® operating systems). The following are the serial connection settings: bits per second: 9600, data bits: 8, parity: none, stop bits: 1, flow control: none.
Device Lock Slot	You can physically secure the HiveAP by attaching a lock and cable (such as a Kensington® notebook lock) to the device lock slot. After looping the cable around a secure object, insert the T-bar component of the lock into the slot on the HiveAP and turn the key to engage the lock mechanism.
802.11b/g RP-SMA Connector	You can connect a detachable single-band antenna, such as the Pulse W1038 dipole antenna for the 2.4 GHz band, to the male 802.11b/g RP-SMA connector. Note that doing so disables the adjacent fixed antenna.

Ethernet and Console Ports

There are two ports on the HiveAP 20: a 10/100Base-T/TX Ethernet port and a male DB-9 console port. Both ports use standard pin assignments.

The pin assignments in the PoE (Power over Ethernet) Ethernet port follow the TIA/EIA-568-B standard (see Figure 2). The PoE port accepts standard types of Ethernet cable—cat3, cat5, cat5e, or cat6—and can receive power over this cable from power sourcing equipment (PSE) that is 802.3af-compatible. Such equipment can be embedded in a switch or router, or it can come from purpose-built devices that inject power into the Ethernet line en route to the HiveAP. Because the PoE port has autosensing capabilities, the wiring termination in the Ethernet cable can be either straight-through or cross-over.
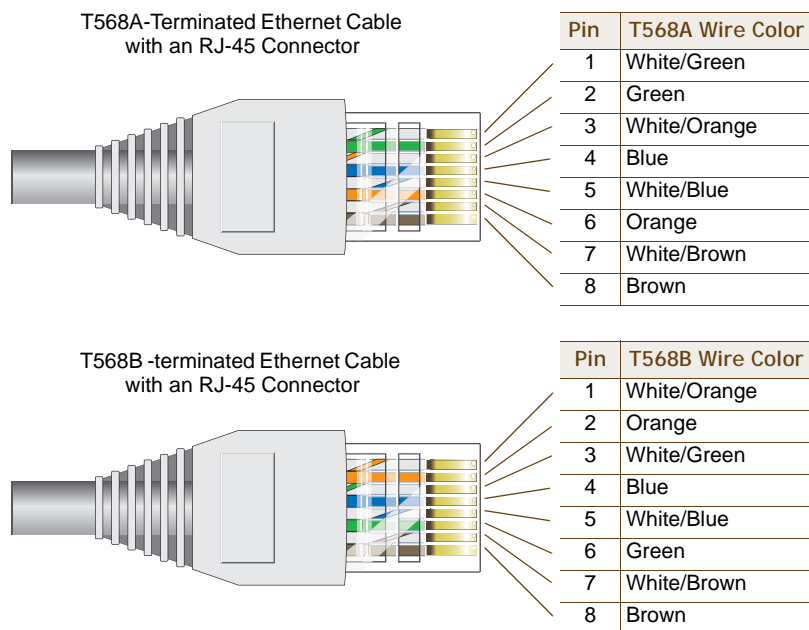
Figure 2   PoE Wire Usage and Pin Assignments

Pin Numbers

POE In

(View of the PoE port
on the HiveAP)
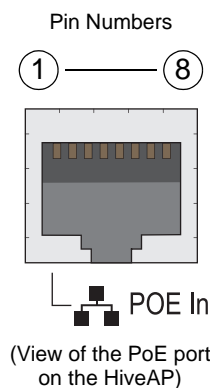
Pin	Data Signal	802.3af Alternative A (Data and Power on the Same Wires)		802.3af Alternative B (Data and Power on Separate Wires)
		MDI	MDI-X	MDI or MDI-X
1	Transmit +	DC+	DC–	– – –
2	Transmit -	DC+	DC–	– – –
3	Receive +	DC–	DC+	– – –
4	(unused)	– – –	– – –	DC+
5	(unused)	– – –	– – –	DC+
6	Receive -	DC–	DC+	– – –
7	(unused)	– – –	– – –	DC–
8	(unused)	– – –	– – –	DC–

MDI = Medium dependent interface for straight-through connections

MDI-X = Medium dependent interface for cross-over (X) connections

The PoE port is auto-sensing and can automatically adjust to transmit and receive data over straight-through or cross-over Ethernet connections. Likewise, it can automatically adjust to 802.3af Alternative A and B power delivery methods. Furthermore, when the Alternative A method is used, the PoE port automatically allows for polarity reversals depending on its role as either MDI or MDI-X.

T568A-Terminated Ethernet Cable
with an RJ-45 Connector

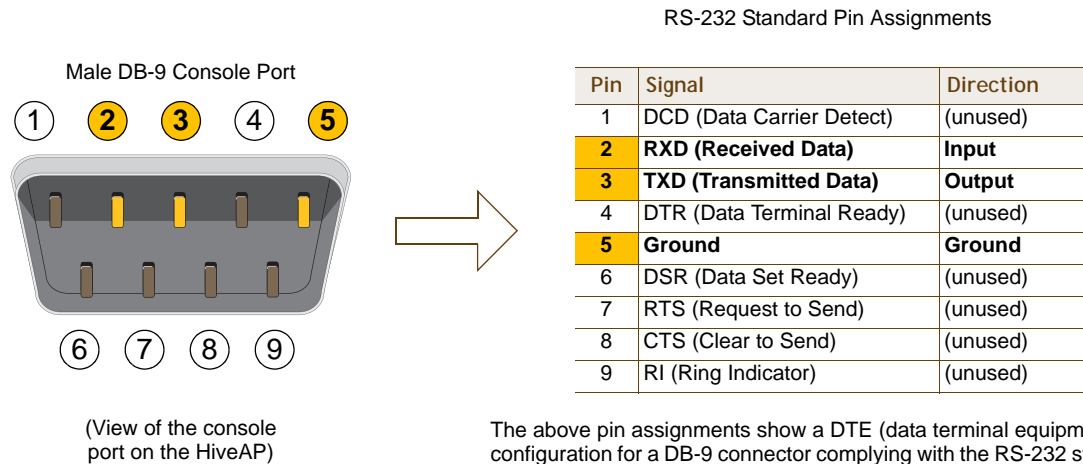| Pin	T568A Wire Color
1	White/Green
2	Green
3	White/Orange
4	Blue
5	White/Blue
6	Orange
7	White/Brown
8	Brown

T568A and T568B are two standard wiring termination schemes. Note that the only difference between them is that the white/green + solid green pair of wires and the white/orange + solid orange pair are reversed.

For straight-through Ethernet cables—using either the T568A or T568B standard—the eight wires terminate at the same pins on each end.

For cross-over Ethernet cables, the wires terminate at one end according to the T568A standard and at the other according to T568B.

T568B -terminated Ethernet Cable
with an RJ-45 Connector

Pin	T568B Wire Color
1	White/Orange
2	Orange
3	White/Green
4	Blue
5	White/Blue
6	Green
7	White/Brown
8	Brown

The pin assignments in the male DB-9 console port follow the EIA (Electronic Industries Alliance) RS-232 standard. To make a serial connection between your management system and the console port on the HiveAP, you can use a null modem serial cable, use another serial cable that complies with the RS-232 standard, or refer to the pin-to-signal mapping shown in Figure 3 to make your own serial cable. Connect one end of the cable to the console port on the HiveAP and the other end to the serial (or COM) port on your management system. The management system must have a VT100 terminal emulation program, such as Tera Term Pro© (a free terminal emulator) or Hilgraeve Hyperterminal® (provided with Windows® operating systems).

Figure 3   Console Port Pin Assignments

Male DB-9 Console Port

(View of the console
port on the HiveAP)

RS-232 Standard Pin Assignments

Pin	Signal	Direction
1	DCD (Data Carrier Detect)	(unused)
2	RXD (Received Data)	Input
3	TXD (Transmitted Data)	Output
4	DTR (Data Terminal Ready)	(unused)
5	Ground	Ground
6	DSR (Data Set Ready)	(unused)
7	RTS (Request to Send)	(unused)
8	CTS (Clear to Send)	(unused)
9	RI (Ring Indicator)	(unused)

The above pin assignments show a DTE (data terminal equipment) configuration for a DB-9 connector complying with the RS-232 standard. Because this is a console port, only pins **2**, **3**, and **5** need be used.

Status LEDs

The four status LEDs on the top of the HiveAP 20 indicate various states of activity through their color (dark, green, amber) and illumination patterns (steady glow or blinking). The meanings of the various color + illumination patterns for each LED are explained below.

Power

- Dark: No power
- Steady green: Powered on and the firmware is running normally
- Steady amber: Firmware is booting up or is being updated
- Blinking amber: Alarm indicating firmware failure

LAN

- Dark: Ethernet link is down or disabled
- Steady green: Ethernet link is up but inactive
- Blinking green: Ethernet link is up and active

Access

- Dark: Wireless link is disabled
- Steady green: Wireless link is up but inactive
- Blinking green: Wireless link is up and active

Mesh

- Dark: Wireless link is disabled
- Steady green: Wireless link is up but inactive
- Blinking green (fast): Wireless link is up and the HiveAP is searching for other hive members
- Blinking green (slowly): Wireless link is up and active

Antennas

The HiveAP 20 includes two fixed dual-band antennas with 3-dBi gains. These antennas are omnidirectional, providing fairly equal coverage in all directions in a toroidal (donut-shaped) pattern around each antenna. When the antennas are vertically positioned, coverage expands primarily on the horizontal plane, extending horizontally much more than vertically. See Figure 4, which shows the toroidal pattern emanating from a single vertically positioned antenna. To change coverage to be more vertical than horizontal, position the antennas horizontally. You can also resize the area of coverage by increasing or decreasing the signal strength.
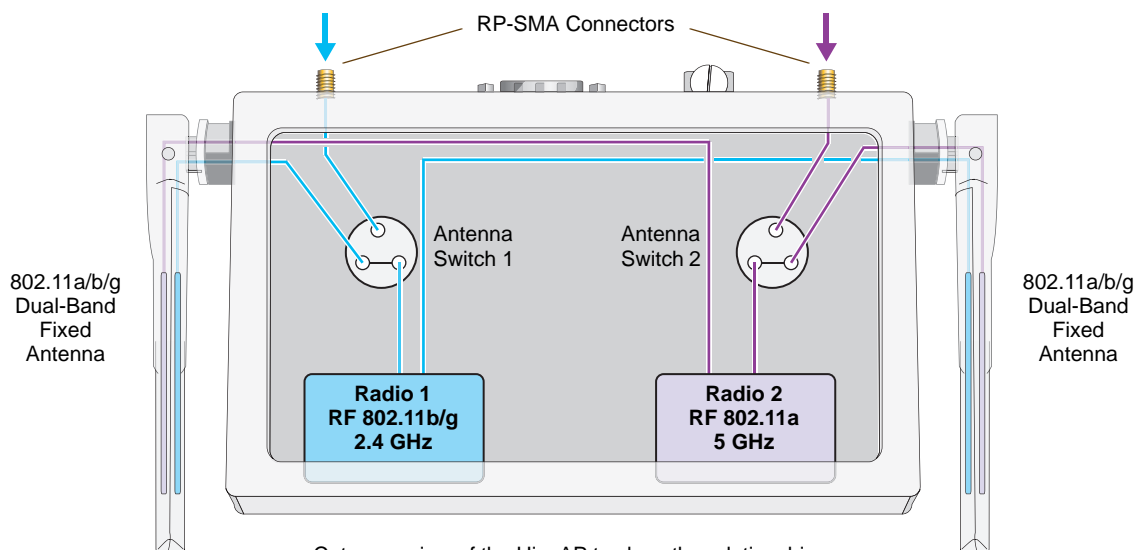
Figure 4   Omnidirectional Radiation Pattern

The omnidirectional antennas radiate equally in all directions, forming a toroidal pattern.

HiveAP
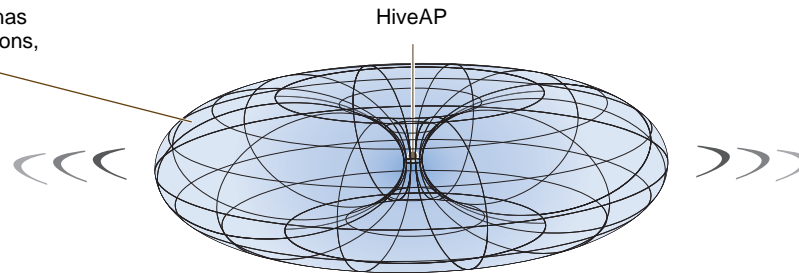
Note: To show the shape of radiation more clearly, this illustration depicts the coverage provided by only one active antenna and is not drawn to scale.

The pair of fixed dual-band antennas operate concurrently in two different frequency ranges: 2.4 GHz (IEEE 802.11b/g) and 5 GHz (IEEE 802.11a). Using two different frequency ranges reduces the probability of interference that can occur when numerous channels operate within the same range. Conceptually, the relationship of antennas and radios is shown in Figure 5.

Figure 5   Antennas and Radios

RP-SMA Connectors

Antenna Switch 1

Antenna Switch 2

802.11a/b/g Dual-Band Fixed Antenna

802.11a/b/g Dual-Band Fixed Antenna

Radio 1 RF 802.11b/g 2.4 GHz

Radio 2 RF 802.11a 5 GHz

Cut-away view of the HiveAP to show the relationship of the antennas and the two internal radios.

After connecting an external antenna to an RP-SMA connector, you must enter the following command to move the appropriate interface from the adjacent fixed antenna to the external antenna:

```
interface interface radio antenna external
```

The wifi0 interface links to radio 1 (frequency range = 2.4 GHz for IEEE 802.11b/g), and the wifi1 interface links to radio 2 (frequency range = 5 GHz for IEEE 802.11a). These interface-to-radio relationships are permanent. However, the interface-to-antenna relationships can be shifted. In other words, you can change which antenna—fixed or external—the wifi0 and wifi1 interfaces use. For example, to link the wifi0 interface to an external antenna connected to the 802.11b/g RP-SMA connector (for radio 1), enter the following command:

```
interface wifi0 radio antenna external
```

If you do not enter this command, the wifi0 interface and all its subinterfaces (wifi0.1, wifi0.2, wifi0.3, and wifi0.4) continue to use both fixed antennas.

Note: After entering the above command, the radio to which you attached the external antenna uses the external antenna and the fixed antenna on the opposite side of the HiveAP. Attaching an external antenna only disconnects the adjacent fixed antenna. Note the two antenna switches shown in Figure 5 on page 28.

To unlink the wifi0 interface from the external antenna and return it to the fixed antennas, enter this command:

```
interface wifi0 radio antenna internal
```
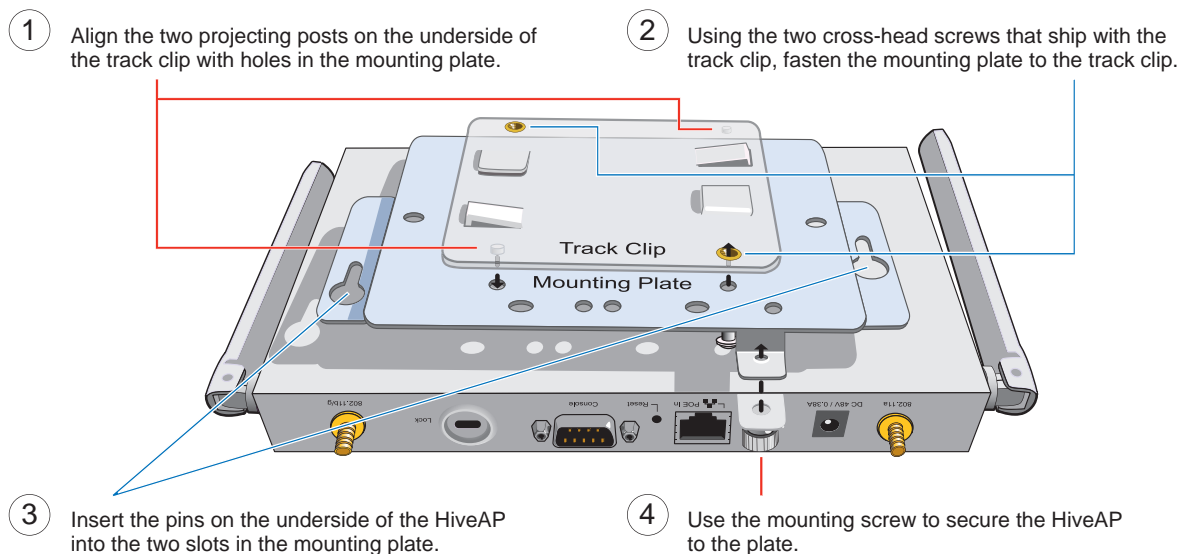
MOUNTING THE HIVEAP 20

Using the mounting plate and track clip, you can mount the HiveAP 20 to the tracks of a dropped ceiling grid. Using just the mounting plate, you can mount the HiveAP to any surface that can support its weight (1.5 lb., 0.68 kg).

Ceiling Mount

To mount the HiveAP 20 to a track in a dropped ceiling, you need the mounting plate, track clip, and two cross-head screws that ship with the track clip. You also need a cross-head screw driver and—most likely—a ladder.
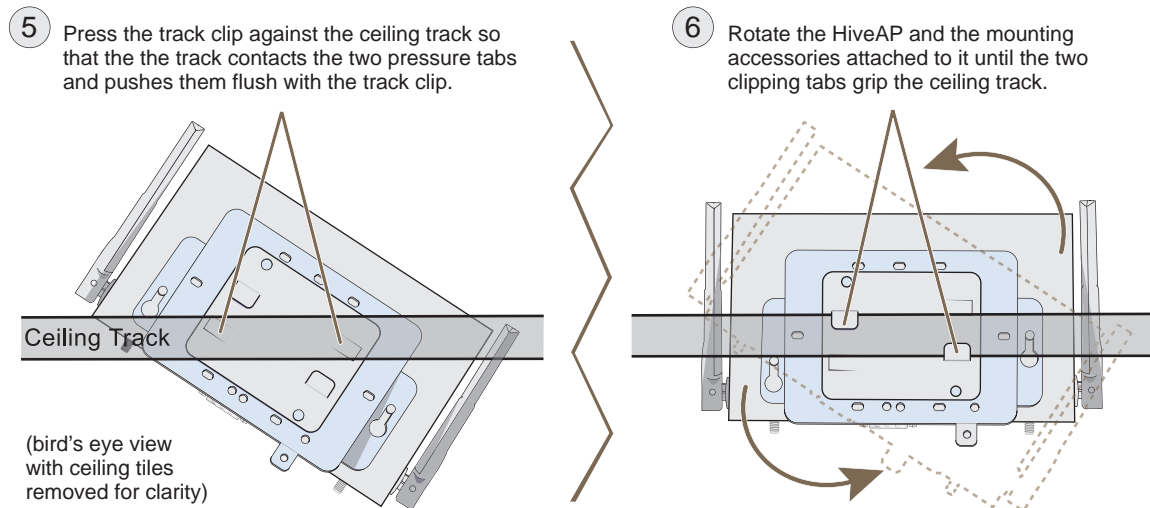
Attach the track clip to the mounting plate, and then attach the clip-plate combination to the HiveAP 20, as shown in Figure 6.

Figure 6   Attaching the HiveAP 20 to the Mounting Plate and Track Clip

1 Align the two projecting posts on the underside of the track clip with holes in the mounting plate.

2 Using the two cross-head screws that ship with the track clip, fasten the mounting plate to the track clip.

3 Insert the pins on the underside of the HiveAP into the two slots in the mounting plate.

4 Use the mounting screw to secure the HiveAP to the plate.

Nudge the ceiling tiles slightly away from the track to clear some space. Then attach the track clip to the ceiling track as shown in Figure 7. When done, adjust the ceiling tiles back into their former position.
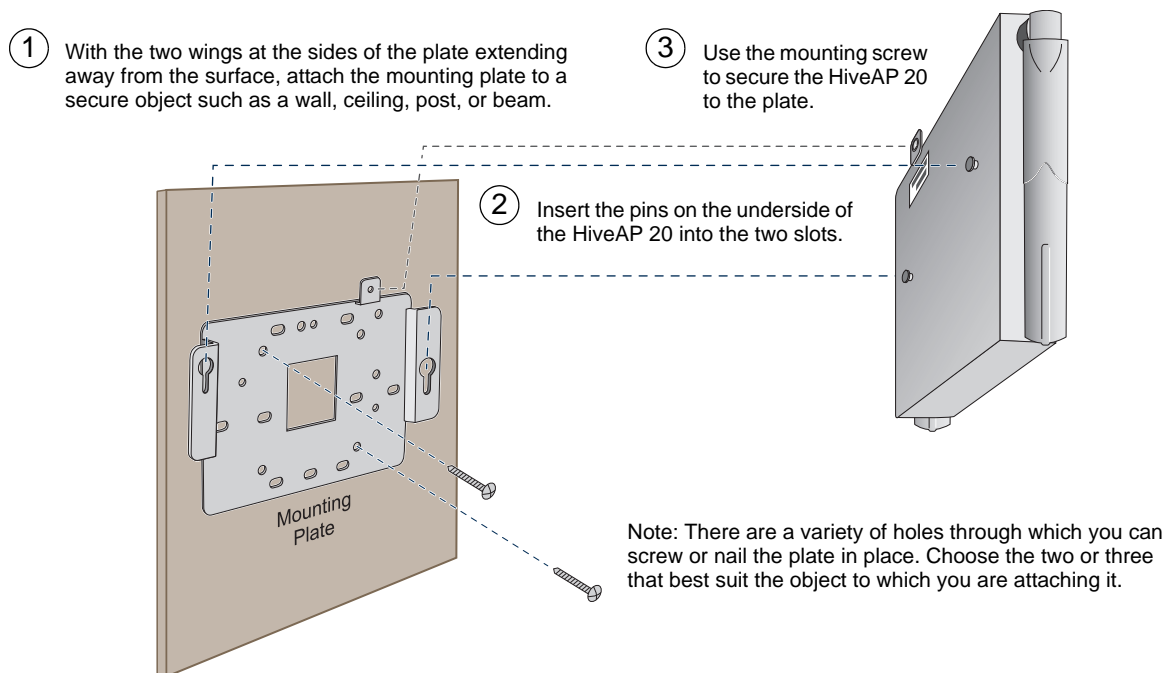
Figure 7 Attaching the HiveAP to a Dropped Ceiling Track

5 Press the track clip against the ceiling track so that the the track contacts the two pressure tabs and pushes them flush with the track clip.

Ceiling Track

(bird's eye view with ceiling tiles removed for clarity)

6 Rotate the HiveAP and the mounting accessories attached to it until the two clipping tabs grip the ceiling track.

Surface Mount

You can use the mounting plate to attach the HiveAP 20 to any surface that supports its weight, and to which you can screw or nail the plate. First, mount the plate to the surface, and then attach the device to the plate, as shown in Figure 8.

Figure 8 Mounting the HiveAP on a Wall

1 With the two wings at the sides of the plate extending away from the surface, attach the mounting plate to a secure object such as a wall, ceiling, post, or beam.

2 Insert the pins on the underside of the HiveAP 20 into the two slots.

3 Use the mounting screw to secure the HiveAP 20 to the plate.

Mounting Plate

Note: There are a variety of holes through which you can screw or nail the plate in place. Choose the two or three that best suit the object to which you are attaching it.

DEVICE, POWER, AND ENVIRONMENTAL SPECIFICATIONS

Understanding the range of specifications for the HiveAP 20 is necessary for optimal deployment and device operation. The following specifications describe the physical features and hardware components, the power adapter and PoE (Power over Ethernet) electrical requirements, and the temperature and humidity ranges in which the device can operate.

Device Specifications

- Chassis dimensions: 8 1/4" W x 1" H x 4 15/16" D (21 cm W x 2.5 cm H x 12.5 cm D)
- Weight: 1.5 lb. (0.68 kg)
- Antennas: Two fixed dual-band 802.11a/b/g antennas, and two RP-SMA connectors for detachable single-band 802.11a or 802.11b/g antennas
- Serial port: DB-9 (bits per second: 9600, data bits: 8, parity: none, stop bits: 1, flow control: none)
- Ethernet port: autosensing 10/100Base-T/TX Mbps, with IEEE 802.3af-compliant PoE (Power over Ethernet)

Power Specifications

- AC/DC power adapter:
  - Input:100 – 240 VAC
  - Output: 48V/0.38A
- PoE nominal input voltages: 48 V, 0.35A
- RJ-45 power input pins: Wires 4, 5, 7, 8 or 1, 2, 3, 6

Environmental Specifications

- Operating temperature: 32 to 122 degrees F (0 to 50 degrees C)
- Storage temperature: -4 to 158 degrees F (-20 to 70 degrees C)
- Relative Humidity: Maximum 95%

Chapter 3   The HiveAP 28 Outdoor Platform

The Aerohive HiveAP 28 is a new generation wireless access point that is customized for outdoor use. It is mountable in any direction and on any hard surface, post, or wire strand. It can receive power either through an Ethernet cable or power cord.

Note: Do not open the HiveAP 28 chassis. There are no serviceable parts inside.

This guide combines product information, installation instructions, and configuration examples for both the HiveAP and HiveManager platforms. This chapter covers the following topics relating to the HiveAP 28:

HIVEAP 28 PRODUCT OVERVIEW

The HiveAP 28 is a multi-channel wireless AP (access point) for outdoor use. It is compatible with IEEE 802.11b/g (2.4 GHz) and IEEE 802.11a (5 GHz) standards and supports a variety of Wi-Fi (wireless fidelity) security protocols, including WPA (Wi-Fi Protected Access) and WPA2.

You can see the hardware components on the HiveAP 28 in Figure 1. Each component is described in Table 1.

Figure 1   HiveAP 28 Hardware Components

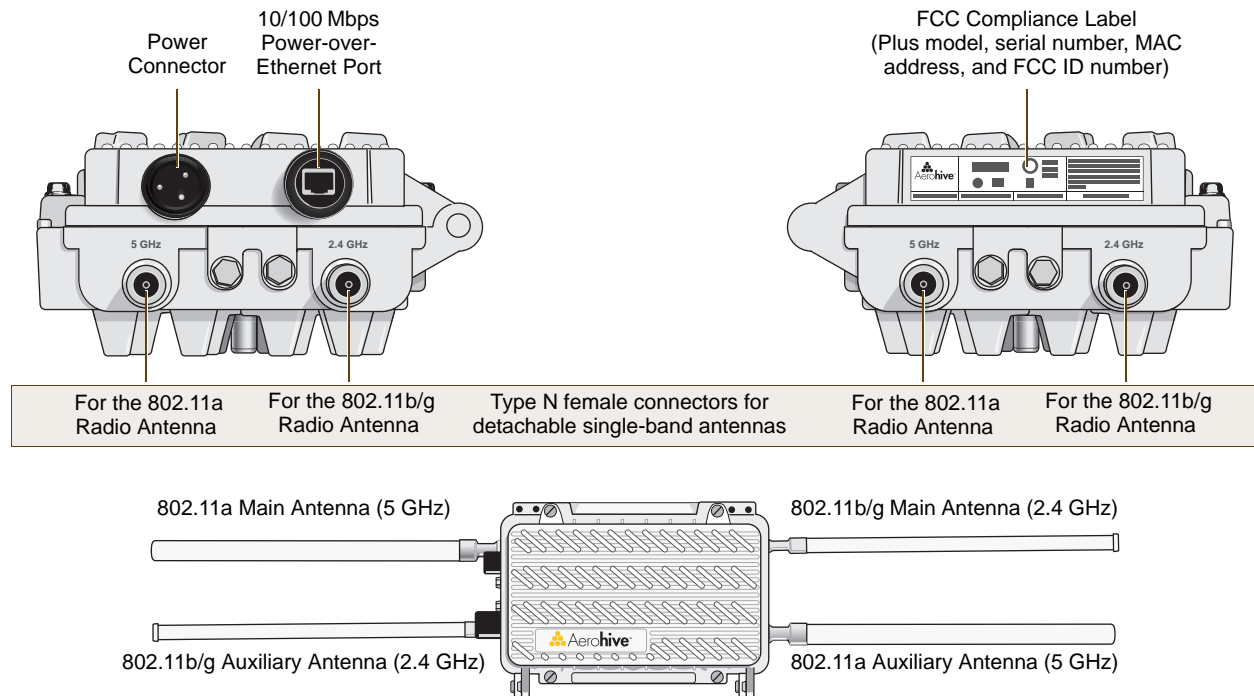*Table 1   HiveAP 28 Component Descriptions*

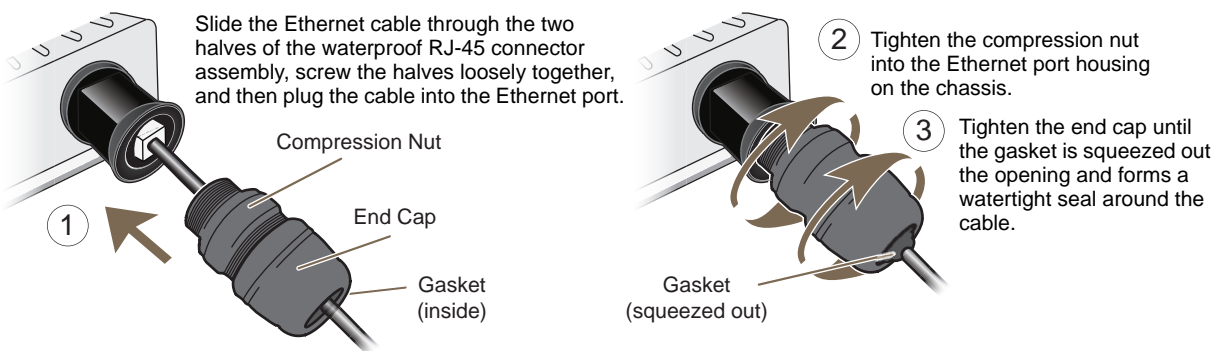| Component	Description
Detachable Single-Band Antennas	The two pairs of detachable omnidirectional dipole antennas operate at two radio frequencies: one pair at 2.4 GHz (for IEEE 802.11b/g) and the other at 5 GHz (for IEEE 802.11a). For details, see "Antennas" on page 37.
Type N Connectors (Female)	Attach antennas to the HiveAP 28 through these connectors. For details, see "Attaching Antennas" on page 42.
Waterproof Power Connector	Using the power connector is one of two methods through which you can power the HiveAP 28. To connect it to a 100 – 240-volt AC power source, use the power cable that ships with the product as an extra option. Because the HiveAP does not have an on/off switch, connecting it to a power source automatically powers on the device. The power source must have a readily accessible service disconnect switch incorporated into the fixed wiring installation so that you have the ability to turn the power on and off. (The other method that the HiveAP can obtain power is through its PoE port.)

Component	Description
10/100 Mbps PoE Port	The 10/100-Mbps Ethernet port supports IEEE 802.3af PoE (Power over Ethernet) and receives RJ-45 connectors. The HiveAP can receive its power through an Ethernet connection to PSE (power sourcing equipment) that is 802.3af-compatible. (If you connect the HiveAP to a power source through the power connector and PoE port simultaneously, the device draws power through the power connector and automatically disables PoE.)
	The HiveAP 28 can also connect to the wired network or to a wired device (such as a security camera) through this port. It is compatible with 10/100Base-T/TX and automatically negotiates half- and full-duplex connections with the connecting device. It is autosensing and adjusts to straight-through and cross-over Ethernet cables automatically (MDI/MDI-X). It also automatically adjusts for 802.3af Alternative A and B methods of PoE. For details, see "Ethernet Port".

Ethernet Port

The HiveAP 28 has a 10/100Base-T/TX PoE (Power over Ethernet) port. Its pin assignments follow the TIA/EIA-568-B standard (see Figure 2 on page 26). The PoE port accepts standard types of Ethernet cable—cat3, cat5, cat5e, or cat6—and can receive power over this cable from power sourcing equipment (PSE) that is 802.3af-compatible. Such equipment can be embedded in a switch or router, or it can come from purpose-built devices that inject power into the Ethernet line en route to the HiveAP. Because the PoE port has autosensing capabilities, the wiring termination in the Ethernet cable can be either straight-through or cross-over (MDI/MDI-X). For outdoor deployments use weatherproofed shielded twisted pair (STP) Ethernet cables.

To ensure a waterproof seal for the Ethernet connection, use the RJ-45 connector assembly, which comes in three parts: a compression nut, end cap, and gasket.

Figure 2   Connecting the Ethernet Cable

Slide the Ethernet cable through the two halves of the waterproof RJ-45 connector assembly, screw the halves loosely together, and then plug the cable into the Ethernet port.

Compression Nut

End Cap

Gasket (inside)

1

2   Tighten the compression nut into the Ethernet port housing on the chassis.

3   Tighten the end cap until the gasket is squeezed out the opening and forms a watertight seal around the cable.

Gasket (squeezed out)

1. Insert one end of the Ethernet cable through the waterproof RJ-45 connector assembly and plug the cable into the Ethernet port.
2. Tighten the compression nut by twisting it clockwise into the Ethernet port housing on the chassis.
3. Tighten the end cap by twisting it clockwise onto the compression nut and tighten until the rubber gasket emerges and wrap itself around the Ethernet cable.

   The Ethernet connection is now sealed and waterproof.

4. Connect the other end of the Ethernet cable to PSE (power sourcing equipment), such as a power injector, if the HiveAP 28 receives power through PoE, or directly to a network device, such as a switch, if it receives power through a power cord.

> *Note: To prevent damage to the HiveAP 28 or power injector when using PoE to provide power, connect the Ethernet cable from the power injector to the HiveAP 28, and connect the injector to a power jack before applying power.*

If the Ethernet cable connects the HiveAP to another device that is indoors, you must install appropriate lightning protection at the point before it enters the building. Failing to do so might cause damage to the equipment as well as serious injury or death.

> *Note: When the HiveAP acts as a mesh point and does not use the Ethernet port, cover the Ethernet port with a connector cap to prevent water intrusion and possible safety hazards.*

Power Connector

The HiveAP 28 can receive power through an Ethernet cable using PoE or through a power cord. Aerohive recommends using either PoE or wiring the power cord directly to a 100 – 240-volt AC power source. Only plug the power cord into an electric outlet when configuring the device before deployment or when testing it in the lab.

> *Note: When the HiveAP receives power through PoE, cover the power connector with a connector cap to prevent water intrusion and possible safety hazards.*

To connect the power cord to the HiveAP 28:

1. Align the slot in the power cord plug with the small tab at the top of the three-pin power connector, and slide the plug firmly over the pins until it is fully seated in the power connector.
2. Slide the cover over the connector and tighten it by turning the cover clockwise.
3. Install a lightning protector between the HiveAP 28 and its power source.
4. When possible, run the cord through a conduit to protect it from the elements. Where the cord is exposed, allow enough slack in it to create a drip loop. Leaving some slack in the cord lets water run away from the connections at each end. Use only a weatherproof power cord, such as the cord that ships with the HiveAP 28.
5. Strip the other end of the power cord and wire it directly to a power source, such as a junction box that has a service disconnect switch that you can use to turn the power on and off. Also, because the HiveAP 28 does not have short-circuit (over current) protection built into it, it relies on the protection provided by the power source to which you connect it. Ensure that the protective device, such as a circuit breaker, is not rated greater than 15A. Furthermore, if you need to install the HiveAP 28 in a wet or damp location, the AC branch circuit that is powering it must be provided with ground fault protection (GFCI), as required by Article 210 of the National Electrical Code (NEC).

> *Note: The HiveAP 28 must be grounded. Do not operate it unless there is a suitably installed ground conductor. Contact the appropriate electrical inspection authority or an electrician if you are uncertain that suitable grounding is available.*
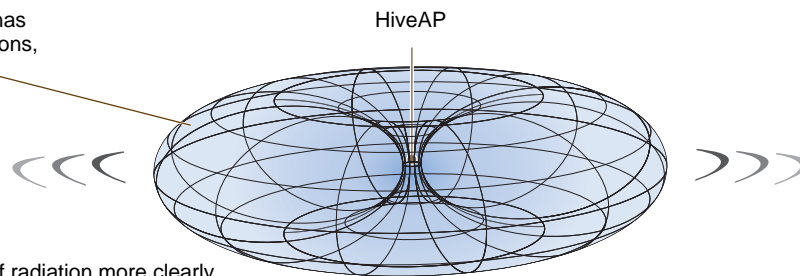
Antennas

The HiveAP 28 includes two detachable single-band antennas with 8dBi gains (802.11b/g) and two detachable single-band antennas with 10dBi gains (802.11a). These antennas are omnidirectional, providing fairly equal coverage in all directions in a toroidal (donut-shaped) pattern around each antenna. When the antennas are vertically positioned, coverage expands primarily on the horizontal plane, extending horizontally much more than vertically. See Figure 3, which shows the toroidal pattern emanating from a single vertically positioned antenna. Note that when high gain antennas are added, the torus shape becomes somewhat elongated or compressed. If the HiveAP 28 is mounted higher than 20 feet the center of the torus curves inward so that the connection quality, directly underneath the center of the HiveAP 28, becomes compromised.

To change coverage to be more vertical than horizontal, position the HiveAP so that the antennas are on a horizontal plane. You can also resize the area of coverage by increasing or decreasing the signal strength.

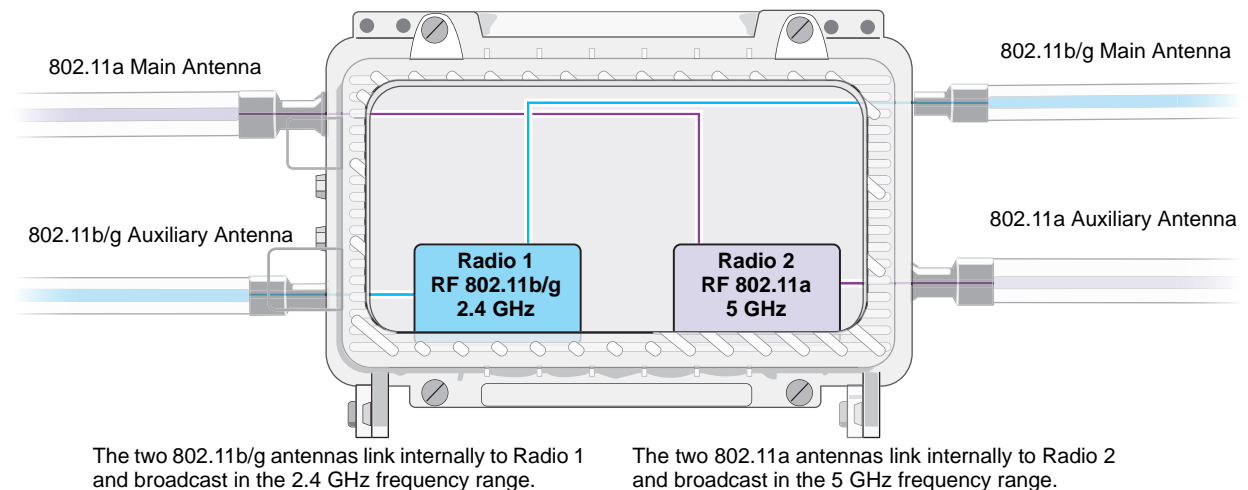*Figure 3   Omnidirectional Radiation Pattern*

The omnidirectional antennas radiate equally in all directions, forming a toroidal pattern.

HiveAP

Note: To show the shape of radiation more clearly, this illustration depicts the coverage provided by only one active antenna and is not drawn to scale.

The pairs of antennas operate concurrently in two different frequency ranges: 2.4 GHz (IEEE 802.11b/g) and 5 GHz (IEEE 802.11a). Using two different frequency ranges reduces the probability of interference that can occur when numerous channels operate within the same range. Conceptually, the relationship of antennas and radios is shown in Figure 4. (For information about attaching the antennas to the HiveAP 28, see "Attaching Antennas" on page 42.)

Figure 4   Antennas and Radios

802.11a Main Antenna

802.11b/g Main Antenna

802.11b/g Auxiliary Antenna

802.11a Auxiliary Antenna

Radio 1
RF 802.11b/g
2.4 GHz

Radio 2
RF 802.11a
5 GHz

The two 802.11b/g antennas link internally to Radio 1 and broadcast in the 2.4 GHz frequency range.

The two 802.11a antennas link internally to Radio 2 and broadcast in the 5 GHz frequency range.

Note: The HiveAP 20 uses `interface` *interface* `radio antenna external` *command to enable an external antenna attached to it. Entering this command on the HiveAP 28 disables the antenna on the opposite side of the device from the radio to which the interface is linked and results in a loss of diversity.*

MOUNTING THE HIVEAP 28 AND ATTACHING ANTENNAS

Using the mounting accessories (available separately) you can mount the HiveAP in various locations:

- "Pole Mount" on page 39 – Mount the HiveAP 28 on a pole such as a street light.
- "Strand Mount" on page 40 – Suspend the HiveAP 28 from a cable or phone line.
- "Surface Mount" on page 41 – Mount the HiveAP 28 on a flat surface such as a wall or beam.

You can mount the HiveAP 28 in any of these locations as long as the object to which you mount it and the attaching screws can support its weight (9 lbs., 4.08 kg).

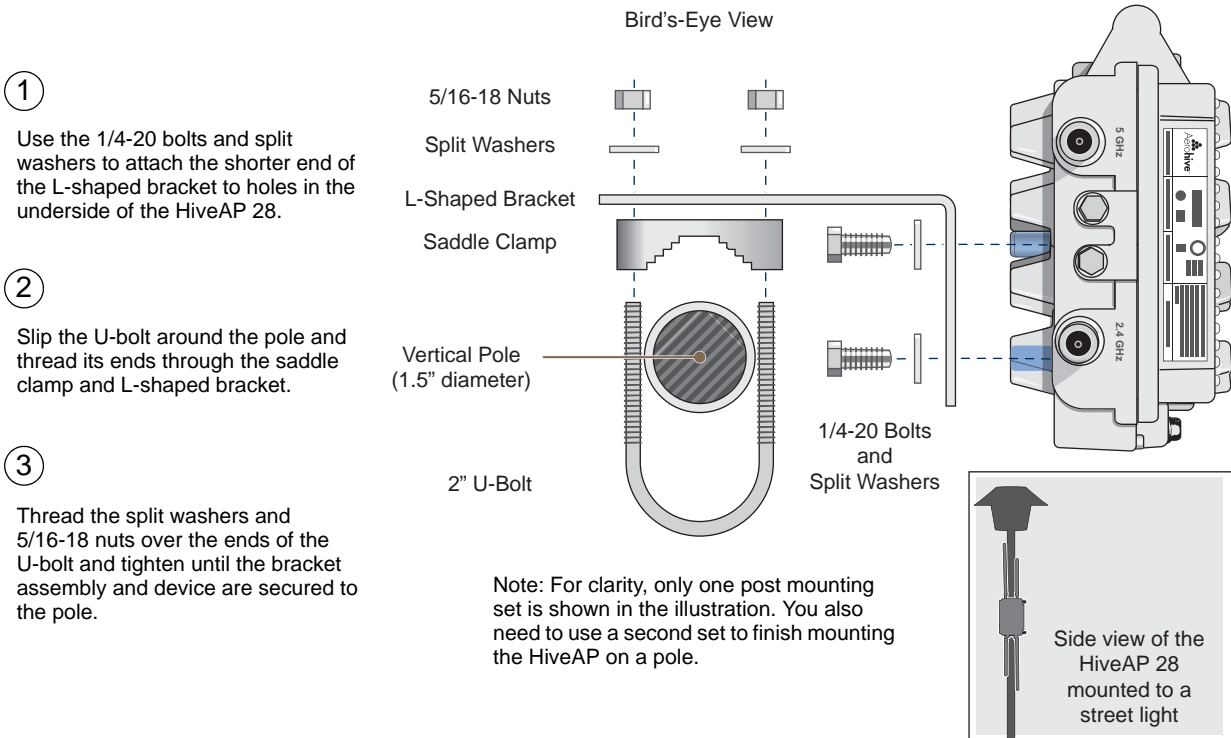After mounting the HiveAP 28, attach the antennas as explained in "Attaching Antennas" on page 42.

Before you mount the HiveAP 28 and attach antennas, read the following warnings and cautions:

- To install the HiveAP 28, you must be a qualified installation professional, licensed or certified in accordance with local regulations.
- Use lightning arrestors and ground both the HiveAP 28 and any separately mounted antennas.
- Do not connect or disconnect antennas or cables from the HiveAP 28 during periods of lightning activity.
- If you need to place the HiveAP 28 in an explosive environment, such as in an oil refinery, mine, or any place where there is flammable gas, it must first be encased in an ATEX enclosure.
- To comply with RF (radio frequency) exposure limits, do not place antennas within 6.56 feet (2 meters) of people.
- Do not locate antennas near overhead power lines or other electric light or power circuits, or where they can come into contact with such circuits. When installing antennas, take extreme care not to come into contact with these circuits, which might cause serious injury or death. For proper installation and grounding of the antenna, refer to national and local electrical codes: NFPA (National Fire Protection Association) 70, National Electrical Code Article 810 (U.S.); Canadian Electrical Code, Part I, CSA 22.1 and Section 54 (Canada); and if local or national electrical codes are not available, refer to IEC (International Electrotechnical Commission) 364, Part 1 through 7 (other countries).
- To prevent damage, avoid over-tightening the connectors, nuts, and screws used to mount the HiveAP 28 and antennas.

Pole Mount

To mount the HiveAP 28 to a pole with a 1.5-inch diameter, you need two sets of the L-shaped brackets, two 2" U-bolts, saddle clamps, and the nuts, bolts, and washers shown in Figure 5. You also need a wrench to tighten the nuts and bolts securely.

Figure 5   Attaching the HiveAP 28 to a Pole

① Use the 1/4-20 bolts and split washers to attach the shorter end of the L-shaped bracket to holes in the underside of the HiveAP 28.

② Slip the U-bolt around the pole and thread its ends through the saddle clamp and L-shaped bracket.

③ Thread the split washers and 5/16-18 nuts over the ends of the U-bolt and tighten until the bracket assembly and device are secured to the pole.

Bird's-Eye View

5/16-18 Nuts
Split Washers
L-Shaped Bracket
Saddle Clamp
Vertical Pole (1.5" diameter)
2" U-Bolt
1/4-20 Bolts and Split Washers

Note: For clarity, only one post mounting set is shown in the illustration. You also need to use a second set to finish mounting the HiveAP on a pole.

Side view of the HiveAP 28 mounted to a street light

1. Align two of the holes in the shorter end of the bracket with two of the holes in the HiveAP, insert the two bolts through the washers and bracket, and screw them into the holes in the HiveAP 28 chassis, using a wrench to tighten the bolts so that the bracket is securely attached.

   Note: Repeat this step to attach the other bracket to the HiveAP. However, this time, place the long end of the bracket in the opposite direction of the first one for better stability. For example, if you attached the first bracket with its long end positioned toward the outside edge of the device, install this second bracket with the long end of the bracket toward the middle.

2. Holding a saddle clamp against the inside of the long end of one of the L-shaped brackets, slip a U-bolt around the pole and thread it through the two holes in the saddle clamp and L-shaped bracket.

   Note: One of the holes in the bracket is arc-shaped so that you can adjust the angle of the mounted device if necessary.
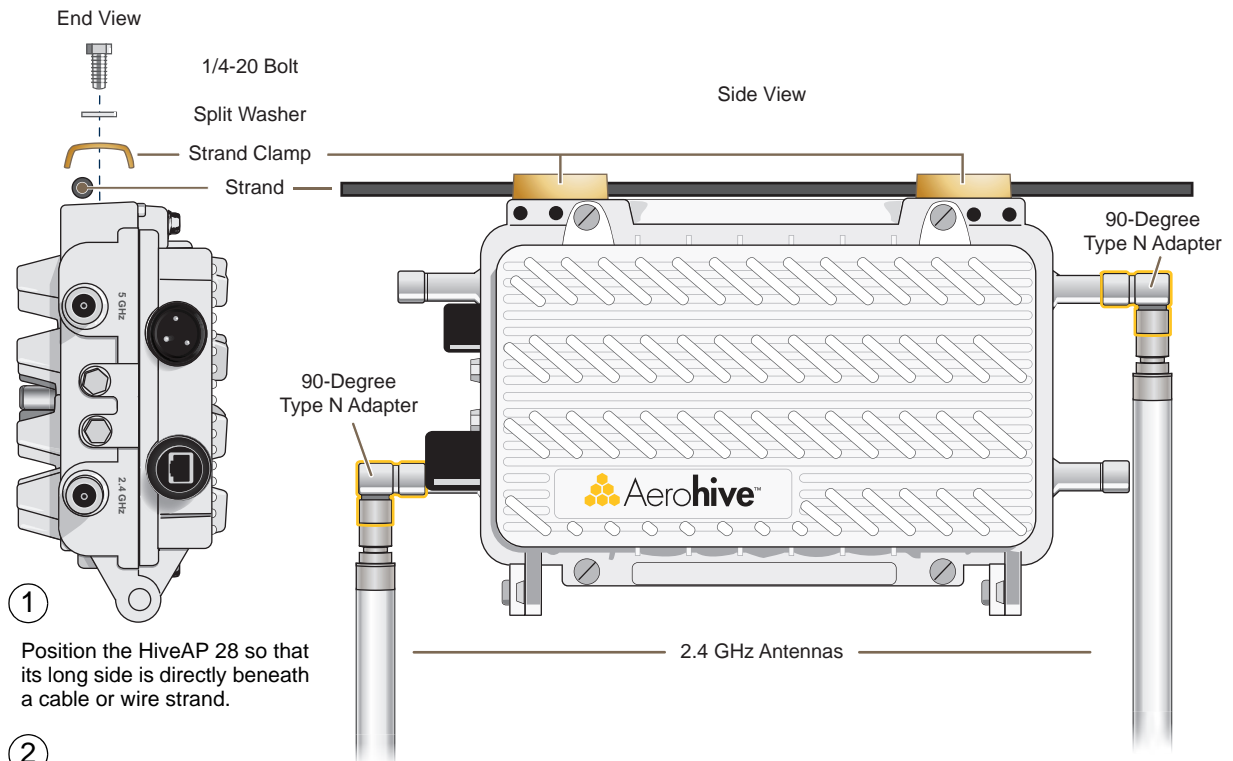
3. Thread a split washer and 5/16-18 nut to each end of the U-bolt, and tighten them with a wrench to secure the U-bolt firmly to the pole.

   Note: Repeat steps 2 and 3 to attach the other U-bolt and saddle clamp to the remaining L-shaped bracket and secure the HiveAP 28 to the pole.

Strand Mount

The HiveAP 28 outdoor platform can also be mounted on a cable or strand of wire as shown in Figure 6. When mounted on a wire strand, use 90-degree N type adapters (not included) to orient the antennas vertically. If you do not use the adapters and orient the antennas horizontally, the area covered will be far less.

*Figure 6   Clamping the HiveAP 28 to a Wire Strand*

End View

1/4-20 Bolt

Side View

Split Washer

Strand Clamp

Strand

90-Degree
Type N Adapter

5 GHz

2.4 GHz

90-Degree
Type N Adapter

Aerohive™

2.4 GHz Antennas

① Position the HiveAP 28 so that its long side is directly beneath a cable or wire strand.

② Place the strand clamps over the wire, and bolt the clamps tightly to the chassis around the strand.

③ Attach 90-degree type N adapters to the 2.4 GHz antenna connectors so that the adapters face downward, and then attach the antennas to the adapters

Note: For clarity, only one bolt, washer, and strand clamp are shown in the illustration on the left. You also need to use a second set of these items to finish clamping the HiveAP to a wire strand.

Side view of the HiveAP 28 mounted on a cable strand
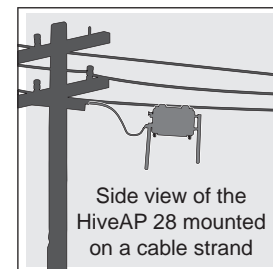
To mount the HiveAP 28 on a wire or strand, you need a wrench and two 1/4-20 bolts, split washers, strand clamps, and 90-degree type N adapters. In the following instructions, you use only the 2.4 GHz antennas.

1. Position the HiveAP 28 so that its long side (with three holes at each end) is underneath a cable or wire strand running lengthwise along the upper side of the chassis (for the proper orientation, see the inset in Figure 6).

2. Place the strand clamp over the wire and use the 1/4-20 bolt and split washer to secure the strand between the clamp and chassis.

   Note: Repeat the preceding steps to fasten the other end of the HiveAP 28 to the cable or wire strand.

3. Attach the 90-degree type N adapters to the two 2.4 GHz antenna connectors and then attach the antennas to the adapters so that the antennas face downward. For details, see "Attaching Antennas" on page 42.
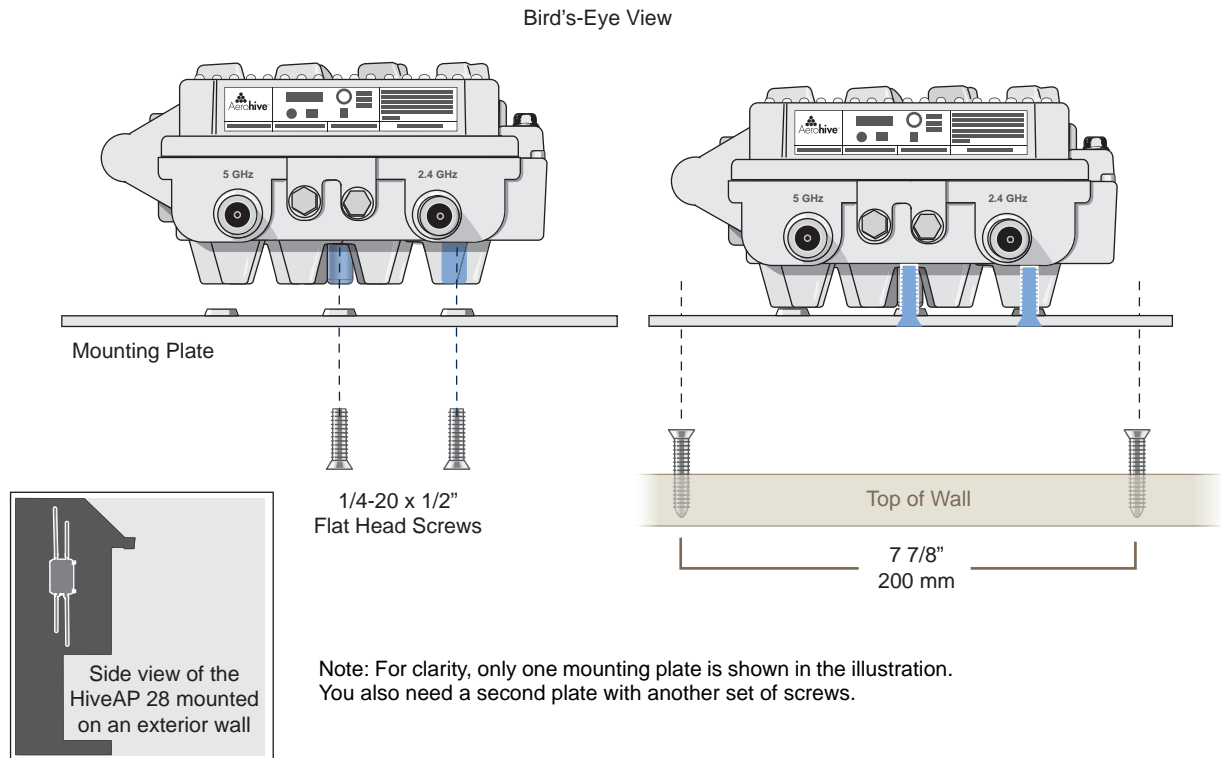
Surface Mount

You can use the mounting plate to attach the HiveAP 28 to any surface that supports its weight (9 lbs., 4.08 kg), and to which you can screw or nail the plate. First, mount the plate to the HiveAP 28, and then attach the plate to the surface, as shown in Figure 7. Note that the screw heads that you attach to the wall or surface must be small enough for the keyholes on the mounting plate to slip over them.

Note: Because the metal in a wall can degrade the radio signal pattern, Aerohive recommends using sector antennas instead of omnidirectional antennas when mounting the device on a wall.

Figure 7   Mounting the HiveAP 28 on a Wall

① With the ridged edge of the holes on the mounting plates facing the HiveAP 28, use 1/4-20 x 1/2 inch screws to secure the two mounting plates to its underside.

② Attach four screws to a secure object such as a wall or beam. Space them 8 1/8" (206 mm) apart vertically and 7 7/8" (200 mm) apart horizontally.

③ Guide the screws fastened to the wall through the keyholes in the mounting plates.

Bird's-Eye View

Mounting Plate

1/4-20 x 1/2"
Flat Head Screws

Top of Wall

7 7/8"
200 mm

Side view of the HiveAP 28 mounted on an exterior wall

Note: For clarity, only one mounting plate is shown in the illustration. You also need a second plate with another set of screws.

To mount the HiveAP 28 to a surface like a wall, you need two mounting plates, four 1/4-20 x 1/2" flat head screws, four screws (no bigger than 5/16"), and a screw driver:

1. Align the ridged edge of one of the mounting plates with two of the holes located on the underside of the HiveAP 28, and use two 1/4-20 x 1/2" flat head screws to secure the plate against the HiveAP 28. Then attach the other mounting plate to the HiveAP 28 in the same way.

2. Attach four 5/16" screws to a wall or beam. They must be 8 1/8" (206 mm) apart vertically and 7 7/8" (200 mm) apart horizontally to accommodate the keyholes on the mounting plates.

3. Guide the keyholes over the screws fastened to the wall and push downward after the screw heads have cleared the keyholes.

Attaching Antennas

You can connect the antennas directly to the HiveAP 28 or mount them separately. Although connecting the antennas directly to the device typically provides better performance, in some cases the location of the HiveAP might not be a good location for the antennas; for example, if the HiveAP 28 is mounted on a reinforced concrete wall that interferes with radio coverage. In such cases, mounting the antennas separately in a more open location can improve coverage; however, bear in mind that cables introduce loss into the overall signal strength and that the longer the cable connecting the antennas to the HiveAP 28, the greater the loss will be.

Note: Cover any unused antenna connectors with a connector cap to prevent water intrusion and possible safety hazards.

Connecting Antennas Directly to the HiveAP 28

The two 2.4 GHz and two 5 GHz antennas that ship with the HiveAP 28 have male Type N connectors that you can connect directly to the female Type N antenna connectors on the HiveAP 28. You can also use self-amalgamating PTFE (polytetrafluoroethylene) tape, which is available separately from Aerohive, to create a waterproof seal at the points of attachment.

To attach the antennas:

1. Remove the antenna connector covers from the HiveAP 28 (leave the covers on any connectors that you do not plan to use), and make sure that the surface of the connectors on the HiveAP 28 and the connectors on the antennas are clean.

2. If you are using PTFE tape, wrap the tape around the threads on the HiveAP 28 antenna connectors as follows:

   2.1. Starting at one end of the threads on one of the connectors, stretch the tape and wrap it in half-lap layers until you cover the threads completely.

   2.2. Wrap the tape in the opposite direction to bring it back onto itself for one full wrap.

   2.3. Place one thumb on the tape at the point of termination and stretch the tape until it breaks.

   2.4. Repeat the preceding steps to cover all the connectors to which you will attach antennas.

3. Connect the 2.4 GHz antennas to the 2.4 GHz antenna connectors. (To tighten an antenna, turn the antenna base cap—the textured metal band that encloses the connector—clockwise over the tape-covered threads of the HiveAP antenna connector.)

   Their connections are now sealed and waterproof.

4. Repeat the preceding steps to connect the 5 GHz antennas.

Mounting Antennas Separately

In addition to connecting antennas directly to the HiveAP 28, you can also mount them separately and run a cable between the antennas and the device. Use either male-to-female cables with Type N connectors or use male-to-male or female-to-female cables with cable gender changers. (The antennas have male Type N connectors and the HiveAP 28 has female Type N connectors.)

Note: Using cables to mount antennas separately causes some signal loss and using a cable gender changer can cause even more. The amount of loss varies from product to product, so refer to the documentation accompanying the cables and gender changer you use for information. To minimize loss, Aerohive recommends using LMR400 cables and using the shortest cables possible.

MOUNTING THE HIVEAP 28 AND ATTACHING ANTENNAS

You can mount antennas at the top of a pole as shown in Figure 8 and Figure 9, or to a flat surface. If you must mount the antenna lower on a pole, the pole must be nonmetallic—such as one made from a hard plastic like PVC (polyvinyl chloride)—so that it does not distort the signal. Aerohive recommends that antennas be installed away from power lines and obstructions that can interfere with radio coverage.

For each antenna that you mount, you need an attachment clamp, a 1 3/8" bolt and nut, a V-bolt, two washers and two nuts, a hose clamp, and two wrenches.

Figure 8   Securing an Antenna to an Attachment Clamp
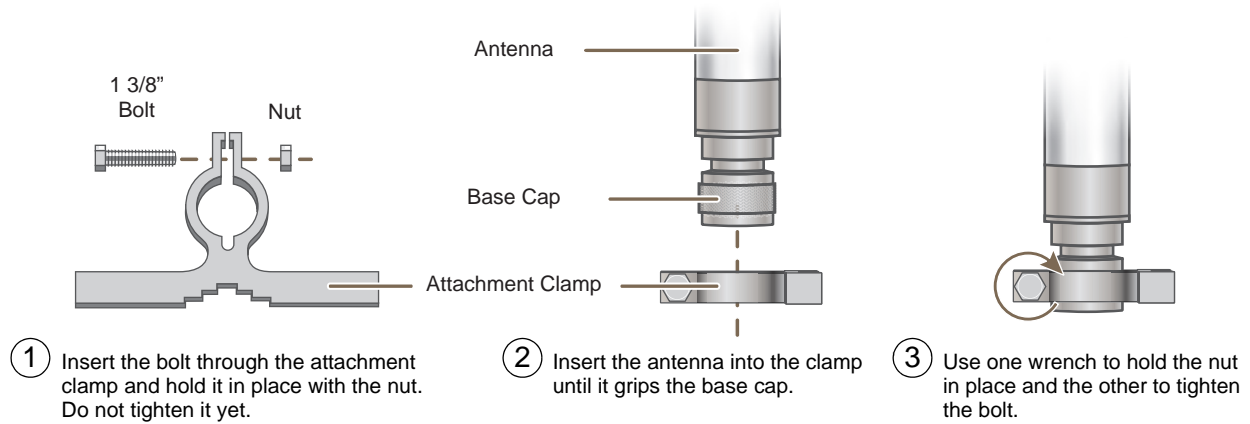
1. Insert the 1 3/8" bolt through the attachment clamp and screw a nut loosely onto its end.
2. Place the antenna base cap inside the attachment clamp.
3. Using a pair of wrenches, tighten the nut to the bolt until the clamp grips the base cap firmly.

Figure 9   Mounting an Antenna to a Pole
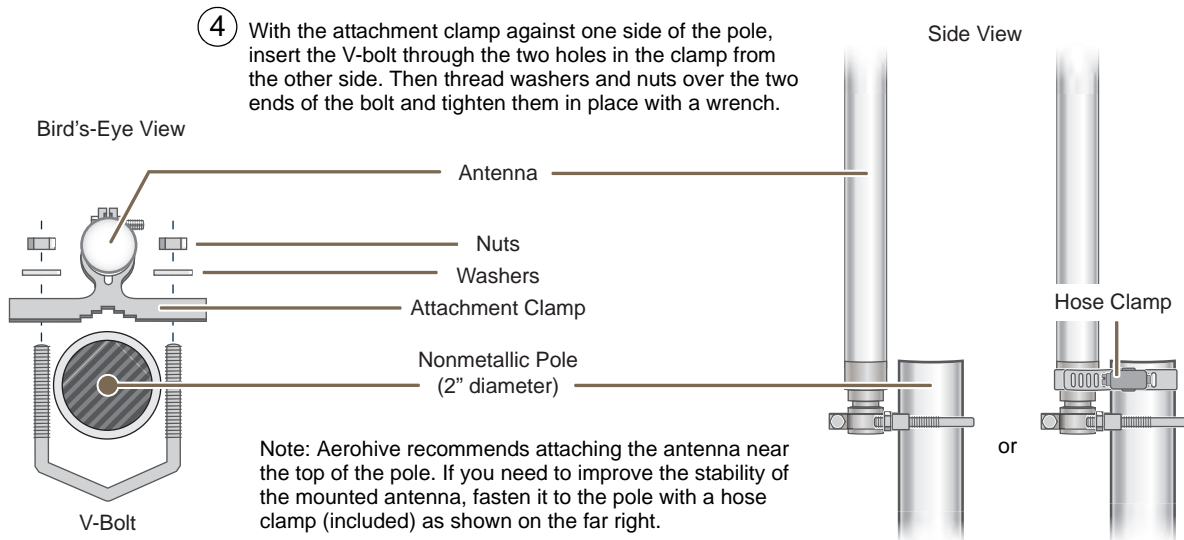
4. To mount the antenna on a nonmetallic pole, place the attachment clamp against the pole, thread the V-bolt through the holes on the attachment, the washers, and nuts, and use the wrenches to tighten the nuts to the bolt. (Optional) For added stability, fasten the top of the antenna to the pole with the hose clamp.

   To mount the antenna directly to a flat surface, run bolts or screws (not included) through the two holes in the attachment clamp, and fasten them firmly to the surface.

Deployment Guide

> *Note: Radio coverage might be limited if the surface acts as an obstruction.*

5. Make sure that all the antenna and cable connectors are clean. If you are using PTFE tape, wrap the tape around the threads on the HiveAP 28 antenna connectors as explained in "Connecting Antennas Directly to the HiveAP 28" on page 42.

6. Assuming that you are using male-to-female cables, connect the female Type N connector on the cables to the male connectors on the antennas.

7. Connect the male Type N connectors on the cables to the female antenna connectors on the HiveAP 28.

DEVICE, POWER, AND ENVIRONMENTAL SPECIFICATIONS

Understanding the range of specifications for the HiveAP is necessary for optimal deployment and device operation. The following specifications describe the physical features and hardware components, the power adapter and PoE (Power over Ethernet) electrical requirements, and the temperature and humidity ranges in which the device can operate.

Device Specifications

- Chassis dimensions: 13 13/16" W x 4 3/8" H x 8 3/8" D (35 cm W x 11 cm H x 21 cm D)
- Weight: (9 lbs., 4.08 kg)
- Antennas: Two detachable single-band 8dBi 802.11b/g antennas and two detachable single-band 10dBi 802.11a antennas
- Maximum Transmission Power: 20 dBm
- Ethernet port: autosensing 10/100Base-T/TX Mbps, with IEEE 802.3af-compliant PoE (Power over Ethernet)

Power Specifications

- AC/DC power adapter:
  - Input:100 – 240 VAC
  - Output: 17 watts
- PoE nominal input voltages: 48 V, 0.35A
- RJ-45 power input pins: Wires 4, 5, 7, 8 or 1, 2, 3, 6
- RF power output:

802.11b RF (8-dBi Omnidirectional Antenna, Model S2406BFNM)			
Frequency	2412 MHz	2437 MHz	2462 MHz
Peak Power Output (dBm)	14.20	14.00	14.20
802.11g RF (8-dBi Omnidirectional Antenna, Model S2406BFNM)			
Frequency	2412 MHz	2437 MHz	2462 MHz
Peak Power Output (dBm)	16.20	16.80	15.00
802.11a RF (10-dBi Omnidirectional Antenna, Model S4908WBF)			
Frequency	5745 MHz	5785 MHz	5825 MHz
Peak Power Output (dBm)	17.80	17.40	17.60

Environmental Specifications

- Operating temperature: -40 to 140 degrees F (-40 to 60 degrees C)
- Storage temperature: -40 to 194 degrees F (-40 to 90 degrees C)
- Relative Humidity: Maximum 100%