

SpiderCloud® Radio Node - SCRN-220 Hardware Installation Guide



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FCC Statements

Caution: Any changes or modification cautions to this device not explicitly approved by manufacturer could void your authority to operate this equipment.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum 25 cm between the radiator and your body. This transmitter must not be collocated or operating in conjunction with any other antenna or transmitter unless authorized to do so by the FCC.

This device can be expected to comply with part 15 of the FCC Rules provided it is assembled in exact accordance with the instructions provided with this kit. Operation is subject to the following conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received including interference that may cause undesired operation.

Revision History

Revision	Date	Summary of Changes
1	4/13/2017	Initial document release

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Table of Contents

About this Manual	5
Product Overview	5
Radio Node Models	6
Radio Node System Isometric Top View and Bottom View	7
Antennas	8
Ports	9
The Top-Panel LED	9
Input Power	10
System Specifications	11
SCRN-220 Bracket Specifications	12
Compliance	13
Radio Specifications	13
Select the Radio Node Location	14
Installation and Mount Bracket Assembly	14
Bracket Mounting and Cabling Guidelines	15
Typical Radio Node Mounting Options	15
Installing the Radio Node	15
Installing the Radio Node (Method 1)	16
Installing the Radio Node (Method 2)	17
Completing the Installation	19
Detaching the Radio Node from the Mount Bracket	19
Boot Sequence and Services Node Communication	20
Radio Node LED Boot Sequence	21
Radio Node LED Management	22
The SpiderCloud Documentation Set	23
Appendix A LTE Antenna Patterns	25

About this Manual

This guide provides the system specifications of the SpiderCloud Wireless® Radio Node 220 (SCRN-220). It includes detailed hardware installation instructions, the boot sequence, and expected LED behavior both during the boot-up and under operating conditions. An appendix shows the radio node antenna patterns.

The primary audience for this guide includes network planners, system administrators and installation personnel. It assumes you have knowledge about networking principles, networking configuration, site preparation, powering, and experience in hardware installation and maintenance.

Product Overview

The SCRN-220 is an integrated LTE small cell with support for Rel13 IOT devices. SpiderCloud's scalable small cell system, called an Enterprise Radio Access Network (E-RAN), hides the complexity of radio management and mobility and provides operators with a single touch point to aggregate and manage a large network of LTE small cells.

Each SCRN-220 supports 2x2 MIMO operation on configurable LTE bands, enabling higher user capacity and average data rates per radio node coverage footprint. Each LTE carrier supports 64 active LTE users and up to 128 RRC Connections. When used with 20 MHz channel bandwidth, an LTE carrier supports a peak downlink rate of 150 Mbps and a peak uplink rate of 50 Mbps.

The radio node implements SON capability by listening to other radio nodes within the E-RAN and neighboring LTE macro cells in multiple frequency bands, and performing continuous self-optimization to provide high-quality radio coverage and mobility.

SpiderCloud radio nodes can be installed on walls or ceilings. Both network connectivity and power are provided over Ethernet. The radio node has no fans and is completely convection cooled. Antennas are built-in for both LTE bands, with an orderable option for QMA connectors for use with external antennas.

SCRN-220 utilizes on-chip Trusted Platform Module (TPM) functions to implement secure boot, and establish certificate- based IPsec tunnel to SpiderCloud services node for all LTE traffic. There is no management or console port on the radio node, and the radio node can be physically locked to prevent theft.

Figure 1 on page 6 shows the logical architecture of the SCRN-220 in the network:

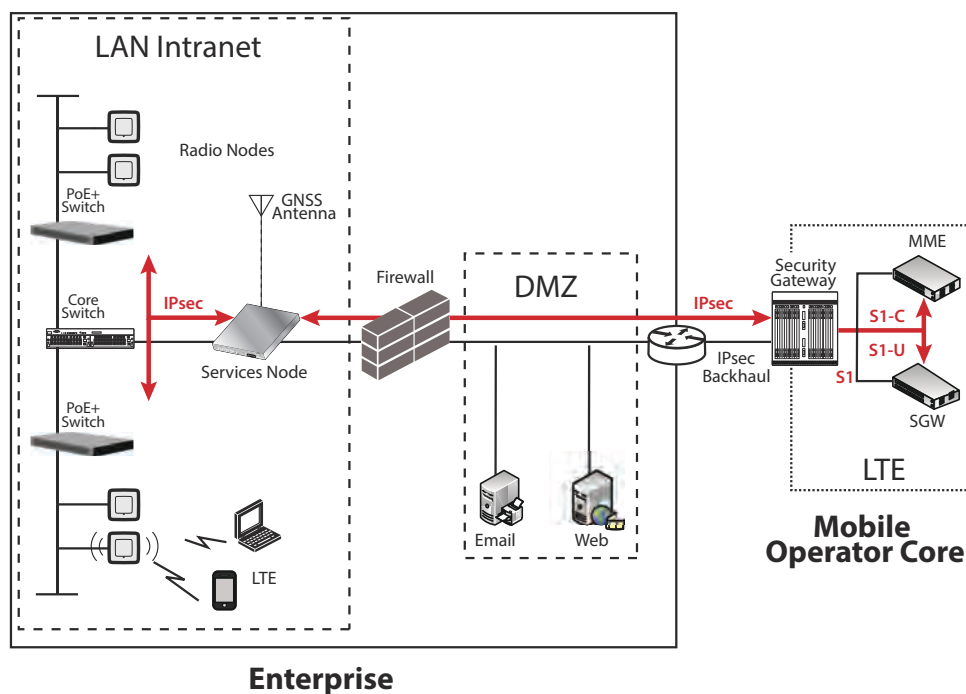


Figure 1 Radio Node Relationship to Enterprise and Mobile Operator Core Networks

Radio Node Models

Table 1 displays the orderable configuration of the SCRN-220 radio node:

Table 1: SCRN-220 Radio Node Configurations

Radio Node Model	Description	Antenna Type
SCRN-220-020412	Software configurable licensed band with support for LTE Band 2, 4, or 12.	Internal
SCRN-220-020412-E	Software configurable licensed band with support for LTE Band 2, 4, or 12.	External
SCRN-220-020413	Software configurable licensed band with support for LTE Band 2, 4, or 13.	Internal
SCRN-220-020413-E	Software configurable licensed band with support for LTE Band 2, 4, or 13.	External

Radio Node System Isometric Top View and Bottom View

The following drawings display an isometric top and bottom views of the radio node:



Figure 2 Radio Node Top View



Figure 3 Radio Node Bottom View

Antennas

The radio node includes four internal Tx/Rx antennas with a peak gain of 5dBi and operates in 2x2 mode with MIMO or four optional ports with QMA coaxial connectors for external antennas. Both models contain one internal network listen antenna:

Figure 4 shows the location of the LTE antennas:

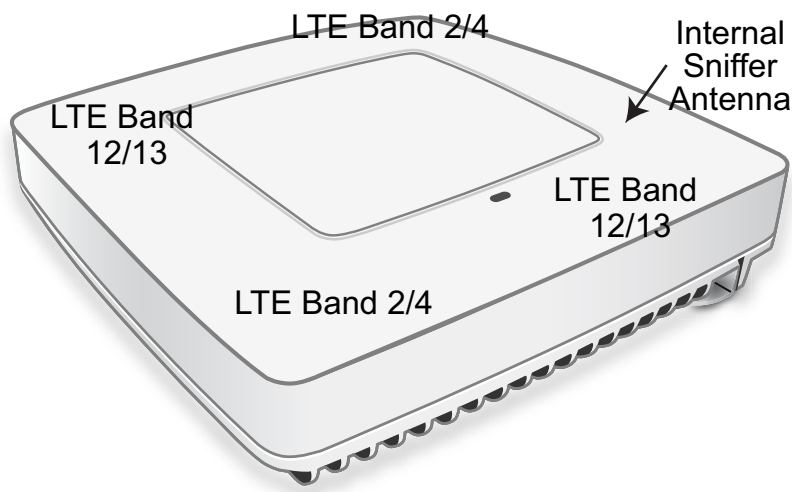


Figure 4 Antenna Band Locations

Figure 5 shows the radio node with external antennas. This view is oriented the same way as Figure 4, so the antenna locations are the same.



Figure 5 External Antenna Locations

Ports

The radio node has one 1 Gigabit Ethernet port that supports a Category 5e (Cat 5e) or better twisted-pair cable with an RJ-45 connector. [Figure 6](#) shows the Ethernet port. There are two LEDs on the connector:

- **Link:** Steady green state indicates a normal Layer 2 link connection has been established.
- **Activity:** Yellow blinking indicates data activity.

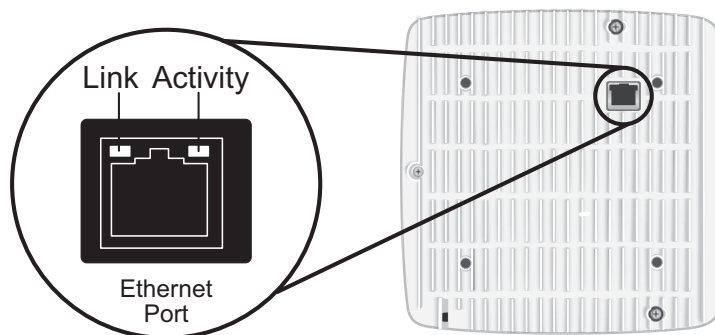


Figure 6 Ethernet Port

The Top-Panel LED

The radio node has one top-panel tricolor (RGB) LED to indicate power and status. This is the only LED visible under normal operating conditions. When the radio node initially boots the LED cycles through a number of colors and flashing behaviors until it is fully operational. Status indications: boot, normal, disabled, fault, emergency call, radio node tracking.

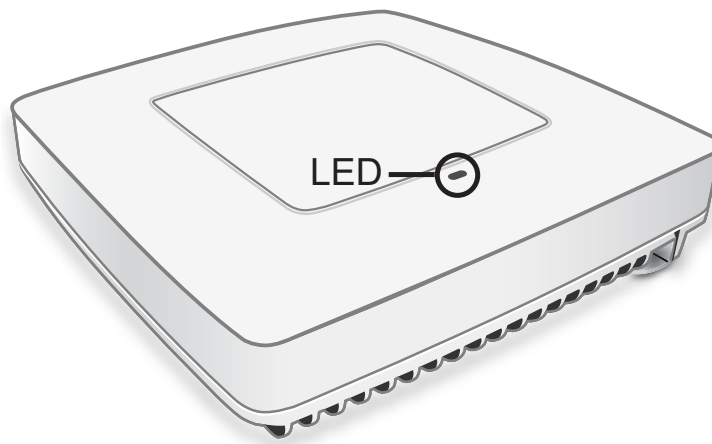


Figure 7 Radio Node Tricolor LED

Input Power

The radio node receives its power from a standard Power Over Ethernet (PoE+) switch (typical) or injector. The radio node is fully compliant with the IEEE 802.3at PoE+ specification.

Per IEEE 802.3at, use standard Cat 5e or better twisted-pair cable with a maximum length restriction of 100 meters (328 feet) for PoE+. This restriction minimizes power loss between the PoE+ power source and the radio node.



Note

Power is distributed over two pairs of the four available pairs in Cat 5e or better cables. The radio node can accept power on either used or un-used pairs.

When connecting the radio node to a PoE+ switch, ensure that the switch port is statically configured to deliver minimum 25W of power.



Note

Some PoE switches may be factory configured to deliver lower power per port. If this is the case change the configuration during installation.

Figure 8 shows the valid radio node cabling/powering options:

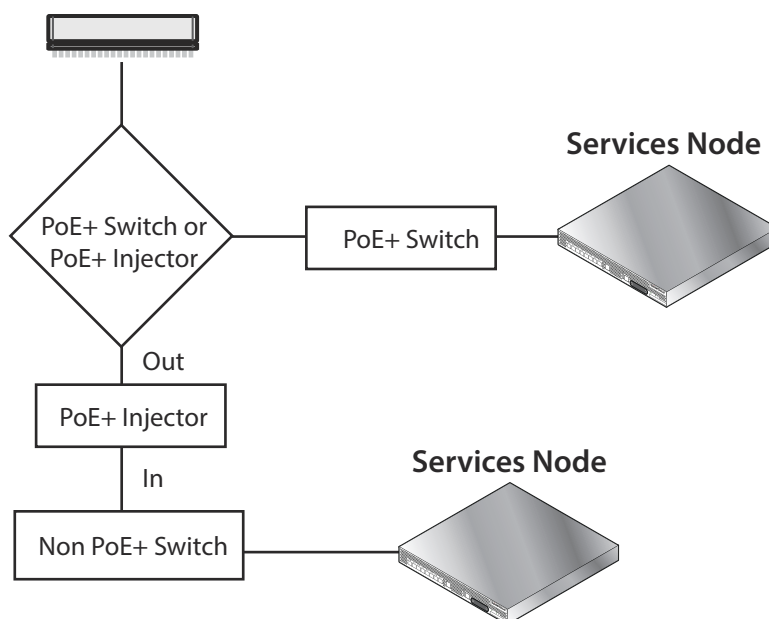


Figure 8 Valid Radio Node Cabling/Powering Options

The illustration below shows a generic single-port PoE+ injector. Use this injector only when a PoE+ Ethernet switch is *not* available.

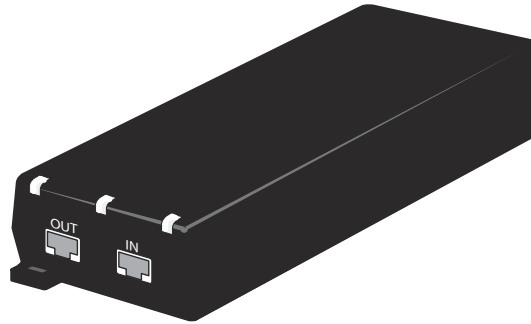


Figure 9 Typical PoE+ Injector

To connect the PoE+ injector to a radio node

- Step 1** Attach the injector power cord to a power source.
- Step 2** Connect an unpowered Ethernet cable from a switch to the **IN** port on the injector.
- Step 3** Connect an Ethernet cable from the injector's **OUT** port to the radio node. The injector will now inject power onto a pair of wire pairs in the cable. The radio node will expect a nominal 48V DC input (57V max) from a typical PoE+ injector.

System Specifications

The SCRN-220 radio node has the following chassis measurements, power requirements, and environmental requirements, and complies with the following standards. Refer to the feature guide for your services node software release for release-specific features and specifications.

Table 2: Radio Node Specifications

Dimensions	Height: 1.83 cm (7.2 in.) Width: 1.83 cm (7.2 in.) Depth: 36 cm (1.4 in.)
Weight	1.23 kg. (2.7 lbs)
Active Sessions per Radio Node	Up to 64 active LTE users 128 RRC connected users
Peak Data Rate	Downlink 150 Mbps; Uplink 50 Mbps (at 20 MHz)
Voice Services	VoLTE; 4 data bearers per UE
Power Requirements	Maximum transmit power: 2x250 mW (27 dBm)
Input Power	Power over Ethernet (PoE+) draws approximately 18W
Channel Size	5, 10, 15, 20 MHz
Ciphering	SNOW 3G and AES air interface encryption

Table 2: Radio Node Specifications *(continued)*

Security	Secure boot and secure key storage using Trusted Platform Module (TPM) functions
	IPsec tunneling to services node
	X.509 certificate-based authentication
Environmental Requirements	Operating temperature range: 0° to 40°C (32° to 104°F)
	Non-operating temperature range: 0 to 85°C (32 to 185°F)
	Relative humidity: Operating and storage: 0% RH to 90% RH non-condensing
	Ingress protection rating: IP30
Physical Interfaces	1 x Gigabit Ethernet 1000 Base-T with an RJ-45 connector
LEDs	1 top-panel tricolor (RGB) LED to indicate power and status
Mounting	Wall, Ceiling, Plenum
Antenna	Four internal Tx/RX antennas that operate in 2x2 mode with MIMO One internal network listen antenna <i>or</i> Four antenna ports with QMA coaxial connectors for external antennas One internal network listen antenna
Synchronization	IEEE 1588v2-based PTP based frequency synchronization to services node Cellular network listen for phase synchronization to LTE macro eNodeBs
MTBF	1,363,791 hours at +40°C (104°F)

SCRN-220 Bracket Specifications

The SCRN-220 radio node connects to one of two brackets for ceiling or wall mounting:

- a quarter-inch (0.64 centimeter) deep for cabling through a surface such as a wall or ceiling
- a 1.25 inch (3.18 centimeters) deep for exposed cabling along a hard surface such as brick or cinder block

[Table 3](#) shows the specification for these brackets:

Table 3: Radio Node Specifications

0.25-Inch Bracket	
Dimensions	Height: 1.57 cm (6.2 in.) Width: 1.3 cm (5.1 in.) Depth: 0.64 cm (0.25 in.)
Weight	0.17 kg. (5.8 oz)

Table 3: Radio Node Specifications *(continued)*

1.25-Inch Bracket	
Dimensions	Height: 1.57 cm (6.2 in.) Width: 1.3 cm (5.1 in.) Depth: 3.18 cm (1.25 in.)
Weight	0.24 kg. (8.2 oz)

Compliance

The SCRN-220 complies with the following standards:

Table 4: SCRN-220 Compliance

Safety	EN 60950-160950 CB certification (IEC 60950, UL 60950-1)
EMC/Radio (FCC)	FCC Part 15B (Class A) FCC Part 24 FCC Part 27
R&TTE	Directive 1999/5/EC: • EN 301 489-1, 301 489-23 • EN 301 908-1, 301 908-3, 301 908-14 • EN 50385 and EN 62311 (SAR)
RoHS	Directive 2011/65/EU
General	CE and NRTL marking

Radio Specifications

The SCRN-220 has the following variants:

Table 5: Radio Node Specifications

Radio Node Model	Operating Mode	Network Listen Bands
SCRN-220-020412	LTE Band 2, 4, or 12	LTE 700/1900/2100MHz
SCRN-220-020412-E	LTE Band 2, 4, or 12	LTE 700/1900/2100MHz
SCRN-220-020413	LTE Band 2, 4, or 13	LTE 700/1900/2100MHz
SCRN-220-020413-E	LTE Band 2, 4, or 13	LTE 700/1900/2100MHz

Select the Radio Node Location

Radio nodes can be installed in a wide range of locations including walls, ceilings, and spaces above the ceiling. Follow the installation guidelines for selecting appropriate mounting locations for the unit. When mounting a radio node vertically, align the bottom-side fins vertically for superior cooling.

Refer to the *E-RAN Deployment Planning Guide* for information about mounting positioning and the affects on cellular coverage. Always consult local codes about mounting and wiring SpiderCloud Wireless equipment.

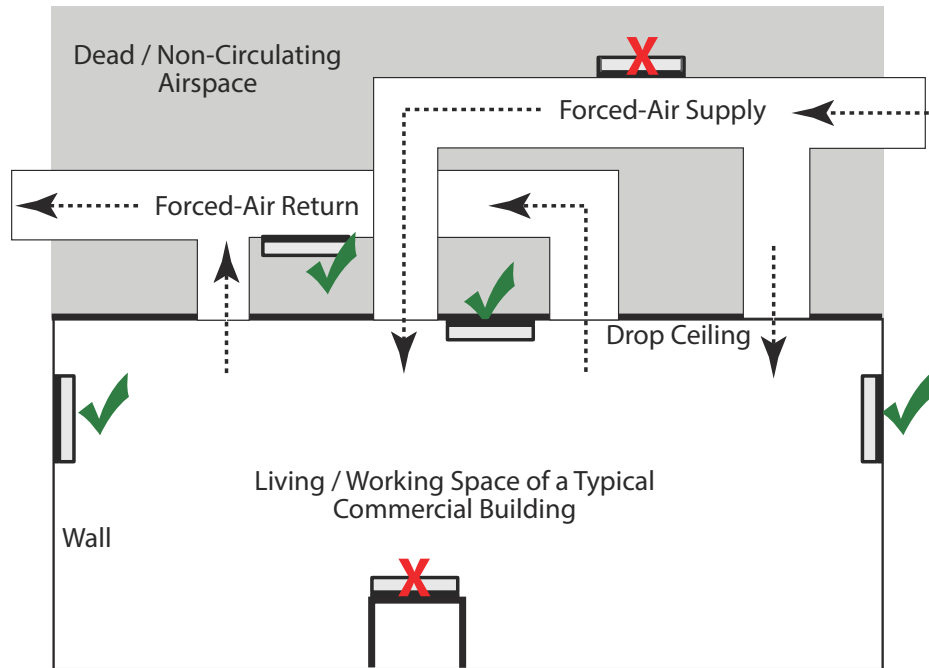


Figure 10 Radio Node Locations

When possible, locate radio node units at least 6 meters (20 feet) from an external wall. This distance maximizes indoor coverage and minimizes RF leakage outside the building. Refer to the *E-RAN Deployment Planning Guide for Dual-Mode Systems* and *E-RAN Deployment Planning Guide for LTE Systems* for more information about radio node placement.

When mounting near a wall or other obstruction, orient the mounting bracket such that the transmit antenna faces towards the coverage area and faces away from the wall. Refer to [Bracket Mounting and Cabling Guidelines](#) on page 15 for more information.

Installation and Mount Bracket Assembly

The radio node slides into one of two brackets for ceiling or wall mounting:

- a quarter-inch (0.64 centimeter) deep for cabling through a surface such as a wall or ceiling
- a 1.25 inch (3.18 centimeters) deep for exposed cabling along a hard surface such as brick or cinder block

Bracket Mounting and Cabling Guidelines

Incorrectly cabling and mounting a radio node can result in crushed cables and loss of communications to the unit. Follow these guidelines in cabling the radio node and mounting it on the bracket:

- Ensure that the cabling is properly routed and dressed.
- Ensure that the radio node is fully inserted into the mount bracket so that it locks into place and is flush. A correctly installed cable should at no time during installation impede inserting the radio node into the mount bracket.
- Secure the radio node to the mount bracket with a padlock or tie wrap to provide physical security.
- When mounting the radio node vertically, orient the bracket such that the bracket keyholes have the narrow side up as shown in [Figure 11](#).

Typical Radio Node Mounting Options

Radio nodes can be mounted on a wide number of surfaces including the following typical surfaces:

- **Light grill:** Use bolts, nuts, and washers to secure the universal mount bracket using holes in the light grill. Adjust the universal mounting bracket until the bracket and light grill holes align.
- **Directly on the wall or ceiling:** Use drywall screws to secure the universal mount bracket directly to sheetrock or plasterboard on the wall or ceiling.
- **Mud or plaster ring:** Secure the universal mount bracket directly on the wall or ceiling as above with a 3 1/4 inch (8.25 centimeter) mud or plaster ring between the mount bracket and the mounting service and run the Ethernet cable through ring's hole.
- **Existing infrastructure:** Secure the universal mount bracket to existing infrastructure as long as the radio node RF propagation or existing installed equipment is not adversely impacted.
- **Non-metal tiles:** Use bracing for rear support and mount the radio node in the center of the tile for even weight distribution. Ensure that the bracing is the same width as the tile.
- **Drop ceiling:** Contact your SpiderCloud Wireless representative for recommendations of supported third-party brackets and clamps.

Installing the Radio Node

The radio node receives its power source over powered Ethernet. If your wiring closet does not have existing PoE+ equipment, SpiderCloud Wireless recommends a PoE+ power injector for the radio node. See section [Input Power](#) on page 10.

The Ethernet cable can directly through a surface such as a wall or ceiling or route the cable openly:

- Refer to [Installing the Radio Node \(Method 1\)](#) on page 16 for direct cable routing installation through an opening behind the mount bracket using the shorter mount bracket.
- Refer to [Installing the Radio Node \(Method 2\)](#) on page 17 for open cable routing installation using the taller mount bracket.

Attach the mount bracket to the radio node as shown in [Figure 11](#):

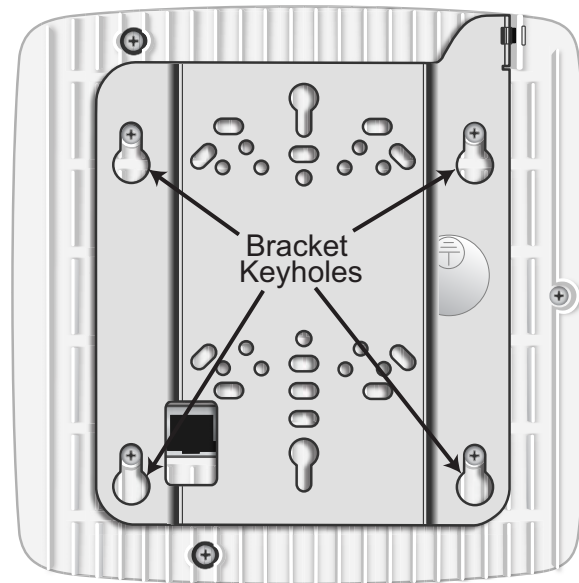


Figure 11 Radio Node Slides into Mount Bracket

Installing the Radio Node (Method 1)

Use this method with the quarter-inch bracket when routing the Ethernet cable through an opening where the bracket will be mounted.

To route the cable directly and mount the radio node

- Step 1** Cut a hole in the ceiling or wall to route the Ethernet cable through. Align the hole with the bracket Ethernet cable entry hole.
- Step 2** Route the Ethernet cable through the rectangular hole in the mounting bracket.

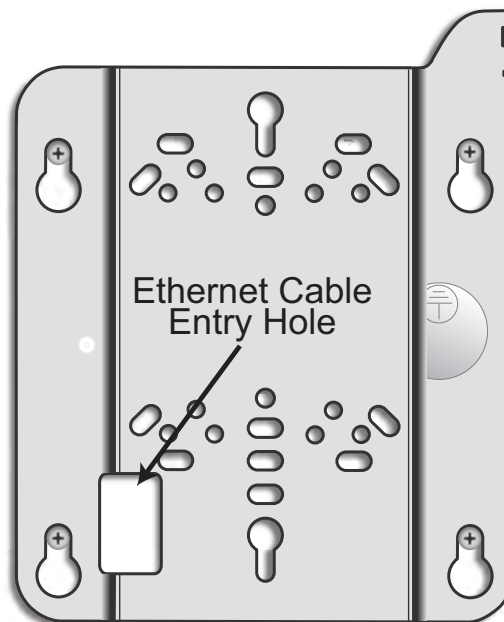


Figure 12 Mount Bracket with Direct Cable Routing

Step 3 With two user-provided screws, attach the mount bracket assembly to a wall or ceiling. The screw holes are sized for an M4 (#10) or larger screw. Ensure the screws have a snug fit onto the studs, sheetrock, anchor, or other material you are bolting onto and that you match the screw head with the appropriate cutout hole size on the bracket.

If needed, use a flat washer between the bracket and screw head to ensure a secure fastening.

Step 4 Insert the RJ-45 connector into the Ethernet port as shown in [Figure 13](#):

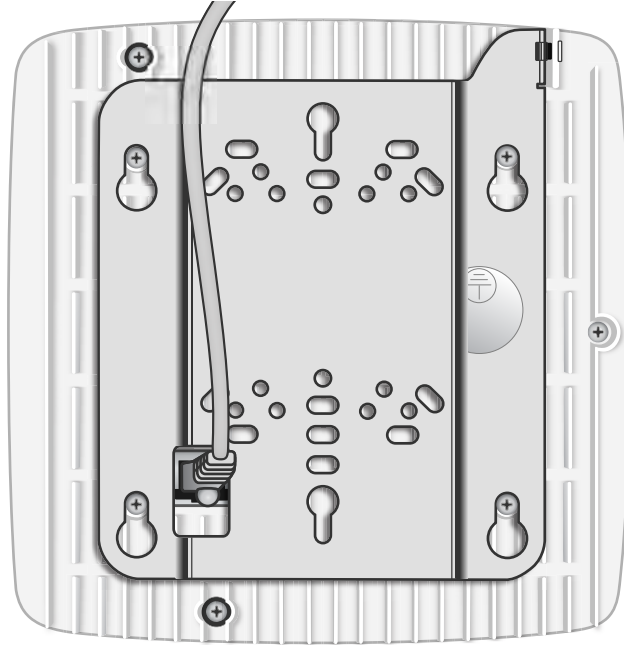


Figure 13 Route and Terminate the Cable

Step 5 Insert the radio node into the mount bracket.

Step 6 Push as much cable back through the wall or ceiling as possible. The mount bracket assembly has room for some cable slack.

Installing the Radio Node (Method 2)

Use this method with the 1.25 inch bracket when routing an exposed Ethernet cable directly to the radio node.

To route the cable openly and mount the radio node

Step 1 With two user-provided screws, attach the mount bracket assembly to a wall or ceiling. The screw holes are sized for an M4 (#10) or larger screw. Ensure the screws have a snug fit onto the studs, sheetrock, anchor, or other material you are bolting onto and that you match the screw head with the appropriate cutout hole size on the bracket.

If needed, use a flat washer between the bracket and screw head to ensure a secure fastening. [Figure 14](#) shows the 1.25-inch mount bracket.

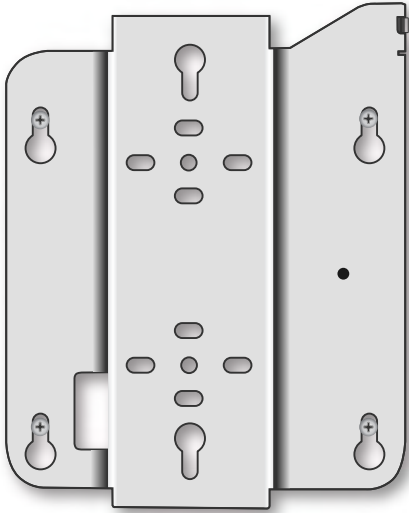


Figure 14 1.25-Inch Mount Bracket

Step 2 Insert the RJ-45 connector through the rectangular bracket opening into the Ethernet port as shown in [Figure 15](#):

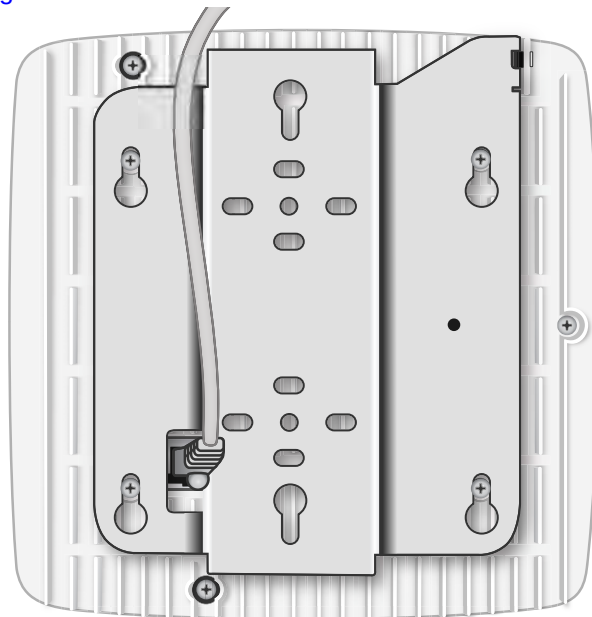


Figure 15 Route and Terminate the Cable

Step 3 Insert the radio node into the mount bracket.

Completing the Installation

- Step 1** Attach a padlock or cable tie wrap into the provided slot to secure the unit to the mount bracket.

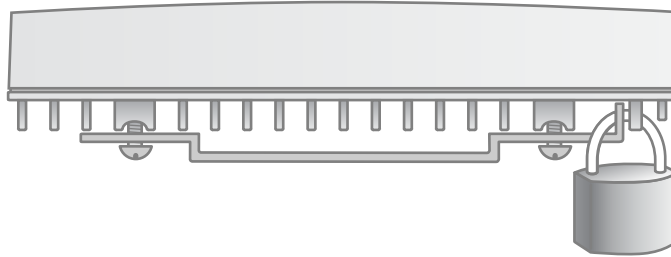


Figure 16 Padlock and Lock Holes



Note

The lock in the above figure is shown schematically. The orientation is for illustration purposes (not accurate) since the bracket is typically wall or ceiling mounted.

- Step 2** The radio node boots up and attempts to connect to the services node. Refer to [Boot Sequence and Services Node Communication](#) on page 20 for more information.

Detaching the Radio Node from the Mount Bracket

To remove the radio node from the bracket assembly

- Step 1** If needed, remove the padlock or cable tie wrap securing the radio node.
- Step 2** Slide the radio node out of the mount bracket.
- Step 3** Detach the RJ-45 clip from the Ethernet port and remove the cable from cable brackets and cable opening.

Boot Sequence and Services Node Communication

On initial boot, the radio node performs the following boot sequence. When finished, all devices are reachable. [Figure 17](#) shows the radio node boot sequence:

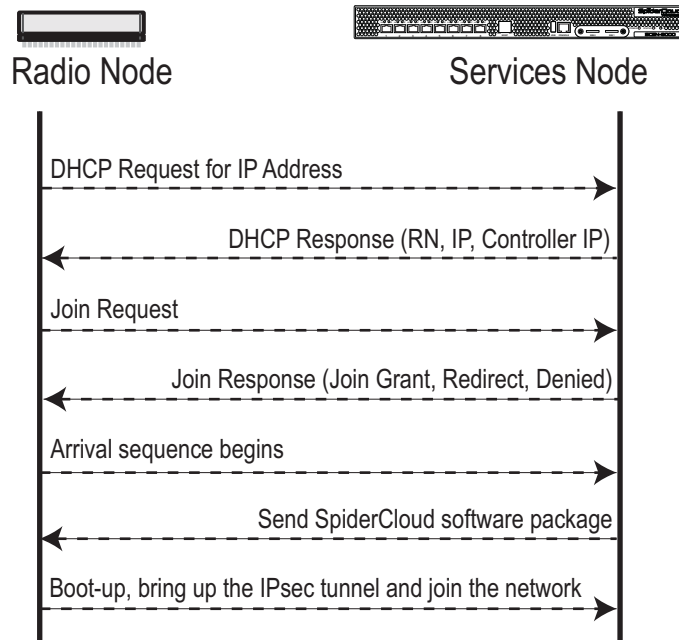


Figure 17 Radio Node Boot Sequence

Boot Sequence:

1. When the radio node is powered on, the device sends a DHCP Request to the services node DHCP server to get IP information. The DHCP server is configured on the services node to respond only to DHCP requests from SpiderCloud Wireless radio nodes. Refer to the *SpiderCloud OS (SCOS) Administrator Guide* for more information about the services node DHCP server configuration.
2. The server responds with the IP addresses of the radio node and the services node (the master of the radio node).
3. Using its own IP address, the radio node sends a Join Request message to the services node. The radio node seeks to join the cellular network.
4. The services node responds with a Join Response message indicating whether the radio node is allowed to join the network or not.
5. The arrival sequence begins. The services node sends the SpiderCloud software image to the radio node.
6. The radio node boots up the received SpiderCloud software package.
7. The radio node establishes an IPsec tunnel with the services node. Based upon the radio configuration, the radio node loads the appropriate protocol elements and joins the network.

Radio Node LED Boot Sequence

The radio node state machine is sequential and progresses in the following order:

State 0 -> State 1 -> State 2 -> State 3 -> State 4 -> State 5

A normal boot sequence transitions through all these states sequentially and the LED state transitions accordingly. If the radio node fails to transition to the next state, the system restarts the boot sequence, starting with State 0. You can determine the progress during the booting stages by observing the LED color transitions. On failure, the last LED state will display the state that encountered the failure. [Table 6](#) shows the radio node boot sequence and corresponding LED behavior:

Table 6: Radio Node LED Boot Sequence

State	LED Color	Description	Possible Failures and Actions
0. Power On/ Reset	Flashing Green	This is the initial state on startup. The radio node bootup is controlled by firmware in this state. It will go through a lamp test in this state. A lamp test involves cycling through all LED colors.	This state should be very short lived and should transition to the next state immediately. A radio node should not stay in this state indefinitely. Note: Flashing Green is also used to indicate a radio node that has been administratively disabled. This can be determined from the CLI.
1. DHCP	Solid Red	The radio node starts by sending out a DHCP Request. The radio node moves to the next state (State 2) upon receiving a DHCP response and an IP Address.	No DHCP Response, IP Address not allocated. Check cabling, DHCP Server configuration.
2. Join	Solid Blue	The radio node has an IP Address and sends a UDP Join request to the Serving services node. The radio node moves to the next state (State 3) upon getting a JOIN GRANT from the services node.	No IP reachability to the services node. Check IP network between radio node and services node for routing issues.
3. TFTP	Flashing Blue	The radio node proceeds next to download the operating system image from the services node. The radio node moves to the next state (State 4) after the image has been downloaded.	Failure to download TFTP image. Check firewall between radio node and services node.

Table 6: Radio Node LED Boot Sequence *(continued)*

State	LED Color	Description	Possible Failures and Actions
4. Operating System Booting	Flashing Green	The radio node loads the operating system and starts the default platform applications. The radio node moves to the next state (State 5) when it establishes connectivity with the service node.	Failure to start the operating system. This normally points to a software/build issue. Please contact SpiderCloud support.
5. Running	Solid Green	The operating system is running. The radio node continues the startup sequence, but is now controlled by the services node.	The operating system is up and running on the radio node. Any subsequent state transitions can now be tracked from events and logs on the services node.

Radio Node LED Management

The LED display is active by default, but can be deactivated in light-sensitive environments as needed. Even when the display is disabled, the LED will be lighted during the following conditions:

- while the radio node is booting
- if the radio node or cell is in fault state
- if there is an active emergency call
- if the locate radio node feature is active
- if the follow IMSI feature is active

[Table 7](#) shows the default LED behavior of the radio node:

Table 7: Radio Node LED Behavior

LED	Status	Flash Rate
Green: slow flashing	The radio node or radio is administratively disabled	Approximately ½ second on, 1½ sec. off
Green: fast flashing	Booting	Approximately 1.4 second on/off cycle
Green: solid	Operational	
Red: solid	Fault	
Red: fast flashing	One or more emergency UMTS calls active	Approximately 1 second on/off cycle
Blue: fast flashing	Locate radio node enabled*	Approximately 1 second on/off cycle
Blue: solid	Follow IMSI enabled and that IMSI is camped on a UMTS cell in the radio node*	
Off	Powered off or LED disabled	

* Refer to the *SpiderCloud OS (SCOS) Administrator Guide* for information about the locate radio node and follow IMSI features.

To disable the LED display

Step 1 From the Configuration Mode, issue the **set System RadioNode LED DefaultMode Dark** command to disable the LED display:

```
set System RadioNode LED DefaultMode Dark
```

Step 2 Issue the **show System RadioNode LED** command to verify the configuration:

```
show System RadioNode LED
DefaultMode Dark;
```

To re-enable the LED display

Step 1 From the Configuration Mode, issue the **set System RadioNode LED DefaultMode Standard** command to re-enable the LED display:

```
set System RadioNode LED DefaultMode Standard
```

Step 2 Issue the **show System RadioNode LED** command to verify the configuration:

```
show System RadioNode LED
DefaultMode Standard;
```

The SpiderCloud Documentation Set

The SpiderCloud documentation set includes:

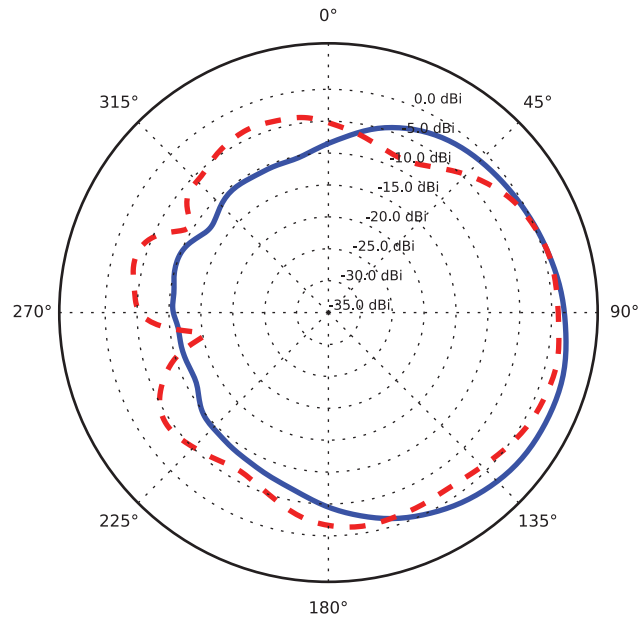
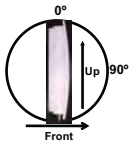
- The *SpiderCloud System Description* provides an overview of how the SpiderCloud system fits within an operator's network and in an enterprise, describes key features of the system, and provides specifications for the services and radio nodes.
- The *SpiderCloud Feature Description* provides high-level descriptions of the E-RAN system features, their impact on the product components (services nodes and radio nodes), manageability considerations, and feature benefits.
- The *SpiderCloud OS (SCOS) Administrator Guide* provides procedures for configuring the software environment and internetworking between the services node and radio node devices.
- The *SpiderCloud Services Node Hardware Installation Guide* provides hardware specifications and installation instructions.
- The *SpiderCloud Radio Node Hardware Installation Guide* provides hardware specifications and installation instructions.
- The *E-RAN Deployment Planning Guide* provides information about planning and dimensioning E-RAN systems.
- The *SpiderCloud OS (SCOS) CLI User Guide* provides an introduction to the key features and functionalities of the SpiderCloud Command Line Interface (CLI).
- The *SCOS NB Data Model Reference Guide* provides details about the objects and parameters that comprise the system configuration and operational state.
- The *SpiderCloud OS Faults, Conditions, and Events Reference Guide* provides details about all alarms, conditions, and events in the system.
- The *SpiderCloud System Commissioning Guide* provides information about turning up a SpiderCloud E-RAN with the Local Configuration Interface (LCI) graphical user interface.

- The *Performance Measurements for Dual-Mode Small-Cell E-RANs* provides a reference guide to UMTS and LTE Key Performance Indicators (KPI) that monitor the health and state of the E-RAN system.
- The *Performance Measurements for LTE Small-Cell E-RANs* provides a reference guide to Key Performance Indicators (KPI) that monitor the health and state of an LTE E-RAN system.
- The *SpiderNet Management System Installation and Administration Guide* provides information about installing the SpiderNet network management server and client and using it to remotely manage E-RAN deployments.
- The *E-RAN Troubleshooting Guide* provides information about diagnosing and correcting problems with installing, provisioning, administering, and maintaining SpiderCloud equipment and services.
- The *Troubleshooting E-RAN Systems with SpiderNet* provides information about diagnosing and correcting problems in the SpiderCloud system with the SpiderNet network management system.
- The *SpiderCloud Time Zone Reference Guide* provides the information required to configure the time zone for SpiderCloud services nodes.
- The *SpiderCloud Call Performance Event Reporting Guide* provides detailed information about call performance events files including the file format, reported events, and event parameters.
- The *SpiderNet NBI Integration Guide* provides information about integrating the SpiderNet network management system into operator's Northbound Interface (NBI) Operations Support Systems (OSSs) to surveil SpiderCloud networks.

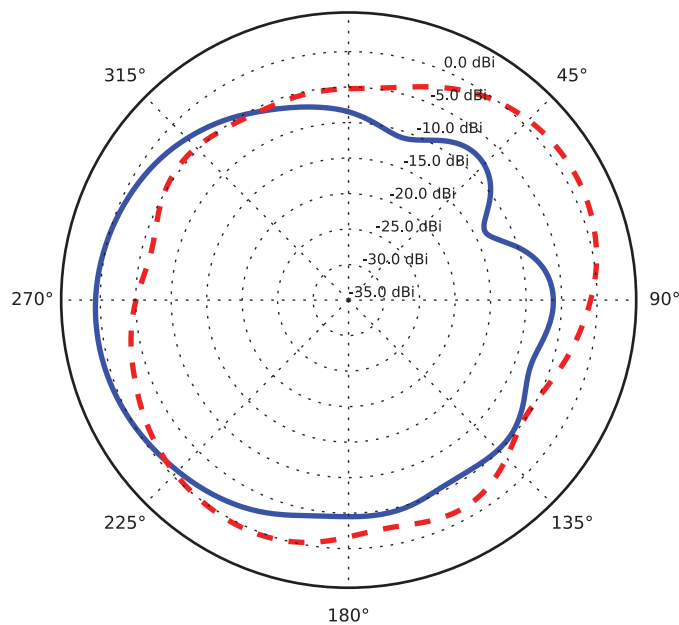
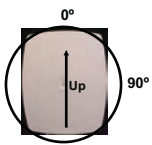
Appendix A: LTE Antenna Patterns

LTE Band 2

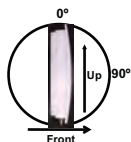
Frequency: 1960 MHz. Peak Gain: 3.21 Dbi.



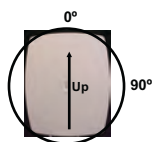
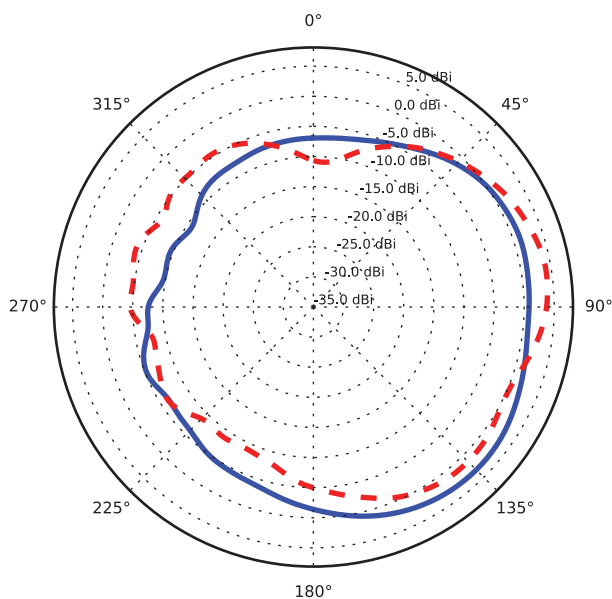
Frequency: 1960 MHz. Peak Gain: 1.50 Dbi.



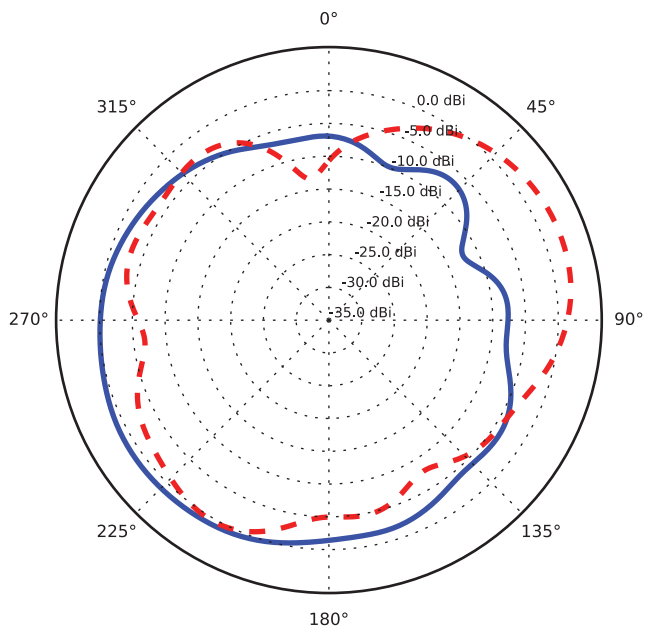
LTE Band 4



Frequency: 2145 MHz. Peak Gain: 4.10 Dbi.



Frequency: 2145 MHz. Peak Gain: 2.63 Dbi.



LTE Band 13

