

## CMM4 (Cabinet with switch)

Designed to deliver consistent and reliable wireless broadband service, the PMP/PTP system gracefully scales to support large deployments. The cluster management module is the heart of the system's synchronization capability which allows network operators to re-use frequencies and add capacity while ensuring consistency in the quality of service to customers. As a result, subscribers can experience carrier-grade service even at the outer edge of the network.

**Figure 42** CMM4 (Cabinet with switch)



## CMM4 (Cabinet without switch)

This CMM includes all the functionality listed above but there is no switch. This provides the network operator the flexibility to use the switch of their choice with the power and synchronization capabilities of the CMM4.

## CMM3/CMMmicro

The CMM3 or CMMmicro (Cluster Management Module micro) provides power, GPS timing, and networking connections for an AP cluster. The CMM3 is configurable through a web interface.

The CMM3 contains an 8-port managed switch that supports Power over Ethernet (PoE – this is Cambium PoE, not the standard PoE) on each port and connects any combination of APs, BHMs, BHSs, or Ethernet feed. The Cambium fixed wireless broadband IP networks PoE *differs from* IEEE Standard 803.3af PoE, and the two should not be intermixed. The CMM3 can auto-negotiate speed to match inputs that are either 100Base-TX or 10Base-T, and either full duplex or half duplex, where the connected device is set to auto-negotiate. Alternatively, these parameters are settable.

A CMM3 requires only one cable, terminating in an RJ-45 connector, for each connected module to distribute

- Ethernet signaling.
- power to as many as 8 co-located modules—APs, BHMs, or BHSs. Through a browser interface to the managed switch, ports can be powered or not.
- sync to APs and BHMs. The CMM3 receives 1-pulse per second timing information from Global Positioning System (GPS) satellites through an antenna (included) and passes the timing pulse embedded in the 24-V power to the connected modules.

GPS status information is available at the CMM3, however

- CMM3 provides time and date information to BHMs and APs if both the CMMmicro is operating on CMMmicro Release 2.1 or later and the AP/BHM is operating on System Release 4.2 or later. See [Configuring time settings](#) on Page 7-18.
- CMM3 *does not* provide time and date information to BHMs and APs if either the CMM3 is operating on a release earlier than CMMmicro Release 2.1 or the AP/BHM is operating on a release earlier than System Release 4.2.

A CMM3/CMMicro is shown in [Figure 43](#) and [Figure 44](#).

**Figure 43** CMM3**Figure 44** Pole mounted CMM3**Note**

A CMM3 cannot be used to power up a 450i or 450m Series ODUs.

# Installing a GPS receiver

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To install a GPS receiver as the timing reference source, use the following procedures:

- [Mounting the GPS receiver](#) on page 2-69
- [Cabling the GPS Antenna](#) on page 2-70
- [Installing and connecting the GPS LPU](#) on page 2-70

**Caution**

Prior to power-up of equipment, ensure that all cables are connected to the correct interfaces of the CMM4 unit and the UGPS receiver module. Failure to do so may result in damage to the equipment.

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## GPS receiver location

Mount the GPS receiver at a location that meets the following requirements:

- It must be possible to protect the installation as described in [Grounding and lightning protection](#) on page 3-8.
- It must have an un-interrupted view of at least half of the southern (resp. northern) sky in the northern (resp. southern) hemisphere. For a receiver mounted on a wall there must be no other significant obstructions in the view of the sky.
- It must be mounted at least 1 m (3 ft), preferably 2 m (6 ft), away from other GPS receiving equipment.
- It must not be sited in the field of radiation of co-located radio communications equipment and should be positioned at a distance of at least 3 m (10 ft) away.

Mount the UGPS receiver on the wall of the equipment building if there is a suitable location on the wall that can meet these requirements.

**Caution**

The GPS receiver is not approved for operation in locations where gas hazards exist, as defined by HAZLOC (USA) and ATEX (Europe).

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## Mounting the GPS receiver module on the equipment building

If mounting the GPS receiver on the equipment building ([Figure 49](#)), select a position on the wall that meets the following requirements:

- It must be below the roof height of the equipment building or below the height of any roof-mounted equipment (such as air conditioning plant).
- It must be below the lightning air terminals.
- It must not project more than 600mm (24 inches) from the wall of the building.

If these requirements cannot all be met, then the module must be mounted on a metal tower or mast.

## Mounting the GPS receiver module on a metal tower or mast

If mounting the GPS receiver module on a metal tower or mast ([Figure 50](#)), select a position that meets the following requirements:

- It must not be mounted any higher than is necessary to receive an adequate signal from four GPS satellites.
- It must be protected by a nearby lightning air terminal that projects farther out from the tower than the GPS receiver module.

## Mounting the GPS receiver

Mount the GPS receiver (following manufacturer's instructions) upon either an external wall ([Figure 49](#)) or a metal tower or mast ([Figure 50](#)).

**Figure 45** GPS antenna mounting



**Procedure 1** Mounting the GPS receiver

- 1 Ensure that the mounting position
  - has an unobstructed view of the sky to 20° above the horizon.
  - is not the highest object at the site. (The GPS antenna does not need to be particularly high on a site, which would give it more exposure to lightning. It just needs to have an unobstructed view of the sky.)
  - is not further than 100 feet (30.4 meters) of cable from the CMM.
- 2 Select a pole that has an outside diameter of 1.25 to 1.5 inches (3 to 4 cm) to which the GPS antenna bracket can be mounted.
- 3 Place the U-bolts (provided) around the pole as shown in [Figure 47](#).
- 4 Slide the GPS antenna bracket onto the U-bolts.
- 5 Slide the ring washers (provided) onto the U-bolts.
- 6 Slide the lock washers (provided) onto the U-bolts.
- 7 Use the nuts (provided) to securely fasten the bracket to the U-bolts.

Please refer to the *PMP Synchronization Solutions User Guide* located on the Cambium website (<http://www.cambiumnetworks.com/resource/pmp-synchronization-solutions> ).

## Cabling the GPS Antenna

Connect the GPS coax cable to the female N-connector on the GPS antenna. Please refer to the *PMP Synchronization Solutions User Guide* located on the Cambium website (<http://www.cambiumnetworks.com/resource/pmp-synchronization-solutions> ).

## Installing and connecting the GPS LPU

Install and ground the GPS drop cable LPU at the building (or cabinet) entry point, as described in [Install the bottom LPU](#) on page 6-24.

## Ordering the components

This section describes how to select components for 450m Series, 450i Series and 450 Series Greenfield network or 450m/450i Series network migration. It specifies Cambium part numbers for 450 Platform Family components.

Order PMP 450m Series, PMP/PTP 450i Series and PMP/PTP 450 Series ODUs from Cambium Networks.

### PMP 450m 5GHz

**Table 66** PMP 450m Series ODU part numbers

| Cambium description                                                | Cambium part number       |
|--------------------------------------------------------------------|---------------------------|
| <b>PMP 450m AP (Access Point)</b>                                  |                           |
| 3 GHz PMP 450m Integrated Access Point, 90 Degree                  | C030045A101A              |
| 3 GHz PMP 450m Integrated Access Point, 90 Degree (No Encryption)  | C030045A104A              |
| 3 GHz PMP 450m Integrated Access Point, 90 Degree, Limited         | C030045A111A<br>(Limited) |
| 3 GHz PMP 450m Integrated Access Point, 90 Degree (No Encryption), | C030045A114A<br>(Limited) |
| 5 GHz PMP 450m Integrated Access Point, 90 Degree (ROW)            | C050045A101A              |
| 5 GHz PMP 450m Integrated Access Point, 90 Degree (FCC)            | C050045A102A              |
| 5 GHz PMP 450m Integrated Access Point, 90 Degree (EU)             | C050045A103A              |
| 5 GHz PMP 450m Integrated Access Point, 90 Degree (DES Only)       | C050045A104A              |
| 5 GHz PMP 450m Integrated Access Point, 90 Degree (IC)             | C050045A105A              |

## PMP 450i

**Table 67** PMP 450i Series ODU part numbers

| Cambium description                                         | Cambium part number |
|-------------------------------------------------------------|---------------------|
| <b>PMP 450i AP (Access Point)</b>                           |                     |
| 900 MHz PMP 450i Connectorized Access Point                 | C009045A001A        |
| 3 GHz PMP 450i Connectorized Access Point                   | C030045A001A        |
| 3 GHz PMP 450i Integrated Access Point, 90 Degree           | C030045A002A        |
| 3 GHz PMP 450i Connectorized Access Point, DES Only         | C030045A003A        |
| 3 GHz PMP 450i Integrated Access Point, 90 Degree, DES Only | C030045A004A        |
| 5 GHz PMP 450i Connectorized Access Point (RoW)             | C050045A001A        |
| 5 GHz PMP 450i Connectorized Access Point (FCC)             | C050045A002A        |
| 5 GHz PMP 450i Connectorized Access Point (EU)              | C050045A003A        |
| 5 GHz PMP 450i Connectorized Access Point (DES Only)        | C050045A004A        |
| 5 GHz PMP 450i Connectorized Access Point (IC)              | C050045A015A        |
| 5 GHz PMP 450i AP, Integrated 90°sector antenna (RoW)       | C050045A005A        |
| 5 GHz PMP 450i AP, Integrated 90°sector antenna (FCC)       | C050045A006A        |
| 5 GHz PMP 450i Integrated Access Point, 90 degree (EU)      | C050045A007A        |
| 5 GHz PMP 450i AP, Integrated 90°sector antenna (DES only)  | C050045A008A        |
| 5 GHz PMP 450i AP, Integrated 90°sector antenna (IC)        | C050045A016A        |
| <b>PMP 450i SM (Subscriber Module)</b>                      |                     |
| 3 GHz PMP 450i Connectorized Subscriber Module              | C030045C001A        |
| 3 GHz PMP 450i SM, Integrated High Gain Antenna             | C030045C002A        |
| 5 GHz PMP 450i Connectorized Subscriber Module              | C050045C001A        |
| 5 GHz PMP 450i SM, Integrated High Gain Antenna             | C050045C002A        |



### Note

The 450i SM does not have license keys.



**Table 68** PMP 450i ATEX/HAZLOC ODU models/part numbers

| ODU model /<br>part number | Description                                                               |
|----------------------------|---------------------------------------------------------------------------|
| <b>ODU model</b>           |                                                                           |
| 5085CHH                    | 450i Connectorized ATEX/HAZLOC                                            |
| 5085HH                     | 450i Integrated 90 Deg Sector ATEX/HAZLOC                                 |
| 5095HH                     | 450i Integrated High Gain Directional ATEX/HAZLOC                         |
| <b>Part Number</b>         |                                                                           |
| C050045A009A               | 5 GHz PMP 450i Conn Access Point (ROW), ATEX/HAZLOC                       |
| C050045A010A               | 5 GHz PMP 450i Conn Access Point (FCC), ATEX/HAZLOC                       |
| C050045A011A               | 5 GHz PMP 450i Conn Access Point (EU), ATEX/HAZLOC                        |
| C050045A012A               | 5 GHz PMP 450i Integrated Access Point, 90 degree (ROW), ATEX/HAZLOC      |
| C050045A013A               | 5 GHz PMP 450i Integrated Access Point, 90 degree (FCC), ATEX/HAZLOC      |
| C050045A014A               | 5 GHz PMP 450i Integrated Access Point, 90 degree (EU), ATEX/HAZLOC       |
| C050045A017A               | 5 GHz PMP 450i Conn Access Point (IC), ATEX/HAZLOC                        |
| C050045A018A               | 5 GHz PMP 450i Integrated Access Point, 90 degree (IC), ATEX/HAZLOC       |
| C050045A019A               | 5 GHz PMP 450i Conn Access Point (DES Only), ATEX/HAZLOC                  |
| C050045A020A               | 5 GHz PMP 450i Integrated Access Point, 90 degree (DES Only), ATEX/HAZLOC |
| C050045C003A               | 5 GHz PMP 450i Conn Subscriber Module, ATEX/HAZLOC                        |
| C050045C004A               | 5 GHz PMP 450i Integrated High Gain Antenna, ATEX/HAZLOC                  |

## PTP 450i

**Table 69** PTP 450i Series ODU part numbers

| Cambium description                                               | Cambium part number |
|-------------------------------------------------------------------|---------------------|
| 3 GHz PTP 450i END, Connectorized                                 | C030045B001A        |
| 3 GHz PTP 450i END, Integrated High Gain Antenna                  | C030045B002A        |
| 3 GHz PTP 450i END, Connectorized (DES only)                      | C030045B003A        |
| 3 GHz PTP 450i END, Integrated Access Point, 90 degree (DES only) | C035045B004A        |
| 5 GHz PTP 450i END, Connectorized (RoW)                           | C050045B001A        |
| 5 GHz PTP 450i END, Connectorized (FCC)                           | C050045B003A        |

| Cambium description                                         | Cambium part number |
|-------------------------------------------------------------|---------------------|
| 5 GHz PTP 450i END, Connectorized (EU)                      | C050045B005A        |
| 5 GHz PTP 450i END, Connectorized (DES only)                | C050045B007A        |
| 5 GHz PTP 450i END, Connectorized (IC)                      | C050045B015A        |
| 5 GHz PTP 450i END, Integrated High Gain Antenna (RoW)      | C050045B002A        |
| 5 GHz PTP 450i END, Integrated High Gain Antenna (FCC)      | C050045B004A        |
| 5 GHz PTP 450i END, Integrated High Gain Antenna (EU)       | C050045B006A        |
| 5 GHz PTP 450i END, Integrated High Gain Antenna (DES only) | C050045B008A        |
| 5 GHz PTP 450i END, Integrated High Gain Antenna (IC)       | C050045B016A        |
| Ethernet cable adapter for CMM4                             | N000045L001A        |

**Table 70** PTP 450i ATEX/HAZLOC ODU models/part numbers

| ODU model /<br>part number | Description                                                                 |
|----------------------------|-----------------------------------------------------------------------------|
| <b>ODU model</b>           |                                                                             |
| 5085CHH                    | 450i Connectorized ATEX/HAZLOC                                              |
| 5085HH                     | 450i Integrated 90 Deg Sector ATEX/HAZLOC                                   |
| 5095HH                     | 450i Integrated High Gain Directional ATEX/HAZLOC                           |
| C050045B009A               | 5 GHz PTP 450i END, Connectorized (ROW), ATEX/HAZLOC                        |
| C050045B010A               | 5 GHz PTP 450i END, Integrated High Gain Antenna (ROW), ATEX/HAZLOC         |
| C050045B011A               | 5 GHz PTP 450i END, Connectorized (FCC), ATEX/HAZLOC                        |
| C050045B012A               | 5 GHz PTP 450i END, Integrated High Gain Antenna (FCC), ATEX/HAZLOC         |
| C050045B013A               | 5 GHz PTP 450i END, Connectorized (EU), ATEX/HAZLOC                         |
| C050045B014A               | 5 GHz PTP 450i END, Integrated High Gain Antenna (EU), ATEX/HAZLOC          |
| C050045B017A               | 5 GHz PTP 450i END, Connectorized (IC), ATEX/HAZLOC                         |
| C050045B018A               | 5 GHz PTP 450i END, Integrated High Gain Antenna (IC), ATEX/HAZLOC          |
| C050045B019A               | 5 GHz PTP 450i END, Connectorized (DES Only), ATEX/HAZLOC                   |
| C050045B020A               | 5 GHz PTP 450i END, Integrated High Gain Antenna (DES Only),<br>ATEX/HAZLOC |

## PMP 450b

**Table 71** PMP 450b Series ODU part numbers

| Cambium description                    | Cambium part number |
|----------------------------------------|---------------------|
| <b>PMP 450b SM (Subscriber Module)</b> |                     |
| 5 GHz 450b Mid-Gain WB SM              | C050045C011A        |
| 5 GHz 450b High Gain WB SM             | C050045C012A        |

## PTP 450b

**Table 72** PTP 450b Series ODU part numbers

| Cambium description                    | Cambium part number |
|----------------------------------------|---------------------|
| <b>PTP 450b SM (Subscriber Module)</b> |                     |
| 5 GHz 450b - Mid-Gain – ROW            | C050045B031A        |
| 5 GHz 450b - Mid-Gain – FCC            | C050045B032A        |
| 5 GHz 450b - Mid-Gain – ISSED          | C050045B033A        |
| 5 GHz 450b - Mid-Gain – EU             | C050045B034A        |
| 5 GHz 450b - Mid-Gain – No Encryption  | C050045B035A        |
| 5 GHz 450b - High Gain – ROW           | C050045B021A        |
| 5 GHz 450b - High Gain – FCC           | C050045B022A        |
| 5 GHz 450b - High Gain – ISSED         | C050045B023A        |
| 5 GHz 450b - High Gain – EU            | C050045B024A        |
| 5 GHz 450b - High Gain – No Encryption | C050045B025A        |
| 5 GHz 450b, 50 Mbps – High Gain – ROW  | C050045B051A        |
| 5 GHz 450b - High Gain – Eolo          | C050045B029A        |

## PMP 450

**Table 73** PMP 450 Series ODU part numbers

| Cambium description                                         | Cambium part number |
|-------------------------------------------------------------|---------------------|
| <b>PMP 450 AP (Access Point)</b>                            |                     |
| 2.4 GHz PMP 450 Connectorized Access Point                  | C024045A001A        |
| 2.4 GHz PMP 450 Connectorized Access Point (DES)            | C024045A003A        |
| 3.5 GHz PMP 450 Connectorized Access Point                  | C035045A001A        |
| 3.5 GHz PMP 450 Connectorized Access Point (DES)            | C035045A003A        |
| 3.6 GHz PMP 450 Connectorized Access Point                  | C036045A001A        |
| 3.6 GHz PMP 450 Connectorized Access Point (DES)            | C036045A003A        |
| 5 GHz PMP 450 Connectorized Access Point                    | C054045A001A        |
| 5 GHz PMP 450 Connectorized Access Point (US only)          | C054045A002A        |
| 5 GHz PMP 450 Connectorized Access Point (DES)              | C054045A003A        |
| <b>PMP 450 AP Lite</b>                                      |                     |
| 2.4 GHz PMP 450 Connectorized Access Point - Lite           | C024045A011A        |
| 3.3-3.6 GHz PMP 450 Connectorized Access Point - Lite       | C035045A011A        |
| 3.55-3.8 GHz PMP 450 Connectorized Access Point - Lite      | C036045A011A        |
| 5 GHz PMP 450 Connectorized Access Point - Lite             | C054045A011A        |
| 5 GHz PMP 450 Connectorized Access Point (FCC) - Lite       | C054045A012A        |
| <b>PMP 450 SM (Subscriber Module)</b>                       |                     |
| 900 MHz PMP 450 Connectorized Subscriber Module             | C009045C001A        |
| 2.4 GHz PMP 450 Subscriber Module, 4 Mbps                   | C024045C001A        |
| 2.4 GHz PMP 450 Subscriber Module, 10 Mbps                  | C024045C002A        |
| 2.4 GHz PMP 450 Subscriber Module, 20 Mbps                  | C024045C003A        |
| 2.4 GHz PMP 450 Subscriber Module, Uncapped                 | C024045C004A        |
| 2.4 GHz PMP 450 Connectorized Subscriber Module, 4 Mbps     | C024045C005A        |
| 2.4 GHz PMP 450 Connectorized Subscriber Module, 10 Mbps    | C024045C006A        |
| 2.4 GHz PMP 450 Connectorized Subscriber Module, 20 Mbps    | C024045C007A        |
| 2.4 GHz PMP 450 Connectorized Subscriber Module, Uncapped   | C024045C008A        |
| 3.5 GHz PMP 450 High Gain Directional Integrated Subscriber | C035045C014A        |
| 3.5 GHz PMP 450 Subscriber Module, 4 Mbps                   | C035045C001A        |

| Cambium description                                         | Cambium part number |
|-------------------------------------------------------------|---------------------|
| 3.5 GHz PMP 450 Subscriber Module, 10 Mbps                  | C035045C002A        |
| 3.5 GHz PMP 450 Subscriber Module, 20 Mbps                  | C035045C003A        |
| 3.5 GHz PMP 450 Subscriber Module, Uncapped                 | C035045C004A        |
| 3.5 GHz PMP 450 Connectorized Subscriber Module, 4 Mbps     | C035045C005A        |
| 3.5 GHz PMP 450 Connectorized Subscriber Module, 10 Mbps    | C035045C006A        |
| 3.5 GHz PMP 450 Connectorized Subscriber Module, 20 Mbps    | C035045C007A        |
| 3.5 GHz PMP 450 Connectorized Subscriber Module, Uncapped   | C035045C008A        |
| 3.6 GHz PMP 450 High Gain Directional Integrated Subscriber | C036045C014A        |
| 3.6 GHz PMP 450 Subscriber Module, 4 Mbps                   | C036045C001A        |
| 3.6 GHz PMP 450 Subscriber Module, 10 Mbps                  | C036045C002A        |
| 3.6 GHz PMP 450 Subscriber Module, 20 Mbps                  | C036045C003A        |
| 3.6 GHz PMP 450 Subscriber Module, Uncapped                 | C036045C004A        |
| 3.6 GHz PMP 450 Connectorized Subscriber Module, 4 Mbps     | C036045C005A        |
| 3.6 GHz PMP 450 Connectorized Subscriber Module, 10 Mbps    | C036045C006A        |
| 3.6 GHz PMP 450 Connectorized Subscriber Module, 20 Mbps    | C036045C007A        |
| 3.6 GHz PMP 450 Connectorized Subscriber Module, Uncapped   | C036045C008A        |
| 5 GHz PMP 450 Connectorized Subscriber Module, 4 Mbps       | C054045C005A        |
| 5 GHz PMP 450 Connectorized Subscriber Module, 10 Mbps      | C054045C006A        |
| 5 GHz PMP 450 Connectorized Subscriber Module, 20 Mbps      | C054045C007A        |
| 5 GHz PMP 450 Connectorized Subscriber Module, Uncapped     | C054045C008A        |
| 5 GHz PMP 450 Integrated Subscriber Module, 4 Mbps          | C054045C001B        |
| 5 GHz PMP 450 Integrated Subscriber Module, 10 Mbps         | C054045C002B        |
| 5 GHz PMP 450 Integrated Subscriber Module, 20 Mbps         | C054045C003B        |
| 5 GHz PMP 450 Integrated Subscriber Module, Uncapped        | C054045C004B        |
| 5 GHz PMP 450 Connectorized Subscriber Module, 4 Mbps       | C054045C005B        |
| 5 GHz PMP 450 Connectorized Subscriber Module, 10 Mbps      | C054045C006B        |
| 5 GHz PMP 450 Connectorized Subscriber Module, 20 Mbps      | C054045C007B        |
| 5 GHz PMP 450 Connectorized Subscriber Module, Uncapped     | C054045C008B        |
| 5 GHz PMP 450d Subscriber Module, 20 Mbps – 4-pack          | C054045H013B        |
| 5 GHz PMP 450d Subscriber Module, Uncapped – 4-pack         | C054045H014B        |

## PTP 450

**Table 74** PTP 450 Series ODU part numbers

| Cambium description                                | Cambium part number |
|----------------------------------------------------|---------------------|
| PTP 450 900 MHz END – Connectorized                | C009045B001A        |
| PTP 450 3.5 GHz END – Integrated                   | C035045B001A        |
| PTP 450 3.5 GHz END – Connectorized                | C035045B002A        |
| PTP 450 3.5 GHz END – Integrated – DES Only        | C035045B003A        |
| PTP 450 3.5 GHz END – Connectorized – DES Only     | C035045B004A        |
| PTP 450 3.65 GHz END – Integrated                  | C036045B001A        |
| PTP 450 3.65 GHz END – Connectorized               | C036045B002A        |
| PTP 450 3.65 GHz END – Integrated – DES Only       | C036045B003A        |
| PTP 450 3.65 GHz END – Connectorized – DES Only    | C036045B004A        |
| PTP 450 5 GHz END – Integrated (ROW)               | C054045B001A        |
| PTP 450 5 GHz END – Connectorized (ROW)            | C054045B002A        |
| PTP 450 5 GHz END – Integrated (ROW) – DES Only    | C054045B003A        |
| PTP 450 5 GHz END – Connectorized (ROW) – DES Only | C054045B004A        |
| PTP 450 5 GHz END – Integrated (FCC)               | C054045B005A        |
| PTP 450 5 GHz END – Connectorized (FCC)            | C054045B006A        |

## PMP/PTP 450/450i Series Accessories

**Table 75** PMP/PTP 450/450i Series Accessories

| Cambium description                                         | Cambium part number |
|-------------------------------------------------------------|---------------------|
| <b>PMP 450 AP Antenna Options</b>                           |                     |
| 900 MHz 65 degree Sector Antenna (Dual Slant)               | N009045D001A        |
| 900 MHz 12 dBi gain directional antenna (Dual Slant)        | N009045D003A        |
| 2.4 GHz Dual Slant Antenna for 60 Degree Sector             | C024045D601A        |
| 3.5 GHz and 3.6 GHz Dual Slant Antenna for 90 Degree Sector | C030045D901A        |
| 5 GHz Antenna for 60 Degree Sector                          | 85009325001         |
| 5 GHz Antenna for 90 Degree Sector                          | 85009324001         |
| N-type to N-type cable (16 inch length)                     | 30009406002         |

| Cambium description                              | Cambium part number |
|--------------------------------------------------|---------------------|
| <b>Power supplies</b>                            |                     |
| Power supply, 60 W, 56 V with Gbps support       | N000065L001B        |
| AC+DC Enhanced Power Injector                    | C000065L002C        |
| Line Cord, Fig 8 – US                            | N000065L003A        |
| Line Cord, Fig 8 – UK                            | N000065L004A        |
| Line Cord, Fig 8 – EU                            | N000065L005A        |
| Power over Ethernet midspan, 60 W, -48 VDC Input | N000000L036A        |
| Power Supply, 30 W, 56 V – Gbps support          | N000000L034A        |
| Gigabit Enet Capable Power Supply - 30VDC, 15W   | N000900L001A        |
| Cable, UL Power Supply Cord Set, US              | N000900L007A        |
| Cable, UL Power Supply Cord Set, EU              | N000900L008A        |
| Cable, UL Power Supply Cord Set, UK              | N000900L009A        |
| <b>AP Optional Equipment</b>                     |                     |
| CMM MICRO (Outdoor Enclosure) (450 only)         | 1070CKHH            |
| CMM5 Controller                                  | C000000L500A        |
| CMM5 Power and Sync Injector 56V                 | C000000L556A        |
| UGPS                                             | 1096H               |
| CMM5 Power Supply, AC, 56V 240W                  | N000000L054B        |
| CMM5 Power Supply AC, 48V, 640W                  | N000000L101A        |
| CMM5 Spare Controller Cable – 1m                 | N000000L102A        |
| CMM5 to UGPS Shielded Cable (20 meter)           | N000000L103A        |
| CMM5 Spare DC Power Connector (10 pack)          | N000000L104A        |
| CMM4 W/RUGGEDIZED Switch and GPS                 | 1090CKHH            |
| CMM4 NO Switch                                   | 1091HH              |
| CMM4 Rack Mount Assembly                         | 1092HH              |
| Ethernet cable adapter for CMM4                  | N000045L001A        |
| Universal GPS Module                             | 1096H               |
| RJ-45 Gland Spare – PG16 style (QTY 10)          | N000065L033A        |
| Blanking Plug Pack (Qty 10)                      | N000065L036A        |
| <b>SM Optional Equipment</b>                     |                     |

| Cambium description                               | Cambium part number |
|---------------------------------------------------|---------------------|
| Power Supply, 30 W, 56 V – Gbps support           | N000000L034A        |
| Gigabit Enet Capable Power Supply – 30 VDC, 15 W  | N000900L001A        |
| Cable, UL Power Supply Cord Set, US               | N000900L007A        |
| Cable, UL Power Supply Cord Set, EU               | N000900L008A        |
| Cable, UL Power Supply Cord Set, UK               | N000900L009A        |
| 53CM Offset, Reflector Dish Kit, 4PK              | HK2022A             |
| Alignment Tool Headset                            | ACATHS-01A          |
| <b>Accessories</b>                                |                     |
| Surge Suppressor (30 VDC)                         | 600SSH              |
| Gigabit Surge Suppressor (56 VDC)                 | C000000L033A        |
| LPU and Grounding Kit (1 kit per ODU)             | C000065L007B        |
| Single Mode Optical SFP Interface per ODU         | C000065L008A        |
| Multimode Kit                                     | C000065L009A        |
| 50 Ohm Braided Coaxial Cable - 75 meter           | 30010194001         |
| 50 Ohm Braided Coaxial Cable - 500 meter          | 30010195001         |
| RF Connector, N, Male, Straight for CNT-400 Cable | 09010091001         |
| Tyco/AMP, Mod Plug RJ45, 100 pack                 | WB3177              |
| Tyco/AMP Crimp Tool                               | WB3211              |
| RJ-45 Spare Grounding Gland - PG16 size (Qty. 10) | N000065L033         |
| DC LPU and Grounding Kit                          | C000000L114A        |
| <b>Mounting brackets</b>                          |                     |
| Tilt Bracket Assembly                             | N000045L002A        |
| Mounting Bracket (Integrated)                     | N000065L031A        |
| Mounting Bracket (Connectorized)                  | N000065L032A        |
| <b>Upgrade Keys</b>                               |                     |
| PMP 450 4 To 10 Mbps Upgrade Key                  | C000045K002A        |
| PMP 450 4 To 20 Mbps Upgrade Key                  | C000045K003A        |
| PMP 450 4 To Uncapped Upgrade Key                 | C000045K004A        |
| PMP 450 10 To 20 Mbps Upgrade Key                 | C000045K005A        |
| PMP 450 10 To Uncapped MBPS Upgrade Key           | C000045K006A        |



| Cambium description                                       | Cambium part number |
|-----------------------------------------------------------|---------------------|
| PMP 450 20 To Uncapped MBPS Upgrade Key                   | C000045K007A        |
| PMP 450 Lite AP to Full AP Upgrade Key                    | C000045K008A        |
| <b>Extended Warranty</b>                                  |                     |
| PMP 450 Platform AP Extended Warranty, 1 Additional Year  | SG00TS4009A         |
| PMP 450 Platform AP Extended Warranty, 2 Additional Years | SG00TS4017A         |
| PMP 450 Platform AP Extended Warranty, 4 Additional Years | SG00TS4025A         |
| PMP 450 Platform SM Extended Warranty, 1 Additional Year  | SG00TS4010A         |
| PMP 450 Platform SM Extended Warranty, 2 Additional Years | SG00TS4018A         |
| PMP 450 Platform SM Extended Warranty, 4 Additional Years | SG00TS4026A         |

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## Chapter 3: System planning

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This chapter provides information to help the user to plan a PMP/PTP 450 Platform link.

The following topics are described in this chapter:

- [Typical deployment](#) on page [3-2](#) contains diagrams illustrating typical PMP/PTP 450 Platform site deployments.
- [Site planning](#) on page [3-7](#) describes factors to be considered when planning the proposed link end sites, including grounding, lightning protection and equipment location.
- [Radio Frequency planning](#) on page [3-17](#) describes how to plan PMP/PTP 450 Platform links to conform to the regulatory restrictions that apply in the country of operation.
- [Link planning](#) on page [3-27](#) describes factors to be taken into account when planning links, such as range, path loss and throughput.
- [Planning for connectorized units](#) on page [3-30](#) describes factors to be taken into account when planning to use connectorized ODUs with external antennas in PMP/PTP 450 Platform links.
- [Data network planning](#) on page [3-32](#) describes factors to be considered when planning PMP/PTP 450 Platform data networks.
- [Network management planning](#) on page [3-40](#) describes how to plan for PMP/PTP 450 Platform links to be managed remotely using SNMP.
- [Security planning](#) on page [3-41](#) describes how to plan for PMP/PTP 450 Platform links to operate in secure mode.
- [Remote AP Deployment](#) on page [3-51](#) describes how to deploy Remote AP.

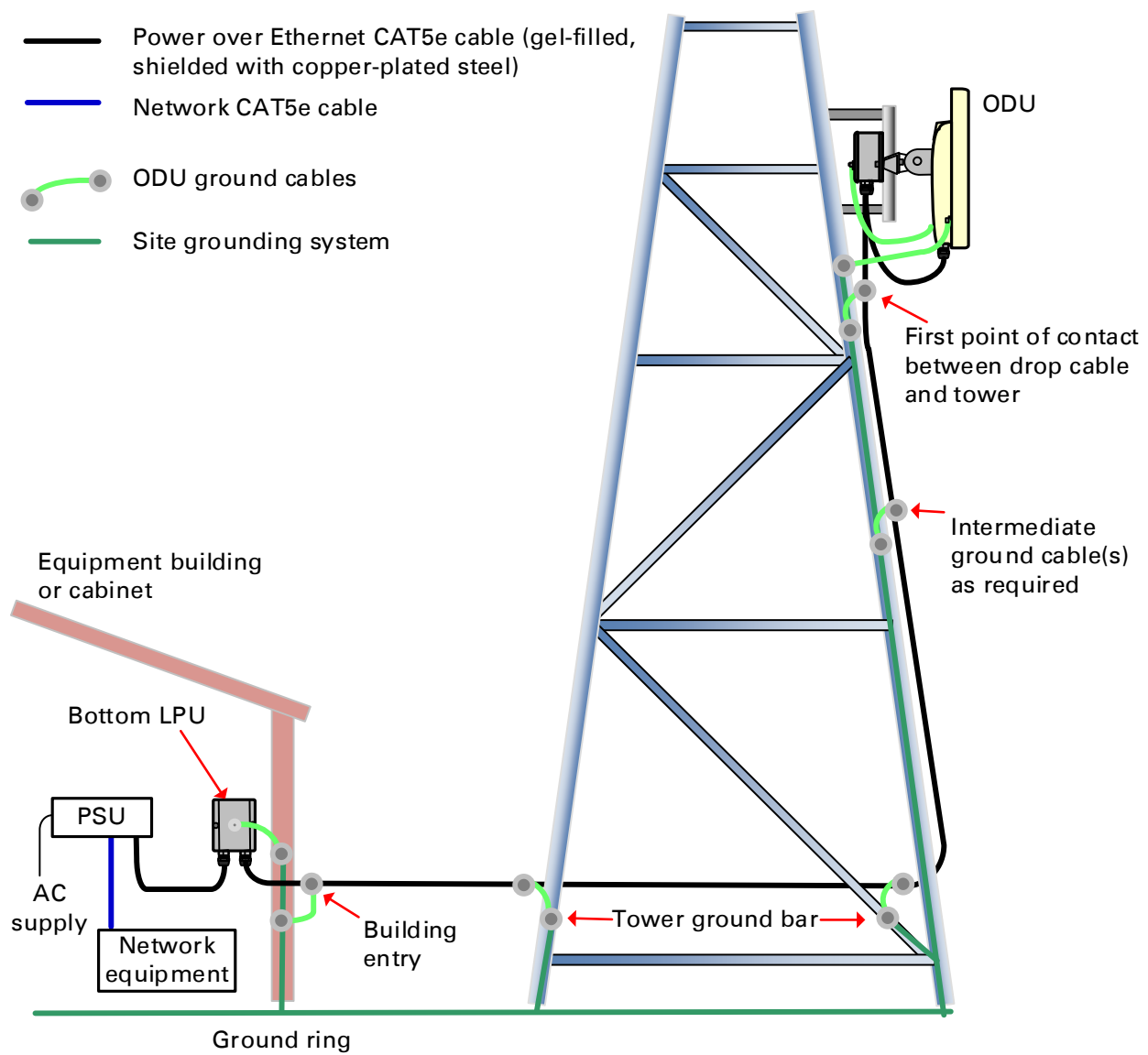
# Typical deployment

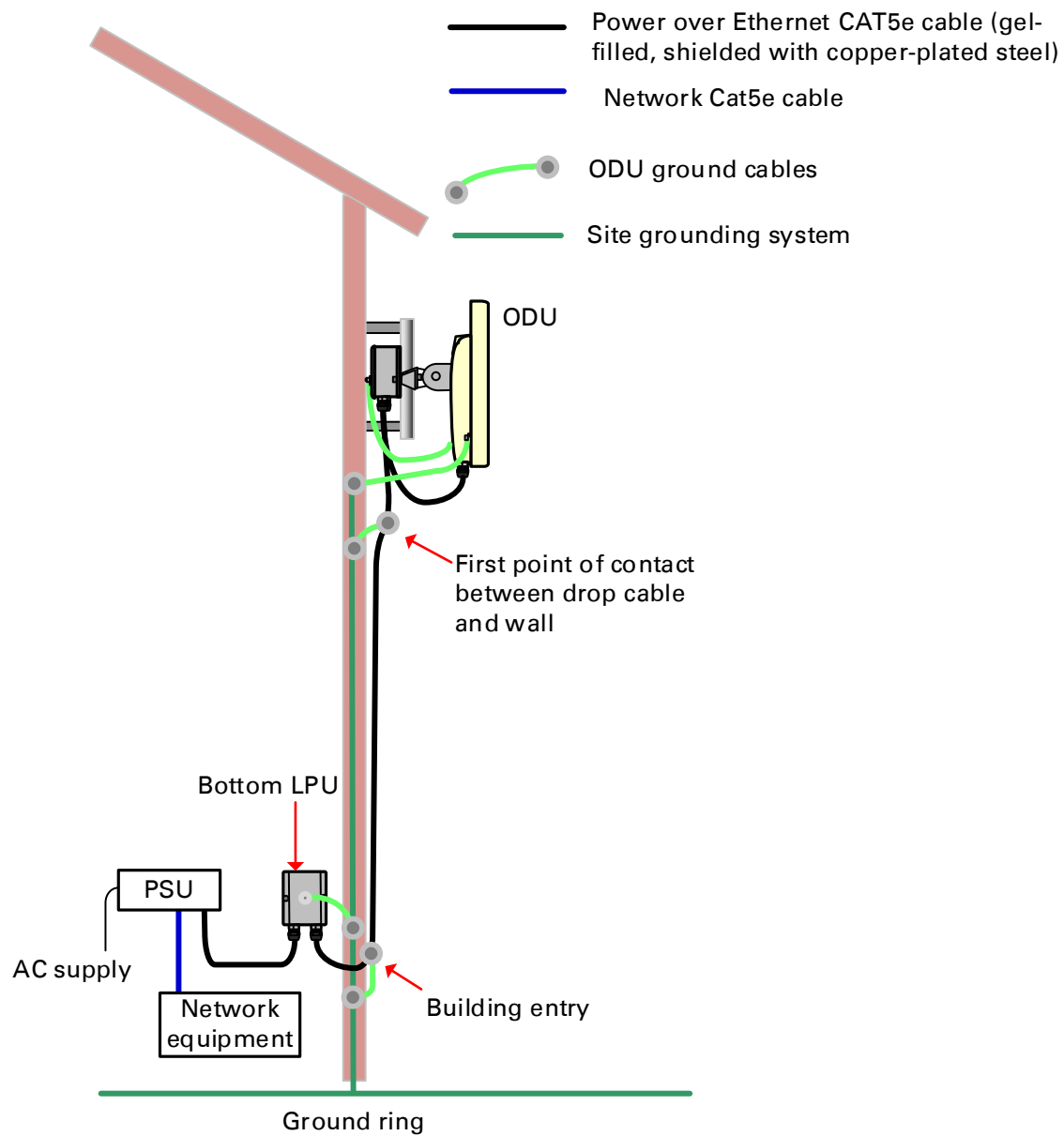
This section contains diagrams illustrating typical PMP/PTP 450 Platform site deployments.

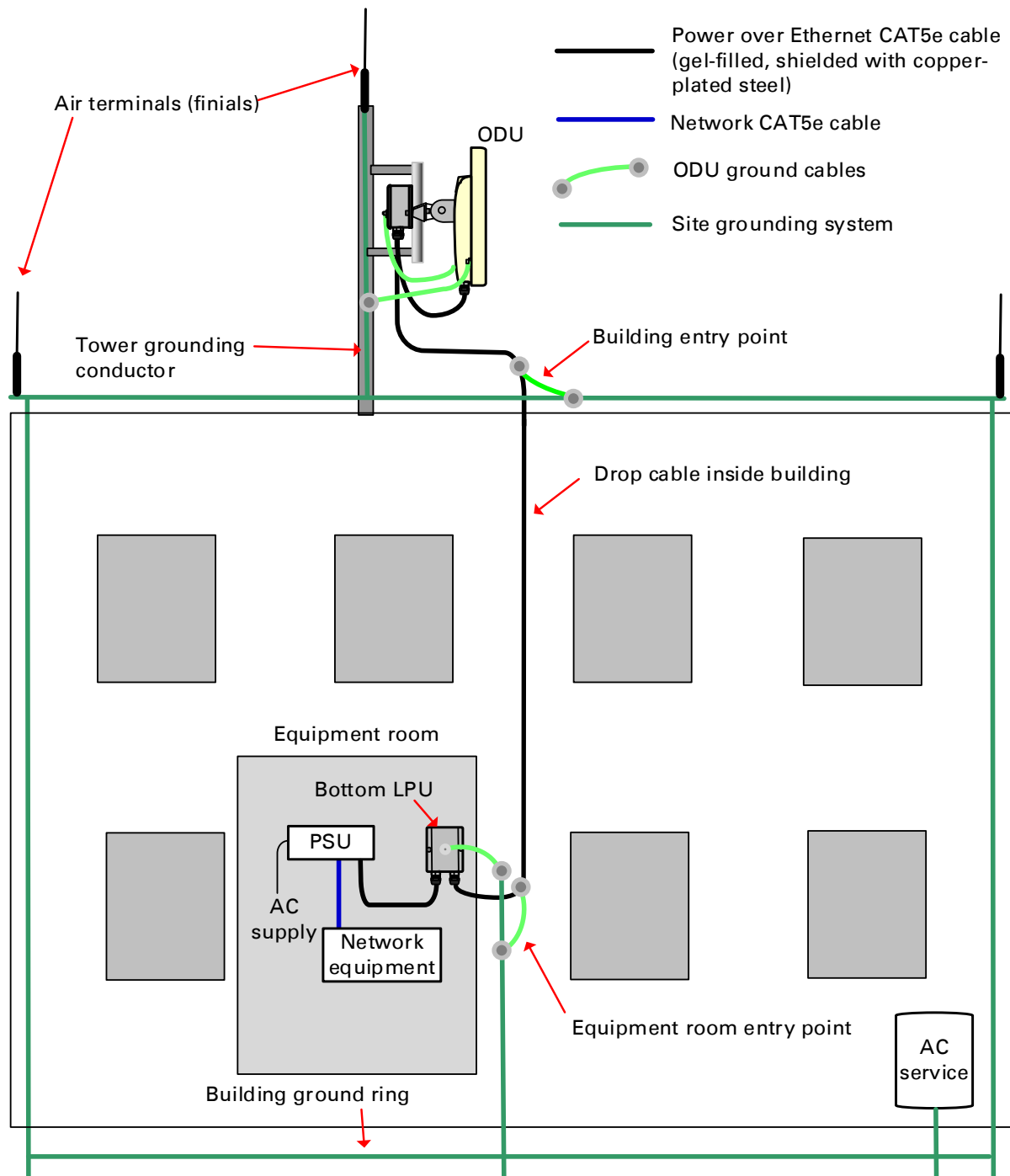
## ODU with PoE interface to PSU

In the basic configuration, there is only one Ethernet interface, a copper cable for Power over Ethernet (PoE) from the PSU to the ODU (PSU port), as shown in the following diagrams: mast or tower installation ([Figure 46](#)), wall installation ([Figure 47](#)) and roof installation ([Figure 48](#)).

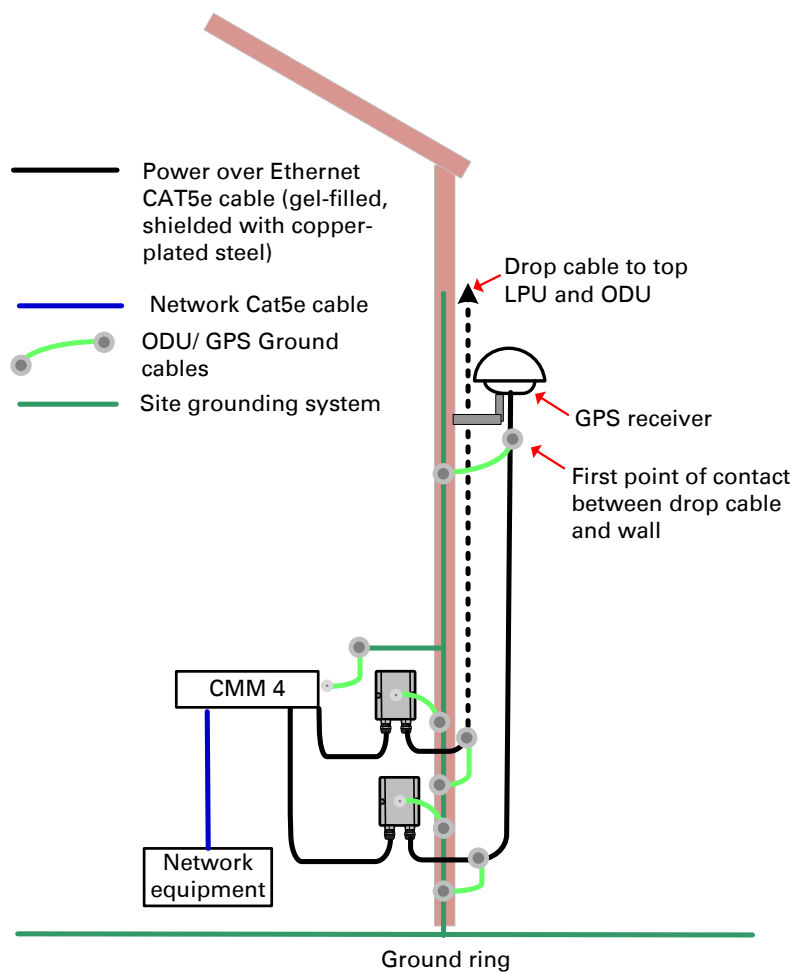
**Figure 46** Mast or tower installation

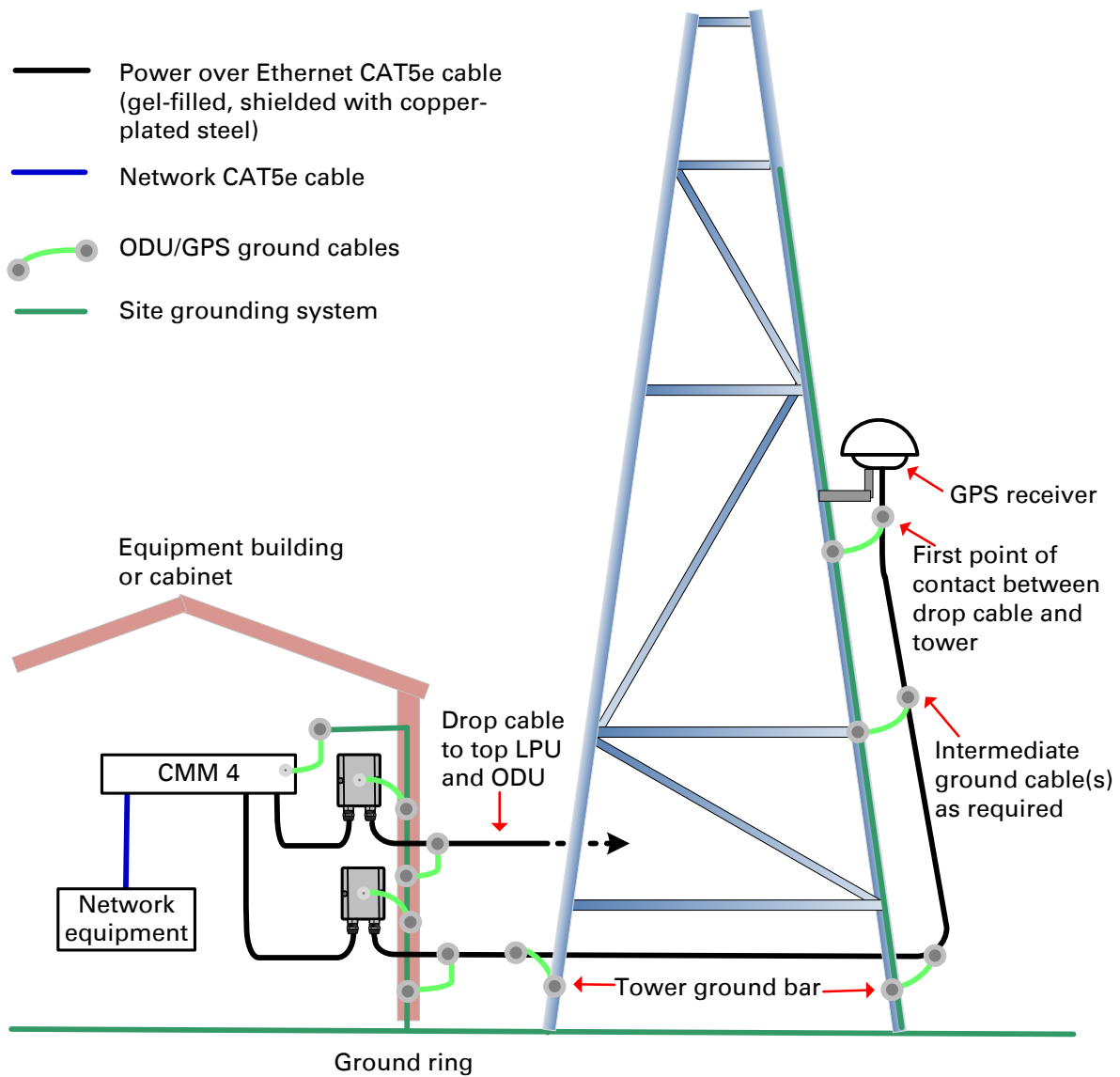


**Figure 47** Wall installation

**Figure 48** Roof installation

**Figure 49** GPS receiver wall installation



**Figure 50** GPS receiver tower or mast installation

# Site planning

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This section describes factors to be considered when choosing sites for PMP or PTP radios, power supplies, CMM4 (if applicable) and UGPS (if applicable).

## Site selection for PMP/PTP radios

When selecting a site for the ODU, consider the following factors:

- Height and location to ensure that people are kept away from the antenna; see Calculated distances and power compliance margins on page 4-25.
- Height and location to achieve the best radio path.
- Indoor location where the power supply LED indicators will be visible, so the drop cable length will not exceed the maximum recommended length; see [Power supply site selection](#) on page 3-8.
- Ability to meet the requirements specified in [Grounding and lightning protection](#) on page 3-8.
- Aesthetics and planning permission issues.
- Cable lengths; see [Ethernet standards and cable lengths](#) on page 2-38.
- The effect of strong winds on the installation; see [ODU wind loading](#) on page 3-11.



## Power supply site selection

When selecting a site for the ODU power supply, consider the following factors:

- Indoor location with no possibility of condensation, flooding or high humidity.
- Availability of a mains electricity supply.
- Located in an environment where it is not likely to exceed its operational temperature rating, allowing for natural convection cooling.
- Accessibility for viewing status indicator LED and connecting Ethernet cables.
- Cable lengths; see [Ethernet standards and cable lengths](#) on page 2-38.

## Maximum cable lengths

When installing PMP/PTP 450i Series ODU, the maximum permitted length of the shielded copper Ethernet interface cable is 330 feet (100m) from AP/BHM/SM/BHS to their associated power supplies or CMM4.

When installing PMP 450m Series ODU, the maximum permitted length of the shielded copper Ethernet interface cable is 330 feet (100m) from ODU to the network interface equipment.

The 3GHz PMP 450M ODU can use a 1.0mm<sup>2</sup>, 984.25 feet (300m) power cable.

## Grounding and lightning protection



### Warning

Electro-magnetic discharge (lightning) damage is not covered under warranty. The recommendations in this guide, when followed correctly, give the user the best protection from the harmful effects of EMD. However, 100% protection is neither implied nor possible.

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Structures, equipment and people must be protected against power surges (typically caused by lightning) by conducting the surge current to ground via a separate preferential solid path. The actual degree of protection required depends on local conditions and applicable local regulations. To adequately protect a PMP/PTP 450 Platform installation, both ground bonding and transient voltage surge suppression are required.

Full details of lightning protection methods and requirements can be found in the international standards IEC 61024-1 and IEC 61312-1, the U.S. National Electric Code ANSI/NFPA No. 70-1984 or section 54 of the Canadian Electric Code.



### Warning

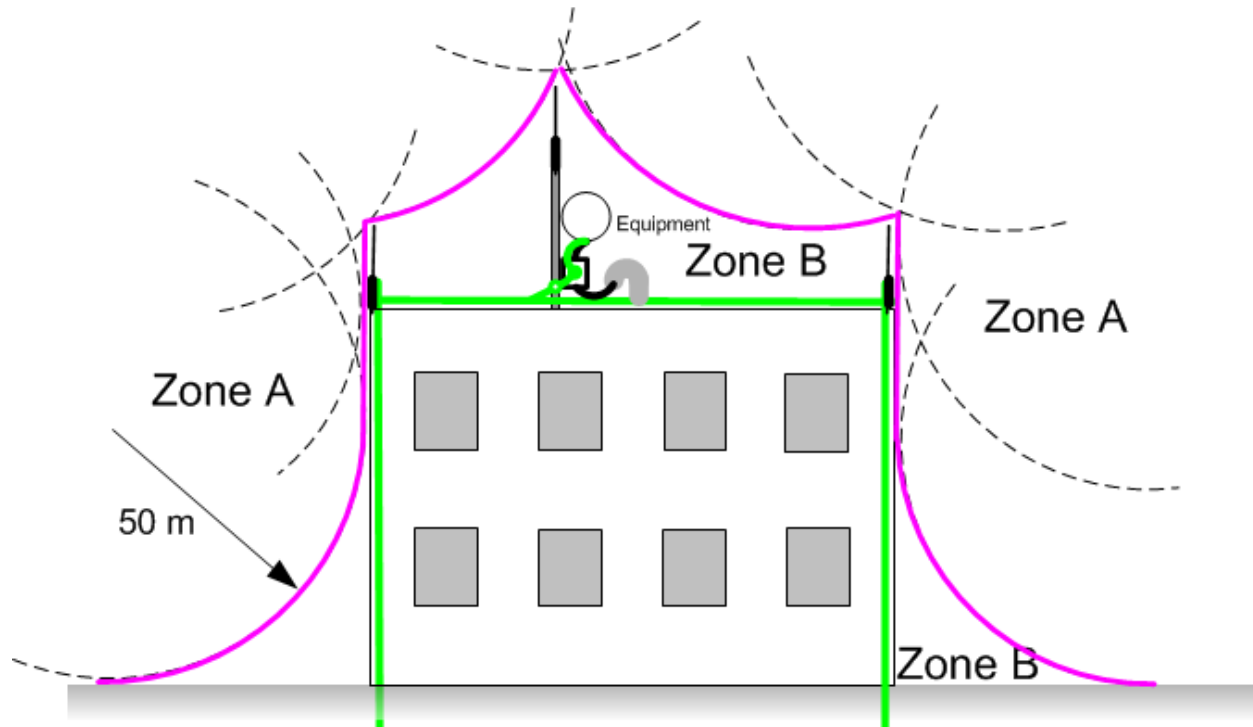
International and national standards take precedence over the requirements in this guide.

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## Lightning protection zones

Use the rolling sphere method (Figure 51) to determine where it is safe to mount equipment. An imaginary sphere, typically 50 meters in radius, is rolled over the structure. Where the sphere rests against the ground and a strike termination device (such as a finial or ground bar), all the space under the sphere is considered to be in the zone of protection (Zone B). Similarly, where the sphere rests on two finials, the space under the sphere is considered to be in the zone of protection.

**Figure 51** Rolling sphere method to determine the lightning protection zones



**Zone A:** In this zone a direct lightning strike is possible. Do not mount equipment in this zone.

**Zone B:** In this zone, direct EMD (lightning) effects are still possible, but mounting in this zone significantly reduces the possibility of a direct strike. Mount equipment in this zone.



### Warning

Never mount equipment in Zone A. Mounting in Zone A may put equipment, structures and life at risk.

## Site grounding system

Confirm that the site has a correctly installed grounding system on a common ground ring with access points for grounding the 450 Platform Family ODU.

If the outdoor equipment is to be installed on the roof of a high building ([Figure 48](#)), confirm that the following additional requirements are met:

- A grounding conductor is installed around the roof perimeter to form the main roof perimeter lightning protection ring.
- Air terminals are installed along the length of the main roof perimeter lightning protection ring, typically every 6.1m (20ft).
- The main roof perimeter lightning protection ring contains at least two down conductors connected to the grounding electrode system. The down conductors should be physically separated from one another, as far as practical.

## ODU and external antenna location

Find a location for the ODU (and external antenna for connectorized units) that meets the following requirements:

- The equipment is high enough to achieve the best radio path.
- People can be kept a safe distance away from the equipment when it is radiating. The safe separation distances are defined in [Calculated distances and power compliance margins on page 4-25](#).
- The equipment is lower than the top of the supporting structure (tower, mast or building) or its lightning air terminal.
- If the ODU is connectorized, select a mounting position that gives it maximum protection from the elements, but still allows easy access for connecting and weatherproofing the cables. To minimize cable losses, select a position where the antenna cable lengths can be minimized. If diverse or two external antennas are being deployed, it is not necessary to mount the ODU at the midpoint of the antennas.

## ODU ambient temperature limits

Select a location where the ODU can operate within safe ambient temperature limits. The following points need to be considered while selecting a location for the ODU:

- The ODU must be mounted in a Restricted Access Location (as defined in EN 60950-1) if the operating ambient temperature may exceed 40°C, including solar radiation.
- If the ambient temperature never exceeds 40°C, the temperature of the external metal case parts of the ODU will not exceed the touch temperature limit of 70°C.
- If the ambient temperature never exceeds 60°C, the temperature of the external metal case parts of the ODU will not exceed the touch temperature limit of 90°C.

**Note**

A restricted access location is defined (in EN 60950-1) as one where access may only be gained by use of a tool or lock and key, or other means of security, and access is controlled by the authority responsible for the location. Access must only be gained by persons who have been instructed about the reasons for the restrictions applied to the location and about any precautions that must be taken. Examples of permissible restricted access locations are a lockable equipment room or a lockable cabinet.

## ODU wind loading

Ensure that the ODU and the structure on which it is mounted are capable of withstanding the prevalent wind speeds at a proposed 450 Platform site. Wind speed statistics are available from national meteorological offices.

The ODU and its mounting bracket are capable of withstanding wind speeds of:

- Up to 200 mph (322 kph) for PMP 450m Series – AP 5 GHz
- Up to 124 mph (200 kph) for PMP 450M – AP 3 GHz
- Up to 124 mph (Integrated) for PMP/PTP 450i – all models 3 GHz and 5 GHz
- Up to 200 mph (Connectorized) for PMP/PTP 450i – all models 3 GHz and 5 GHz
- Up to 200 mph (322 kph) for PMP/PTP 450 – all models
- Up to 200 mph (322 kph) for PMP 450 – Ruggedized
- Up to 200 mph (322 kph) for PMP 450i – all models 900 MHz
- Up to 118 mph (191 kph) for PMP 450b Mid-Gain
- Up to 90 mph (145 kph) for PMP 450b High Gain
- Up to 90 mph (145 kph) for PMP 450d
- Up to 100 mph (161 kph) for 900 MHz antennas

Wind blowing on the ODU will subject the mounting structure to significant lateral force. The magnitude of the force depends on both wind strength and surface area of the ODU. Wind loading is estimated using the following formulae:

- Force (in kilograms) =  $0.1045aV^2$   
where:
  - “a” is the surface area in square meters, and
  - “V” is the wind speed in meters per second.
- Force (in pounds) =  $0.0042Av^2$   
where:
  - “A” is the surface area in square feet, and
  - “v” is the wind speed in miles per hour.

Applying these formulae to the 450 platform at different wind speeds, the resulting wind loadings are shown in below tables.

**Table 76** PMP 450m Series wind loading (Newton)

| Type of ODU                   | Max surface area<br>(square meters) | Wind speed (kilometer per hour) |     |     |     |      |
|-------------------------------|-------------------------------------|---------------------------------|-----|-----|-----|------|
|                               |                                     | 160                             | 170 | 180 | 190 | 200  |
| Integrated 90° sector antenna | 0.331                               | 671                             | 757 | 849 | 946 | 1048 |

**Table 77** PMP/PTP 450i Series wind loading (Newton)

| Type of ODU                            | Max surface area<br>(square meters) | Wind speed (kilometer per hour) |     |     |     |      |
|----------------------------------------|-------------------------------------|---------------------------------|-----|-----|-----|------|
|                                        |                                     | 160                             | 170 | 180 | 190 | 200  |
| Connectorized                          | 0.035                               | 94                              | 106 | 119 | 132 | 146  |
| Directional Yagi antenna - 900 MHz     | 0.025                               | 67                              | 76  | 85  | 94  | 105  |
| External 65° sector antenna – 900 MHz  | 0.253                               | 677                             | 764 | 857 | 954 | 1058 |
| Directional antenna – 3.x GHz          | 0.1                                 | 142                             | 160 | 180 | 200 | 222  |
| Integrated 90° sector antenna -3.x GHz | 0.18                                | 83                              | 94  | 105 | 117 | 130  |
| Directional antenna – 5 GHz            | 0.093                               | 249                             | 281 | 315 | 351 | 389  |
| Integrated 90° sector antenna - 5 GHz  | 0.126                               | 337                             | 381 | 427 | 475 | 527  |

**Table 78** PMP 450m Series wind loading (lb force)

| Type of ODU                   | Max surface area<br>(square feet) | Wind speed (miles per hour) |     |     |     |     |
|-------------------------------|-----------------------------------|-----------------------------|-----|-----|-----|-----|
|                               |                                   | 100                         | 105 | 110 | 115 | 120 |
| Integrated 90° sector antenna | 3.565                             | 150                         | 165 | 181 | 198 | 216 |

**Table 79** PMP/PTP 450i Series wind loading (lb force)

| Type of ODU                           | Max surface area<br>(square feet) | Wind speed (miles per hour) |     |     |     |     |
|---------------------------------------|-----------------------------------|-----------------------------|-----|-----|-----|-----|
|                                       |                                   | 100                         | 105 | 110 | 115 | 120 |
| Connectorized                         | 0.377                             | 16                          | 17  | 19  | 21  | 23  |
| Directional antenna – 5 GHz           | 1.001                             | 42                          | 46  | 51  | 56  | 61  |
| Integrated 90° sector antenna - 5 GHz | 1.356                             | 57                          | 63  | 69  | 75  | 82  |
| Directional Yagi antenna - 900 MHz    | 0.27                              | 11                          | 13  | 14  | 15  | 16  |
| External 65° sector antenna – 900 MHz | 2.72                              | 114                         | 126 | 138 | 151 | 165 |

For a connectorized ODU, add the wind loading of the external antenna to that of the ODU. The antenna manufacturer should be able to quote wind loading.

**Table 80** PMP/PTP 450 Series wind loading (Newton)

| Type of ODU                              | Max surface area<br>(square meters) | Wind speed (kilometer per hour) |     |     |      |      |
|------------------------------------------|-------------------------------------|---------------------------------|-----|-----|------|------|
|                                          |                                     | 160                             | 170 | 180 | 190  | 200  |
| External 60° sector antenna – 2.4 GHz AP | 0.27                                | 722                             | 815 | 914 | 1019 | 1129 |
| External 60° sector antenna – 5 GHz AP   | 0.066                               | 177                             | 199 | 223 | 249  | 276  |
| External 90° sector antenna – 5 GHz AP   | 0.083                               | 222                             | 251 | 281 | 313  | 347  |
| SM                                       | 0.027                               | 72                              | 82  | 91  | 102  | 113  |
| Integrated High Gain, Ruggedized         | 0.093                               | 249                             | 281 | 315 | 351  | 389  |
| Integrated Dish                          | 0.14                                | 375                             | 423 | 474 | 528  | 585  |

**Table 81** PMP/PTP 450 Series wind loading (lb force)

| Type of ODU                              | Max surface area<br>(square feet) | Wind speed (miles per hour) |     |     |     |     |
|------------------------------------------|-----------------------------------|-----------------------------|-----|-----|-----|-----|
|                                          |                                   | 100                         | 105 | 110 | 115 | 120 |
| External 60° sector antenna – 2.4 GHz AP | 2.9                               | 122                         | 134 | 147 | 161 | 175 |
| External 60° sector antenna – 5 GHz AP   | 0.71                              | 29.8                        | 33  | 37  | 39  | 43  |
| External 90° sector antenna – 5 GHz AP   | 0.89                              | 37                          | 41  | 45  | 49  | 54  |
| SM                                       | 0.29                              | 12                          | 13  | 15  | 16  | 18  |
| Integrated High Gain, Ruggedized         | 1                                 | 42                          | 46  | 51  | 56  | 60  |
| Integrated Dish                          | 1.49                              | 63                          | 69  | 76  | 83  | 90  |

**Table 82** PMP 450b Series wind loading (Newton)

| Type of ODU          | Max surface area<br>(square meters) | Wind speed (miles per hour) |     |     |     |     |
|----------------------|-------------------------------------|-----------------------------|-----|-----|-----|-----|
|                      |                                     | 160                         | 170 | 180 | 190 | 200 |
| Integrated Mid-Gain  | 0.03                                | 80                          | 90  | 101 | 113 | 125 |
| Integrated High Gain | 0.13                                | 347                         | 392 | 440 | 490 | 543 |

**Table 83** PMP 450b Series wind loading (lb force)

| Type of ODU          | Max surface area<br>(square feet) | Wind speed (miles per hour) |     |     |     |     |
|----------------------|-----------------------------------|-----------------------------|-----|-----|-----|-----|
|                      |                                   | 100                         | 105 | 110 | 115 | 120 |
| Integrated Mid-Gain  | 0.33                              | 13                          | 15  | 16  | 18  | 19  |
| Integrated High Gain | 1.41                              | 59                          | 65  | 71  | 78  | 85  |

## Hazardous locations

Check that the ODUs will not be exposed to hazardous gases, as defined by HAZLOC (USA) and ATEX (Europe) regulations. If there is a risk of such exposure, then order the PTP/PMP 450i ATEX/Hazloc product variants, as these are intended for operation in locations with gas hazards. The ATEX and HAZLOC standards limit the EIRP as shown in [Table 84](#).

**Table 84** EIRP limits from ATEX and HAZLOC standards

| ATEX gas group | HAZLOC gas group | Typical gas type | Maximum EIRP (Watt) |
|----------------|------------------|------------------|---------------------|
| IIA            | D                | Propane          | 6                   |
| IIB            | C                | Ethylene         | 3.5                 |
| IIC            | B                | Hydrogen         | 2                   |
| IIC            | A                | Acetylene        | 2                   |

## Further reading

| For information about...                            | Refer to...                                                                                                  |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Ordering Connectorized/ Integrated ATEX/HAZLOC ODUs | <a href="#">Table 68</a> and <a href="#">Table 69</a> on pages <a href="#">2-73</a> and <a href="#">2-73</a> |
| ATEX/HAZLOC standards and type approval             | <a href="#">Hazardous location compliance</a> on page <a href="#">4-34</a>                                   |
| Deployment of ATEX/HAZLOC ODUs                      | PMP/PTP 450i Hazardous Location Safety Guidance (pmp-1712)                                                   |

## Drop cable grounding points

To estimate how many grounding kits are required for each drop cable, refer to the site installation diagrams ([Figure 46](#), [Figure 47](#), and [Figure 48](#)) and use the following criteria:

- The drop cable shield must be grounded near the ODU at the first point of contact between the drop cable and the mast, tower or building.
- The drop cable shield must be grounded at the building entry point.

For mast or tower installations ([Figure 46](#)), use the following additional criteria:

- The drop cable shield must be grounded at the bottom of the tower, near the vertical to horizontal transition point. This ground cable must be bonded to the tower or tower ground bus bar (TGB), if installed.



- If the tower is greater than 61 m (200 ft) in height, the drop cable shield must be grounded at the tower midpoint, and at additional points as necessary to reduce the distance between ground cables to 61 m (200 ft) or less.
- In high lightning-prone geographical areas, the drop cable shield must be grounded at spacing between 15 to 22 m (50 to 75 ft). This is especially important on towers taller than 45 m (150 ft).

For roof installations ([Figure 48](#)), use the following additional criteria:

- The drop cable shield must be bonded to the building grounding system at its top entry point (usually on the roof).
- The drop cable shield must be bonded to the building grounding system at the entry point to the equipment room.

## Lightning Protection Unit (LPU) location

Find a location for the bottom LPU that meets the following requirements:

- The bottom LPU can be connected to the drop cable from the ODU.
- The bottom LPU is within 600 mm (24 in) of the point at which the drop cable enters the building, enclosure or equipment room within a larger building.
- The bottom LPU can be bonded to the grounding system.

# Radio Frequency planning

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This section describes how to plan 450 Platform Family links to conform to analysis of spectrum and the regulatory restrictions that apply in the country of operation.

## Regulatory limits

Many countries impose EIRP limits (Allowed EIRP) on products operating in the bands used by the 450 Platform Family.

Refer to [Equipment Disposal \(Chapter 10: Reference information\)](#) on page 10-61 to determine what the maximum transmitted power and EIRP for PMP/PTP 450 Platform that can be used in each of countries and frequency band.



### Caution

It is the responsibility of the user to ensure that the PMP/PTP ODU is operated in accordance with local regulatory limits.



### Note

Contact the applicable radio regulator to find out if registration of the PMP/PTP 450 Platform link is required.

---

## Conforming to the limits

Ensure the link is configured to conform to local regulatory requirements by configuring the PMP 450/450i Series AP or PTP 450/450i Series BHM for the correct country. In the following situations, this does not prevent operation outside the regulations:

- When using connectorized ODUs with external antennas, the regulations may require the maximum transmit power to be reduced.

## Available spectrum

The available spectrum for operation depends on the regulatory band. When configured appropriately, the unit will only allow operation on those channels which are permitted by the regulations.

Certain regulations have allocated certain channels as unavailable for use:

- FCC has allocated part of the 5.1 & 5.2 GHz
- ETSI has allocated part of the 5.4 GHz band to weather radar.
- UK and some other European countries have allocated part of the 5.8 GHz band to Road Transport and Traffic Telematics (RTTT) systems.

The number and identity of channels barred in a given regulatory band is dependent on the channel bandwidth and channel raster selected.

## Analyzing the RF Environment

An essential element in RF network planning is the analysis of spectrum usage and the strength of the signals that occupy the spectrum. Regardless of how these parameters are measured and log or chart the results (through the Spectrum Analyzer feature or by using a spectrum analyzer), ensure measurements are performed:

- At various times of day.
- On various days of the week.
- Periodically into the future.

As new RF neighbors move in or consumer devices proliferate in currently used spectrum, this keeps the user aware of the dynamic possibilities for interference within the network.

## Channel bandwidth

Select the required channel bandwidth for the link. The selection depends upon the regulatory band selected.

The wider the channel bandwidth, the greater the capacity. As narrower channel bandwidths take up less spectrum, selecting a narrow channel bandwidth may be a better choice when operating in locations where the spectrum is very busy.

Both ends of the link must be configured to operate on the same channel bandwidth.

## Anticipating Reflection of Radio Waves

In the signal path, any object that is larger than the wavelength of the signal can reflect the signal. Such an object can even be the surface of the earth or of a river, bay or lake. The wavelength of the signal is approximately

- 2 inches (or 5 cm) for 5.4 GHz and 5.8 GHz signals.
- 12 inches for 900 MHz signals

A reflected signal can arrive at the antenna of the receiver later than the non-reflected signal arrives. These two or more signals cause the condition known as multipath. Multipath may increase or decrease the signal level, resulting in overall attenuation that may be higher or lower than that caused by the link distance. This is problematic at the margin of the link budget, where the standard operating margin (fade margin) may be compromised.

## Obstructions in the Fresnel Zone

The Fresnel (pronounced fre-NEL) Zone is a three-dimensional volume around the line of sight of an antenna transmission. Objects that penetrate this area can cause the received strength of the transmitted signal to fade. Out-of-phase reflections and absorption of the signal result in signal cancellation.

The foliage of trees and plants in the Fresnel Zone can cause signal loss. Seasonal density, moisture content of the foliage, and other factors such as wind may change the amount of loss. Plan to perform frequent and regular link tests if you must transmit through foliage.

## Planning for co-location

The first step to avoid interference in wireless systems is to set all AP/BHMs to receive timing from a synchronization source (Cluster Management Module, or Universal Global Positioning System). This ensures that the modules are in sync and start transmitting at the same time each frame.

The second step to avoid interference is to configure parameters on all AP/BHMs of the same frequency band in proximity such that they have compatible transmit/receive ratios (all stop transmitting each frame before any start receiving). This avoids the problem of one AP/BHM attempting to receive the signal from a distant SM/BHS while a nearby AP/BHM transmits, which could overpower that signal.



### Note

Refer to Frame Alignment Legacy Mode parameter of Configuration > Radio > Advance tab for legacy product settings (See [Table 155 PMP 450i AP Radio attributes - 5 GHz](#) on page 7-145).

The following parameters on the AP/BHM determine the transmit/receive ratio:

- Downlink Data percentage
- Frame Period
- Max Range
- (reserved) Contention slots

If OFDM (450 Platform Family, PMP/PTP 230) and FSK (PMP/PTP 1x0) APs/BHMs of the same frequency band and channel bandwidth are in proximity, or if you want BHMs set to different parameters then you must use the Frame Calculator to identify compatible settings for APs/BHMs.

The co-location is also supported for 900 MHz PMP 450i Series APs (OFDM) and PMP 100 Series APs (FSK).

The Frame Calculator is available on the web management interface **Tools > Frame Calculator**. To use the Frame Calculator, type into the calculator various configurable parameter values for each proximal AP/BHM and then record the resulting AP/BHM Receive Start value. Next vary the Downlink Data percentage in each calculation and iterate until a calculated AP/BHM Receive Start for all co-located AP/BHMs where the transmit end does not come before the receive start.

Cambium also provides co-location tool which helps in co-location planning:

<https://support.cambiumnetworks.com/files/colocationtool>

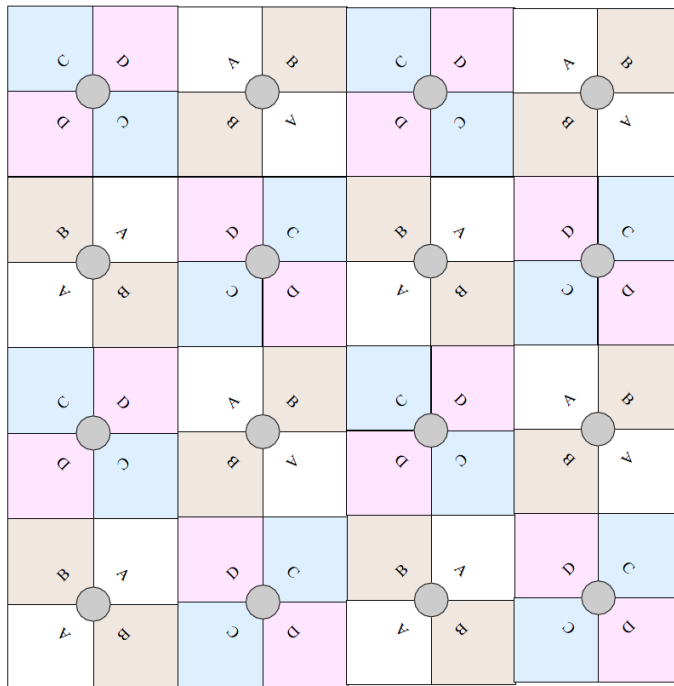
For more information on 450 Platform Family co-location, see

<http://www.cambiumnetworks.com/solution-papers>

## Multiple OFDM Access Point Clusters

When deploying multiple AP clusters in a dense area, consider aligning the clusters as shown below. However, this is only a recommendation. An installation may dictate a different pattern of channel assignments.

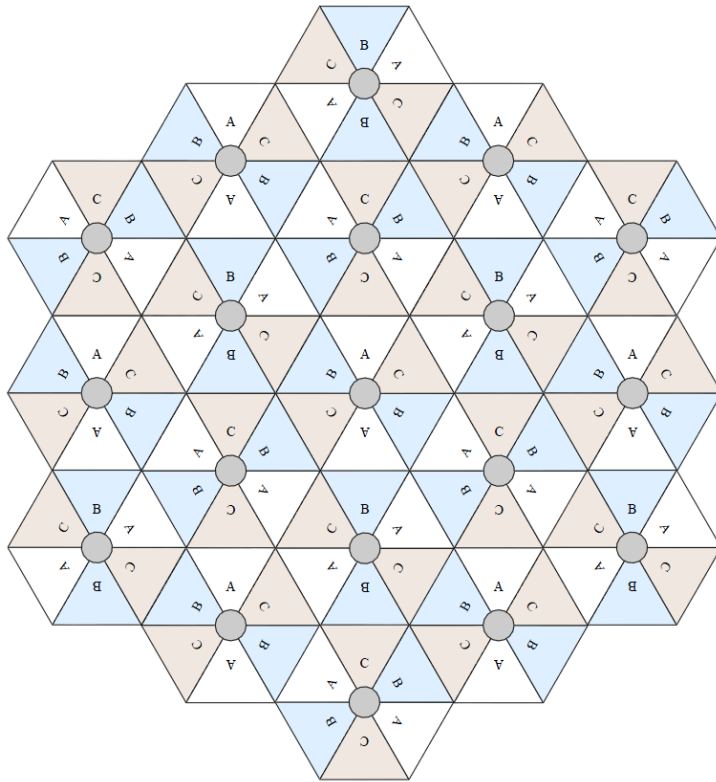
**Figure 52** Example layout of 16 Access Point sectors (ABCD), 90-degree sectors



An example for assignment of frequency channels is provided in the following table.

**Table 85** Example 5.8 GHz 4-channel assignment by access site

| Symbol | Frequency |
|--------|-----------|
| A      | 5.740 GHz |
| B      | 5.780 GHz |
| C      | 5.760 GHz |
| D      | 5.800 GHz |

**Figure 53** Example layout of 6 Access Point sectors (ABC), 60-degree sectors

An example for assignment of frequency channels and sector IDs is provided in the following table.

**Table 86** Example 5.8 GHz 3-channel assignment by access site

| Symbol | Frequency |
|--------|-----------|
| A      | 5.740 GHz |
| B      | 5.760 GHz |
| C      | 5.780 GHz |

## Considerations on back-to-back frequency reuse

Cambium Networks recommends using back-to-back (ABAB) frequency reuse, as shown in [Figure 52](#). This means that a base site of four sectors can be created using two frequencies, which works very well and helps define networks in situations where high capacity is required in a limited amount of spectrum.

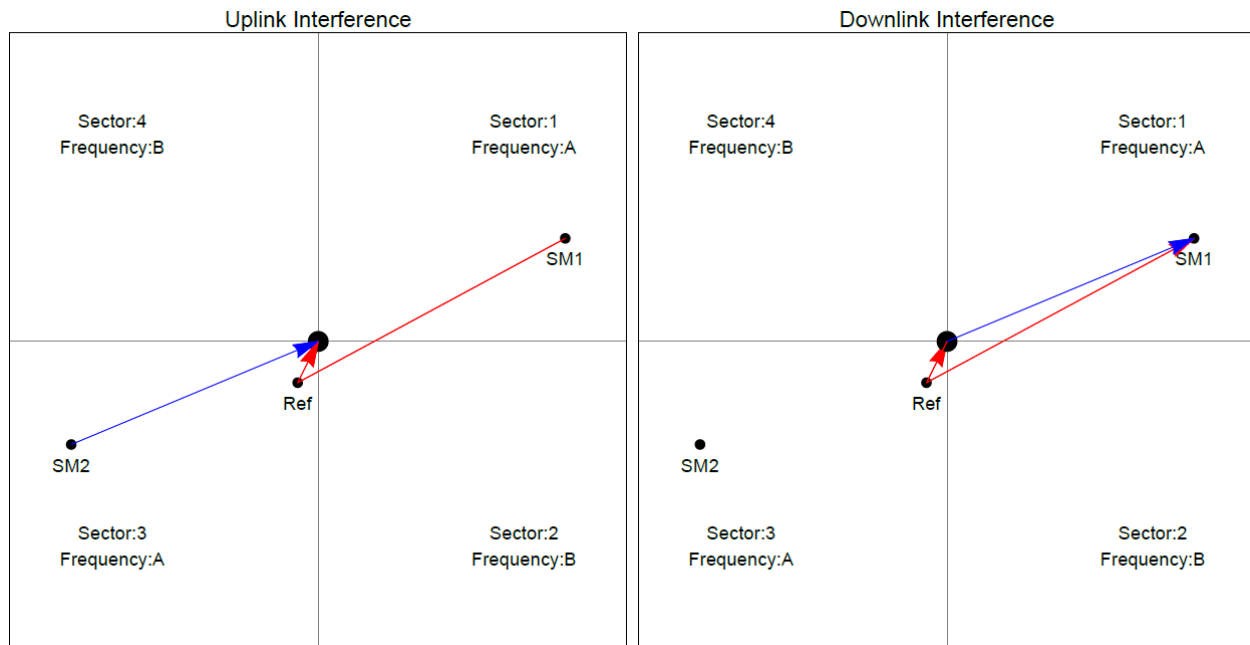
The conditions necessary to implement this plan are:

- GPS synchronization: all the access points transmit at the same time
- Uplink and Downlink timings across APs do not overlap: they can be adjusted using the frame calculators and co-location tools provided by Cambium
- Uplink power control to ensure that all signals are received on the uplink at the same level: this is automatically enabled on all sectors
- There are no reflecting objects which are too large in the exclusion zones defined in this section.
- The SMs do not normally have line-of-sight (LoS) to an interfering base station. The worst-case range ratio in [Figure 52](#) is 5:1 which in LoS only gives 14 dB protection. Greater than 30 dB is required for 256QAM capability. Down tilt can be used to advantage when the elevation beamwidth is low. Also, the range ratio applies to the longest distance SM, shorter distance SMs have a better range ratio. This frequency reuse plan may not always give 256QAM for the longest distance SMs. It is usually a good compromise between using more spectrum and guaranteed modulation rate.

## Reflecting objects

[Figure 54](#) shows two diagrams of the same reflecting object. Uplink interference demonstrates the situation when the two SMs are transmitting at the same time. SM2 should be received cleanly by the AP for Sector 3. At the same time interference can arise from SM1 via the reflecting object and cause a lower Signal-to-Interference ratio than required at AP3. This may either cause transmission errors which are corrected by ARQ or cause the selected modulation rate to be lowered. Either may cause a lower throughput from SM2 and therefore sector 3.

Downlink interference shows the situation when AP3 interferes with SM1. Again, the transmission may be reduced by errors or a reduction in modulation rate.

**Figure 54 Reflection**

## Reflection likelihood guidance

As shown in the previous section, reflection can cause a decrease in throughput in an ABAB base site. This section provides guidance on whether a reflection is likely to cause interference. The first condition for whether a reflection can cause the data rate to reduce is that the reflecting object must be in view of the AP and the SM to re-transmit the signal. If this is not the case, then the object cannot cause interference.

Given that the potential reflecting object is seen by the AP and the SM, there are a range of object sizes and a range of zones where we can predict that interference will occur which may reduce the throughput when both sector 1 and sector 3 are carrying traffic.

Figure 55 and Figure 56 show regions enumerated A, B, C, and D. We also need to consider objects of size 1, 2, 3 and 4 and define the areas where the objects may interfere.

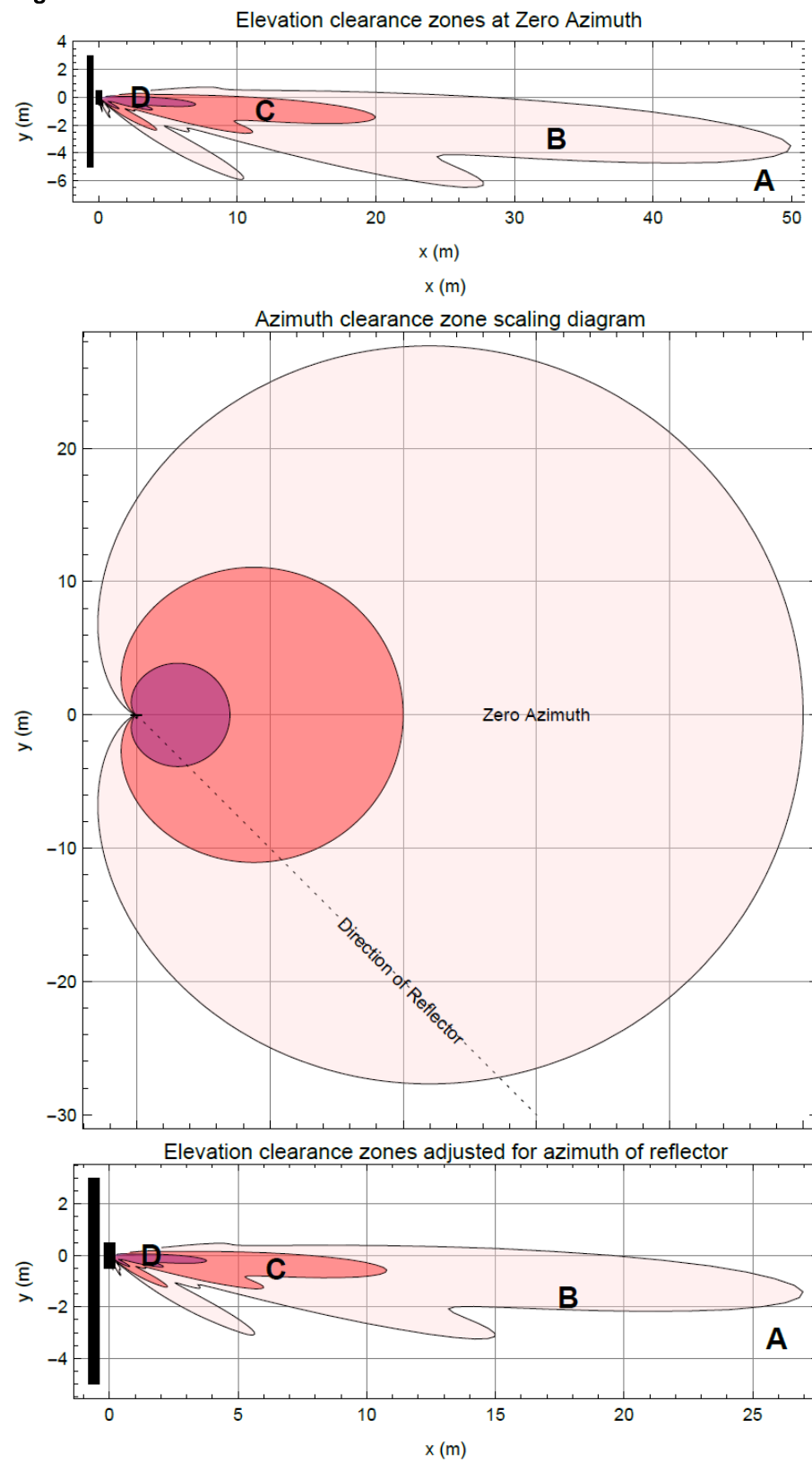
- object size 1: a flat building face with a clear reflecting property from sector to AP
- object size 2: random metalwork such as a wireless tower
- object size 3: a 0.5 X 0.5m flat metallic face or tree
- object size 4: a 0.2 X 0.2m random metal structure or 0.5 X 0.5m foliage.

The conditions for no interference are:

- size 2 outside zone B
- size 3 outside zone C
- size 4 outside zone D

The size 1 object can interfere at large distances. It is necessary to look at the geometry by which reflection could occur and cause interference. Typically, this will occur at a restricted range of azimuths and ranges.



**Figure 55** Sector Antenna

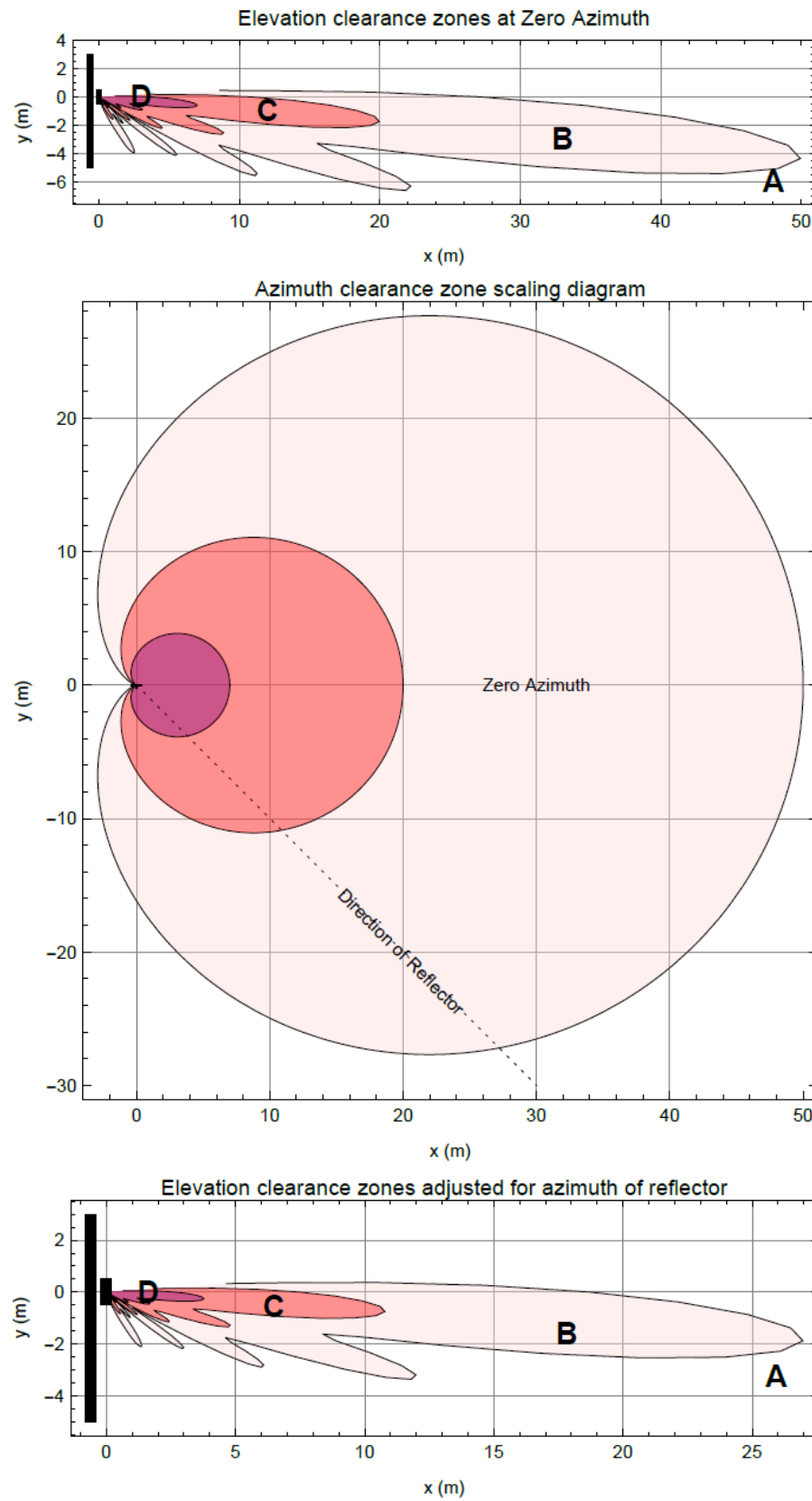
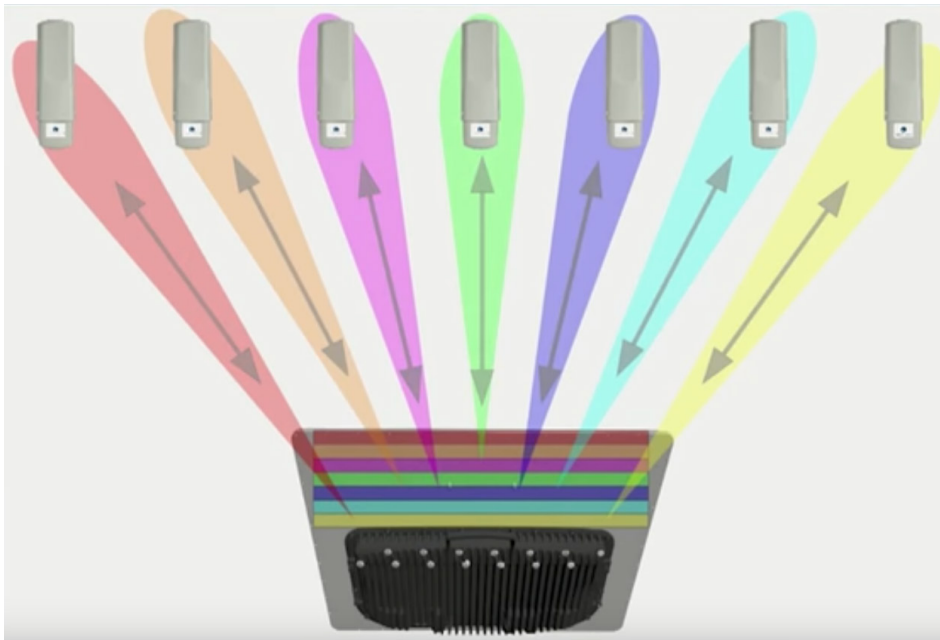
**Figure 56** cnMedusa Antenna

Figure 55 and Figure 56 each have three diagrams scaled in meters where Figure 55 is for the sector antenna and Figure 56 is for cnMedusa. In each figure the distances and heights assume a typical down tilt of 4°.

In each figure the top diagram represents the clearances required at zero azimuth. The middle diagram represents the scaling required to the top diagram to allow for differences in azimuth of the considered reflecting object. The bottom diagram is the scaled version of the top diagram allowing for the dotted azimuth line in the middle diagram.

PMP 450m Series AP is based on Massive **MU-MIMO** technology. The 5GHz 450m is a 14x14 MIMO system which allows simultaneous communication to up to seven SMs. The 3GHz 450m is an 8x8 MIMO system which allows simultaneous communication to up to seven SM's.

**Figure 57** PMP 450m Series AP antenna beam



## PMP 450m installation recommendations

- For best performance it is recommended to have a clearance zone around the mast. The clearance zone depends on the surrounding environment and the antenna's down tilt. If the mast is surrounded by metal, then larger clearance is required compared to an environment where the antenna is surrounded by foliage
- SMs should be spread in azimuth of AP antenna
- 450m is susceptible to movement, for best MU-MIMO performance it is recommended that the 450m AP is mounted/installed on a mast that is extremely rigid (no movement and is 100% vertical).
- LINKPlanner can be used to plan SMs across the AP antenna azimuth

# Link planning

---

This section describes factors to be considered when planning links, such as range, obstacles path loss and throughput. LINKPlanner is recommended.

## Range and obstacles

Calculate the range of the link and identify any obstacles that may affect radio performance.

Perform a survey to identify all the obstructions (such as trees or buildings) in the path and to assess the risk of interference. This information is necessary in order to achieve an accurate link feasibility assessment.

The 450 Platform Family is designed to operate in Non-Line-of-Sight (NLoS) and Line-of-Sight (LoS) environments. An NLOS environment is one in which there is no optical line-of-sight, that is, there are obstructions between the antennas.

OFDM technology can often use multi-pathing to an advantage to overcome nLOS, especially in cases where the Fresnel zone is only partially blocked by buildings, “urban canyons”, or foliage. OFDM tends to help especially when obstacles are near the middle of the link, and less so when the obstacles are very near the ODU.

However, attenuation through walls and trees is substantial for any use of the 5.4 GHz and 5.8 GHz frequency bands. The lower frequency radio waves of 900 MHz radios provide greater penetration through walls, trees and other obstacles, making it optimal for most non-line-of-sight applications. Even with OFDM, these products are not expected to penetrate walls or extensive trees and foliage.

## Path loss

Path loss is the amount of attenuation the radio signal undergoes between the two ends of the link. The path loss is the sum of the attenuation of the path if there were no obstacles in the way (Free Space Path Loss), the attenuation caused by obstacles (Excess Path Loss) and a margin to allow for possible fading of the radio signal (Fade Margin). The following calculation needs to be performed to judge whether a link can be installed:

$$L_{free\_space} + L_{excess} + L_{fade} + L_{seasonal} < L_{capability}$$

Where:

Is:

$L_{free\_space}$

Free Space Path Loss (dB)

$L_{excess}$

Excess Path Loss (dB)

$L_{fade}$

Fade Margin Required (dB)

$L_{seasonal}$  Seasonal Fading (dB)

$L_{capability}$  Equipment Capability (dB)

## Calculating Link Loss

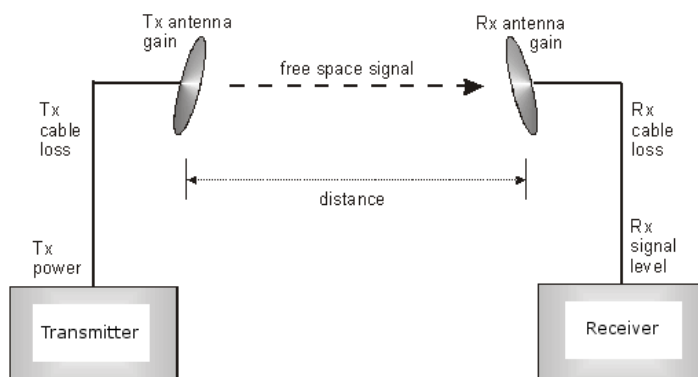
The link loss is the total attenuation of the wireless signal between two point-to-multipoint units. The link loss calculation is presented below:

$$\begin{aligned} \text{Link Loss (dB)} = & \text{Transmit power of the remote wireless unit (dBm)} - \text{Tx Cable loss (dB)} \\ & - \text{Received power at the local unit (dBm)} - \text{Rx cable loss (dB)} + \\ & \text{Antenna gain at the remote unit (dBi)} + \text{Antenna gain at the local unit (dBi)} \end{aligned}$$

## Calculating Rx Signal Level

The determinants in Rx signal level are illustrated in [Figure 58](#).

**Figure 58** Determinants in Rx signal level



Rx signal level is calculated as follows:

$$\begin{aligned} \text{Rx signal level dB} = & \text{Tx power} - \text{Tx cable loss} + \text{Tx antenna gain} \\ & - \text{free space path loss} + \text{Rx antenna gain} - \text{Rx cable loss} \end{aligned}$$



### Note

This Rx signal level calculation presumes that a clear line of sight is established between the transmitter and receiver and that no objects encroach in the Fresnel zone.

## Calculating Fade Margin

Free space path loss is a major determinant in Rx (received) signal level. Rx signal level, in turn, is a major factor in the system operating margin (fade margin), which is calculated as follows:

$$\text{System operating margin (fade margin) dB} = \text{Rx signal level dB} - \text{Rx sensitivity dB}$$

Thus, fade margin is the difference between strength of the received signal and the strength that the receiver requires for maintaining a reliable link. A higher fade margin is characteristic of a more reliable link.

## Adaptive modulation

Adaptive modulation ensures that the highest throughput that can be achieved instantaneously will be obtained, taking account of propagation and interference. When the link has been installed, web pages provide information about the link loss currently measured by the equipment, both instantaneously and averaged. The averaged value will require maximum seasonal fading to be added, and then the radio reliability of the link can be computed.

For details of the system throughput, link loss and maximum distance for each frequency band in all modulation modes, see [Link](#) on page 10-56.

# Planning for connectorized units

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This section describes factors to be considered when planning to use connectorized ODUs with external antennas in 450 Platform Family links.

## When to install connectorized units

Most of radio links can be successfully deployed with the integrated ODU. However, the integrated units may not be sufficient in some areas, for example:

- Where the path is heavily obscured by dense woodland on an NLOS link.
- Where long LOS links are required.
- Where there are known to be high levels of interference.

In these areas, connectorized ODUs and external antennas should be used.

## Choosing external antennas

When selecting external antennas, consider the following factors:

- The required antenna gain.
- Ease of mounting and alignment.
- Use dual-polarization antenna (as the integrated antenna).



### Note

Enter the antenna gain and cable loss into the Installation Wizard, if the country selected has an EIRP limit, the corresponding maximum transmit power will be calculated automatically by the unit.

---

## Calculating RF cable length (5.8 GHz FCC only)

The 5.8 GHz band FCC approval for the product is based on tests with a cable loss between the ODU and antenna of not less than 1.2 dB. If cable loss is below 1.2 dB with a 1.3 m (4 ft) diameter external antenna, the connectorized 450 Platform Family may exceed the maximum radiated spurious emissions allowed under FCC 5.8 GHz rules.

Cable loss depends mainly upon cable type and length. To meet or exceed the minimum loss of 1.2 dB, use cables of the type and length specified in [Table 87](#) (source: Times Microwave). This data excludes connector losses.

**Table 87** RF cable lengths required to achieve 1.2 dB loss at 5.8 GHz

| RF cable type | Minimum cable length |
|---------------|----------------------|
| LMR100        | 0.6 m (1.9 ft)       |
| LMR200        | 1.4 m (4.6 ft)       |
| LMR300        | 2.2 m (7.3 ft)       |
| LMR400        | 3.4 m (11.1 ft)      |
| LMR600        | 5.0 m (16.5 ft)      |



# Data network planning

---

This section describes factors to be considered when planning 450 Platform Family data networks.

## Understanding addresses

A basic understanding of Internet Protocol (IP) address and subnet mask concepts is required for engineering your IP network.

### IP address

The IP address is a 32-bit binary number that has four parts (octets). This set of four octets has two segments, depending on the class of IP address. The first segment identifies the network. The second identifies the hosts or devices on the network. The subnet mask marks a boundary between these two sub-addresses.

## Dynamic or static addressing

For any computer to communicate with a module, the computer must be configured to either

- use DHCP (Dynamic Host Configuration Protocol). In this case, when not connected to the network, the computer derives an IP address on the 169.254 network within two minutes.
- have an assigned static IP address (for example, 169.254.1.5) on the 169.254 network.



#### Note

If an IP address that is set in the module is not the 169.254.x.x network address, then the network operator must assign the computer a static IP address in the same subnet.

---

## When a DHCP server is not found

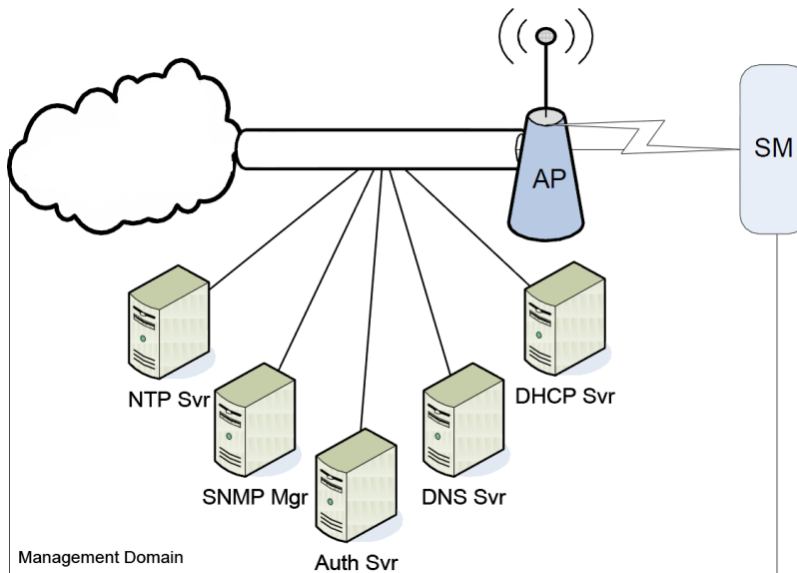
To operate on a network, a computer requires an IP address, a subnet mask, and possibly a gateway address. Either a DHCP server automatically assigns this configuration information to a computer on a network or an operator must input these items.

When a computer is brought on line and a DHCP server is not accessible (such as when the server is down or the computer is not plugged into the network), Microsoft and Apple operating systems default to an IP address of 169.254.x.x and a subnet mask of 255.255.0.0 (169.254/16, where /16 indicates that the first 16 bits of the address range are identical among all members of the subnet).

## DNS Client

The DNS Client is used to resolve names of management servers within the operator's management domain (see [Figure 59](#)). This feature allows hostname configuration for NTP servers, Authorization Servers, DHCP relay servers, and SNMP trap servers. Operators may choose to either enter in the FQDN (Fully Qualified Domain Name) for the host name or to manually enter the IP addresses of the servers.

**Figure 59** Cambium networks management domain



## Network Address Translation (NAT)

### NAT, DHCP Server, DHCP Client and DMZ in SM

The system provides NAT (network address translation) for SMs in the following combinations of NAT and DHCP (Dynamic Host Configuration Protocol):

- NAT Disabled
- NAT with DHCP Client (**DHCP** selected as the **Connection Type** of the WAN interface) and DHCP Server
- NAT with DHCP Client (**DHCP** selected as the **Connection Type** of the WAN interface)
- NAT with DHCP Server
- NAT without DHCP

## NAT

NAT isolates devices connected to the Ethernet/wired side of a SM from being seen directly from the wireless side of the SM. With NAT enabled, the SM has an IP address for transport traffic (separate from its address for management), terminates transport traffic, and allows you to assign a range of IP addresses to devices that are connected to the Ethernet/wired side of the SM.

In the Cambium system, NAT supports many protocols, including HTTP, ICMP (Internet Control Message Protocols), and FTP (File Transfer Protocol). For virtual private network (VPN) implementation, L2TP over IPSec (Level 2 Tunneling Protocol over IP Security) and PPTP (Point to Point Tunneling Protocol) are supported.

## DHCP

DHCP enables a device to be assigned a new IP address and TCP/IP parameters, including a default gateway, whenever the device reboots. Thus DHCP reduces configuration time, conserves IP addresses, and allows modules to be moved to a different network within the Cambium system.

In conjunction with the NAT features, each SM provides:

- A DHCP server that assigns IP addresses to computers connected to the SM by Ethernet protocol.
- A DHCP client that receives an IP address for the SM from a network DHCP server.

## DMZ

In conjunction with the NAT features, a DMZ (demilitarized zone) allows the assignment of one IP address behind the SM for a device to logically exist outside the firewall and receive network traffic. The first three octets of this IP address must be identical to the first three octets of the NAT private IP address.

## Developing an IP addressing scheme

Network elements are accessed through IP Version 4 (IPv4) addressing.

A proper IP addressing method is critical to the operation and security of a network.

Each module requires an IP address on the network. This IP address is for only management purposes. For security, you must either:

- Assign a non-routable IP address.
- Assign a routable IP address only if a firewall is present to protect the module.

You assign an IP addresses to computers and network components by either static or dynamic IP addressing. You will also assign the appropriate subnet mask and network gateway to each module.

## Address Resolution Protocol

As previously stated, the MAC address identifies a module in:

- Communications between modules.
- The data that modules store about each other.

The IP address is essential for data delivery through a router interface. Address Resolution Protocol (ARP) correlates MAC addresses to IP addresses.

For communications to outside the network segment, ARP reads the network gateway address of the router and translates it into the MAC address of the router. Then the communication is sent to MAC address (physical network interface card) of the router.

For each router between the sending module and the destination, this sequence applies. The ARP correlation is stored until the ARP cache times out.

## Allocating subnets

The subnet mask is a 32-bit binary number that filters the IP address. Where a subnet mask contains a bit set to 1, the corresponding bit in the IP address is part of the network address.

### Example IP address and subnet mask

In [Figure 60](#), the first 16 bits of the 32-bit IP address identify the network:

**Figure 60** Example of IP address in Class B subnet

|                         | Octet 1  | Octet 2  | Octet 3  | Octet 4  |
|-------------------------|----------|----------|----------|----------|
| IP address 169.254.1.1  | 10101001 | 11111110 | 00000001 | 00000001 |
| Subnet mask 255.255.0.0 | 11111111 | 11111111 | 00000000 | 00000000 |

In this example, the network address is 169.254 and  $2^{16}$  (65,536) hosts are addressable.

## Selecting non-routable IP addresses

The factory default assignments for network elements are:

- Unique MAC address
- IP address of 169.254.1.1
- Subnet mask of 255.255.0.0
- Network gateway address of 169.254.0.0

For each radio and CMM4, assign an IP address that is both consistent with the IP addressing plan for your network and cannot be accessed from the Internet. IP addresses within the following ranges are not routable from the Internet, regardless of whether a firewall is configured:

- 10.0.0.0 – 10.255.255.255
- 172.16.0.0 – 172.31.255.255
- 192.168.0.0 – 192.168.255.255

Also, the subnet mask and network gateway for each CMM4 can be assigned.

## Translation bridging

Optionally, the AP can be configured to change the source MAC address in every packet it receives from its SMs to the MAC address of the SM/BHS that bridged the packet, before forwarding the packet toward the public network. In this case:

- Not more than 128 IP devices at any time are valid to send data to the AP from behind the SM.
- SM populates the Translation Table tab of its Statistics web page, displaying the MAC address and IP address of all the valid connected devices.
- Each entry in the Translation Table is associated with the number of minutes that have elapsed since the last packet transfer between the connected device and the SM.
- If 128 are connected, and another attempt to connect:
  - If no Translation Table entry is older than 255 minutes, the attempt is ignored.
  - If an entry is older than 255 minutes, the oldest entry is removed and the attempt is successful.
- The **Send Untranslated ARP** parameter in the General tab of the Configuration page can be:
  - Disabled, so that the AP overwrites the MAC address in ARP packets before forwarding them.
  - Enabled, so that the AP forwards ARP packets regardless of whether it has overwritten the MAC address.

This is the **Translation Bridging** feature, which you can enable in the General page of the Configuration web page in the AP. When this feature is disabled, the setting of the **Send Untranslated ARP** parameter has no effect, because all packets are forwarded untranslated (with the source MAC address intact). See [Address Resolution Protocol](#) on Page 3-34.

## Engineering VLANs

The radios support VLAN functionality as defined in the 802.1Q (Virtual LANs) specification, except for the following aspects of that specification:

- Protocols:
  - Generic Attribute Registration Protocol (GARP) GARV
  - Spanning Tree Protocol (STP)
  - Multiple Spanning Tree Protocol (MSTP)
  - GARP Multicast Registration Protocol (GMRP)
- Embedded source routing (ERIF) in the 802.1Q header
- Multicast pruning
- Flooding unknown unicast frames in the downlink

As an additional exception, the AP/BHM does not flood downward the unknown unicast frames to the SM/BHS.

A VLAN configuration in Layer 2 establishes a logical group within the network. Each computer in the VLAN, regardless of initial or eventual physical location, has access to the same data. For the network operator, this provides flexibility in network segmentation, simpler management, and enhanced security.

## Special case VLAN numbers

This system handles special case VLAN numbers according to IEEE specifications:

**Table 88** Special case VLAN IDs

| VLAN Number | Purpose                                                                                                                                                                                                         | Usage Constraint                          |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| 0           | These packets have 802.1p priority, but are otherwise handled as untagged.                                                                                                                                      | Must not be used as a management VLAN.    |
| 1           | Although not noted as special case by IEEE specifications, these packets identify traffic that was untagged upon ingress into the SM and must remain untagged upon egress. This policy is hard-coded in the AP. | Must not be used for system VLAN traffic. |
| 4095        | This VLAN is reserved for internal use.                                                                                                                                                                         | Must not be used at all.                  |

## SM membership in VLANs

With the supported VLAN functionality, the radios determine bridge forwarding on the basis of not only the destination MAC address, but also the VLAN ID of the destination. This provides flexibility in how SMs are used:

- Each SM can be a member in its own VLAN.
- Each SM can be in its own broadcast domain, such that only the radios that are members of the VLAN can see broadcast and multicast traffic to and from the SM.
- The network operator can define a work group of SMs, regardless of the AP(s) to which they register.

PMP 450 Platform Family modules provide the VLAN frame filters that are described in [Table 89](#).

**Table 89** VLAN filters in point-to-multipoint modules

| Where VLAN is active,<br>if this parameter value<br>is selected ...                                                | then a frame is discarded if...                            |                                              | because of this VLAN<br>filter in the software: |
|--------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|----------------------------------------------|-------------------------------------------------|
|                                                                                                                    | entering the bridge/<br>NAT switch through...              |                                              |                                                 |
|                                                                                                                    | Ethernet...                                                | TCP/IP...                                    |                                                 |
| any combination of<br>VLAN<br>parameter settings                                                                   | with a VID not in the<br>membership table                  |                                              | Ingress                                         |
| any combination of<br>VLAN<br>parameter settings                                                                   |                                                            | with a VID not in<br>the<br>membership table | Local Ingress                                   |
| <b>Allow Frame Types:<br/>Tagged Frames Only</b>                                                                   | with no 802.1Q tag                                         |                                              | Only Tagged                                     |
| <b>Allow Frame Types:<br/>Untagged Frames Only</b>                                                                 | with an 802.1Q tag,<br>regardless of VID                   |                                              | Only Untagged                                   |
| <b>Local SM Management:<br/>Disable</b> in the SM, or<br><b>All Local SM<br/>Management:<br/>Disable</b> in the AP | with an 802.1Q tag<br>and a VID in the<br>membership table |                                              | Local SM Management                             |
|                                                                                                                    | <b>leaving the bridge/<br/>NAT switch through...</b>       |                                              |                                                 |
|                                                                                                                    | <b>Ethernet...</b>                                         | <b>TCP/IP...</b>                             |                                                 |
| any combination of<br>VLAN<br>parameter settings                                                                   | with a VID not in the<br>membership table                  |                                              | Egress                                          |
| any combination of<br>VLAN<br>parameter settings                                                                   |                                                            | with a VID not in<br>the<br>membership table | Local Egress                                    |

## Priority on VLANs (802.1p)

The radios can prioritize traffic based on the eight priorities described in the IEEE 802.1p specification. When the high-priority channel is enabled on a SM, regardless of whether VLAN is enabled on the AP for the sector, packets received with a priority of 4 through 7 in the 802.1p field are forwarded onto the high-priority channel.

For example, when the high priority and low priority channels are enabled on an SM, medium and ultra high priority channels are disabled.

Operators may configure priority precedence as 802.1p Then Diffserv (Default) or Diffserv Then 802.1p. Since these priority precedence configurations are independent between the AP and SM, this setting must be configured on both the AP and SM to ensure that the precedence is adhered to by both sides of the link.

VLAN settings can also cause the module to convert received non-VLAN packets into VLAN packets. In this case, the 802.1p priority in packets leaving the module is set to the priority established by the DiffServ configuration.

If VLAN is enabled, immediately monitor traffic to ensure that the results are as desired. For example, high-priority traffic may block low-priority.

## Q-in-Q DVLAN (Double-VLAN) Tagging (802.1ad)

PMP and PTP modules can be configured with 802.1ad Q-in-Q DVLAN (Double-VLAN) tagging which is a way for an operator to put an 802.1Q VLAN inside of an 802.1ad VLAN. A nested VLAN, which is the original 802.1Q tag and a new second 802.1ad tag, allows for bridging of VLAN traffic across a network and segregates the broadcast domains of 802.1Q VLANs. Q-in-Q can be used with PPPoE and/or NAT.

The 802.1ad standard defines the S-VLAN as the Service Provider VLAN and the C-VLAN as the customer VLAN. The radio software does 2-layer Q-in-Q whereby the C-VLAN is the 802.1Q tag and the S-VLAN is the second layer Q tag as shown in [Table 90](#).

**Table 90** Q-in-Q Ethernet frame

|                 |                          |                          |                        |
|-----------------|--------------------------|--------------------------|------------------------|
| Ethernet Header | S-VLAN EthType<br>0x88a8 | C-VLAN EthType<br>0x8100 | IP Data EthType 0x0800 |
|-----------------|--------------------------|--------------------------|------------------------|

The 802.1ad S-VLAN is the outer VLAN that is configurable on the **Configuration > VLAN** web page of the AP/BHM. The Q-in-Q EtherType parameter is configured with a default EtherType of 0x88a8 in addition to four alternate EtherTypes that can be configured to aid in interoperability with existing networks that use a different EtherType than the default.

The C-VLAN is the inner VLAN tag, which is the same as 802.1Q. As a top-level concept, this operates on the outermost tag at any given time, either “pushing” a tag on or “popping” a tag off. This means packets will at most transition from an 802.1Q frame to an 801.ad frame (with a tag “pushed” on) or an untagged 802.1 frame (with the tag “popped” off. Similarly, for an 802.1ad frame, this can only transition from an 802.1ad frame to an 802.1Q frame (with the tag “popped” off) since the radio software only supports 2 levels of tags.



# Network management planning

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This section describes how to plan for 450 Platform Family links to be managed remotely using SNMP.

## Planning for SNMP operation

Cambium modules provide the following SNMP traps for automatic notifications to the NMS:

- coldStart, which signals that the SNMPv2c element is reinitializing itself and that its configuration may have been altered.
- warmStart, which signals that the SNMPv2c element is reinitializing such that its configuration is unaltered.
- authenticationFailure, which signals that the SNMPv2c element has received a protocol message that is not properly authenticated (contingent on the snmpEnableAuthenTraps object setting).
- linkDown, as defined in RFC 1573
- linkUp, as defined in RFC 1573
- egpNeighborLoss, as defined in RFC 1213
- whispGPSInSync, which signals a transition from not synchronized to synchronized.
- whispGPSOutSync, which signals a transition from synchronized to not synchronized.
- whispRegComplete, which signals registration completed.
- whispRegLost, which signals registration lost.
- whispRadarDetected, which signals that the one-minute scan has been completed, radar has been detected and the radio will shut down.
- whispRadarEnd, which signals that the one-minute scan has been completed, radar has not been detected and the radio will resume normal operation.

**Note**

The proprietary MIBs are provided in the 450 Platform Family software download files in the support website (see [Contacting Cambium Networks](#) on page 1).

---

## Enabling SNMP

Enable the SNMP interface for use by configuring the following attributes in the SNMP Configuration page:

- SNMP State (default disabled)
- SNMP Version (default SNMPv2c)
- SNMP Port Number (default 161)

# Security planning

---

This section describes how to plan for 450 Platform Family links to operate in secure mode.

- Managing module access by passwords
- Filtering protocols and ports
- Port Configuration

## Isolating AP/BHM from the Internet

Ensure that the IP addresses of the AP/BHM in the network:

- are not routable over the Internet.
- do not share the subnet of the IP address of your user.

RFC 1918, Address Allocation for Private Subnets, reserves for private IP networks three blocks of IP addresses that are not routable over the Internet:

- /8 subnets have one reserved network, 10.0.0.0 to 10.255.255.255.
- /16 subnets have 16 reserved networks, 172.16.0.0 to 172.31.255.255.
- /24 subnets have 256 reserved networks, 192.168.0.0 to 192.168.255.255.

## Encrypting radio transmissions

Cambium fixed wireless broadband IP systems employ the following form of encryption for security of the wireless link:

**AES (Advanced Encryption Standard):** An over-the-air link encryption option that uses the Rijndael algorithm and 128-bit keys to establish a higher level of security than DES. AES products are certified as compliant with the Federal Information Processing Standards (FIPS 197) in the U.S.A.

The default encryption setting for 450 Platform Family ODU is "None".

## Planning for HTTPS operation

Before starting to configure HTTPS operation, ensure that the cryptographic material listed in [Table 91](#) is available.

**Table 91** HTTPS security material

| Item                                    | Description                                                                                                                                                | Quantity required                                        |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|
| User Defined Security Banner            | The banner provides warnings and notices to be read by the user before logging in to the ODU. Use text that is appropriate to the network security policy. | Normally one per link. This depends upon network policy. |
| Port numbers for HTTP, HTTPS and Telnet | Port numbers allocated by the network.                                                                                                                     | As allocated by network.                                 |

## Planning for SNMPv3 operation

### SNMP security mode

Decide how SNMPv3 security will be configured.

MIB-based security management uses standard SNMPv3 MIBs to configure the user-based security model and the view-based access control model. This approach provides considerable flexibility, allowing a network operator to tailor views and security levels appropriate for different types of user. MIB-based security management may allow a network operator to take advantage of built-in security management capabilities of existing network managers.

Web-based security management allows an operator to configure users, security levels, privacy and authentication protocols, and passphrases using the 450 Platform Family web-based management interface. The capabilities supported are somewhat less flexible than those supported using the MIB-based security management, but will be sufficient in many applications. Selection of web-based management for SNMPv3 security disables the MIB-based security management. 450 Platform Family does not support concurrent use of MIB-based and web-based management of SNMPv3 security.

### Web-based management of SNMPv3 security

Initial configuration of SNMPv3 security is available only to HTTP or HTTPS user accounts with security role of Security Officer.

Identify the format used for SNMP Engine ID. The following formats are available:

- MAC address (default)
- 5 and 32 hex characters (the hex character input is driven by RFC 3411 recommendations on the Engine ID)

Identify the user names and security roles of initial SNMPv3 users. Two security roles are available:

- Read Only
- System Administrator

Identify the security level for each of the security roles. Three security levels are available:

- (a) No authentication, no privacy
- (b) Authentication, no privacy
- (c) Authentication, privacy

If authentication is required, identify the protocol. The authentication protocol available is MD5.

If privacy will be used, identify the protocol. The privacy protocol available is cbc-des.

## Managing module access by passwords

From the factory, each module has a preconfigured administrator-level account in the name `root`, which initially requires no associated password. When you upgrade a module:

- An account is created in the name `admin`.
- Both `admin` and `root` inherit the password that was previously used to access the module, if:
  - **Full Access** password, if one was set.
  - **Display-Only Access** password, if one was set and no Full Access password was set.



### Caution

If you use Wireless Manager, do not delete the root account from any module. If you use a NMS that communicates with modules through SNMP, do not delete the root account from any module unless you first can confirm that the NMS does not rely on the root account for access to the modules.

---

Each module supports four or fewer user accounts, regardless of account levels. The available levels are

- **ADMINISTRATOR**, who has full read and write permissions. This is the level of the `root` and `admin` users, as well as any other administrator accounts that one of them creates.
- **INSTALLER**, who has permissions identical to those of **ADMINISTRATOR** except that the installer cannot add or delete users or change the password of any other user.
- **TECHNICIAN**, who has permissions to modify basic radio parameters and view informational web pages.
- **GUEST**, who has no write permissions and only a limited view of General Status tab.
- Admin, Installer and Tech accounts can be configured as **READ-ONLY**. This will allow the account to only see the items.

The ability to view information of General Status tab can be controlled by the "Site Information Viewable to Guest Users" under the SNMP tab.

From the factory default state, configure passwords for both the `root` and `admin` account at the ADMINISTRATOR permission level, using the **Account > Change Users Password** page. (If configure only one of these, then the other will still require no password for access into it and thus remain a security risk.) If you are intent on configuring only one of them, delete the `admin` account. The `root` account is the only account that CNUt uses to update the module.

After a password has been set for any ADMINISTRATOR-level account, initial access to the module GUI opens the view of GUEST level.

## Planning for RADIUS operation

Configure RADIUS where remote authentication is required for users of the web-based interface. Remote authentication has the following advantages:

- Control of passwords can be centralized.
- Management of user accounts can be more sophisticated. For example; users can be prompted by a network manager to change passwords at regular intervals. As another example, passwords can be checked for inclusion of dictionary words and phrases.
- Passwords can be updated without reconfiguring multiple network elements.
- User accounts can be disabled without reconfiguring multiple network elements.

Remote authentication has one significant disadvantage in a wireless link product such as 450 Platform Family. If the wireless link is down, a unit on the remote side of the broken link may be prevented from contacting a RADIUS Server, with the result that users are unable to access the web-based interface.

One useful strategy would be to combine RADIUS authentication for normal operation with a single locally-authenticated user account for emergency use.

PMP 450 Platform Family SM provides a choice of the following authentication methods:

- Phase 1:
  - EAP-MSCHAPv2
  - EAP-TTLS
  - EAP PEAP
- Phase 2:
  - PAP
  - CHAP
  - MSCHAPv2

Ensure that the authentication method selected in 450 Platform Family is supported by the RADIUS server.

## Filtering protocols and ports

Configure filters for specified protocols and ports from leaving the AP/BHM and SM/BHS and entering the network. This protects the network from both intended and inadvertent packet loading or probing by network users. By keeping the specified protocols or ports off the network, this feature also provides a level of protection to users from each other.

Protocol and port filtering is set per AP/SM/BH. Except for filtering of SNMP ports, filtering occurs as packets leave the AP/SM/BH.

For example, if SM is configured to filter SNMP, then SNMP packets are blocked from entering the SM and, thereby, from interacting with the SNMP portion of the protocol stack on the SM.

## Port Filtering with NAT Enabled

Where NAT is enabled on the SM/BHS, the filtering can be enabled for only the user-defined ports. The following are examples for situations where the configure port can be filtered where NAT is enabled:

- To block a subscriber from using FTP, you can filter Ports 20 and 21 (the FTP ports) for both the TCP and UDP protocols.
- To block a subscriber from access to SNMP, you can filter Ports 161 and 162 (the SNMP ports) for both the TCP and UDP protocols.



### Note

In only the SNMP case, filtering occurs before the packet interacts with the protocol stack.

---

## Protocol and Port Filtering with NAT Disabled

Where NAT is disabled on the SM/BHS, the filtering can be enabled for both protocols and the three user-defined ports. Using the check boxes on the interface, it can be either:

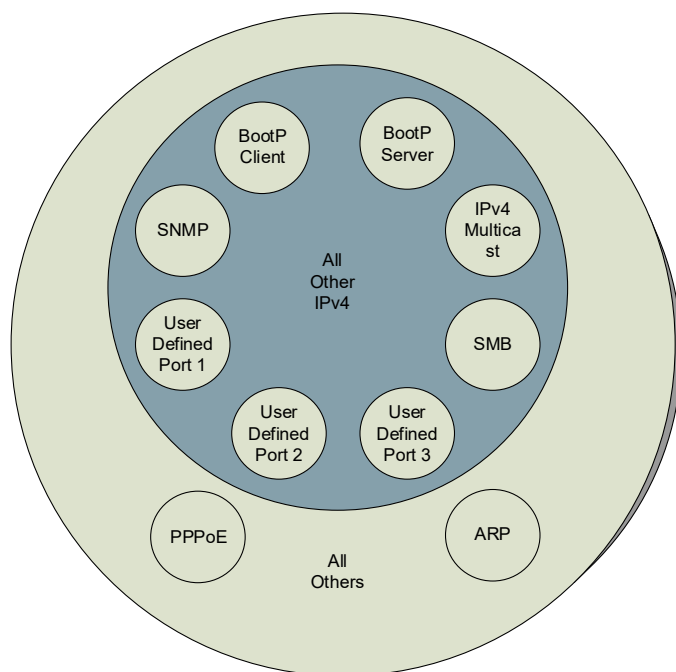
- Allow all protocols except those that user wish to block.
- Block all protocols except those that user wish to allow.

Allow or block any of the following protocols:

- PPPoE (Point to Point Protocol over Ethernet)
- Any or all the following IPv4 (Internet Protocol version 4) protocols:
  - SMB (Network Neighborhood)
  - SNMP
  - Bootp Client
  - Bootp Server
  - Up to 3 user-defined ports
  - All other IPv4 traffic (see [Figure 29](#))
- Any or all of the following IPv6 (Internet Protocol version 6) protocols:
  - SMB (Network Neighborhood)
  - SNMP
  - Bootp Client
  - Bootp Server
  - Up to 3 user-defined ports

- All other IPv6 traffic (see Figure 29)
- Filter Direction – Upstream and Downstream
- ARP (Address Resolution Protocol)

**Figure 61** Categorical protocol filtering



The following are example situations in which the protocol filtering is configured where NAT is disabled:

- If a subscriber is blocked from only PPPoE and SNMP, then the subscriber retains access to all other protocols and all ports.
- If PPPoE, IPv4, and Uplink Broadcast are blocked, and check the **All others** selection, then only Address Resolution Protocol is not filtered.

The ports filtered because of protocol selections in the **Protocol Filtering** tab of the SM/BHS are listed in [Table 92](#).

**Table 92** Ports filtered per protocol selections

| Protocol Selected      | Port Filtered (Blocked)                                                                                                    |
|------------------------|----------------------------------------------------------------------------------------------------------------------------|
| SMB                    | Destination Ports UDP: 137, 138, 139, 445, 3702 and 1900<br>Destination Ports TCP: 137, 138, 139, 445, 2869, 5357 and 5358 |
| SNMP                   | Destination Ports TCP and UDP: 161 and 162                                                                                 |
| Bootp Client           | Source Port 68 UDP                                                                                                         |
| Bootp Server           | Source Port 67 UDP                                                                                                         |
| User Defined Port 1..3 | User defined ports for filtering UDP and TCP                                                                               |
| IPv4 Multicast         | Block IPv4 packet types except other filters defined                                                                       |
| IPv6 Multicast         | Block IPv6 packet types except other filters defined                                                                       |
| ARP                    | Filter all Ethernet packet type 806                                                                                        |
| Upstream               | Applies packet filtering to traffic coming into the FEC interface                                                          |
| Downstream             | Applies packet filtering to traffic destined to exit the FEC interface                                                     |

## Port Configuration

450 Platform Family supports access to various communication protocols and only the ports required for these protocols are available for access by external entities. Operators may change the port numbers for these protocols via the radio GUI or SNMP.

**Table 93** Device default port numbers

| Port | Usage                           | Port Usage       | Device |
|------|---------------------------------|------------------|--------|
| 21   | FTP                             | Listen Port      | AP, SM |
| 80   | HTTP                            | Listen Port      | AP, SM |
| 443  | HTTPS                           | Listen Port      | AP, SM |
| 161  | SNMP port                       | Listen Port      | AP, SM |
| 162  | SNMP trap port                  | Destination Port | AP, SM |
| 514  | Syslog Server port              | Destination Port | AP, SM |
| 1812 | Standard RADIUS port            | Destination Port | AP     |
| 1813 | Standard RADIUS accounting port | Destination Port | AP, SM |



## Encrypting downlink broadcasts

An AP can be enabled to encrypt downlink broadcast packets such as the following:

- ARP
- NetBIOS
- broadcast packets containing video data on UDP.

The encryption used is DES for a DES-configured module and AES for an AES-configured module. Before the Encrypt Downlink Broadcast feature is enabled on the AP, air link security must be enabled on the AP.

## Isolating SMs in PMP

In an AP, SMs in the sector can be prevented from directly communicating with each other. In CMM4, the connected APs can be prevented from directly communicating with each other, which prevents SMs that are in different sectors of a cluster from communicating with each other.

In the AP, the **SM Isolation** parameter is available in the General tab of the Configuration web page. Configure the SM Isolation feature by any of the following selections from drop-down menu:

- **Disable SM Isolation** (the default selection). This allows full communication between SMs.
- **Enable Option 1 - Block SM destined packets from being forwarded**. This prevents both multicast/broadcast and unicast SM-to-SM communication.
- **Enable Option 2 - Forward SM destined packets upstream**. This not only prevents multicast/broadcast and unicast SM-to-SM communication but also sends the packets, which otherwise may have been handled SM to SM, through the Ethernet port of the AP.

In the CMM and the CMM4, SM isolation treatment is the result of how to manage the port-based VLAN feature of the embedded switch, where all traffic can be switched from any AP to a specified uplink port. However, this is not packet level switching. It is not based on VLAN IDs.

## Filtering management through Ethernet

Configure the SM to disallow any device that is connected to its Ethernet port from accessing the IP address of the SM. If the **Ethernet Access Control** parameter is set to **Enabled**, then:

- No attempt to access the SM management interface (by http, SNMP, ftp, or tftp) through Ethernet is granted.
- Any attempt to access the SM management interface over the air (by IP address, presuming that **LAN1 Network Interface Configuration, Network Accessibility** is set to **Public**, or by link from the Session Status or Remote Subscribers tab in the AP) is unaffected.

## Allowing management from only specified IP addresses

The Security sub-menu of the Configuration web page in the AP/BHM and SM/BHS includes the **IP Access Control** parameter. Specify one, two, or three IP addresses that must be allowed to access the management interface (by HTTP, SNMP, FTP or TFTP).

If the selection is:

- **IP Access Filtering** Disabled, then management access is allowed from any IP address, even if the Allowed Source IP 1 to 3 parameters are populated.
- **IP Access Filtering** Enabled, and specify at least one address in the Allowed Source IP 1 to 3 parameter, then management access is limited to the specified address(es).

## Configuring management IP by DHCP

The **Configuration > IP** web page of every radio contains a **LAN1 Network Interface** Configuration, DHCP State parameter that, if enabled, causes the IP configuration (IP address, subnet mask, and gateway IP address) to be obtained through DHCP instead of the values of those individual parameters. The setting of this DHCP state parameter is also viewable, but is not settable, in the Network Interface tab of the Home page.

In the SM/BHS, this parameter is settable

- in the **NAT** tab of the Configuration web page, but only if NAT is enabled.
- in the **IP** tab of the Configuration web page, but only if the Network Accessibility parameter in the IP tab is set to Public.

## DHCP option 81

The DHCP server can be used to register and update the pointer (PTR) and host (A) DNS resource records on behalf of its DHCP-enabled clients.

The DHCP option 81 permits the client to provide its fully qualified domain name (FQDN) as well as instructions to the DHCP server on how it would like the server to process DNS dynamic updates (if any) on its behalf. The hostname is populated as SiteName.DomainName depending upon following conditions:

- If SiteName is default i.e. No Site Name, mac address will be used instead.
- The SiteName should only be a-z | A-Z | 0-9 and period(.) and dash (-).
- The domain name part should not start or end with dash (-).
- The underscore or space in domain name part will be converted to dash (-), anything else apart from valid characters will be skipped.

## Controlling PPPoE PADI Downlink Forwarding

The AP supports the control of forwarding of PPPoE PADI (PPPoE Active Discovery Initiation) packets. This forwarding is configured on the AP GUI **Configuration > Radio** page by parameter **PPPoE PADI Downlink Forwarding**. When set to “Enabled”, the AP allows downstream and upstream transmission of PPPoE PADI packets. When set to “Disabled”, the AP does NOT allow PPPoE PADI packets to be sent out of the AP RF interface (downstream) but will allow PPPoE PADI packets to enter the RF interface (upstream) and exit the Ethernet interface.

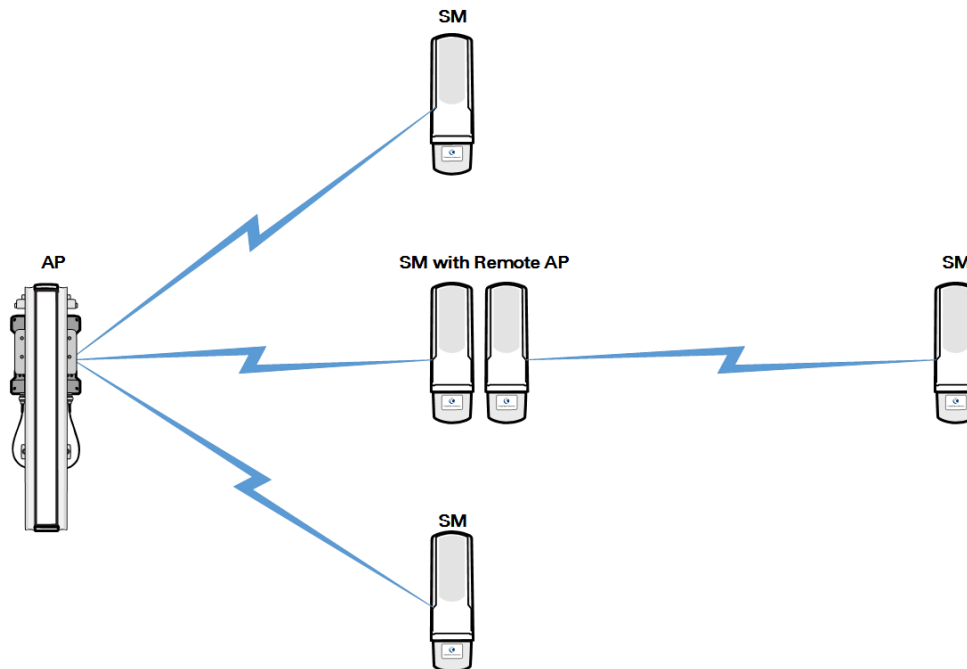
## Remote AP Deployment

In cases where the subscriber population is widely distributed, or conditions such as geography restrict network deployment, you can add a Remote AP to:

- provide high-throughput service to near LoS business subscribers.
- reach around obstructions or penetrate foliage with non-LoS throughput.
- reach new, especially widely distributed, residential subscribers with broadband service.
- pass sync to an additional RF hop.

In the remote AP configuration, a remote AP is co-located with an SM. The remote AP distributes the signal to SMs that are logically behind the co-located SM. A remote AP deployment is illustrated in [Figure 62](#).

**Figure 62** Remote AP deployment



The co-located SM receives data in one channel, and the remote AP must redistribute the data in a different channel. The two channels need to have a frequency gap equal to at least two times the used channel bandwidth.

Base your selection of frequency band ranges on regulatory restrictions, environmental conditions, and throughput requirements.



### Note

Each relay hop (additional daisy-chained remote AP) adds approximately 5-7 msec round trip latency.

## Remote AP (RAP) Performance

The performance of a remote AP is identical to the AP performance in cluster. Throughputs, ranges, and antenna coverage are identical.

As with all equipment operating in the unlicensed spectrum, Cambium strongly recommends that you perform site surveys before you add network elements. These will indicate that spectrum is available in the area where you want to grow. Keep in mind that:

- non-LoS ranges heavily depend on environmental conditions.
- in most regions, not all frequencies are available.
- your deployments must be consistent with local regulatory restrictions.

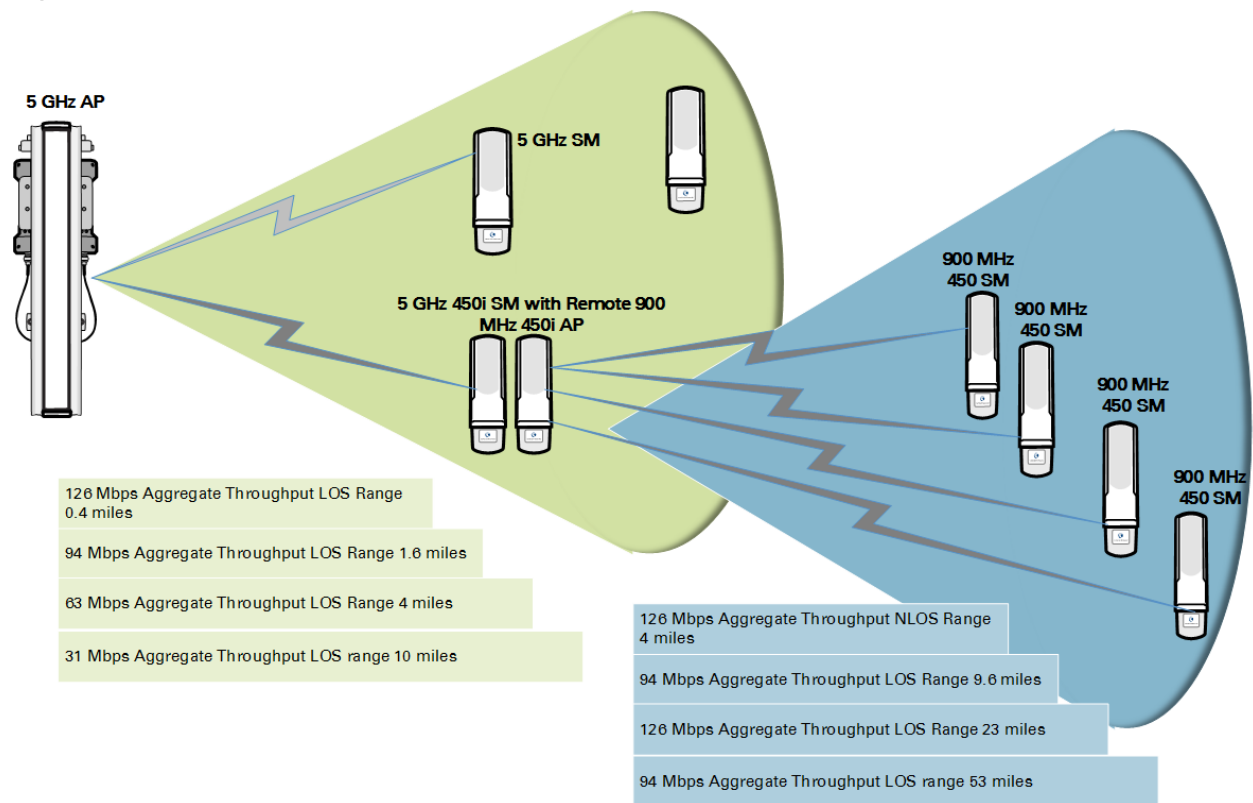
## Example Use Case for RF Obstructions

A remote AP can be used to provide last-mile access to a community where RF obstructions prevent SMs from communicating with the higher-level AP in cluster. For example, you may be able to use 900 MHz for the last mile between a remote AP and the outlying SMs where these subscribers cannot form good links to a higher-level 5 GHz AP. In this case, the ability of the 900-MHz wavelength to be effective around foliage at short range solves the foliage penetration problem.

An example of this use case is shown in [Figure 63](#).

In this example, the 5 GHz AP is a PMP 450i AP in the 5.8 GHz band operating on a 20 MHz channel with a 2.5 ms frame; the SMs are 5 GHz PMP 450 integrated SMs. The SM connected to the remote AP is a PMP 450i SM.

The remote AP is a PMP 450i AP in the 900 MHz band, also operating in a 20 MHz channel with a 2.5 ms frame; the SMs are 900 MHz PMP 450 connectorized SMs using the Cambium 23 dBi gain antenna.

**Figure 63** Example for 900-MHz remote AP behind 5 GHz SM

The 5 GHz modules provide a sustained aggregate throughput of up to 126 Mbps to the sector. One of the SMs in the sector is wired to a 900-MHz remote AP, which provides NLoS sustained aggregate throughput<sup>2</sup> of:

- 126 Mbps to 900-MHz SMs up to 4 miles away in the sector.
- 94 Mbps to 900-MHz SMs between 4 and 10 miles away in the sector.

## Example Use Case for Passing Sync

All radios support the remote AP functionality. The BHS and the SM can reliably pass the sync pulse, and the BHM and AP can reliably receive it.

However, not all devices are compatible with all other devices. The following table shows which SMs can be connected to which APs.

| Devices         | PMP 450 AP/BHM | PMP 450i AP/BHM | PMP 450m AP |
|-----------------|----------------|-----------------|-------------|
| PMP 450 SM/BHS  | X              |                 |             |
| PMP 450i SM/BHS |                | X               | X           |

<sup>2</sup> NLoS ranges depend on environmental conditions. Your results may vary from these.

Examples of passing sync over cable are shown under [Passing Sync in an Additional Hop](#) on page 3-56.

For PMP 450, the sync is passed in a cable that connects Pins 1 and 6 of the RJ-11 timing ports of the two modules.

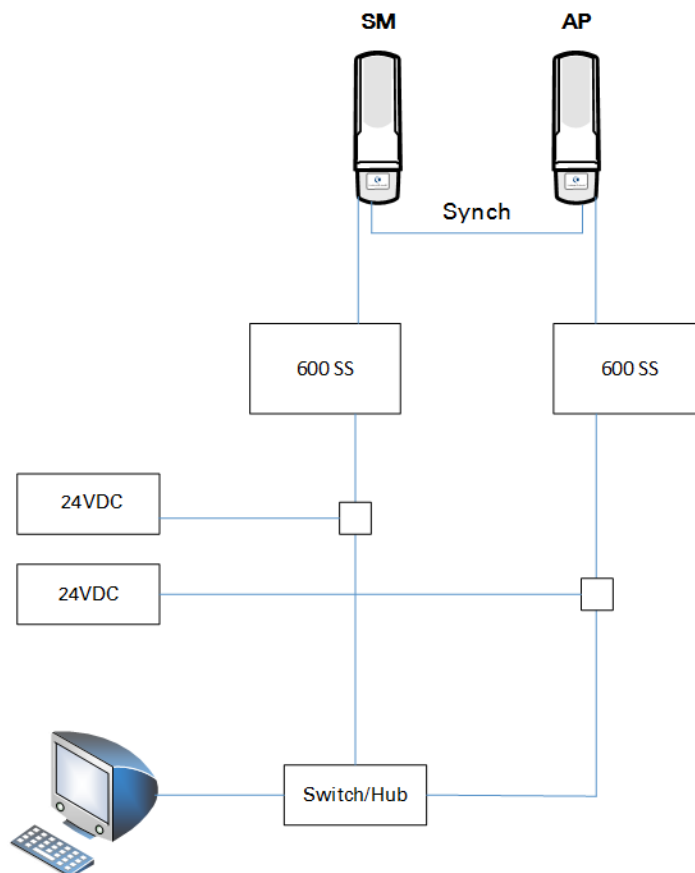
For PMP 450i/450m the sync is passed in a cable that connects Pins 7 and 8 of the RJ-45 timing ports of the two modules.

When connecting modules in this way, make sure the AP and SM are properly configured, as described in the [Wiring to Extend Network Sync](#).

## Physical Connections Involving the Remote AP

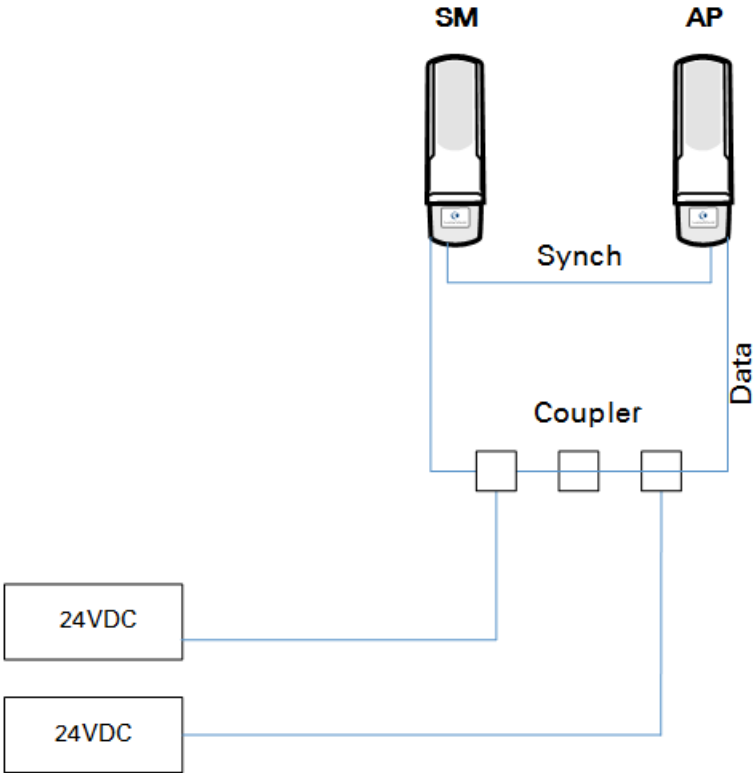
The SM to which a remote AP is connected to can be either an SM that serves a customer or an SM that simply serves as a relay. If the SM serves a customer, wire the remote AP to the SM as shown in [Figure 64](#).

**Figure 64** Remote AP wired to SM that also serves a customer



If the SM simply serves as a relay, you must use a straight-through RJ-45 female-to-female coupler and wire the SM to the remote AP as shown in [Figure 65](#).

**Figure 65** Remote AP wired to SM that serves as a relay





## Passing Sync signal

### Passing Sync in a Single Hop

Network sync can be passed in a single hop in the following network designs:

- Design 1
  - A CMM provides sync to a co-located AP.
  - This AP sends the sync over the air to SMs.
- Design 2
  - A CMM provides sync to a co-located BH timing master.
  - This BH timing master sends the sync over the air to a BH timing slave.

### Passing Sync in an Additional Hop

Network sync can be extended by one additional link in any of the following network designs:



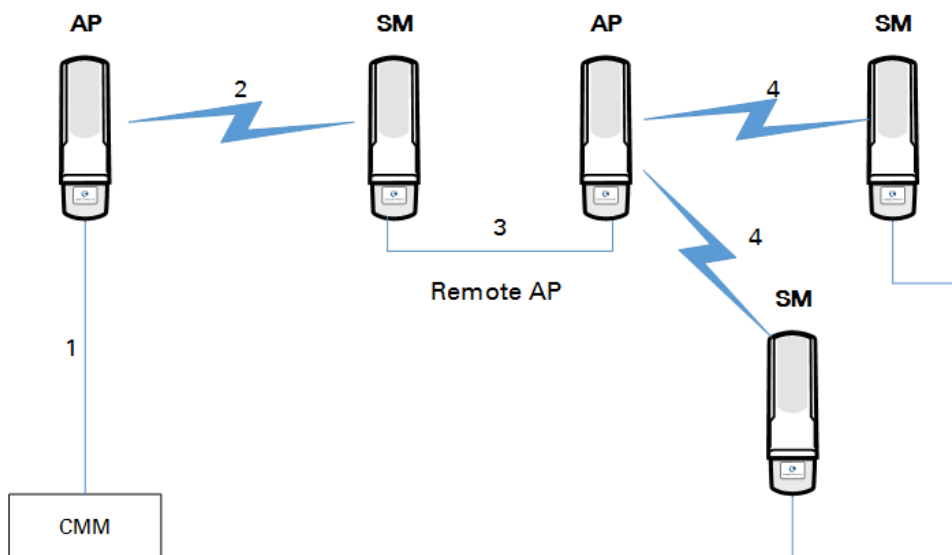
#### Note

In each of these following designs, Link 2 is not on the same frequency band as Link 4. (For example, Link 2 may be a 5.2 GHz link while Link 4 is a 5.7 or 2.4 GHz link.)

- Design 3
  - A CMM provides sync to a co-located AP.
  - This AP sends the sync over the air to an SM.
  - This SM delivers the sync to a co-located AP.
  - This AP passes the sync in the additional link over the air to SMs.

This design is illustrated in [Figure 66](#).

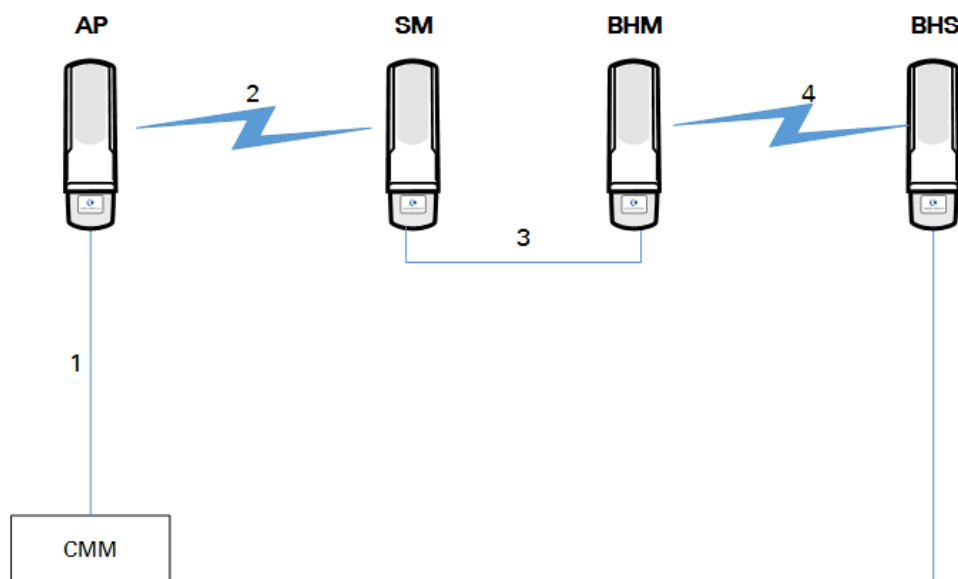
**Figure 66** Additional link to extend network sync, Design 3



- Design 4
  - A CMM provides sync to a co-located AP.
  - This AP sends the sync over the air to an SM.
  - This SM delivers the sync to a co-located BHM.
  - This BHM passes the sync in the additional link over the air to a BHS.

This design is illustrated in [Figure 67](#).

**Figure 67** Additional link to extend network sync, Design 4

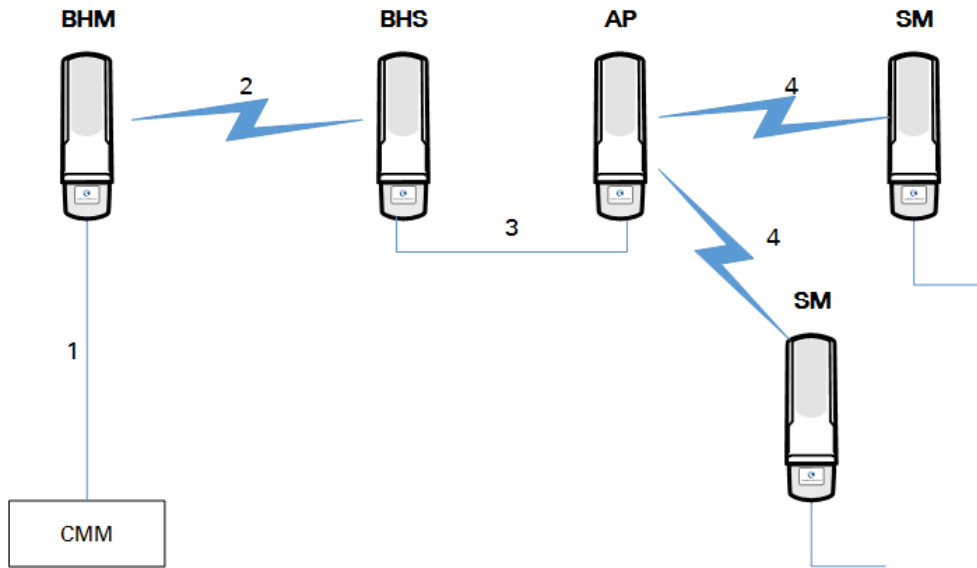


- Design 5
  - A CMM provides sync to a co-located BHM or the BHM generates timing.
  - This BHM sends the sync over the air to a BHS.
  - This BHS delivers the sync to a co-located AP.

This AP passes the sync in the additional link over the air to SMs.

This design is illustrated in [Figure 68](#).

**Figure 68** Additional link to extend network sync, Design 5



Wiring and configuration information for this sync extension is described under [Wiring to Extend Network Sync](#) on page 3-59.

## Wiring to Extend Network Sync

The following procedure can be used to extend network sync by one additional hop, as described under [Passing Sync in an Additional Hop](#) on page 3-56. When a co-located module receives sync over the air, the co-located modules can be wired to pass the sync as follows:

1. Connect the GPS Utility ports of the co-located modules using a sync cable with RJ-11 (for 450) or RJ-45 (for 450i/450m) connectors.
2. Set the Sync Input parameter on the Configuration page of the co-located AP or BH timing master to AutoSync.
3. Set the Device Type parameter on the Configuration page of the co-located AP or BH timing master to Remote.
4. Set the Sync Output to Aux Port parameter on the Configuration page of the co-located AP or BH timing master to Disabled.
5. Set the UGPS Power parameter on the Configuration page of the co-located AP or BH timing master to Disabled.
6. Set the Frame Timing Pulse Gated parameter on the Configuration page of the co-located SM or BH timing slave to Enable.



### Note

This setting prevents interference if the SM or BH timing slave loses sync.

**Figure 69** Co-located AP or BH timing master Sync Setting configuration

| Sync Setting                  |                                                                            |
|-------------------------------|----------------------------------------------------------------------------|
| Sync Input :                  | AutoSync ▼                                                                 |
| Free Run Before GPS Sync :    | <input type="radio"/> Enabled<br><input checked="" type="radio"/> Disabled |
| Device Type :                 | <input type="radio"/> Standard<br><input checked="" type="radio"/> Remote  |
| Verify GPS Message Checksum : | <input checked="" type="radio"/> Enabled<br><input type="radio"/> Disabled |
| Sync Output to Aux Port :     | <input type="radio"/> Enabled<br><input checked="" type="radio"/> Disabled |
| UGPS Power :                  | <input type="radio"/> Enabled<br><input checked="" type="radio"/> Disabled |

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## Chapter 4: Legal and regulatory information

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This chapter provides end user license agreements and regulatory notifications.



### Caution

Intentional or unintentional changes or modifications to the equipment must not be made unless under the express consent of the party responsible for compliance. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty.



### Attention

Changements ou modifications Intentionnels ou non de l'équipement ne doivent pas être entrepris sans l'autorisation de l'organisme responsable de la déclaration de conformité. Ces modifications ou changements pourraient invalider le droit de l'utilisateur à utiliser cet appareil et annuleraient la garantie du fabricant.

---

The following topics are described in this chapter:

- [Cambium Networks end user license agreement](#) on page [4-2](#) contains the Cambium and third-party license agreements for the 450 Platform Family ODUs.
- [Compliance with safety standards](#) on page [4-22](#) lists the safety specifications against which the 450 Platform Family has been tested and certified. It also describes how to keep RF exposure within safe limits.
- [Compliance with radio regulations](#) on page [4-36](#) describes how the 450 Platform Family complies with the radio regulations that are in force in various countries, and contains notifications made to regulatory bodies for the 450 Platform Family.

# Cambium Networks end user license agreement

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## D3 JS library

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# Compliance with safety standards

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This section lists the safety specifications against which the 450 Platform Family has been tested and certified. It also describes how to keep RF exposure within safe limits.

## Electrical safety compliance

The 450 Platform Family hardware has been tested for compliance to the electrical safety specifications listed in [Table 94](#).

**Table 94** Safety compliance specifications

| Region        | Specification                           |
|---------------|-----------------------------------------|
| USA           | UL 60950                                |
| Canada        | CSA C22.2 No.60950                      |
| International | CB certified & certificate to IEC 60950 |

## Electromagnetic compatibility (EMC) compliance

The EMC specification type approvals that have been granted for 450 Platform Family are listed under [Table 95](#).

**Table 95** EMC emissions compliance

| Region        | Specification                               |
|---------------|---------------------------------------------|
| USA           | FCC Part 15 Class B                         |
| Canada        | RSS Gen and RSS 210                         |
| International | EN 301 489-1 V1.9.2<br>EN 301 489-17 V2.1.1 |

## Human exposure to radio frequency energy

Relevant standards (USA and EC) applicable when working with RF equipment are:

- ANSI IEEE C95.1-1991, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
- Council recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC) and respective national regulations.

- *Directive 2004/40/EC of the European Parliament and of the Council of 29 April 2004* on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (18th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC).
- US FCC limits for the general population. See the FCC web site at <http://www.fcc.gov>, and the policies, guidelines, and requirements in Part 1 of Title 47 of the Code of Federal Regulations, as well as the guidelines and suggestions for evaluating compliance in FCC OET Bulletin 65.
- Health Canada limits for the general population. See the Health Canada web site at <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/consultations/limits-human-exposure-radiofrequency-electromagnetic-energy-frequency-range-3-300.html> and Safety Code 6.
- EN 50383:2002 to 2010 Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz - 40 GHz).
- BS EN 50385:2017 Product standard to demonstrate the compliances of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz – 40 GHz) – general public.
- ICNIRP (International Commission on Non-Ionizing Radiation Protection) guidelines for the general public. See the ICNIRP web site at <https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf> and Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields.

## Power density exposure limit

Install the radios for the 450 Platform Family of wireless solutions so as to provide and maintain the minimum separation distances from all persons.

The applicable FCC power density exposure limit for RF energy in the 4.9, 5.4 and 5.8 GHz frequency bands is **10 W/m<sup>2</sup>** and in 900 MHz frequency band is **6 W/m<sup>2</sup>**. For more information, see [Human exposure to radio frequency energy](#) on page 4-22.

The applicable ISED power density exposure limit for RF energy in unlicensed bands is  $0.02619 * (f^{0.6834})$ , where  $f$  is the lowest frequency of the supported band. For licensed bands, the power density exposure limit is  $0.6455 * (f^{0.5})$ , where  $f$  is the lowest frequency of the supported band.

## Calculation of power density

The following calculation is based on the ANSI IEEE C95.1-1991 method, as that provides a worst case analysis. Details of the assessment to EN50383:2002 can be provided, if required.

Peak power density in the far field of a radio frequency point source is calculated as follows:

$$S = \frac{P \cdot G}{4\pi d^2}$$

**Where:**

**Is:**

|   |                                                              |
|---|--------------------------------------------------------------|
| S | power density in W/m <sup>2</sup>                            |
| P | maximum average transmit power capability of the radio, in W |
| G | total Tx gain as a factor, converted from dB                 |
| d | distance from point source, in m                             |

Rearranging terms to solve for distance yields:

$$d = \sqrt{\frac{P \cdot G}{4\pi \cdot S}}$$

## Calculated distances and power compliance margins

The following tables show calculated minimum separation distances, recommended distances and resulting margins for each frequency band and antenna combination for the USA and Canada. These are conservative distances that include compliance margins. At these and greater separation distances, the power density from the RF field is below generally accepted limits for the general population.

450 Platform Family ODU adheres to all applicable EIRP limits for transmit power when operating in MIMO mode. Separation distances and compliance margins include compensation for both transmitters.

Explanation of terms used in the following tables:

P burst – maximum average transmit power during transmit burst (Watt)

P – maximum average transmit power of the radio (Watt)

G – total transmit gain as a factor, converted from dB

S – power density (Watt/m<sup>2</sup>)

d – minimum safe separation distance from point source (meters)

**Table 96** FCC minimum safe distances – PMP 450m 3GHz and 5 GHz (5.1 GHz, 5.2 GHz, 5.4 GHz and 5.8 GHz)

| Band (GHz) | Antenna    | PG (W) | S (W/ m <sup>2</sup> ) | d (m) |
|------------|------------|--------|------------------------|-------|
| 3.65       | 90° sector | 40.0   | 10                     | 0.56  |
| 5.1        | 90° sector | 3.38   | 10                     | 0.16  |
| 5.2        | 90° sector | 0.85   | 10                     | 0.08  |
| 5.4        | 90° sector | 0.85   | 10                     | 0.08  |
| 5.8        | 90° sector | 3.38   | 10                     | 0.16  |

**Table 97** FCC minimum safe distances – PMP/PTP 450b 4.9 GHz, 5.1 GHz, 5.2 GHz, 5.4 GHz and 5.8 GHz

| Band (GHz) | Antenna     | P (W) | G (dBi) | S (W/ m <sup>2</sup> ) | d (m) |
|------------|-------------|-------|---------|------------------------|-------|
| 4.9        | Dish        | 0.501 | 24      | 10                     | 1.00  |
|            | Patch Array | 0.501 | 17      | 10                     | 0.45  |
|            | On-board    | 0.501 | 0       | 10                     | 0.06  |
| 5.1        | Dish        | 0.501 | 24      | 10                     | 1.00  |
|            | Patch Array | 0.501 | 17      | 10                     | 0.45  |
|            | On-board    | 0.501 | 0       | 10                     | 0.06  |
| 5.2        | Dish        | 0.004 | 24      | 10                     | 0.09  |
|            | Patch Array | 0.020 | 17      | 10                     | 0.09  |
|            | On-board    | 0.251 | 0       | 10                     | 0.04  |
| 5.4        | Dish        | 0.004 | 24      | 10                     | 0.09  |
|            | Patch Array | 0.020 | 17      | 10                     | 0.09  |
|            | On-board    | 0.501 | 0       | 10                     | 0.06  |
| 5.8        | Dish        | 0.501 | 24      | 10                     | 1.00  |
|            | Patch Array | 0.501 | 17      | 10                     | 0.45  |
|            | On-board    | 0.501 | 0       | 10                     | 0.06  |

**Table 98** ISED minimum safe distances – PMP 450m 3GHz and 5 GHz (5.4 GHz and 5.8 GHz)

| Band (GHz) | Antenna    | PG (W) | S (W/ m <sup>2</sup> ) | d (m) |
|------------|------------|--------|------------------------|-------|
| 3.45       | 90° sector | 851    | 6.85                   | 3.14  |
| 3.65       | 90° sector | 33.84  | 7.12                   | 0.61  |
| 5.4        | 90° sector | 0.85   | 9.39                   | 0.08  |
| 5.8        | 90° sector | 3.38   | 9.83                   | 0.17  |

**Table 99** ISEDC minimum safe distances – PMP/PTP 450b 4.9 GHz, 5.1 GHz, 5.2 GHz, 5.4 GHz and 5.8 GHz

| Band (GHz) | Antenna     | P (W) | G (dBi) | S (W/ m <sup>2</sup> ) | d (m) | S @ 20 cm (W/ m <sup>2</sup> ) |
|------------|-------------|-------|---------|------------------------|-------|--------------------------------|
| 4.9        | Dish        | 0.501 | 24      | 8.76                   | 1.07  | 250.5                          |
|            | Patch Array | 0.501 | 17      | 8.76                   | 0.48  | 50.0                           |
|            | On-board    | 0.501 | 0       | 8.76                   | 0.07  | 1.0                            |
| 5.1        | Dish        | 0.501 | 24      | 9.01                   | 1.05  | 250.5                          |
|            | Patch Array | 0.501 | 17      | 9.01                   | 0.47  | 50.0                           |
|            | On-board    | 0.501 | 0       | 9.01                   | 0.07  | 1.0                            |
| 5.2        | Dish        | 0.004 | 24      | 9.13                   | 0.09  | 2.0                            |
|            | Patch Array | 0.020 | 17      | 9.13                   | 0.09  | 2.0                            |
|            | On-board    | 0.251 | 0       | 9.13                   | 0.05  | 0.5                            |
| 5.4        | Dish        | 0.004 | 24      | 9.39                   | 0.09  | 2.0                            |
|            | Patch Array | 0.020 | 17      | 9.39                   | 0.09  | 2.0                            |
|            | On-board    | 0.501 | 0       | 9.39                   | 0.07  | 1.0                            |
| 5.8        | Dish        | 0.501 | 24      | 9.69                   | 1.02  | 250.5                          |
|            | Patch Array | 0.501 | 17      | 9.69                   | 0.45  | 50.0                           |
|            | On-board    | 0.501 | 0       | 9.69                   | 0.06  | 1.0                            |

**Table 100** FCC minimum safe distances – PMP/PTP 450i 900 MHz, 3.65 GHz, 4.9 GHz, 5.1 GHz, 5.2 GHz, 5.4 GHz and 5.8 GHz

| Band     | Antenna                           | P burst<br>(W) | P<br>(W) | G<br>(dBi)        | S<br>(W/ m <sup>2</sup> ) | d<br>(m) |
|----------|-----------------------------------|----------------|----------|-------------------|---------------------------|----------|
| 900 MHz  | Sector antenna                    | -              | 0.19     | 22.75 (13 dBi)    | 6.0                       | 0.27     |
| 3.65 GHz | 90° sector antenna, integrated    | -              | 0.316    | 50.0 (17 dBi)     | 10.0                      | 0.36     |
|          | 90° sector antenna, connectorized | -              | 0.316    | 40.0 (16 dBi)     | 10.0                      | 0.32     |
|          | Panel, integrated                 | -              | 0.251    | 79.0 (19 dBi)     | 10.0                      | 0.40     |
| 4.9 GHz  | Omni-directional                  | 0.2138         | 0.2512   | 20.0 (13 dBi)     | 10.0                      | 0.17     |
|          | 90° sector antenna                | 0.2138         | 0.2512   | 50.0 (17 dBi)     | 10.0                      | 0.26     |
|          | 2ft directional flat plate        | 0.2138         | 0.2512   | 631.0 (28 dBi)    | 10.0                      | 0.93     |
|          | 4ft directional parabolic         | 0.851          | 0.1000   | 2344.0 (34.9 dBi) | 10.0                      | 1.14     |
|          | 6ft directional parabolic         | 0.1413         | 0.1659   | 5248.0 (37.2 dBi) | 10.0                      | 2.19     |
| 5.1 GHz  | Omni-directional                  | 0.170          | 0.200    | 20.0 (13.0 dBi)   | 10                        | 0.15     |
|          | 90° sector                        | 0.034          | 0.040    | 50.1 (17.0 dBi)   | 10                        | 0.10     |
|          | 2ft directional flat plate        | 0.002          | 0.002    | 707.9 (28.5 dBi)  | 10                        | 0.09     |
|          | 4ft directional parabolic         | 0.011          | 0.013    | 2818.4 (34.5 dBi) | 10                        | 0.44     |
| 5.2 GHz  | Omni-directional                  | 0.036          | 0.042    | 20.0 (13.0 dBi)   | 10                        | 0.07     |
|          | 90° sector                        | 0.014          | 0.017    | 50.1 (17.0 dBi)   | 10                        | 0.07     |
|          | 2ft directional flat plate        | 0.001          | 0.001    | 707.9 (28.5 dBi)  | 10                        | 0.07     |
|          | 4ft directional parabolic         | 0.000          | 0.000    | 2818.4 (34.5 dBi) | 10                        | 0.06     |
| 5.4 GHz  | Omni-directional                  | 0.036          | 0.042    | 20.0 (13.0 dBi)   | 10                        | 0.07     |
|          | 90° sector                        | 0.014          | 0.017    | 50.1 (17.0 dBi)   | 10                        | 0.07     |
|          | 2ft directional flat plate        | 0.001          | 0.001    | 707.9 (28.5 dBi)  | 10                        | 0.07     |
|          | 2ft directional parabolic         | 0.001          | 0.001    | 707.9 (28.5 dBi)  | 10                        | 0.08     |
| 5.8 GHz  | Omni-directional                  | 0.24           | 0.28     | 20.0 (13 dBi)     | 10.0                      | 0.18     |
|          | 90° sector                        | 0.10           | 0.12     | 50.0 (17 dBi)     | 10.0                      | 0.18     |
|          | 2ft directional flat plate        | 0.54           | 0.63     | 708.0 (28.5 dBi)  | 10.0                      | 1.57     |
|          | 4ft directional parabolic         | 0.54           | 0.63     | 3388.0 (35.3 dBi) | 10.0                      | 3.43     |
|          | 6ft directional parabolic         | 0.54           | 0.63     | 6457.0 (38.1 dBi) | 10.0                      | 4.74     |



**Table 101** ISEDC minimum safe distances – PMP/PTP 450i, 900 MHz, 3.5 GHz, 3.65 GHz, 4.9 GHz, 5.2 GHz, 5.4 GHz, and 5.8 GHz

| Band                       | Antenna                           | P burst<br>(W) | P<br>(W) | G<br>(dBi)        | S<br>(W/ m <sup>2</sup> ) | d<br>(m) |
|----------------------------|-----------------------------------|----------------|----------|-------------------|---------------------------|----------|
| 900 MHz                    | Sector                            | -              | .02      | 20.0 (13 dBi)     | 2.74                      | 0.11     |
|                            | 90° sector antenna, integrated    | -              | 0.794    | 50.0 (17 dBi)     | 6.99                      | 0.62     |
| 3.5 GHz                    | 90° sector antenna, connectorized | -              | 0.794    | 40.0 (16 dBi)     | 6.99                      | 0.55     |
|                            | Panel, integrated                 | -              | 0.794    | 79.0 (19 dBi)     | 6.99                      | 0.78     |
| 3.65 GHz<br>(Lower Canada) | 90° sector antenna, integrated    | -              | 0.794    | 50.0 (17 dBi)     | 7.13                      | 0.67     |
|                            | 90° sector antenna, connectorized | -              | 0.794    | 40.0 (16 dBi)     | 7.13                      | 0.59     |
|                            | Panel, integrated                 | -              | 0.794    | 79.0 (19 dBi)     | 7.13                      | 0.84     |
| 3.65 GHz<br>(Upper Canada) | 90° sector antenna, integrated    | -              | 0.316    | 50.0 (17 dBi)     | 7.13                      | 0.42     |
|                            | 90° sector antenna, connectorized | -              | 0.316    | 40.0 (16 dBi)     | 7.13                      | 0.37     |
|                            | Panel, integrated                 | -              | 0.251    | 79.0 (19 dBi)     | 7.13                      | 0.47     |
| 4.9 GHz                    | Omni-directional                  | 0.214          | 0.251    | 20.0 (13 dBi)     | 8.71                      | 0.20     |
|                            | 90° sector                        | 0.214          | 0.251    | 50.1 (17 dBi)     | 8.71                      | 0.31     |
|                            | 2ft directional flat plate        | 0.214          | 0.251    | 631.0 (28 dBi)    | 8.71                      | 1.11     |
|                            | 6ft directional parabolic         | 0.141          | 0.166    | 5248.0 (37.2 dBi) | 8.71                      | 2.60     |
| 5.2 GHz                    | Omni-directional                  | 0.009          | 0.011    | 20.0 (13.0 dBi)   | 9.13                      | 0.04     |
|                            | 90° sector                        | 0.012          | 0.014    | 50.1 (17.0 dBi)   | 9.13                      | 0.06     |
|                            | 2ft directional flat plate        | 0.001          | 0.001    | 707.9 (28.5 dBi)  | 9.13                      | 0.07     |
|                            | 2ft directional parabolic         | 0.001          | 0.001    | 707.9 (28.5 dBi)  | 9.13                      | 0.06     |

| Band    | Antenna                    | P burst<br>(W) | P<br>(W) | G<br>(dBi)        | S<br>(W/ m <sup>2</sup> ) | d<br>(m) |
|---------|----------------------------|----------------|----------|-------------------|---------------------------|----------|
| 5.4 GHz | Omni-directional           | 0.036          | 0.042    | 20.0 (13.0 dBi)   | 9.39                      | 0.07     |
|         | 90° sector                 | 0.014          | 0.017    | 50.1 (17.0 dBi)   | 9.39                      | 0.07     |
|         | 2ft directional flat plate | 0.001          | 0.001    | 707.9 (28.5 dBi)  | 9.39                      | 0.07     |
|         | 2ft directional parabolic  | 0.001          | 0.001    | 707.9 (28.5 dBi)  | 9.39                      | 0.06     |
| 5.8 GHz | Omni-directional           | 0.24           | 0.28     | 20.0 (13 dBi)     | 9.69                      | 0.20     |
|         | 90° sector                 | 0.10           | 0.12     | 50.1 (17 dBi)     | 9.69                      | 0.20     |
|         | 2ft directional flat plate | 0.54           | 0.63     | 707.9 (28.5 dBi)  | 9.69                      | 1.67     |
|         | 4ft directional parabolic  | 0.54           | 0.63     | 3388.4 (35.3 dBi) | 9.69                      | 4.82     |

**Table 102** FCC minimum safe distances – PMP/PTP 450 900 MHz, 2.4 GHz, 3.65 GHz and 5 GHz

| Band        | Antenna                | P burst<br>(W) | G<br>(dBi)    | S<br>(W/ m <sup>2</sup> ) | d<br>(m) |
|-------------|------------------------|----------------|---------------|---------------------------|----------|
| 900 MHz     | Yagi                   | 0.032          | 13 (11 dBi)   | 6                         | 0.07     |
|             | Sector Antenna         | 0.079          | 50 (17 dBi)   | 10                        | 0.18     |
| 2.4 GHz     | Integrated             | 0.158          | 6 (8 dBi)     | 10                        | 0.09     |
|             | Reflector              | 0.040          | 100 (20 dBi)  | 10                        | 0.18     |
|             | Sector Antenna         | 0.316          | 32 (15 dBi)   | 10                        | 0.28     |
| 3.65<br>GHz | Integrated             | 0.316          | 6 (8 dBi)     | 10                        | 0.12     |
|             | Reflector              | 0.25           | 100 (20 dBi)  | 10                        | 0.45     |
|             | High Gain Ruggedized   | 0.25           | 79 (19 dBi)   | 10                        | 0.40     |
|             | Sector                 | 0.025          | 40 (16 dBi)   | 10                        | 0.09     |
|             | Integrated             | 0.126          | 8 (9 dBi)     | 10                        | 0.09     |
| 5.4 GHz     | Reflector              | 0.003          | 316 (25 dBi)  | 10                        | 0.09     |
|             | CLIP                   | 0.020          | 50 (17 dBi)   | 10                        | 0.09     |
|             | LENS                   | 0.032          | 28 (14.5 dBi) | 10                        | 0.08     |
|             | Integrated Dish (450d) | 0.0032         | 316 (25 dBi)  | 10                        | 0.09     |
|             | Sector                 | 0.079          | 40 (16 dBi)   | 10                        | 0.16     |
|             | Integrated             | 0.158          | 8 (9 dBi)     | 10                        | 0.10     |
| 5.8 GHz     | Reflector              | 0.158          | 316 (25 dBi)  | 10                        | 0.63     |
|             | CLIP                   | 0.158          | 50 (17 dBi)   | 10                        | 0.25     |
|             | LENS                   | 0.158          | 28 (14.5 dBi) | 10                        | 0.19     |
|             | Integrated Dish (450d) | 0.158          | 316 (25 dBi)  | 10                        | 0.63     |

**Table 103** ISED minimum safe distances – PMP/PTP 450 900 MHz, 2.4 GHz, 3.5/3.65 GHz and 5 GHz

| Band                             | Antenna                | P burst<br>(W) | G<br>(dBi)    | S<br>(W/ m <sub>2</sub> ) | d<br>(m) |
|----------------------------------|------------------------|----------------|---------------|---------------------------|----------|
| 900 MHz                          | Yagi                   | 0.316          | 13 (11 dBi)   | 2.74                      | 0.35     |
| 2.4 GHz                          | Sector Antenna         | 0.079          | 50 (17 dBi)   | 5.35                      | 0.24     |
|                                  | Integrated             | 0.158          | 6 (8 dBi)     | 5.35                      | 0.12     |
|                                  | Reflector              | 0.040          | 100 (20 dBi)  | 5.35                      | 0.24     |
| 3.5 GHz                          | Sector                 | 0.316          | 32 (15 dBi)   | 37.10                     | 0.15     |
|                                  | Integrated             | 0.316          | 6 (8 dBi)     | 37.10                     | 0.06     |
|                                  | Reflector              | 0.316          | 100 (20 dBi)  | 37.10                     | 0.26     |
|                                  | High Gain Ruggedized   | 0.316          | 79 (19 dBi)   | 37.10                     | 0.23     |
| 3.65<br>GHz<br>(lower<br>Canada) | Sector                 | 0.316          | 32 (15 dBi)   | 38.20                     | 0.15     |
|                                  | Integrated             | 0.316          | 6 (8 dBi)     | 38.20                     | 0.06     |
|                                  | Reflector              | 0.316          | 100 (20 dBi)  | 38.20                     | 0.26     |
|                                  | High Gain Ruggedized   | 0.316          | 79 (19 dBi)   | 38.20                     | 0.23     |
| 3.65<br>GHz<br>(upper<br>Canada) | Sector                 | 0.316          | 32 (15 dBi)   | 38.20                     | 0.14     |
|                                  | Integrated             | 0.316          | 6 (8 dBi)     | 38.20                     | 0.06     |
|                                  | Reflector              | 0.20           | 100 (20 dBi)  | 38.20                     | 0.20     |
|                                  | High Gain Ruggedized   | 0.003          | 79 (19 dBi)   | 38.20                     | 0.23     |
| 5.4 GHz                          | Sector                 | 0.025          | 40 (16 dBi)   | 9.39                      | 0.09     |
|                                  | Integrated             | 0.126          | 8 (9 dBi)     | 9.39                      | 0.09     |
|                                  | Reflector              | 0.003          | 316 (25 dBi)  | 9.39                      | 0.09     |
|                                  | CLIP                   | 0.020          | 50 (17 dBi)   | 9.39                      | 0.09     |
|                                  | LENS                   | 0.032          | 28 (14.5 dBi) | 9.39                      | 0.09     |
|                                  | Integrated Dish (450d) | 0.0032         | 316 (25 dBi)  | 9.39                      | 0.09     |
| 5.8 GHz                          | Sector                 | .079           | 40 (16 dBi)   | 9.69                      | 0.16     |
|                                  | Integrated             | 0.158          | 8 (9 dBi)     | 9.69                      | 0.10     |
|                                  | Reflector              | 0.158          | 316 (25 dBi)  | 9.69                      | 0.064    |
|                                  | CLIP                   | 0.158          | 50 (17 dBi)   | 9.69                      | 0.25     |
|                                  | LENS                   | 0.158          | 28 (14.5 dBi) | 9.69                      | 0.19     |
|                                  | Integrated Dish (450d) | 0.158          | 316 (25 dBi)  | 9.69                      | 0.64     |

(\*1) P: maximum average transmit power capability of the radio including cable loss (Watt)

*Capacité de puissance d'émission moyenne maximale de la radio comprenant la perte dans les câble de connexion (W)*

(\*2) G: total transmit gain as a factor, converted from dB

*Gain total d'émission, converti à partir de la valeur en dB*

(\*3) S: power density ( $\text{W}/\text{m}^2$ )

*Densité de puissance ( $\text{W}/\text{m}^2$ )*

(\*4) d: minimum distance from point source (meters)

*Distance minimale de source ponctuelle (en mètres)*

**Note**

Gain of antenna in dBi =  $10 * \log(G)$ .

The regulations require that the power used for the calculations is the maximum power in the transmit burst subject to allowance for source-based time-averaging.

At 5.4 GHz and EU 5.8 GHz, the products are generally limited to a fixed EIRP which can be achieved with the Integrated Antenna. The calculations above assume that the maximum EIRP allowed by the regulations is being transmitted.

**Remarque**

Gain de l'antenne en dBi =  $10 * \log(G)$ .

Les règlements exigent que la puissance utilisée pour les calculs soit la puissance maximale de la rafale de transmission soumis à une réduction pour prendre en compte le rapport cyclique pour les signaux modulés dans le temps.

Pour une opération dans la CEE dans les bandes 5,4 GHz et 5,8 GHz, les produits sont généralement limités à une PIRE qui peut être atteinte avec l'antenne intégrée. Les calculs ci-dessus supposent que la PIRE maximale autorisée par la réglementation est atteinte.

**Note**

If there are no EIRP limits in the country of deployment, use the distance calculations for FCC 5.8 GHz for all frequency bands.

At FCC 5.8 GHz, for antennas between 0.6m (2ft) and 1.8m (6ft), alter the distance proportionally to the antenna gain.

**Remarque**

Si aucune limite de PIRE existe pour le pays de déploiement, utilisez les calculs de distance pour FCC 5,8 GHz pour toutes les bandes de fréquence.

Pour la band FCC 5,8 GHz et les antennes entre 0,6 m (2 pieds) et 1,8 m (6 pieds), modifier la distance proportionnellement au gain de l'antenne.

## Hazardous location compliance

The PMP/PTP 450i series ATEX/HAZLOC ODUs have been certified for operation in the following hazardous locations:

### ATEX

The products have been approved under an "Intrinsic Safety" assessment as defined in EN60079-11:2007.

The approval is given by certificate number TRAC09ATEX31224X, issued by TRaC Global, with the specific level of coverage shown below:

- II 3 G Ex ic IIC T4
- II - Equipment group (surface applications)
- 3 - Equipment category (infrequent exposure)

- G - Atmosphere (Gas)
- ic - Protection concept (intrinsic safety)
- IIC - Gas group (up to and including Hydrogen and Acetylene)
- T4 - Temperature class (135°C)

# Compliance with radio regulations

---

This section describes how the 450 Platform Family complies with the radio regulations that are in force in various countries.

**Caution**

Where necessary, the end user is responsible for obtaining any National licenses required to operate this product and these must be obtained before using the product in any country. Contact the appropriate national administrations for details of the conditions of use for the bands in question and any exceptions that might apply.

**Caution**

Changes or modifications not expressly approved by Cambium Networks could void the user's authority to operate the system.

**Caution**

For the connectorized version of the product and in order to reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the Effective Isotropically Radiated Power (EIRP) is not more than that permitted for successful communication.

**Attention**

Le cas échéant, l'utilisateur final est responsable de l'obtention des licences nationales nécessaires pour faire fonctionner ce produit. Celles-ci doivent être obtenus avant d'utiliser le produit dans un pays particulier. Contactez les administrations nationales concernées pour les détails des conditions d'utilisation des bandes en question, et toutes les exceptions qui pourraient s'appliquer

**Attention**

Les changements ou modifications non expressément approuvés par les réseaux de Cambium pourraient annuler l'autorité de l'utilisateur à faire fonctionner le système.

**Attention**

Pour la version du produit avec une antenne externe, et afin de réduire le risque d'interférence avec d'autres utilisateurs, le type d'antenne et son gain doivent être choisis afin que la puissance isotrope rayonnée équivalente (PIRE) ne soit pas supérieure au minimum nécessaire pour établir une liaison de la qualité requise.

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## Type approvals

This system has achieved Type Approval in various countries around the world. This means that the system has been tested against various local technical regulations and found to comply. The frequency bands in which the system operates may be 'unlicensed' and, in these bands, the system can be used provided it does not cause interference. The system is not guaranteed protection against interference from other products and installations.

The radio specification type approvals that have been granted for 450 Platform Family frequency variants are listed under [Table 104](#).

**Table 104** Radio certifications

| Region/Country | Band         | Specification                                                                            |
|----------------|--------------|------------------------------------------------------------------------------------------|
| Brazil         | 4.9 GHz      | ANATEL, RESOLUÇÃO N° 633, DE 14 DE MARÇO DE 2014                                         |
|                | 5.4 GHz      | ANATEL, RESOLUTION No. 506, FROM JULY 1, 2008                                            |
|                | 5.8 GHz      | ANATEL, RESOLUTION No. 506, FROM JULY 1, 2008                                            |
| Mexico         | 900 MHz      | NOM-121-SCT1-2009                                                                        |
|                | 4.9 GHz      | Protocol Between the UNITED STATES OF AMERICA and MEXICO – Use of 4940 to 4990 MHz band. |
|                | 5.4 GHz      | Acuerdo del 27 de noviembre de 2012                                                      |
|                | 5.8 GHz      | NOM-121-SCT1-2009                                                                        |
| USA            | 900 MHz      | FCC Part 15.247 and Part 15 Class B                                                      |
|                | 2.4 GHz      | FCC Part 15 247 and Part 15 Class B                                                      |
|                | 3.6 GHz      | FCC Part 90Z and Part 15 Class B                                                         |
|                | 4.9 GHz      | FCC 47 CFR Part 90Y and Part 15 Class B                                                  |
|                | 5.1 GHz      | FCC 47 CFR Part 15 E and Part 15 Class B                                                 |
|                | 5.2 GHz      | FCC 47 CFR Part 15 E and Part 15 Class B                                                 |
|                | 5.4 GHz      | FCC 47 CFR Part 15 E and Part 15 Class B                                                 |
|                | 5.8 GHz      | FCC 47 CFR Part 15 E and Part 15 Class B                                                 |
| Canada         | 900 MHz      | RSS Gen and RSS 210                                                                      |
|                | 2.4 GHz      | RSS Gen and RSS 210                                                                      |
|                | 3.5 /3.6 GHz | RSS Gen, RSS 192 and RSS 197                                                             |
|                | 4.9 GHz      | RSS Gen and RSS-111, Issue 5                                                             |
|                | 5.8 GHz      | RSS Gen and RSS-247, Issue 2                                                             |
| Europe         | 3.5/3.6 GHz  | ETSI EN 302 326-2 V1.2.2                                                                 |

|         |                                                  |
|---------|--------------------------------------------------|
| 4.9 GHz | ETSI EN302 625; V1.1.1 Broadband Disaster Relief |
| 5.4 GHz | ETSI EN 301 893 V1.8.1                           |
| 5.8 GHz | ETSI EN 302 502 V2.1.1                           |

## Brazil specific information

### Brazil notification

For compliant operation in the 5.4 GHz band, the Equivalent Isotropic Radiated Power from the integrated antenna or connectorized antenna shall not exceed 30 dBm (0.5 W).

The operator is responsible for enabling the DFS feature on any Canopy 5.4 GHz radio by setting the Country Code to “Brazil”, including after the module is reset to factory defaults.

Important Note: This equipment operates as a secondary application, so it has no rights against harmful interference, even if generated by similar equipment, and cannot cause harmful interference on systems operating as primary applications.

### Brazil certification numbers

The Anatel certification number for Brazil for the PMP/PTP 450i Series is 2426-15-7745.

## Australia Notification

900 MHz modules must be set to transmit and receive only on center channels of 920, 922, or 923 MHz to stay within the ACMA approved band of 915 MHz to 928 MHz for the class license and not interfere with other approved users.

After considering antenna gain (in dBi), 900 MHz modules' transmitter output power (in dBm) must be set to stay within the legal regulatory limit of 30 dBm (1 W) EIRP for this 900 MHz frequency band.

## Regulatory Requirements for CEPT Member States ([www.cept.org](http://www.cept.org))

When operated in accordance with the instructions for use, Cambium Wireless equipment operating in the 5.1 GHz and 5.4 GHz bands is compliant with CEPT Resolution 229 (REV. WRC-12).

Operating the 450 Platform Family in the bands 5150 to 5350 MHz and 5470 to 5725 MHz is granted providing it is not causing interference to the existing primary services allocated to those bands.

For compliant operation in the 5250 to 5350 MHz band, the transmit power from the integrated antenna or a connectorized antenna shall be limited to a maximum mean EIRP of 200 mW and a maximum mean EIRP density of 10 mW/MHz in any 1 MHz band.

For compliant operation in the 5470 to 5725 MHz band, the transmit power shall be restricted to a maximum of 250 mW with a maximum mean EIRP of 1 W and a maximum mean EIRP density of 50 mW/MHz in any 1 MHz band.

For compliant operation in the bands 5 250-5 350 MHz and 5 470-5 725 MHz, the 450 Platform Family employs transmitter power control.

For EU member states, RLAN equipment in the 5.4GHz bands is exempt from individual licensing under Commission Recommendation 2003/203/EC. Contact the appropriate national administrations for details on the conditions of use for the bands in question and any exceptions that might apply. Also see [www.ero.dk](http://www.ero.dk) for further information.

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# Chapter 5: Preparing for installation

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This chapter describes how to stage and test the hardware for a 450 Platform network. This chapter is arranged as follows:

- [Safety](#) on page 5-2: Describes the precautions to be observed and checks to be performed before proceeding with the installation
- [Preparing for installation](#) on page 5-6: Describes the pre-configuration procedure before proceeding with installation.
- [Testing system components](#) on page 5-8: Describes the procedures for unpacking and performing and initial staging of the 450 Platform Family ODU.
- [Configuring Link for Test](#) on page 5-17: Describes the procedures for testing the equipment's radio links.

# Safety

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**Warning**

To prevent loss of life or physical injury, observe the following safety guidelines. In no event shall Cambium Networks be liable for any injury or damage caused during the installation of the Cambium 450 Platform Family. Ensure that only qualified personnel install a 450 Platform link.

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## Hazardous locations

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**Warning**

When installing the PMP/PTP 450i ATEX/HAZLOC product variants in hazardous locations, follow the instructions contained in the PMP/PTP 450i Series Hazardous Location Guide (supplied in box with the products), in addition to the instructions in this user guide.

---

## Power lines

Exercise extreme care when working near power lines.

## Working at heights

Exercise extreme care when working at heights.

## Power supply

Always use one of the Cambium 450 Platform Family power supply units (PSU) to power the ODU. Failure to use a Cambium supplied PoE could result in equipment damage and will invalidate the safety certification and may cause a safety hazard.

## Grounding and protective earth

The Outdoor Unit (ODU) must be properly grounded to protect against lightning. It is the user's responsibility to install the equipment in accordance with national regulations. In the USA follow the requirements of the National Electrical code NFPA 70-2005 and 780-2004 *Installation of Lightning Protection Systems*. In Canada, follow Section 54 of the *Canadian Electrical Code*. These codes describe correct installation procedures for grounding the outdoor unit, mast, lead-in wire and discharge unit, size of grounding conductors and connection requirements for grounding electrodes. Other regulations may apply in different countries and therefore it is recommended that installation of the outdoor unit be contracted to a professional installer.

## Powering down before servicing

Always power down and unplug the equipment before servicing.

## Primary disconnect device

The ODU power supply is the primary disconnect device.

## External cables

Safety may be compromised if outdoor rated cables are not used for connections that will be exposed to the outdoor environment. For outdoor copper Cat5e Ethernet interfaces, always use Cat5e cable that is gel-filled and shielded with copper-plated steel.

## RF exposure near the antenna

Strong radio frequency (RF) fields will be present close to the antenna when the transmitter is on. Always turn off the power to the ODU before undertaking maintenance activities in front of the antenna.

## Minimum separation distances

Ensure that personnel are not exposed to unsafe levels of RF energy. The units start to radiate RF energy as soon as they are powered up. Never work in front of the antenna when the ODU is powered. Install the ODUs so as to provide and maintain the minimum separation distances from all persons. For minimum separation distances, see Calculated distances and power compliance margins on page 4-25.

## Grounding and lightning protection requirements

Ensure that the installation meets the requirements defined in [Grounding and lightning protection](#) on page 3-8.

## Grounding cable installation methods

To provide effective protection against lightning induced surges, observe these requirements:

- Grounding conductor runs are as short, straight and smooth as possible, with bends and curves kept to a minimum.
- Grounding cables must not be installed with drip loops.
- All bends must have a minimum radius of 200 mm (8 in) and a minimum angle of 90°. A diagonal run is preferable to a bend, even though it does not follow the contour or run parallel to the supporting structure.
- All bends, curves and connections must be routed towards the grounding electrode system, ground rod, or ground bar.
- Grounding conductors must be securely fastened.
- Braided grounding conductors must not be used.
- Approved bonding techniques must be used for the connection of dissimilar metals.

## Siting ODUs and antennas

ODUs, external antennas and GPS receivers are not designed to survive direct lightning strikes. For this reason they must be installed in Zone B as defined in [Lightning protection zones](#) on page 3-9. Mounting in Zone A may put equipment, structures and life at risk.

## Thermal Safety

The ODU enclosure may be hot to the touch when in operation. The ODU must not be operated in ambient temperatures exceeding 40°C unless mounted in a Restricted Access Location. For more information, see [ODU ambient temperature limits](#) on page 3-10.



### Warning

Do not install the ODU in a location where the ambient temperature could exceed 40°C unless this is a Restricted Access Location as defined by EN 60950-1.

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**Alerte**

L'unité externe ne doit pas être installée dans un endroit où la température ambiante est supérieure à 40C à moins que l'accès soit limité au personnel autorisé.

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# Preparing for installation

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## ODU pre-configuration

It is common practice to pre-configure the units during staging before site installation by performing the following tasks:

- [Connecting to the unit](#)
- [Configuring IP and Ethernet interfaces](#)
- [Upgrading the software version and using CNUT](#)
- [General configuration](#)
- [Configuring security](#)
- [Configuring radio parameters](#)
- [Setting up SNMP agent](#)
- [Configuring syslog](#)
- [Configuring remote access](#)
- [Monitoring the Link](#)
- [Configuring quality of service](#)
- [Zero Touch Configuration Using DHCP Option 66](#)
- [Configuring Radio via config file](#)
- [Configuring a RADIUS server](#)

If the units are to be pre-configured during staging, the safety precautions below **MUST** be observed.

## Preparing personnel

In no event shall Cambium Networks be liable for any injury or damage caused during the installation of the Cambium 450 Platform Family ODU.

Ensure that only qualified personnel undertake the installation of a 450 Platform system.

Ensure that all safety precautions are observed.

## Preparing inventory

Perform the following inventory checks:

- Check that the correct components are available, as described in [Ordering the components](#) on page 2-71.
- Check the contents of all packages against their packing lists.

## Preparing tools

Check that following specific tools are available, in addition to general tools:

- RJ45 crimp tool (it must be the correct tool for the type of RJ45 being used).
- Personal Computer (PC) with 10 or 100 or 1000 BaseT Ethernet port
- Web browser
- Ethernet patch cables

# Testing system components

---

The best practice is to connect all components—AP/BHM, SMs/BHS, GPS antenna (if applicable) and CMM (if applicable)—in a test setting and initially configure and verify them before deploying them to an installation. In this way, any configuration issues are worked out before going on-site, on a tower, in the weather, where the discovery of configuration issues or marginal hardware is more problematic and work-flow affecting.

## Unpacking Components

When a delivery arrives, inspect all packages immediately for damages.

Carefully unpack the equipment, verify that all the components have arrived as per order and are in good condition. Save all packaging materials for equipment transportation to the installation site.

## Preparing the ODU

After the equipment is unpacked, the units may be configured for staging tests.

Use either of two methods to configure an AP/BHM:

- Use the Quick Start feature of the product (via GUI menu **Quick Start**)
- Manually set each parameter

After changing configuration parameters on a GUI web page:

- Before you leave a web page, click the **Save** button to save the change(s)
- After making change(s) on multiple web pages, click the **Reboot** button to reboot the module and implement the change(s)

## Configuring the Computing Device for Test

If the computer is configured for Dynamic Host Configuration Protocol (DHCP), disconnect the computer from the network. If the computer is instead configured for static IP addressing

- Set the static address in the 169.254 network
- Set the subnet mask to 255.255.0.0.

For detailed instructions, see section [Configuring the management PC](#) on page 5-17.

## Factory default Configuration

From the factory, the APs/BHMs and SMs/BHSs are all configured to *not transmit* on any frequency. This configuration ensures that equipment operators do not accidentally turn on an unsynchronized module. Site synchronization of modules is required because

- modules:
  - cannot transmit and receive signals at the same time.
  - use TDD (Time Division Duplexing) to distribute signal access of the downlink and uplink frames.
- when one module transmits while an unintended module nearby receives signal, the transmitting module may interfere with or desense the receiving module. In this context, interference is self-interference (within the same network).

## ODU interfaces

See section [450 Platform Family interfaces](#) on page 2-7

## ODU diagnostic LEDs

See section [AP/BHM LEDs](#) on page 2-18.

See section [SM/BHS LEDs](#) on page 2-20.

## Recommended Tools for Installation

The following tools may be needed for installation:

**Table 105** Tools for PMP and PTP 450 Platform ODU installation

| Equipment to Be Installed | Tools Required                                                                                                                                                                                                                                                                                                        |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AP or BHM                 | <ul style="list-style-type: none"> <li>• 3 mm Allen Wrench<br/>Used for connecting the antenna mating bracket to the rear of the AP housing</li> <li>• Crescent Wrench Pair<br/>Used for tightening cable glands</li> <li>• Self-amalgamating and PVC Tape<br/>Used for weatherproofing N-type connections</li> </ul> |

| Equipment to Be Installed           | Tools Required                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AP or BHM or BHS Antenna            | <ul style="list-style-type: none"> <li>13 mm Spanner Wrench (or Ratchet Spanner Wrench) Pair<br/>Used for connecting the antenna (sector or omni for AP, or directional for BH)base to the pole/mast mounting bracket</li> <li>Self-amalgamating and PVC Tape<br/>Used for weatherproofing N-type connections</li> <li>N-type Torque Wrench (not required but recommended)<br/>Used for assuring proper tightening of N-type connectors terminating the RF cables</li> </ul> |
| SM                                  | <ul style="list-style-type: none"> <li>Wrench/driver (depending on operator's choice of clamps)<br/>Used for tightening clamps to the pole</li> <li>Alignment tone adapter / headset<br/>Used for aligning the SM to the AP</li> </ul>                                                                                                                                                                                                                                       |
| Universal Global Positioning System | <ul style="list-style-type: none"> <li>Philips Screwdriver<br/>Used for attaching the UGPS unit to the pole/mast mounting bracket</li> <li>13mm Spanner Wrench (or Ratchet Spanner Wrench)<br/>Used for connecting the mounting bracket's U-bolt to the antenna or mast</li> </ul>                                                                                                                                                                                           |
| Cabling                             | <ul style="list-style-type: none"> <li>Electrician's Scissors or Wire Cutters<br/>Used for cutting wire to length</li> <li>RJ-11/RJ-45 Crimping Tool<br/>Used for stripping RJ-11/RJ-45 cables and for terminating cable ends</li> <li>Cable Testing Device<br/>Used to ensure that cables are properly constructed</li> </ul>                                                                                                                                               |

## Standards for Wiring

Modules automatically sense whether the Ethernet cable in a connection is wired as straight-through or crossover. Operators may use either straight-through or crossover cable to connect a network interface card (NIC), hub, router, or switch to these modules. This guide follows the EIA/TIA-568B colour code standard.

## Best Practices for Cabling

The following practices are essential to the reliability and longevity of cabled connections:

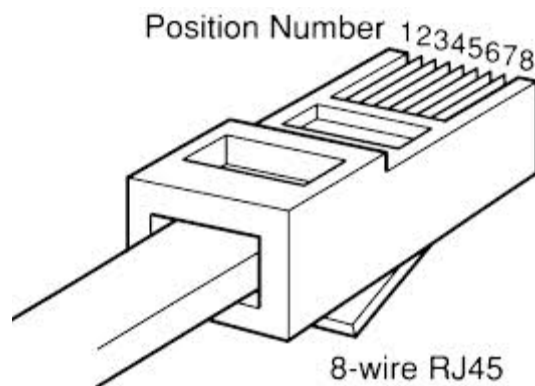
- Use only shielded cables to resist interference.
- For vertical runs, provide cable support and strain relief.
- Include a 2-ft (0.6-m) service loop on each end of the cable to allow for thermal expansion and contraction and to facilitate terminating the cable again when needed.
- Include a drip loop to shed water so that most of the water does not reach the connector at the device.
- Properly crimp all connectors.
- Use dielectric grease on all connectors to resist corrosion.
- Use only shielded connectors to resist interference and corrosion.

## Wiring Connectors

The following diagrams correlate pins to wire colors and illustrate crossovers where applicable.

**Pin 1**, relative to the lock tab on the connector of a straight-through cable is located as shown below.

**Figure 70** Pin 1 location



## Main port pinout

**Table 106** Main port pinout

| RJ45 pin | Description |
|----------|-------------|
| 1        | +TxRx0      |
| 2        | –TxRx0      |
| 3        | +TxRx1      |
| 4        | +TxRx2      |
| 5        | –TxRx2      |
| 6        | –TxRx1      |
| 7        | +TxRx3      |
| 8        | –TxRx3      |

## Aux port pinout

**Table 107** Aux port pinout

| RJ45 pin | Description                                     |
|----------|-------------------------------------------------|
| 1        | +TxRx0                                          |
| 2        | –TxRx0                                          |
| 3        | +TxRx1                                          |
| 4        | GPS power out, Alignment tone out, GPS data out |
| 5        | GPS data in                                     |
| 6        | –TxRx1                                          |
| 7        | GPS 0v                                          |
| 8        | GPS Sync in                                     |

## RJ-45 Pinout for Straight-through Ethernet Cable

Figure 71 Straight-through Ethernet Cable

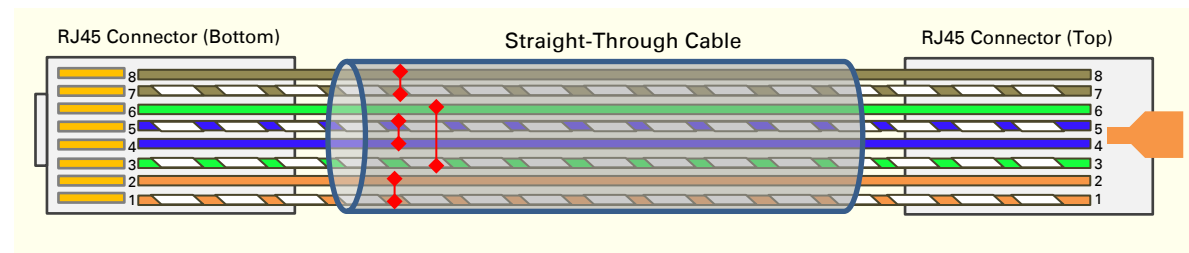
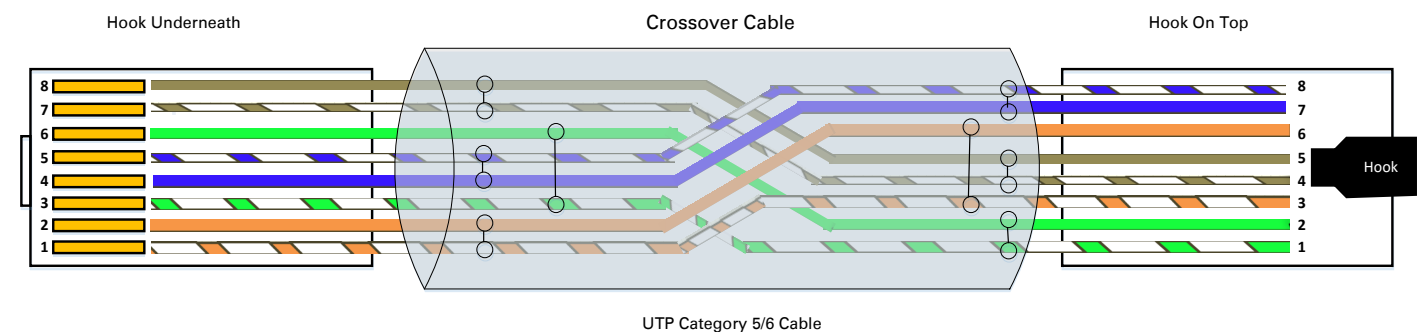


Table 108 RJ-45 pinout for straight-through Ethernet cable

| Pin | Signal | Pair | Color               |
|-----|--------|------|---------------------|
| 1   | TP1+   | 2    | White/orange stripe |
| 2   | TP1-   | 2    | Orange solid        |
| 3   | TP2+   | 3    | White/green stripe  |
| 4   | TP3+   | 1    | Blue solid          |
| 5   | TP3-   | 1    | White/blue stripe   |
| 6   | TP2-   | 3    | Green solid         |
| 7   | TP4+   | 4    | White/brown stripe  |
| 8   | TP4-   | 4    | Brown solid         |

## RJ-45 Pinout for Crossover Ethernet Cable

Figure 72 Crossover Ethernet Cable





**Table 109** RJ-45 pinout for crossover Ethernet cable

| Pin | Connection 1 |      |                     | Connection 2 |      |                     |
|-----|--------------|------|---------------------|--------------|------|---------------------|
|     | Signal       | Pair | Color               | Signal       | Pair | Color               |
| 1   | TP1+         | 2    | White/orange stripe | TP2+         | 3    | White/green stripe  |
| 2   | TP1-         | 2    | Orange solid        | TP2-         | 3    | Green solid         |
| 3   | TP2+         | 3    | White/green stripe  | TP1+         | 2    | White/orange stripe |
| 4   | TP3+         | 1    | White/blue stripe   | TP4+         | 4    | White/brown stripe  |
| 5   | TP3-         | 1    | Blue solid          | TP4-         | 4    | Brown solid         |
| 6   | TP2-         | 3    | Green solid         | TP1-         | 2    | Orange solid        |
| 7   | TP4+         | 4    | White/brown stripe  | TP3+         | 1    | Blue solid          |
| 8   | TP4-         | 4    | Brown solid         | TP3-         | 1    | White/blue stripe   |

## AP/BHM to UGPS cable

The AP/BHM to UGPS cable can be constructed from RJ12 to RJ 45 cable using the pin configuration described in [Table 110](#).

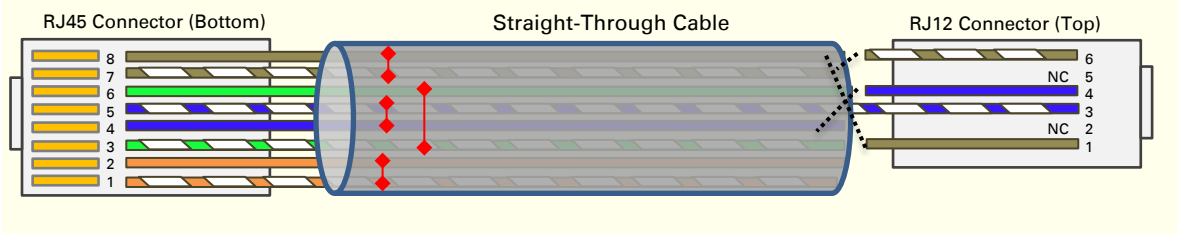


### Note

This is only applicable for 450 AP/BHM.

The AP/BHM will only power up the UGPS if it configured to do so.

**Figure 73** AP/BHM to UGPS cable



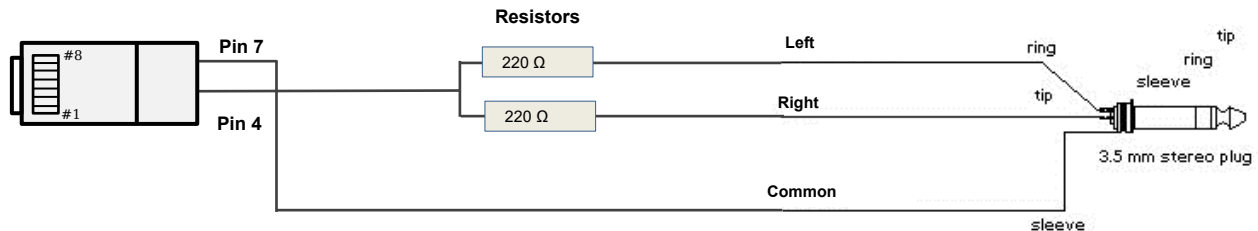
**Table 110** AP/BHM to UGPS cable pinout

| Pin | 450i Series AP RJ 45 Connector | Pin | UGPS RJ 12 Connector | Connector |
|-----|--------------------------------|-----|----------------------|-----------|
| 1   | NC                             | 1   | 8 on RJ 45           |           |
| 2   | NC                             | 2   | NC                   |           |
| 3   | NC                             | 3   | 5 on RJ 45           |           |
| 4   | 4 on RJ 12                     | 4   | 4 on RJ 45           |           |
| 5   | 3 on RJ 12                     | 5   | NC                   |           |
| 6   | NC                             | 6   | 7 on RJ 45           |           |
| 7   | 6 on RJ 12                     |     |                      |           |
| 8   | 1 on RJ 12                     |     |                      |           |

## Alignment tone cable (for PMP/PTP 450i)

The alignment tone cable is constructed using RJ45 plug and Stereo plug. The pin configuration is shown in Figure 74

**Figure 74** Alignment tone cable pin configuration



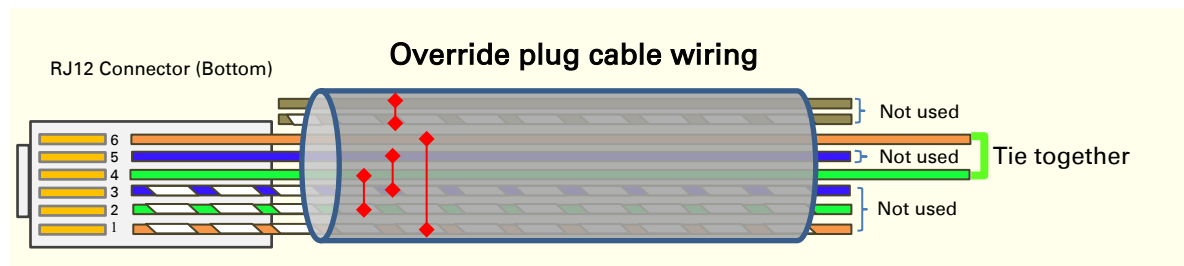
For more information, refer [Aux port to alignment tone headset wiring](#).

## Override plug cable (for PMP 450 only)

To construct an override plug, perform the following steps:

- Crimp an RJ-12 6 pins connector onto a 6-inch length of CAT 5 cable
- Pin out all 6 pins
- Short (solder together) pins 4 and 6 on the other end. Do not connect any other wires to anything.

**Figure 75** RJ-12 pinout for the default plug



# Configuring Link for Test

---

It is important to stage the AP/BHM and SM/BHS units first to verify proper registration before deploying the modules to the site. To begin configuring the modules for test, see the sections below:

## Configuring the management PC

To configure the local management PC to communicate with the AP, SM, BHM or BHS, proceed as follows:

### Powering the AP/SM/BH for test configuration

Perform the following steps to power on the ODU.

#### Procedure 2 Powering the ODU

- 1 Plug one end of a CAT 5 Ethernet cable into the ODU.
- 2 Plug the Ethernet cable connector labeled To Radio into the jack in the pig tail that hangs from the power supply.
- 3 Plug the other connector of the pig tail (this connector labeled To Computer) into the Ethernet jack of the computing device.
- 4 Plug the power supply into an electrical outlet.



#### Warning

From this point until you remove power from the ODU, stay at least as far from the AP as the minimum separation distance specified in [Minimum separation distances](#) on page 5-3.

---

- 5 Power up the computing device
- 6 Start the browser in the computing device

The AP/BHM interface provides a series of web pages to configure and monitor the unit. Access web-based interface through a computing device that is either directly connected or connected through a network to the AP/BHM. If the computing device is not connected to a network when it is being configured for test environment, and if the computer has used a proxy server address and port to configure a module, then the operator may need to first disable the proxy setting in the computer.

Perform the following procedure to toggle the computer to *not* use the proxy setting.

**Procedure 3** Bypassing browser proxy settings to access module web pages

- 1 Launch Microsoft Internet Explorer
- 2 Select **Tools, Internet Options, Connections, LAN Settings**. Alternate web browser menu selections may differ.
- 3 Uncheck the **Use a proxy server** box.

In the address bar of your browser, enter the IP address of the AP/BHM. (For example, enter `http://169.254.1.1` to access the AP/BHM through its default IP address). The AP/BHM responds by opening the General Status tab of its Home page.

## Logging into the web interface – AP/SM/BH

**Procedure 4** Logging into the web interface

- 1 Plug one end of a CAT 5 Ethernet cable into the AP/BHM
- 2 Plug the Ethernet cable connector labeled To Radio into the jack in the pig tail that hangs from the power supply.
- 3 Plug the other connector of the pig tail (this connector labeled To Computer) into the Ethernet jack of the computing device.
- 4 Plug the power supply into an electrical outlet.

---

**Warning**



From this point until you remove power from the ODU, stay at least as far from the ODU as the minimum separation distance specified in [Minimum separation distances](#) on page 5-3.

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## Using the Quick Start Configuration Wizard of the AP/BHM

See section [Quick link setup](#) on page 7-12.

---

# Chapter 6: Installation

---

This chapter describes how to install and test the hardware for a 450 Platform link. It contains the following topics:

- [ODU variants and mounting bracket options](#) on page 6-2 provides details of six different bracket options, including the type of ODU and range of pole diameters supported by each option.
- [Mount the ODU, LPU and surge suppressor](#) on page 6-3 describes how to mount and ground an integrated or connectorized ODU, how to mount and ground the top LPU.
- [Installing the copper Cat5e Ethernet interface](#) on page 6-22 describes how to install the copper Cat5e power over Ethernet interface from the ODU to the PSU.
- [Installing external antennas to a connectorized ODU](#) on page 6-26 describes how to install external antennas for a connectorized ODU.
- [Installing ODU](#) on page 6-61 describes how to install PTP and PMP ODU radios.
- [Installing the AC Power Injector](#) on page 6-66 describes how to install a power supply unit for the PMP/PTP 450 platform, either the AC Power Injector.
- [Supplemental installation information](#) on page 6-68 contains detailed installation procedures that are not included in the above topics, such as how to strip cables, create grounding points and weatherproof connectors.



## Note

These instructions assume that LPUs are being installed from the 450 Platform Family LPU and grounding kit (Cambium part number C000065L007). If the installation does not require LPUs, adapt these instructions as appropriate.

If LPUs are being installed, only use the five black-capped EMC cable glands supplied in the LPU and grounding kit. The silver-capped cable glands supplied in the ODU kits must only be used in 450 Platform installations which do not require LPUs.

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## ODU variants and mounting bracket options

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### Mounting bracket– PMP/PTP 450i Series

The PMP/PTP 450i Series supports below mentioned mounting bracket option:

**Table 111** PMP/PTP 450i Series - ODU mounting bracket part numbers

| Cambium description                       | Cambium part number |
|-------------------------------------------|---------------------|
| Mounting bracket – low profile adjustable | N000045L002A        |

The low-profile bracket provides elevation adjustment with the PMP/PTP 450i Series Integrated ODUs of +10° to –5° or +5° to –10°. A larger adjustment range is available using the standard integrated mounting bracket. The connectorized mounting bracket does not provide elevation adjustment.

### Mounting bracket– PMP 450 Series – SM 900 MHz

The PMP 450i Series – SM 900 MHz has special mounting bracket option. The PMP 450i Series AP - 900 MHz mounting procedure is the same as the other 450i Series radios. The 450 Series SM 900 MHz has a different mounting bracket which is supplied along with Yagi antenna.

## Mount the ODU, LPU and surge suppressor

---

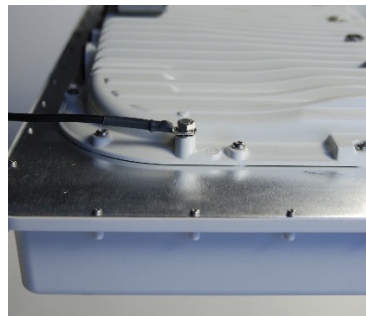
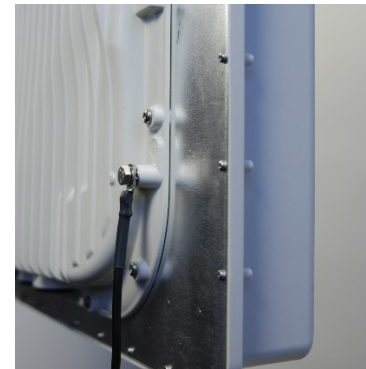
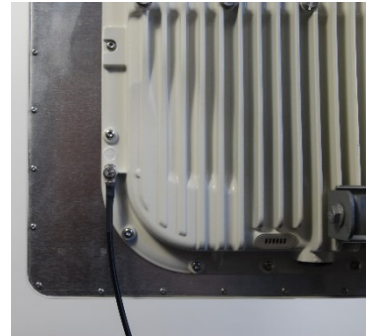
To install the ODU and top LPU, use the following procedures:

- [Attach ground cables to the ODU](#) on page 6-3
- [Mount the ODU on the mast](#) on page 6-6
- [Mount the top LPU](#) on page 6-12
- [Mount the Surge Suppressor](#) on page 6-12

### Attach ground cables to the ODU

#### PMP 450m Series – AP

- 1 Fasten an AWG 10 (or 6mm<sup>2</sup>) copper ground cable to each ODU grounding point using the M6 (small) lugs.
- 2 Secure the M6 grounding bolts by applying 3 Nm torque.
- 3 Securely connect the copper wires to the grounding system (Protective Earth) and the LPU or Gigabit Ethernet Surge Suppressor according to applicable regulations.





## PMP/PTP 450i Series – AP/SM/BH, PMP 450 3GHz Ruggedized SM

- 1 Fasten an AWG 10 (or 6mm<sup>2</sup>) copper ground cable to each ODU grounding point using the M6 (small) lugs.



- 2 Tighten the Ground post screws.



- 3 Securely connect the copper wires to the grounding system (Protective Earth) and the LPU or Gigabit Ethernet Surge Suppressor according to applicable regulations.

## PMP 450 AP

- 1 Fasten an AWG 10 (or 6mm<sup>2</sup>) copper ground cable to each ODU grounding point using the M6 (small) lugs



- 2 Tighten the Ground post locking nut in the copper wire



- 3 Securely connect the copper wire to the grounding system (Protective Earth) according to applicable regulations.

## PMP 450 SM

- 1 Fasten an AWG 10 (or 6mm<sup>2</sup>) copper ground cable to each ODU grounding point using the M6 (small) lugs



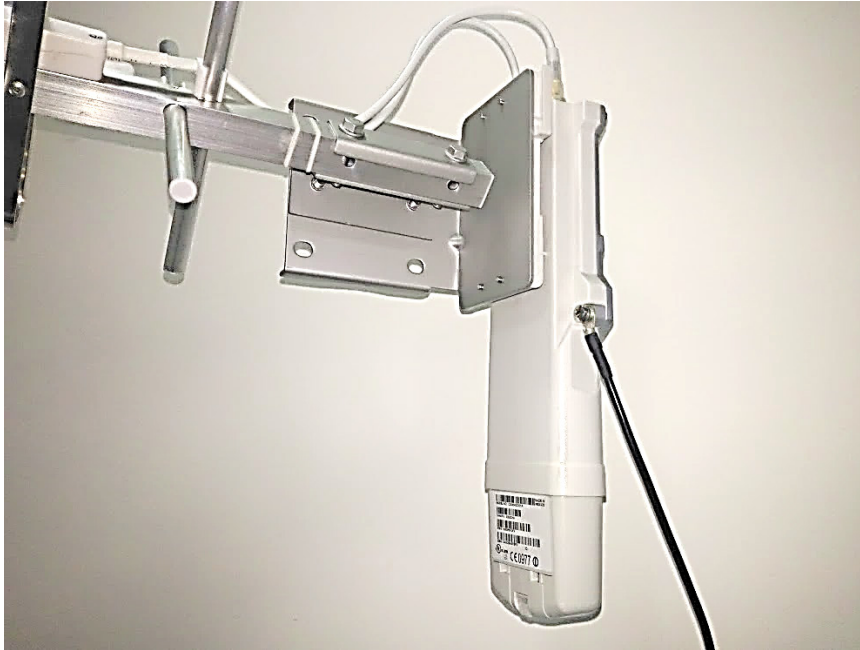
- 2 Tighten the Ground post locking nut in the copper wire



- 3 Securely connect the copper wire to the grounding system (Protective Earth) according to applicable regulations.

The grounding point on PMP 450 Series SM 900 MHz is different from 2.4, 3.5/3.65 and 5 GHz PMP 450 SMs as shown in [Figure 76](#).

**Figure 76** PMP 450 900 MHz SM grounding

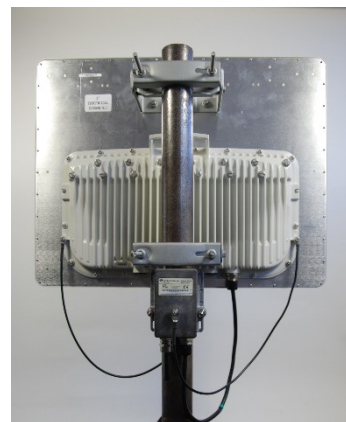


## Mount the ODU on the mast

### PMP 450m Series – AP

- 1 See - [PMP 450m Series – AP](#) on page 6-54 for Installation for an integrated ODU
- 2 Remove the rear bracket strap from upper and lower brackets of ODU
- 3 Attach the upper and lower bracket of ODU to the mount point by closing the rear strap around the pole
- 4 Secure the four-serrated flange M8 nuts by applying 10 Nm torque on upper and lower rear strap using a 13 mm spanner wrench. These must be tightened evenly on the pole to avoid jumping/stripping threads

Secure the bolts on four sides by applying 8 Nm torque as per the angle of the antenna.



## PMP/PTP 450i Series – AP/SM/BH, PMP 450 3 GHz Ruggedized SM



### Caution

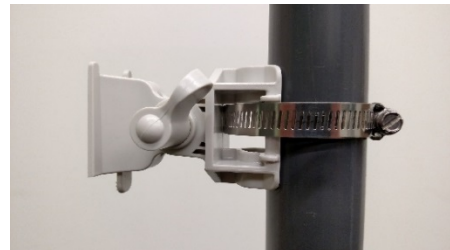
Do not reverse the bracket clamp, as this arrangement may lead to failure of the assembly. Do not over-tighten the bolts as this may lead to failure of the assembly.

- 1 Fix the mounting plate to the back of the ODU using the four bolts, and spring and plain washers provided. Tighten the bolts.
- 2 Attach the bracket body to the mounting plate using the M8 bolt, spring and plain washers.
- 3 Hoist the ODU to the mounting position
- 4 Attach the bracket body to the pole using the bracket clamp, M8 bolts, and spring and plain washers.
- 5 Adjust the elevation and azimuth to achieve visual alignment.



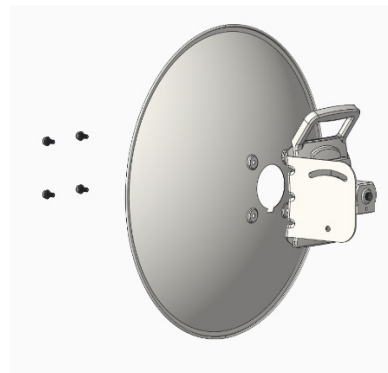
## PMP 450b Mid-Gain SM

- 1 Use a stainless steel hose clamp for the attachment.
- 2 Attach the mounting bracket to the structure with the release tab facing downward. Tighten the hose clamp.
- 3 Slide the 450b SM onto the mounting bracket. Press downwards until it clicks into place.
- 4 Loosen the adjuster wingnut on the bracket and set the required SM tilt angle. Retighten the adjuster wingnut by hand to secure the SM at the chosen angle.



## PMP 450b High Gain SM

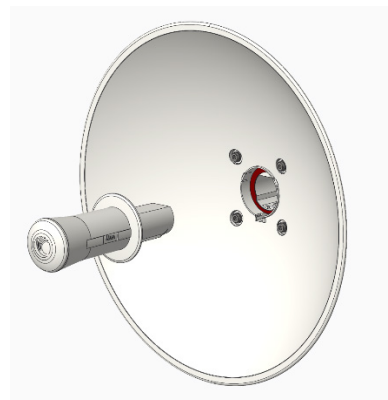
- 1 Snap in the rear housing assembly.



- 2 Insert screws to hold the rear housing assembly to the dish by applying 5 Nm Torque.



- 3 Snap in the center feed tube to the assembly.



- 4 Tighten the center feed tube lock screw.



- 5 Assemble the pole bracket to the Rear housing bracket.



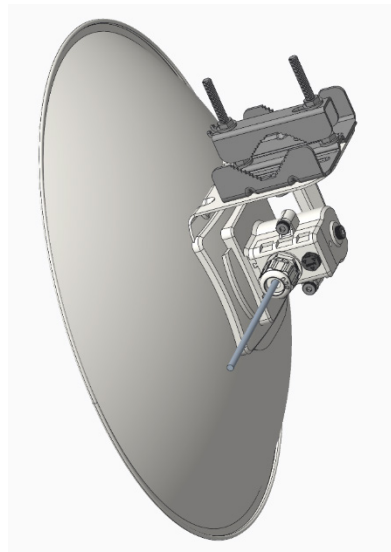
- 6 Remove the cable gland from bottom cover. Feed the RJ45 cable through the gland, bottom cover and connect to the radio.



- 7 Keep part loose and screw gland to the bottom cover. Audio cable is not shown in the figure.



- 8 Tighten gland, bottom cover screws and connect to the radio.

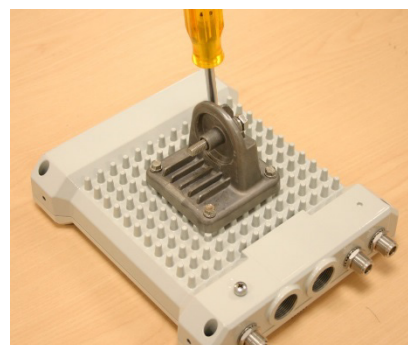


- 9 Loosen M8 nuts to remove outer clamp. Slip clamp over pole and tighten M8 nuts by applying 8 Nm torque. Do not over tighten to prevent aligning the dish.



## PMP 450 AP

- 1 Using an 8mm nut driver, attach the pole mount's AP housing bracket to the unit using the 4 M5 x 16mm bolts included with the AP.





**2** Using the included (depending on pole diameter):

- M8 x 70mm hex cap bolts (2 quantity)  
or
- M8 x 40mm hex cap bolts (2 quantity)  
and
- M8 flat washers (2 quantity)
- M8 coil washers (2 quantity)

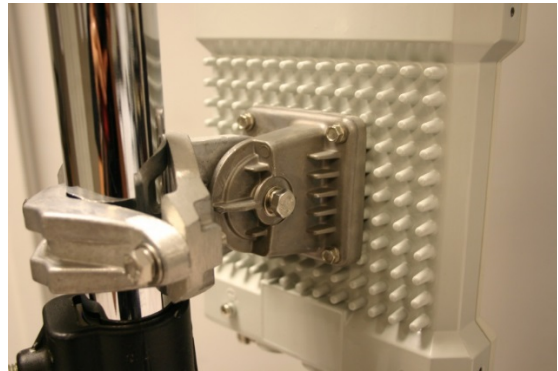
Attach the mounting bracket to the pole/mast. The mounting bracket is designed to attach to poles with diameters in the range of 2 in. (50mm) to 3in. (75mm).



**3** Complete the AP mounting assembly by attaching the included:

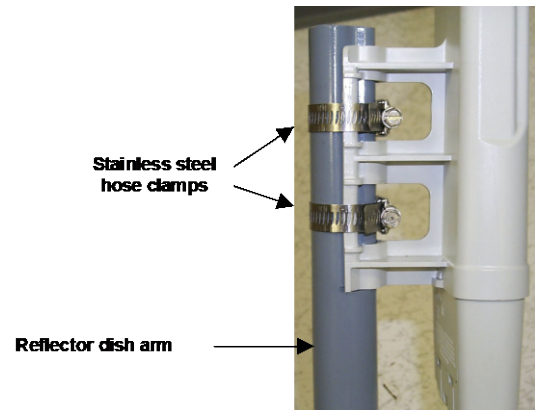
- 8mm hex cap bolt (one quantity)

Through the AP's attached mounting bracket and pole mount. Now the AP may be adjusted to the desired position and tightened with a 1/2-inch spanner wrench to 11 lb/ft (14Nm).



## PMP 450 SM (except PMP 450 SM - 900 MHz)

- 1** Use stainless steel hose clamps for the attachment.
- 2** Attach the mounting bracket to the structure. Tighten the locking nut.

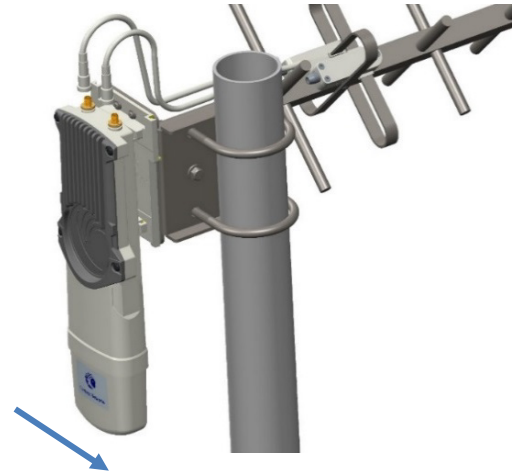


## PMP 450 SM 900 MHz (connectorized)

The PMP 450 900 MHz connectorized SM mounting procedure is different from other radios. It does not get directly mounted on pole.



- 1 Align the 900 MHz SM to E bracket of Yagi antenna
- 2 Slide the radio towards right to lock on the antenna

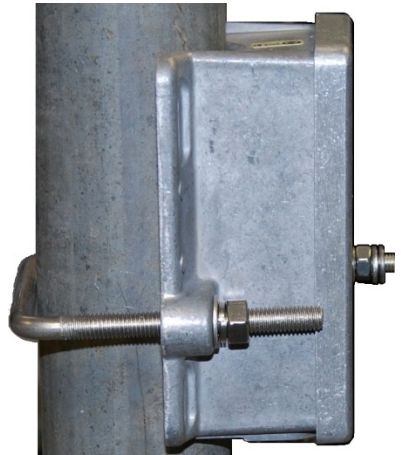


Slide towards right to lock

## Mount the top LPU

- 1 For separate LPU mounting, use the U-bolt bracket from the LPU kit to mount the top LPU on the pole below the ODU. Tighten to a torque setting of 7.0 Nm (5.2 lb ft).

Please refer *Gigabit LPU and Grounding Kit Installation Guide* for more details.



## Mount the Surge Suppressor

### PMP/PTP 450i/450b Series

Gigabit Ethernet Surge Suppressors are installed at both ends of the drop cable. One within 600 mm (24") of and under the ODU. The other located within 600 mm (24") of the building entry point.

#### Quick procedure:

The quick procedure for the Surge Suppressor for PMP/PTP 450i/450b Series mounting is as follows:

- 1 Ground using the terminal on the back of the units. Use the supplied Tubular Lug and 6 mm<sup>2</sup> (10 AWG) stranded cable, max length 600 mm (24").

- I. Waterproof the cable lug with heat shrink sleeving.
  - II. Secure the Cable assembly to the unit using the supplied screw and washer.
- 2 Mount the Gigabit Ethernet Surge Suppressor on the wall or pole
  - 3 Connect the two CAT5e cables to the Gigabit Ethernet Surge Suppressor
  - 4 Slide the end cap over the bottom of the Gigabit Ethernet Surge Suppressor, ensuring it clicks firmly in place



Refer to the *Gigabit Ethernet Surge Suppressor Installation Guide* for more details.

**Figure 77** Gigabit Ethernet Surge Suppressor



## PMP/PTP 450 Series

The PMP/PTP 450 Series uses 600SSH Surge Suppressor. The inside of the surge suppressor is shown in [Figure 78](#).



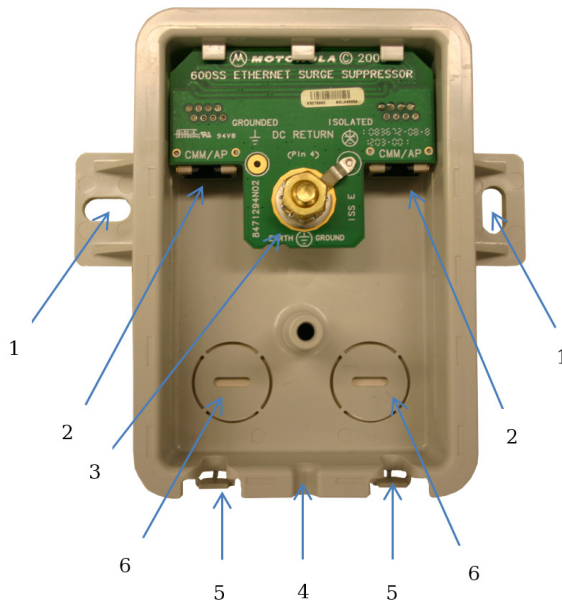
### Caution

The PMP 450 SM 900 MHz is based off of the 450 Series, be sure to use a 600SS to protect this radio type.

**Figure 78** 600SSH Surge Suppressor – inside

### Key to Callouts 600SSH

- 1 Holes—for mounting the Surge Suppressor to a flat surface (such as an outside wall). The distance between centers is 4.25 inches (108 mm).
- 2 RJ-45 connectors—One side (neither side is better than the other for this purpose) connects to the product (AP, SM, AC Adapter, or cluster management module). The other connects to the drop cable.



- 3 Ground post and washer—use heavy gauge (10 AWG or 6 mm<sup>2</sup>) copper wire for connection. Refer to local electrical codes for exact specifications.
- 4 Ground Cable Opening—route the 10 AWG (6 mm<sup>2</sup>) ground cable through this opening.
- 5 CAT-5 Cable Knockouts—route the two CAT-5 cables through these openings, or alternatively through the Conduit Knockouts.
- 6 Conduit Knockouts—on the back of the case, near the bottom. Available for installations where cable is routed through building conduit.

**Note**

The 600SSH surge suppressor is shipped in the “isolated” position (pin 4 isolated by 68V from protective earth). If packet error issues occur over the Ethernet link (verify by pinging the device through the 600SSH), configure the 600SSH to “grounded” position (by moving the 600SSH switch from “isolated” to “ground”) to avoid ground loops that may be present in the system.

The mounting procedure for the Surge Suppressor for PMP/PTP 450 Series is as follows:

- 1 Remove the cover of the 600SSH Surge Suppressor.
- 2 With the cable openings facing downward, mount the 600SSH to the *outside* of the subscriber premises, as close to the point where the Ethernet cable penetrates the residence or building as possible, and as close to the grounding system (Protective Earth) as possible.
- 3 Wrap an AWG 10 (or 6mm<sup>2</sup>) copper wire around the Ground post of the 600SSH.
- 4 Tighten the Ground post locking nut in the 600SSH onto the copper wire.
- 5 Securely connect the copper wire to the grounding system (Protective Earth) according to applicable regulations.
- 6 Using diagonal cutters or long nose pliers, remove the knockouts that cover the cable openings to the 600SSH.
- 7 Pack both surge suppressor Ethernet jacks with dielectric grease.
- 8 Wrap a splice loop in the loose end of the Ethernet cable from the SM.
- 9 Connect that cable to one of the Ethernet jacks.

- 10 Connect an Ethernet cable to the other Ethernet jack of the 600SSH and to the power adapter.
- 11 Replace the cover of the 600SSH.

## General protection installation

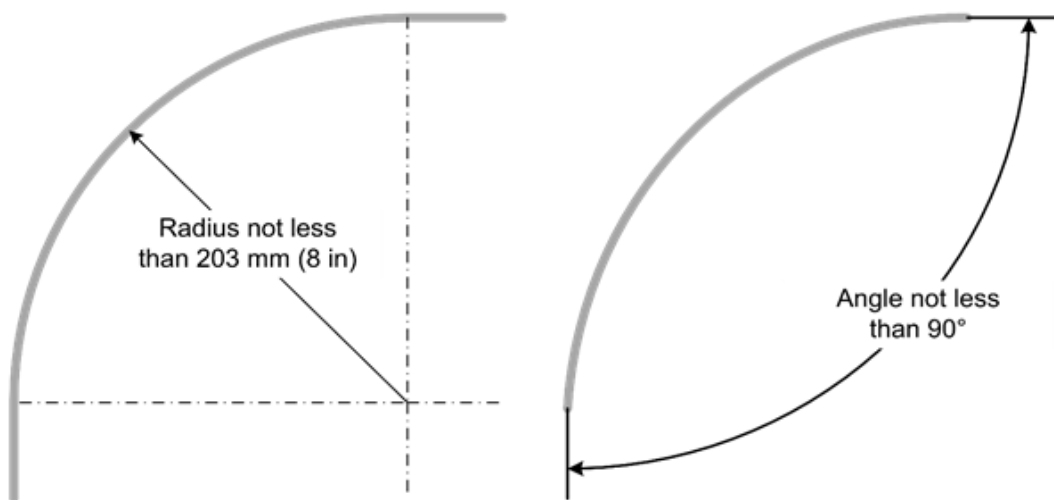
To adequately protect a 450 Platform Family installation, both ground bonding and transient voltage surge suppression are required.

### Grounding cable requirements

When routing, fastening and connecting grounding cables, the following requirements must be implemented:

- Grounding conductors must be run as short, straight, and smoothly as possible, with the fewest possible number of bends and curves.
- Grounding cables must not be installed with drip loops.
- All bends must have a minimum radius of 203 mm (8 in) and a minimum angle of 90° (Figure 79). A diagonal run is preferable to a bend, even though it does not follow the contour or run parallel to the supporting structure.
- All bends, curves and connections must be routed towards the grounding electrode system, ground rod, or ground bar.
- Grounding conductors must be securely fastened.
- Braided grounding conductors must not be used.
- Approved bonding techniques must be used for the connection of dissimilar metals.

**Figure 79** Grounding cable minimum bend radius and angle



**Caution**

Do not attach grounding cables to the ODU mounting bracket bolts, as this arrangement will not provide full protection.

---

## Basic requirements

The following basic protection requirements must be implemented:

- ODU must be in 'Zone B' (see [Lightning protection zones](#) on page 3-9).
- ODU must be grounded to the supporting structure.
- A surge suppression unit must be installed on the outside of the building.
- The distance between the ODU and Gigabit Surge Suppressor should be kept to a minimum.
- The drop cable must not be laid alongside a lightning air terminal.
- All grounding cables must be a minimum size of 10 mm<sup>2</sup> csa (8AWG), preferably 16 mm<sup>2</sup> csa (6AWG), or 25 mm<sup>2</sup> csa (4AWG).

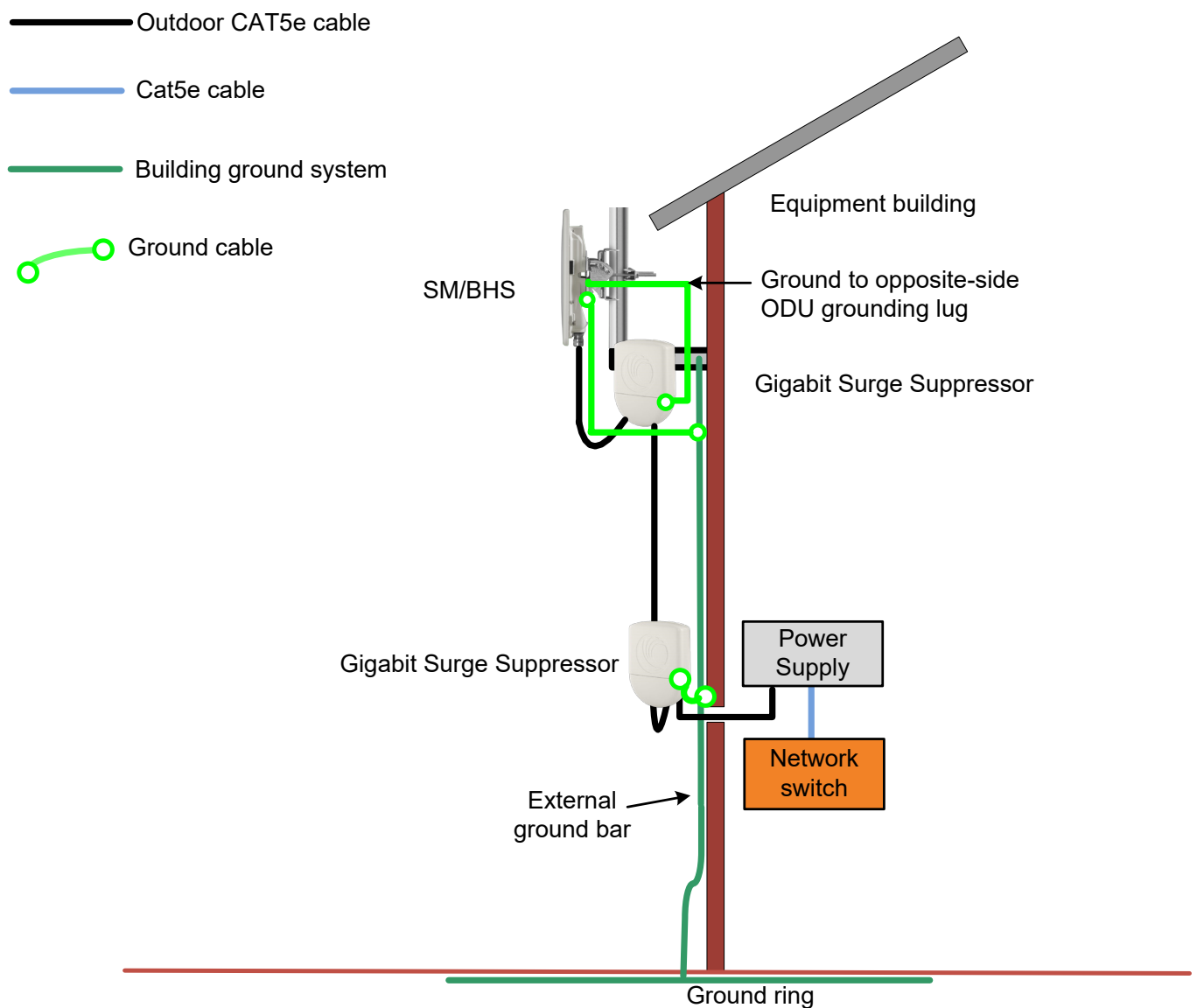
## Protection requirements for a wall installation

If the ODU is to be mounted on the wall of a building, then in addition to the general protection requirements (above), the following requirements must be observed:

- The equipment must be lower than the top of the building or its lightning air terminal.
- The building must be correctly grounded.

Schematic examples of wall installations are shown in [Figure 80](#).

**Figure 80** Grounding and lightning protection on wall





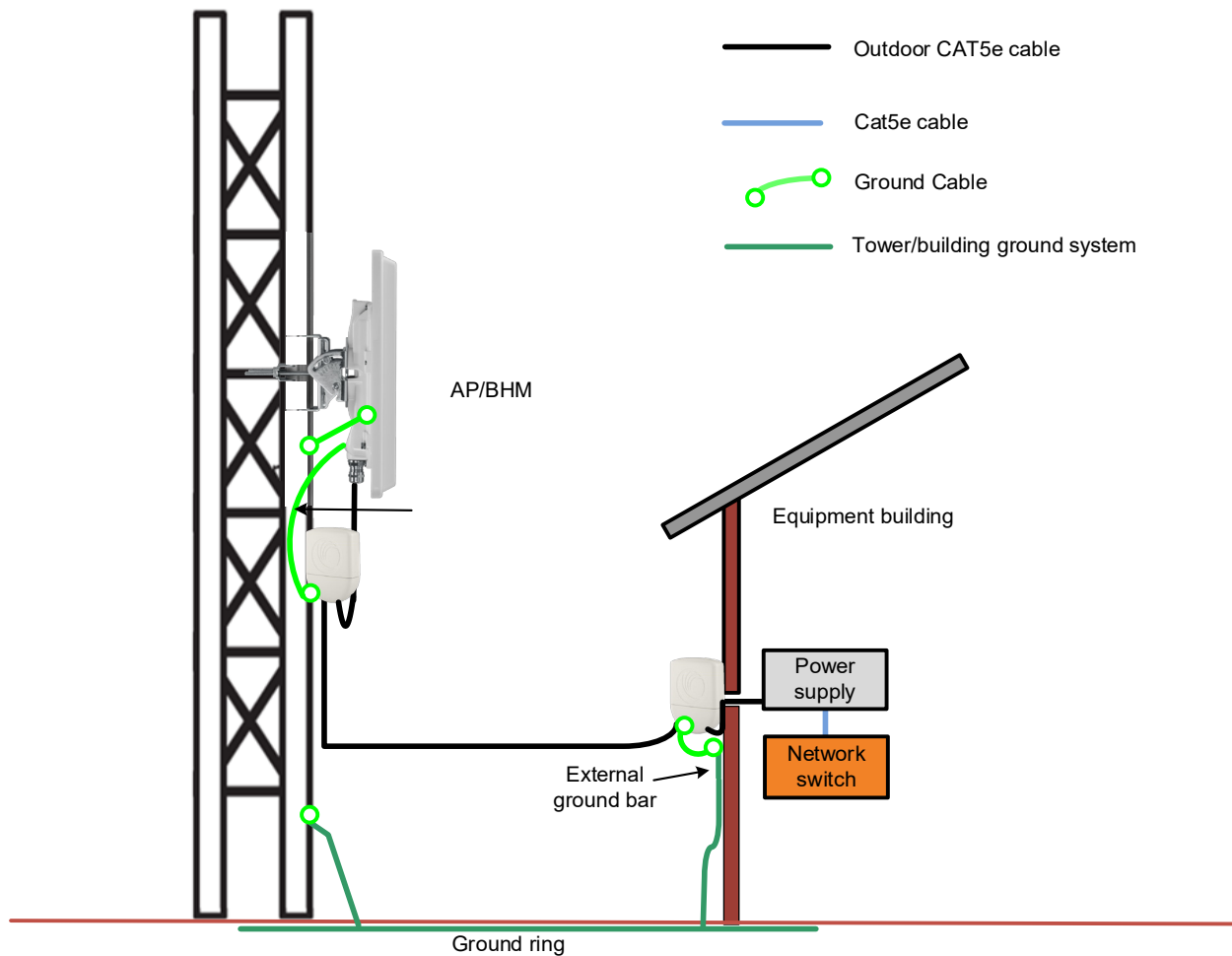
## Protection requirements for a mast or tower installation

If the ODU is to be mounted on a metal tower or mast, then in addition to the general protection requirements (above), the following requirements must be observed:

- The equipment must be lower than the top of the tower or its lightning air terminal.
- The metal tower or mast must be correctly grounded.

Schematic examples of mast or tower installations are shown in [Figure 81](#).

**Figure 81** Grounding and lightning protection on mast or tower

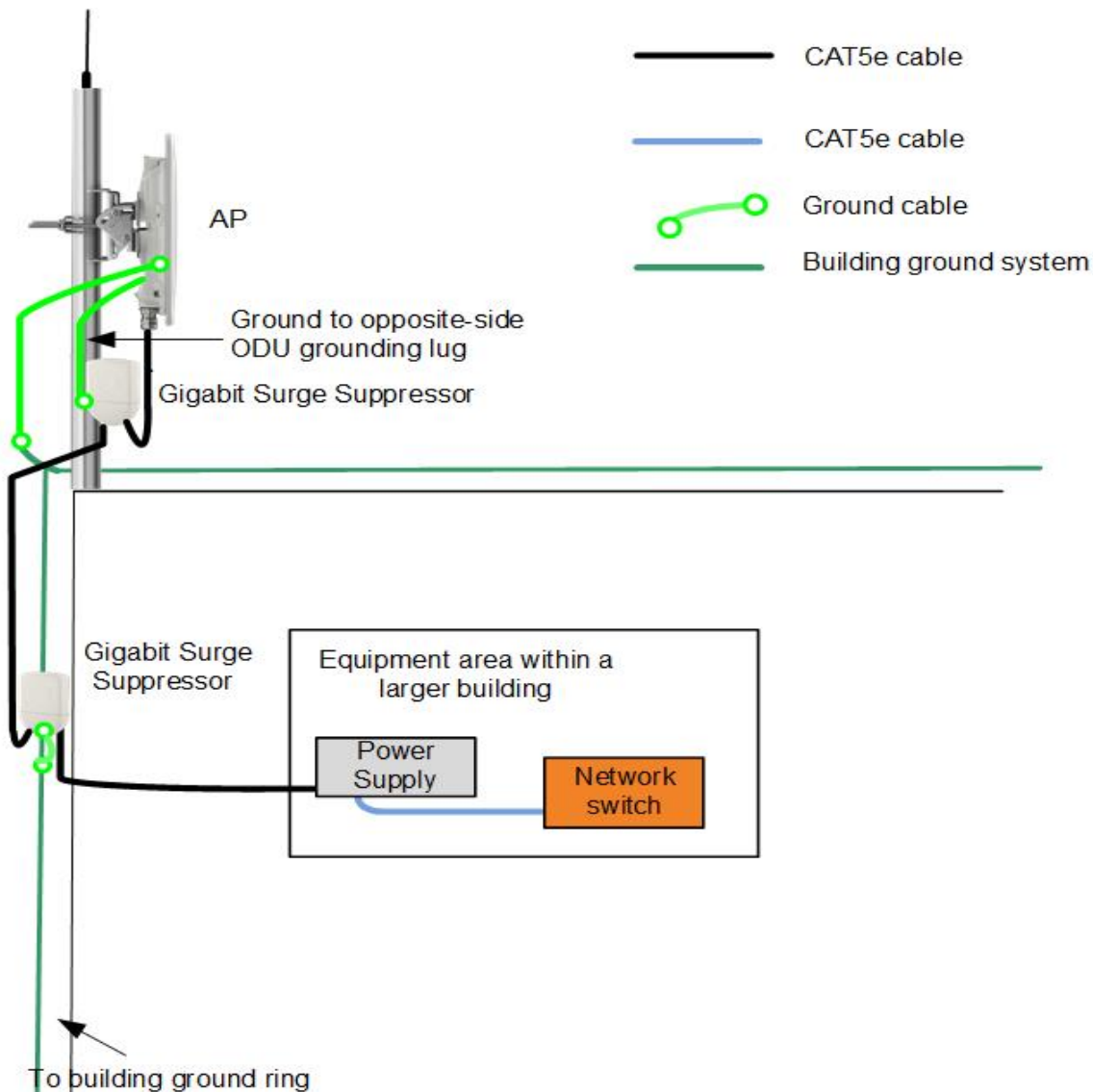


## Protection requirements on a multi-floor building

If the ODU is to be mounted on a high-rise building, it is likely that cable entry is at roof level (Figure 48) and the equipment room is several floors below. The following additional requirements must be observed:

- The ODU must be below the lightning terminals and finials.
- A grounding conductor must be installed around the roof perimeter to form the main roof perimeter lightning protection ring.
- Air terminals are typically installed along the length of the main roof perimeter lightning protection ring typically every 6.1m (20ft).
- The main roof perimeter lightning protection ring must contain at least two down conductors connected to the grounding electrode system. The down conductors should be physically separated from one another, as far as practical.

**Figure 82** Grounding and lightning protection on building



# Installing the copper Cat5e Ethernet interface

---

To install the copper Cat5e Ethernet interface, use the following procedures:

- [Install the main drop cable](#) on page 6-22
  - [Install the bottom LPU to PSU drop cable](#) on page 6-24
  - [Installing external antennas to a connectorized ODU](#) on page 6-26
- 

**Caution**

To avoid damage to the installation, do not connect or disconnect the drop cable when power is applied to the PSU or network terminating equipment.

---

**Caution**

Always use Cat5e cable that is gel-filled and shielded with copper-plated steel. Alternative types of Cat5e cable are not supported by Cambium Networks. Cambium Networks supply this cable (Cambium part numbers WB3175 and WB3176), RJ45 connectors (Cambium part number WB3177) and a crimp tool (Cambium part number WB3211). The LPU and grounding kit contains a 600-mm length of this cable.

---

## Install the main drop cable

**Warning**

The metal screen of the drop cable is very sharp and may cause personal injury.

- ALWAYS wear cut-resistant gloves (check the label to ensure they are cut resistant).
  - ALWAYS wear protective eyewear.
  - ALWAYS use a rotary blade tool to strip the cable (DO NOT use a bladed knife).
- 

**Warning**

Failure to obey the following precautions may result in injury or death:

- Use the proper hoisting grip for the cable being installed. If the wrong hoisting grip is used, slippage or insufficient gripping strength will result.
  - Do not reuse hoisting grips. Used grips may have lost elasticity, stretched, or become weakened. Reusing a grip can cause the cable to slip, break, or fall.
  - The minimum requirement is one hoisting grip for each 60 m (200 ft) of cable.
-

## Cut to length and fit hoisting grips

- 1 Cut the main drop cable to length from the top LPU to the bottom LPU.
- 2 Slide one or more hoisting grips onto the top end of the drop cable.
- 3 Secure the hoisting grip to the cable using a special tool, as recommended by the manufacturer.

## Terminate with RJ45 connectors

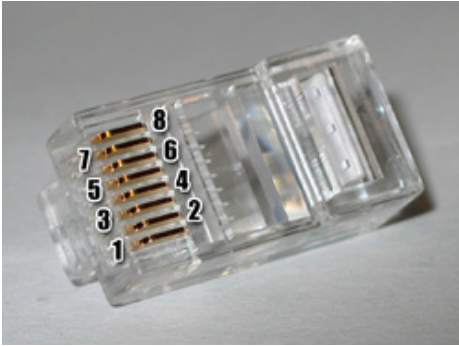


### Caution

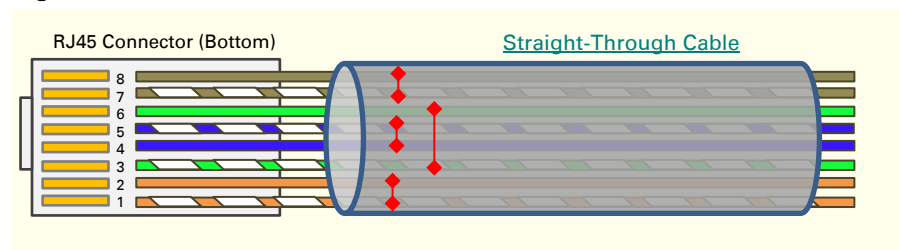
Check that the crimp tool matches the RJ45 connector, otherwise the cable or connector may be damaged.

- 1 Strip the cable outer sheath and fit the RJ45 connector load bar.
- 2 Fit the RJ45 connector housing as shown. To ensure there is effective strain relief, locate the cable inner sheath under the connector housing tang.

**Table 112** RJ45 connector and cable color code

| Pin | Color (Supplied cable) | Color (Conventional) | Pins on plug face                                                                    |
|-----|------------------------|----------------------|--------------------------------------------------------------------------------------|
| 1   | Light Orange           | White/Orange         |  |
| 2   | Orange                 | Orange               |                                                                                      |
| 3   | Light Green            | White/Green          |                                                                                      |
| 4   | Blue                   | Blue                 |                                                                                      |
| 5   | Light Blue             | White/Blue           |                                                                                      |
| 6   | Green                  | Green                |                                                                                      |
| 7   | Light Brown            | White/Brown          |                                                                                      |
| 8   | Brown                  | Brown                |                                                                                      |

**Figure 83** RJ45 cable

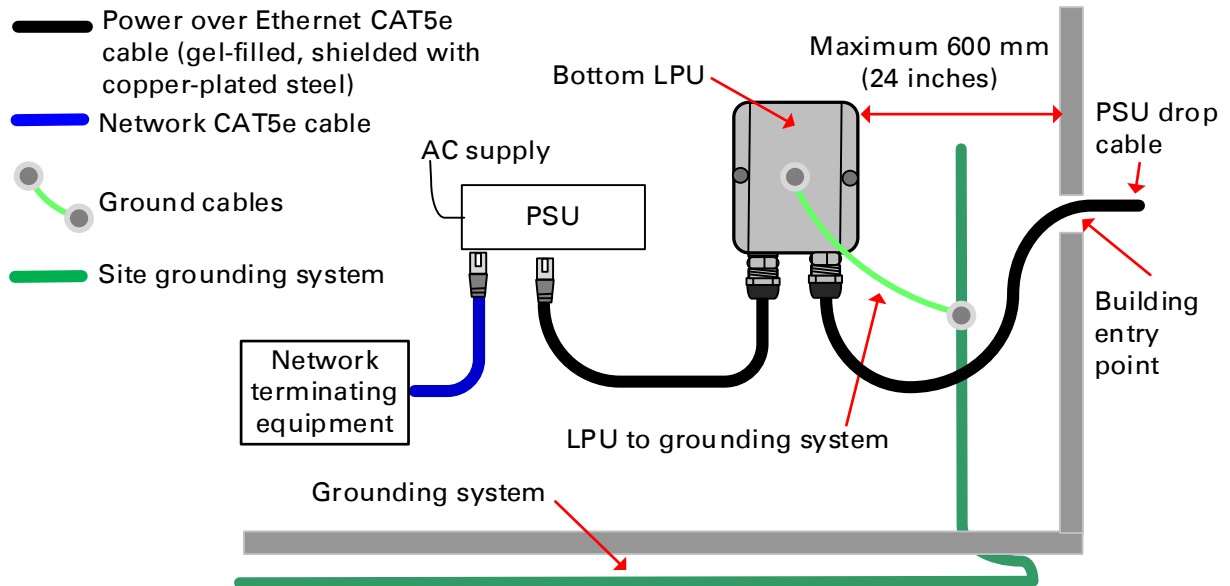


## Install the bottom LPU to PSU drop cable

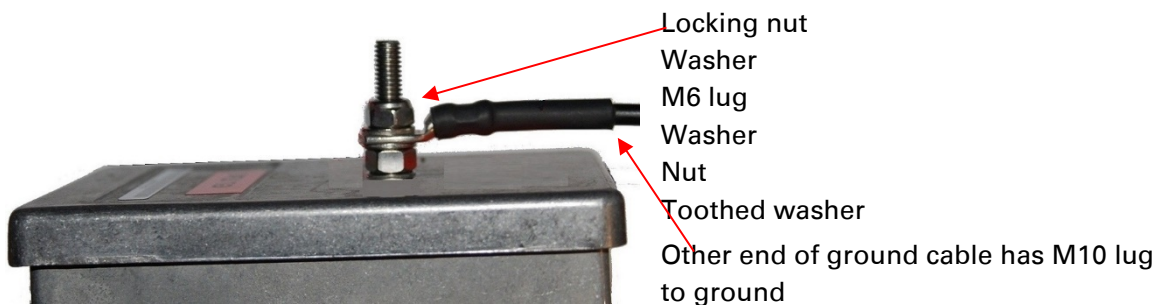
### Install the bottom LPU

Install the bottom LPU, ground it, and connect it to the main drop cable.

- 1 Select a mounting point for the bottom LPU within 600 mm (24 in) of the building entry point. Mount the LPU vertically with cable glands facing downwards.



- 2 Connect the main drop cable using the EMC cable gland to the bottom LPU.
- 3 Fasten one ground cable to the bottom LPU using the M6 (small) lug. Tighten both nuts to a torque of 5 Nm (3.9 lb ft):



- 4 Select a building grounding point near the LPU bracket. Remove paint from the surface and apply anti-oxidant compound. Fasten the LPU ground cable using the M10 (large) lug.

## Install the LPU to PSU drop cable

Use this procedure to terminate the bottom LPU to PSU drop cable with RJ45 connectors at both ends, and with a cable gland at the LPU end.



### Warning

The metal screen of the drop cable is very sharp and may cause personal injury. ALWAYS wear cut-resistant gloves (check the label to ensure they are cut resistant). ALWAYS wear protective eyewear. ALWAYS use a rotary blade tool to strip the cable, not a bladed knife.

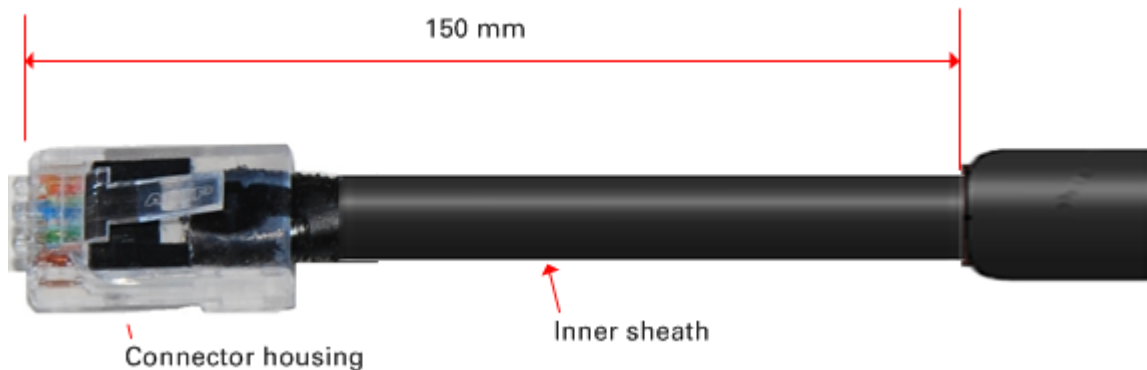


### Caution

Check that the crimp tool matches the RJ45 connector, otherwise the cable or connector may be damaged.

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- 1 Cut the drop cable to the length required from bottom LPU to PSU.
- 2 **At the LPU end only:**
  - Fit one cable gland and one RJ45 connector by following the procedure [Terminate with RJ45 connectors](#) on page 6-23.
  - Connect this cable and gland to the bottom LPU.
- 3 **At the PSU end only:** Do not fit a cable gland. Strip the cable outer sheath and fit the RJ45 connector load bar. Fit the RJ45 connector housing. To ensure there is effective strain relief, locate the cable inner sheath under the connector housing tang:



# Installing external antennas to a connectorized ODU

## PMP 450i Series

To mount and connect an external antenna to the connectorized ODU, proceed as follows:

- 1 Mount the antenna(s) according to manufacturer's instructions.
- 2 Connect the ODU A and B interfaces to the antenna(s) with RF cable of type LMR-400 (Cambium part numbers 30010194001 and 30010195001) and N type connectors (Cambium part number 09010091001). Tighten the N type connectors to a torque setting of 1.7 Nm (1.3 lb ft).
- 3 If the ODU is mounted indoors, install lightning arrestors at the building entry point:
- 4 Form drip loops near the lower ends of the antenna cables. These ensure that water is not channeled towards the connectors.
- 5 If the ODU is mounted outdoors, weatherproof the N type connectors (when antenna alignment is complete) using PVC tape and self-amalgamating rubber tape.
- 6 Weatherproof the antenna connectors in the same way (unless the antenna manufacturer specifies a different method).

