Cambium Networks™

PLANNING AND INSTALLATION GUIDE

PMP/PTP 450 Series

System Release 22.0

Covers:

PMP 450 AP / PMP 450 SM / PTP 450 BH / PMP 450d

PMP 450i / PTP 450i

PMP 450b / PTP 450b

PMP 450m

PMP 450 MicroPoP

PMP / PTP 450b Retro

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Contents

About This User Guide

This guide describes planning and installation of the Cambium point-to-point and point-to-multipoint wireless Ethernet bridges. It covers PMP/PTP 450, 450i, 450b, 450d and PMP 450m platform Series. It is intended for use by the system designer, system installer and system administrator.

For radio network design, planning, and installation refer to the following chapters:

- Chapter 1: Product description
- Chapter 2: System hardware
- Chapter 3: System planning
- Chapter 4: Preparing for installation
- Chapter 5: Installation

Contacting Cambium Networks

Support website:	https://support.cambiumnetworks.com
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Sales enquiries:	solutions@cambiumnetworks.com
Support enquiries:	https://support.cambiumnetworks.com
Repair enquiries:	https://support.cambiumnetworks.com
Telephone number list:	http://www.cambiumnetworks.com/contact
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Purpose

Cambium Networks Point-to-Multi-Point (PMP)/Point-To-Point (PTP) 450 documents are intended to instruct and assist personnel in the operation, installation and maintenance of the Cambium PMP/PTP equipment and ancillary devices of 450 Platform Family. It is recommended that all personnel engaged in such activities be properly trained.

Cambium disclaims all liability whatsoever, implied or express, for any risk of damage, loss or reduction in system performance arising directly or indirectly out of the failure of the customer, or anyone acting on the customer's behalf, to abide by the instructions, system parameters, or recommendations made in this document.

Product notation conventions in document

This document covers Cambium 450 Series, 450i Series and 450m Series products. The following notation conventions are followed while referring to product series and product family:

Product notation	Description
450 Platform Family	Refers to the complete 450 Series family, which includes 450 Series, 450i Series, 450b Series and 450m Series

450 Series	Refers to 450 Series devices in the following configurations:
	PMP 450
	• AP [2.4GHz/3.5 GHz/3.65 GHz /5 GHz]
	  ◦ Connectorized
	• SM [900 MHz/2.4GHz/3.5 GHz/3.65 GHz /5 GHz]
	  ◦ Connectorized / Integrated
	PTP 450
	• BHM/BHS [900 MHz/3.5 GHz/3.65 GHz/5 GHz]
	  ◦ Connectorized / Integrated
	PMP 450d
	• SM [5 GHz] - Dish

450i Series	Refers to 450i Series devices in the following configurations:
	PMP 450i
	• AP [900 MHz/3 GHz/5 GHz]
	  ◦ Connectorized / Integrated
	• SM [3 GHz/5 GHz]
	  ◦ Connectorized / Integrated
	PTP 450i
	• BHM/ BHS [3 GHz/5 GHz]
	  ◦ Connectorized / Integrated

450b Series	Refers to 450b Series devices in the following configurations: PMP/PTP 450b Mid-Gain • SM [5 GHz] ◦ Integrated • BHM/BHS [5 GHz]

Product notation	Description
	◦ Integrated PMP/PTP 450b Connectorized • SM [5 GHz] • BHM/BHS [5 GHz] PMP/PTP 450b High Gain • SM [3 GHz/5 GHz] - Dish • BHM/BHS [3 GHz/5 GHz] - Dish
450m Series	Refers to 450m Series device configuration: PMP 450m • AP 5 GHz ◦ Integrated • AP 3 GHz ◦ Integrated
450 MicroPoP Series	Refers to 450 MicroPoP Series devices in the following configurations: • PMP 450 MicroPop Omni AP 5 GHz ◦ Integrated • PMP 450 MicroPop Sector AP 5 GHz ◦ Integrated • PMP 450 MicroPop Connectorized AP 5 GHz ◦ Connectorized
450b Retro Series	Refers to 450b Retro Series devices in the following configurations: • PMP 450b Retro SM 5 GHz ◦ Integrated • PTP 450b BHM/BHS 5 GHz ◦ Integrated

Cross references

References to external publications are shown in italics. Other cross references, emphasized in blue text in electronic versions, are active links to the references.

This document is divided into numbered chapters that are divided into sections. Sections are not numbered but are individually named at the top of each page and are listed in the table of contents.

Feedback

We appreciate feedback from the users of our documents. This includes feedback on the structure, content, accuracy, or completeness of our documents. To provide feedback, visit our support website.https://support.cambiumnetworks.com.

Caution

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation

Important regulatory information

The 450 Platform Family products are certified as an unlicensed device in frequency bands where it is not allowed to cause interference to licensed services (called primary users of the bands).

Application software

Download the latest 450 Platform Family software and install it in the Outdoor Units (ODUs) before deploying the equipment. Instructions for installing software are provided in 450 Platform Planning and Installation Guide.

USA specific information

The USA Federal Communications Commission (FCC) requires manufacturers to implement special features to prevent interference to weather radar systems that operate in the band 5600 MHz to 5650 MHz. These features must be implemented in all products able to operate outdoors in the band 5470 MHz to 5725 MHz.

Manufacturers must ensure that such radio products cannot be configured to operate outside of FCC rules; specifically, it must not be possible to disable or modify the radar protection functions that have been demonstrated to the FCC.

Cambium supplies variants of the 5 GHz 450, 450i, 450b, and 450m Series specifically for operation in the USA to comply with FCC requirements (KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02). These variants are only allowed to operate with license keys that comply with FCC rules.

To ensure compliance when using PMP 450 Series and PTP 450 Series, follow the recommendation in Avoidance of weather radars (USA only).

External antennas

When using a connectorized version of the product, the conducted transmit power may need to be reduced to ensure the regulatory limit on transmitter EIRP is not exceeded. The installer must have an

understanding of how to compute the effective antenna gain from the actual antenna gain and the feeder cable losses.

The range of permissible values for maximum antenna gain and feeder cable losses are included in this user guide together with a sample calculation. The product GUI automatically applies the correct conducted power limit to ensure that it is not possible for the installation to exceed the EIRP limit, when the appropriate values for antenna gain and feeder cable losses are entered into the GUI.

Avoidance of weather radars (USA only)

To comply with FCC rules (KDB 443999: Interim Plans to Approve UNII Devices Operating in the 5470 - 5725 MHz Band with Radar Detection and DFS Capabilities), units which are installed within 35 km (22 miles) of a Terminal Doppler Weather Radar (TDWR) system (or have a line of sight propagation path to such a system) must be configured to avoid any frequency within +30 MHz or –30 MHz of the frequency of the TDWR device. This requirement applies even if the master is outside the 35 km (22 miles) radius but communicates with outdoor clients which may be within the 35 km (22 miles) radius of the TDWRs. If interference is not eliminated, a distance limitation based on line-of-sight from TDWR will need to be used. Devices with bandwidths greater than 20 MHz may require greater frequency separation.

When planning a link in the USA, visit http://spectrumbridge.com/udia/home.aspx, enter the location of the planned link and search for TDWR radars. If a TDWR system is located within 35 km (22 miles) or has line of sight propagation to the PTP device, perform the following tasks:

- Register the installation on http://spectrumbridge.com/udia/home.aspx.
- Make a list of channel center frequencies that must be barred, that is, those falling within +30 MHz or –30 MHz of the frequency of the TDWR radars.

The 450 Platform Family AP must be configured to not operate on the affected channels.

Canada specific information

Caution

This device complies with ISEDC 's license-exempt RSSs. Operation is subject to the following two conditions:

(1) This device may not cause interference; and

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

ISEDC requires manufacturers to implement special features to prevent interference to weather radar systems that operate in the band 5600 MHz to 5650 MHz. These features must be implemented in all products able to operate outdoors in the band 5470 MHz to 5725 MHz.

Manufacturers must ensure that such radio products cannot be configured to operate outside of ISEDC rules; specifically it must not be possible to disable or modify the radar protection functions that have been demonstrated to ISEDC .

In order to comply with these ISEDC requirements, Cambium supplies variants of the 450 Platform Family for operation in Canada. These variants are only allowed to operate with license keys that comply with ISEDC rules. In particular, operation of radio channels overlapping the band 5600 MHz to 5650 MHz is not allowed and these channels are permanently barred.

In addition, other channels may also need to be barred when operating close to weather radar installations.

Other variants of the 450 Platform Family are available for use in the rest of the world, but these variants are not supplied to Canada except under strict controls, when they are needed for export and deployment outside Canada.

Renseignements specifiques au Canada

Attention

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

ISEDC a demandé aux fabricants de mettre en œuvre des mécanismes spécifiques pour éviter d'interférer avec des systèmes radar fonctionnant dans la bande 5600 MHz à 5650 MHz. Ces mécanismes doivent être mis en œuvre dans tous les produits capables de fonctionner à l'extérieur dans la bande 5470 MHz à 5725 MHz.

Les fabricants doivent s'assurer que les produits de radiocommunications ne peuvent pas être configurés pour fonctionner en dehors des règles ISEDC, en particulier, il ne doit pas être possible de désactiver ou modifier les fonctions de protection des radars qui ont été démontrés à ISEDC.

Afin de se conformer à ces exigences de ISEDC, Cambium fournit des variantes du 450 Platform Family exclusivement pour le Canada. Ces variantes ne permettent pas à l'équipement de fonctionner en dehors des règles de ISEDC. En particulier, le fonctionnement des canaux de radio qui chevauchent la bande 5600-5650 MHz est interdite et ces canaux sont définitivement exclus.

ISEDC Approved Antennas

The list of antennas used to obtain ISEDC approvals is provided in section Reference Information of 450 Platform Configuration Guide.

Antennas externes

Lorsque vous utilisez une version du produit sans antenne intégrée, il peut être nécessaire de réduire la puissance d'émission pour garantir que la limite réglementaire de puissance isotrope rayonnée équivalente (PIRE) n'est pas dépassée. L'installateur doit avoir une bonne compréhension de la façon de calculer le gain de l'antenne réelle et les pertes dans les câbles de connections.

La plage de valeurs admissibles pour un gain maximal de l'antenne et des pertes de câbles de connections sont inclus dans ce guide d'utilisation avec un exemple de calcul. L'interface utilisateur du produit applique automatiquement la limite de puissance menée correct afin de s'assurer qu'il ne soit pas possible pour l'installation de dépasser la limite PIRE, lorsque les valeurs appropriées pour le gain d'antenne et les pertes de câbles d'alimentation sont entrées dans l'interface utilisateur.

Antennes approuvées par ISEDC

La liste des antennas approveés pour l'operation au Canada est founie dans le 450 Platform Configuration Guide.

EU Declaration of Conformity

Hereby, Cambium Networks declares that the Cambium 450 Series, 450b Series, 450i Series and 450m Series Wireless Ethernet Bridge complies with the essential requirements and other relevant provisions of Radio Equipment Directive 2014/53/EU. The declaration of conformity may be consulted at: https://www.cambiumnetworks.com/eu_dofc

Specific expertise and training for professional installers

To ensure that the 450 Platform Family products – PMP/PTP 450 Series, PMP/PTP 450i Series, PMP 450m Series, PMP 450 MicroPoP Series are installed and configured in compliance with the requirements of ISEDC and the FCC, installers must have the radio engineering skills and training described in this section.

The installer needs to have basic competence in radio and IP network installation. The specific requirements applicable to the 450 Platform should be gained by reading:

- Chapter 4: Preparing for installation and Chapter 5: Installation of 450 Platform Planning and Installation Guide (this document),
- Chapter 1: Configuration, Chapter 2: Tools, and Chapter 3: Operation of 450 Platform Configuration Guide, and by performing sample set ups at base workshop before live deployments.

The Cambium Networks technical training program details can be accessed from below link:

https://www.cambiumnetworks.com/training/

Ethernet networking skills

The installer must have the ability to configure IP addressing on a PC and to set up and control products using a web browser interface.

Lightning protection

To protect outdoor radio installations from the impact of lightning strikes, the installer must be familiar with the normal procedures for site selection, bonding and grounding. Installation guidelines for the 450 Platform Family can be found in Chapter 2: System hardware and Chapter 3: System planning.

Problems and warranty

Reporting problems

If any problems are encountered when installing or operating this equipment, follow this procedure to investigate and report:

1	Search this document and the software release notes of supported releases.
2	Visit the support website.
3	Ask for assistance from the Cambium product supplier.
4	Gather information from affected units, such as any available diagnostic downloads.
5	Escalate the problem by emailing or telephoning support.

Repair and service

If unit failure is suspected, obtain details of the Return Material Authorization (RMA) process from the support website (http://www.cambiumnetworks.com/support).

Hardware warranty

Cambium's standard hardware warranty is for one (1) year from date of shipment from Cambium Networks or a Cambium distributor. Cambium Networks warrants that hardware will conform to the relevant published specifications and will be free from material defects in material and workmanship under normal use and service. Cambium shall within this time, at its own option, either repair or replace the defective product within thirty (30) days of receipt of the defective product. Repaired or replaced product will be subject to the original warranty period but not less than thirty (30) days.

To register PMP and PTP products or activate warranties, visit the support website. For warranty assistance, contact the reseller or distributor. The removal of the tamper-evident seal will void the warranty.

Caution

Using non-Cambium parts for repair could damage the equipment or void warranty. Contact Cambium for service and repair instructions.

Portions of Cambium equipment may be damaged from exposure to electrostatic discharge. Use precautions to prevent damage.

Security advice

Cambium Networks systems and equipment provide security parameters that can be configured by the operator based on their particular operating environment. Cambium recommends setting and using these parameters following industry recognized security practices. Security aspects to be considered are protecting the confidentiality, integrity, and availability of information and assets. Assets include the ability to communicate, information about the nature of the communications, and information about the parties involved.

In certain instances, Cambium makes specific recommendations regarding security practices, however the implementation of these recommendations and final responsibility for the security of the system lies with the operator of the system.

Warnings, cautions, and notes

The following describes how warnings and cautions are used in this document and in all documents of the Cambium Networks document set.

Warnings

Warnings precede instructions that contain potentially hazardous situations. Warnings are used to alert the reader to possible hazards that could cause loss of life or physical injury. A warning has the following format:

Warning

Warning text and consequence for not following the instructions in the warning.

Cautions

Cautions precede instructions and are used when there is a possibility of damage to systems, software, or individual items of equipment within a system. However, this damage presents no danger to personnel. A caution has the following format:

Caution

Caution text and consequence for not following the instructions in the caution.

Notes

A note means that there is a possibility of an undesirable situation or provides additional information to help the reader understand a topic or concept. A note has the following format:

Note

Note text.

Caring for the environment

The following information describes national or regional requirements for the disposal of Cambium Networks supplied equipment and for the approved disposal of surplus packaging.

In EU countries

The following information is provided to enable regulatory compliance with the European Union (EU) directives identified and any amendments made to these directives when using Cambium equipment in EU countries.

Disposal of Cambium equipment

European Union (EU) Directive 2012/19/EU Waste Electrical and Electronic Equipment (WEEE)

Do not dispose of Cambium equipment in landfill sites. For disposal instructions, refer to

https://www.cambiumnetworks.com/support/compliance/

Disposal of surplus packaging

Do not dispose of surplus packaging in landfill sites. In the EU, it is the individual recipient's responsibility to ensure that packaging materials are collected and recycled according to the requirements of EU environmental law.

In non-EU countries

In non-EU countries, dispose of Cambium equipment and all surplus packaging in accordance with national and regional regulations.

Chapter 1: Product description

This chapter provides a high-level description of 450 Platform Family products. It describes in general terms the function of the product, the main product variants and the main hardware components. The following topics are described in this chapter:

- Overview of the 450 Platform Family introduces the key features, typical uses, product variants and components of the 450 Platform Family.
- *Wireless operation* describes how the 450 Platform Family wireless link is operated, including modulation modes and spectrum management.
- *System management* introduces the 450 Platform Family management system, including the web interface, configuration, security, alerts and recovery.

Overview of the 450 Platform Family

This section introduces the key features, typical uses, product variants and components of the 450 Platform Family.

Purpose

Cambium 450 Platform Family products are designed for Ethernet bridging over point-to-point and point-to-multipoint microwave links in unlicensed and lightly-licensed frequency bands 900MHz, 2.4 GHz, 3.5/3.65 GHz and 4.9 to 5.925 GHz.

Users must ensure that the 450 Platform Family complies with local operating regulations.

The 450 Platform Family acts as a transparent bridge between two or more segments of the operator's network. In this sense, it can be treated as a virtual wired connection among points. The 450 Series platform forwards 802.3 Ethernet frames destined for the other part of the network and filters frames it does not need to forward.

450 Platform Family

The 450 Series platform supports following:

- PMP_450m_Series
- PMP/PTP_450i_Series
- PMP/PTP_450b_Series
- PMP/PTP_450_Series
- PMP_450_MicroPoP_Series
- PMP/PTP_450b_Retro_Series
- PMP/PTP_450b_Connectorized_Series

PMP 450m Series

The PMP 450m Series AP is a revolutionary product which is based on Multi-User Multiple-Input and Multiple-Output (MU-MIMO) technology. By combining a sophisticated beam forming antenna array with multiple transceivers, Cambium Networks is using leading edge technology to provide a substantial shift upward in capacity per sector.

Key features

The Cambium PMP 450m Series AP offers the following benefits:

- MU-MIMO Access Point is a technologically cutting-edge device providing up to 900 Mbps in 20 MHz channel bandwidth and up to 1.4 Gbps in a 40 MHz channel, depending upon SMs position within sector. Even higher data rates are possible by using 5 ms frame sizes.
- Releases 16.0 and beyond support 3 GHz AP, as well as MU-MIMO in the UL direction.
- PMP 450m AP is compatible with existing PMP 450/450i Series Subscriber Modules (SM), providing an easy network upgrade path. This benefits to re-use existing SMs (i.e. capital investment). With releases 15.1.3 and beyond, 5 GHz PMP 450m also provides basic sector mode support for 430 SMs.
- 3x higher throughput packet rate compare 450 Series.
- 5 GHz Integrated with 14x14 MU-MIMO antenna; 3 GHz Integrated with 8x8 MU-MIMO antenna.
- 5 GHz ports - Gigabit copper/power port combined, 100BaseT port with power out and SFP port, 2.5G Copper SFP.
- 3 GHz ports - Gigabit copper Ethernet port without Power, Ethernet, 100/1000BASE-T Auxiliary with power out, SFP1, SFP2.
- 45 bps/Hz spectral efficiency in a single sector and 90 bps/Hz in a back-to-back frequency reuse deployment.

The table below gives a summary of the main PMP 450m Series AP characteristics.

Table 1: Main characteristics of the PMP 450m Series AP

Characteristic	Value
Topology	PMP
Wireless link condition	LOS, near LOS or non-LOS
Range	PMP: Up to 40 mi (or 64 km)
Duplexing	TDD (symmetric and asymmetric)
Connectivity	1000BASE-T Ethernet Main port with PoE input
Operating frequencies	4.9 to 5.925 GHz 3.3 to 3.9 GHz
Tx EIRP	5 GHz - 48 dBm 3 GHz - 52 dBm
Channel bandwidth	5, 7, 10, 15, 20, 30, and 40 MHz

Characteristic	Value
High spectral efficiency	90 bps/Hz[1]
Timing synchronization	CMM5 or UGPS/cnPulse
Data rate	Up to 900 Mbps with 20 MHz channel bandwidth and up to 1.4 Gbps in a 40 MHz channel. Additional data rate improvements are available by using 5 ms frame size.

Frequency bands

The PMP 450m Series AP operates from

- 4900 to 5925 MHz.
- 3300 to 3900 MHz

Hardware components

The ODU (Outdoor unit) is a self-contained transceiver unit that houses both radio and networking electronics.

The PMP 450m Series is supplied in the following configurations:

Table 2: PMP 450m Series hardware configurations

ODU	Frequency	ODU type	
5 GHz PMP 450m AP	4900 to 5925 MHz	Integrated	15 dBi, 90° MU-MIMO sector antenna
3 GHz PMP 450m AP	3300 to 3900 MHz	Integrated	16 dBi, 90° MU-MIMO sector antenna

PMP/PTP 450i Series

The PMP/PTP 450i Series is a high performance wireless bridge for Ethernet traffic. It is capable of operating in line-of-sight (LOS), near-LOS and non-LOS propagation conditions. It supports 900 MHz, 3 GHz, and 4.9 to 5.925 GHz frequency band.

Key features

The PMP/PTP 450i Series has extensive quality of service (QoS) involving traffic classification, traffic policy and shaping capability.

The Cambium PMP/PTP 450i Series offers the following benefits:

- Cambium's high performing point-to-multipoint solution, with up to 310 Mbps (40 MHz Channel Bandwidth and 5 ms Frame Period) usable throughput for PMP and PTP
- State-of-the-art MIMO (Multi In Multi Out) technology
- Upto 7.5 bps/Hz spectral efficiency

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- Increased Packet Processing rate
- Efficient GPS synchronized, scheduled TDD operation for easy AP/BHM site deployment and performance that is consistent regardless of SM/BHS loading
- A range of cost-effective subscriber device solutions to meet the business case of any network application
- MIMO B Mode: This technique provides for the ability to double the throughput of a radio transmission under proper RF conditions. Different data streams are transmitted simultaneously on two different antennas
- MIMO-A mode: This mode of operation has same modulation levels as the MIMO-B mode, namely: QPSK, 16-QAM, 64-QAM and 256-QAM. This mode increases system reliability in the links.
- GPS synchronization via CMM4, CMM5, or UGPS

Below table gives a summary of the main PMP/PTP 450i Series characteristics.

Table 3: Main characteristics of the PMP/PTP 450i Series

Characteristic	Value
Topology	PMP/PTP
Wireless link condition	LOS, near LOS or non-LOS
Range	• PTP: Up to 186 mi (or 299 km) depending on configuration for all bands • PMP: Up to 40 mi (or 64 km) for 5 GHz band • PMP: Up to 120 mi (or 193 km) for 900 MHz band
Duplexing	TDD (symmetric and asymmetric)
Connectivity	1000BASE-T Ethernet Main port with PoE input
Operating frequencies	• 902 to 928 MHz • 3.3 to 3.9 GHz • 4.9 to 5.925 GHz
Tx Power - conducted	• Max 25 dBm (3 GHz) • Max 27 dBm (5 GHz) • Max 25 dBm (900 MHz)
Channel bandwidth	5, 7, 10, 15, 20, 30, and 40 MHz  **Note** All bands do not support all channel bandwidths. For more information, refer to this link.
Spectral efficiency	Up to 7.5 bps/Hz
Timing synchronization	CMM4, CMM5, or UGPS/cnPulse
Data rate	Up to 310 Mbps (40 MHz channel Bandwidth) for PMP/PTP

Frequency bands

The PMP/PTP 450i Series ODU can operate in the following bands:

- 900 MHz band: 902 to 928 MHz
- 3 GHz band: 3300 to 3900 MHz
- 5 GHz band: 4900 to 5925 MHz

Note

900 MHz, 3 GHz, and 5 GHz bands with different frequencies require different hardware components.

Hardware components

The ODU (Outdoor unit) is a self-contained transceiver unit that houses both radio and networking electronics. The main hardware components of the PMP/PTP 450i Series are as follows:

- PMP 450i AP
- PMP 450i SM
- PTP 450i BH (BHM/BHS)

The PMP/PTP 450i Series is supplied in the following configurations:

Table 4: PMP/PTP 450i Series hardware configurations

ODU	Frequency	ODU type	
PMP 450i AP	902 to 928 MHz	Connectorized	Use with an external antenna
	3.3 to 3.9 GHz	Integrated	17 dBi, 90° sector dual slant antenna
		Connectorized	Use with an external antenna
	4.9 to 5.925 GHz (support 4.9, 5.1, 5.2, 5.4 and 5.8 GHz)	Integrated	16 dBi, 90° sector antenna
		Connectorized	Use with an external antenna

ODU	Frequency	ODU type	
PMP 450i SM	3.3 to 3.9 GHz	Integrated	19 dBi, SM/BH with MARS antenna
		Connectorized	Use with an external antenna
	4.9 to 5.925 GHz (support 4.9, 5.1, 5.2, 5.4 and 5.8 GHz)	Integrated	23 dBi flat panel antenna
		Connectorized	Use with an external antenna
PTP 450i BH	3.3 to 3.9 GHz	Integrated	19 dBi, SM/BH with MARS antenna
		Connectorized	Use with an external antenna
	4.9 to 5.925 GHz (support 4.9, 5.1, 5.2, 5.4 and 5.8 GHz)	Integrated	23 dBi flat panel antenna
		Connectorized	Use with an external antenna

Note

The BH ODU can be configured as a BHM or a BHS in PTP mode.

PMP/PTP 450b Series

The 450b Series of products offer high-performance wireless PMP Subscriber Modules that can also support PTP operation. Each radio is capable of operating in line-of-sight (LOS), near-LOS and non-LOS propagation conditions. Variants support the 3 GHz and the 4.9 to 5.925 GHz frequency band.

Key features

The Cambium 450b Series offers the following benefits:

- In the 5 GHz band, ultra-wide band radios support the entire band from 4.9 to 5.925 GHz.
- In the 3 GHz band, radios support the 3.3 to 3.9 GHz range.
- Gigabit Ethernet Interface provides the maximum transfer rates to the device.
- 3.5 mm audio jack allows direct connection of headphones without any adapters.
- Updated FPGA enhances Packet Processing Power more than 4 times that of the 450 SM.
- Capable of up to 300 Mbps aggregate in a 40 MHz channel.

Table 5 gives a summary of the main PMP/PTP 450b Series characteristics.

Table 5: Main characteristics of the PMP/PTP 450b Series

Characteristic	Value
Topology	PMP/PTP
Wireless link condition	LOS, near LOS or non-LOS
Range	• PTP: Up to 186 mi (or 299 km) depending on configuration for all bands • PMP: Up to 40 mi (or 64 km)
Duplexing	TDD (symmetric and asymmetric)
Connectivity	100/1000BASE-T Ethernet Main port with PoE input
Operating frequencies	• 3.3 to 3.9 GHz • 4.9 to 5.925 GHz
Tx Power - conducted	• Max 29 dBm (3 GHz) • Max 27 dBm (5 GHz)
Channel bandwidth	5, 7, 10, 15, 20, 30, and 40 MHz **Note** All bands do not support all channel bandwidths. For more information, refer to this link.
Spectral efficiency	Up to 7.5 bps/Hz
Timing synchronization	CMM4, CMM5, or UGPS/cnPulse
Data rate	Up to 310 Mbps (40 MHz channel Bandwidth).

Hardware components

The ODU (Outdoor unit) is a self-contained transceiver unit that houses both radio and networking electronics. Each radio supports operation as a PMP 450b SM or a PTP 450b BH (BHM/BHS). Note that earlier versions of the 5 GHz 450b radios supported only one mode of operation either PMP 450b SM or PTP 450b BH (BHM/BHS).

The 450b Series is supplied in the following configurations:

Table 6: PMP/PTP 450b Series hardware configurations

ODU	Frequency	ODU type	Antenna Gain / Type
PMP/PTP 450b	3.3 to 3.9 GHz	High Gain	20 dBi Dish antenna
	4.9 to 5.925 GHz (supports 4.9, 5.1, 5.2, 5.4 and 5.8 GHz bands)	Mid-Gain	16 dBi integrated antenna
		High Gain	23 dBi Dish antenna

PMP/PTP 450 Series

Cambium PMP/PTP 450 Series networks are designed for wireless point-to-multipoint and point-to-point links in the unlicensed/licensed 900 MHz, 2.4 GHz, 3.5 GHz, 3.65 GHz, 5.4 GHz and 5.8 GHz bands. Users

must ensure that the PMP/PTP 450 Series complies with local operating regulations.

The PMP/PTP 450 Series enables network operators to grow their business by offering more capacity for data, voice and video applications.

Key features

The Cambium PMP/PTP 450 Series offers the following benefits:

- Cambium's point-to-multipoint and point-to-point solution, with up to 310 Mbps usable throughput
- State-of-the-art MIMO (Multi In Multi Out) technology
- Efficient GPS synchronized, scheduled TDD operation for easy Access Point site deployment and performance that is consistent regardless of subscriber loading
- A range of cost-effective subscriber device solutions to meet the business case of a network application
- MIMO-B Mode: This technique provides for the ability to double the throughput of a radio transmission under proper RF conditions. Different data streams are transmitted simultaneously on two different antennas.
- MIMO-A Mode: This mode of operation using the same modulation levels as the MIMO-B mode, namely: QPSK, 16-QAM, 64-QAM and 256-QAM but it provides an additional combining gain.

Below table gives a summary of PMP/PTP 450 Series products main characteristics.

Table 7: Main characteristics of the PMP/PTP 450 Series

Characteristic	Value
Topology	PMP/PTP
Wireless link condition	LOS, near LOS or non-LOS
Range	• Up to 40 mi (or 64 km) for PMP • Up to 186 mi (or 299 km) for PTP
Duplexing	TDD (symmetric and asymmetric)
Connectivity	100Base-T Ethernet Main port with PoE input
Operating frequencies	900 MHz, 2.4 GHz, 3.5 GHz, 3.65 GHz and 5 GHz
Tx Power - conducted	• max 22 dBm (2.4 GHz and 5 GHz) • max 25 dBm (3.5 GHz and 3.65 GHz) • max 25 dBm (900 MHz - PMP 450 SM and BH)
Channel bandwidth	5, 7, 10, 15, 20, 30, and 40 MHz  **Note** All bands do not support all channel bandwidths. For more information, refer to this link.
High spectral efficiency	Up to 7.5 bps/Hz

Characteristic	Value
Timing synchronization	CMM4, CMM5, internal GPS or UGPS/cnPulse
Data rate	Up to 310 Mbps (40 MHz channel Bandwidth) for PMP/PTP

Frequency bands

The PMP/PTP 450 Series ODU can operate in the following bands:

- 900 MHz band: 902 to 928 MHz (SM and BH)
- 2.4 GHz band: 2400 to 2483 MHz
- 3.5 GHz band: 3300 to 3600 MHz
- 3.65 GHz band: 3500 to 3850 MHz
- 5 GHz band: 5470 to 5875 MHz

Hardware components

The main hardware components of the PMP/PTP 450 are as follows:

- PMP 450 AP
- PMP 450 SM
- PTP 450 BH (BHM/BHS)

The PMP/PTP 450 is supplied in the following configurations:

Table 8: PMP/PTP 450 Series hardware configurations

ODU	Frequency	ODU type	
PMP 450 AP	2.4 GHz	Connectorized	Use with an external antenna
		Integrated	18 dBi Dual Slant
	3.5/3.65 GHz	Connectorized	Use with an external antenna
		Integrated	16 dBi Dual Slant
	5 GHz (5.4 and 5.8 GHz)	Connectorized	Use with an external antenna

ODU	Frequency	ODU type	
PMP 450 SM	900 MHz	Connectorized	Use with an external antenna
	2.4 GHz	Connectorized	Use with an external antenna
		Integrated	7 dBi Dual Slant, integrated patch
	3.5/3.65 GHz	Connectorized	Use with an external antenna
		Integrated	8 dBi Dual Slant, integrated patch
		Integrated	19 dBi Flat Plate, integrated patch
	5 GHz (5.4 and 5.8 GHz)	Connectorized	Use with an external antenna
		Integrated	9 dBi H+V, integrated patch
		Integrated	25 dBi H+V, Integrated dish
PTP 450 BH	902 to 928 MHz	Connectorized	Use with an external antenna
	3.5/3.65 GHz	Connectorized	Use with an external antenna
		Integrated	8 dBi Dual Slant
	5 GHz (5.4 and 5.8 GHz)	Connectorized	Use with an external antenna
		Integrated	9 dBi H+V

Note

The BH ODU can be configured as a BHM or a BHS in PTP mode

PMP 450 MicroPoP Series

The PMP 450 MicroPoP Series is a high-performance wireless bridge for Ethernet traffic. It is an Access Point based on the PMP 450b Series hardware, available with an integrated omni or sector antenna, and a Connectorized option.

Key Features

The Cambium PMP 450 MicroPoP Series offers the following benefits:

- Ultra-wide band radios support the entire band from 4.9 GHz to 5.925 GHz.
- Gigabit Ethernet Interface provides the maximum transfer rates to the device.
- Capable of up to 300 Mbps aggregate in a 40 MHz channel.
- Supports a range up to 2 miles and a number of subscribers up to 20.
- To unlock the full capabilities of the platform (range up to 40 miles and number of subscribers up to 238) a license key is available for purchase.
- Efficient GPS synchronized, scheduled TDD operation for easy Access Point site deployment and performance that is consistent regardless of subscriber loading.

Note

MicroPoP Omni and Sector models are not provisioned with a 3.5mm audio jack, but support an integrated GPS Module with an internal active antenna. MicroPoP Connectorized model is equipped with an RF GPS port for the connection of an external active GPS antenna puck.

Table 9: PMP 450 MicroPoP Series characteristics

Characteristic	Value
Topology	PMP
Wireless link condition	LOS, near LOS or non-LOS
Range	Up to 2 miles License key available to unlock range up to 40 miles
Duplexing	TDD (symmetric and asymmetric)
Connectivity	100/1000BASE-T Ethernet Main port with PoE input
Operating frequencies	4.9 to 5.925 GHz
Tx Power - conducted	Max 27 dBm (5 GHz)
Channel bandwidth	5, 7, 10, 15, 20, 30, and 40 MHz
Spectral efficiency	Up to 7.5 bps/Hz
Timing synchronization	CMM4, CMM5, or internal/external GPS
Data rate	Up to 300 Mbps (40 MHz channel Bandwidth).

Frequency bands

The PMP 450 MicroPoP Series ODU can operate in the following band:

- 5 GHz band: 4900 to 5925 MHz

Hardware components

The ODU (Outdoor unit) is a self-contained transceiver unit that contains both radio and networking electronics. The main hardware components of the PMP 450 MicroPoP Series are as follows:

- PMP 450 MicroPoP Omni AP
- PMP 450 MicroPoP Sector AP
- PMP 450 MicroPoP Connectorized AP

The PMP 450 MicroPoP Series is supplied in the following configuration:

Table 10: PMP 450 MicroPoP Series hardware configurations

ODU	Frequency	ODU type	
PMP 450 MicroPoP AP	4.9 to 5.925 GHz (support 4.9, 5.1, 5.2, 5.4 and 5.8 GHz)	Integrated Omni	9 dBi Integrated antenna
		Integrated Sector	13 dBi integrated antenna
		Connectorized	External antenna

PMP/PTP 450b Retro Series

The PMP/PTP 450b Retro Series is a high-performance wireless bridge for Ethernet traffic. It is a Subscriber Module based on the PMP 450b Series hardware that can also support PTP operation, available with an integrated antenna and with the same form factor of the PMP 450 SM, which allows reuse of the same reflector dish.

Key Features

The Cambium PMP/PTP 450b Retro Series offers the following benefits:

- Ultra-wide band radios support the entire band from 4.9 to 5.925 GHz.
- Gigabit Ethernet Interface provides the maximum transfer rates to the device.
- 3.5 mm audio jack allows direct connection of headphones without any adapters.
- Updated FPGA enhances Packet Processing Power more than 4 times that of the 450m SM.
- Capable of up to 300 Mbps aggregate in a 40 MHz channel.
- Same form factor of the PMP 450 SM.
- The form factor allows use of existing Offset Reflector dishes.

Table 11: PMP 450 Retro Series characteristics

Characteristic	Value
Topology	PMP, PTP
Wireless link condition	LOS, near LOS or non-LOS
Range	PMP: up to 40 miles
Duplexing	TDD (symmetric and asymmetric)
Connectivity	100/1000BASE-T Ethernet Main port with PoE input
Operating frequencies	4.9 to 5.925 GHz
Tx Power - conducted	Max 27 dBm
Channel bandwidth	5, 10, 15, 20, 30, and 40 MHz
Spectral efficiency	Up to 7.5 bps/Hz
Timing synchronization	CMM4, CMM5, or UGPS/cnPulse
Data rate	Up to 300 Mbps (40 MHz channel Bandwidth).

Frequency bands

The PMP/PTP 450b Retro Series ODU can operate in the following band:

- 5 GHz band: 4900 to 5925 MHz

Hardware components

The ODU (Outdoor unit) is a self-contained transceiver unit that houses both radio and networking electronics. The main hardware components of the PMP/PTP 450b Retro Series are as follows:

- PMP/PTP 450b Retro SM

The PMP/PTP 450b Retro Series is supplied in the following configuration:

Table 12: PMP/PTP 450b Retro Series hardware configurations

ODU	Frequency	ODU type	
PMP/PTP 450b Retro	4.9 to 5.925 GHz (support 4.9, 5.1, 5.2, 5.4 and 5.8 GHz)	Integrated	8 dBi Integrated antenna

PMP/PTP 450b Connectorized Series

The PMP/PTP 450b Connectorized Series is a high-performance wireless bridge for Ethernet traffic. It is a Subscriber Module based on the PMP 450b Series hardware that can also support PTP operation, available with an integrated antenna and with the same form factor of the PMP 450 SM, which allows reuse of the same reflector dish.

Key Features

The Cambium PMP/PTP 450b Connectorized Series offers the following benefits:

- Ultra-wide band radios support the entire band from 4.9 to 5.925 GHz.
- Gigabit Ethernet Interface provides the maximum transfer rates to the device.
- 3.5 mm audio jack allows direct connection of headphones without any adapters.
- Updated FPGA enhances Packet Processing Power more than 4 times that of the 450m SM.
- Capable of up to 300 Mbps aggregate in a 40 MHz channel.
- Same form factor of the PMP 450 SM.
- The form factor allows use of existing Offset Reflector dishes.

Table 13: PMP 450b Connectorized Series characteristics

Characteristic	Value
Topology	PMP, PTP
Wireless link condition	LOS, near LOS or non-LOS
Range	PMP: up to 40 miles
Duplexing	TDD (symmetric and asymmetric)
Connectivity	100/1000BASE-T Ethernet Main port with PoE input
Operating frequencies	4.9 to 5.925 GHz
Tx Power - conducted	Max 27 dBm
Channel bandwidth	5, 10, 15, 20, 30, and 40 MHz
Spectral efficiency	Up to 7.5 bps/Hz
Timing synchronization	CMM4, CMM5, or UGPS/cnPulse
Data rate	Up to 300 Mbps (40 MHz channel Bandwidth).

Frequency bands

The PMP/PTP 450b Connectorized Series ODU can operate in the following band:

- 5 GHz band: 4900 to 5925 MHz

Hardware components

The ODU (Outdoor unit) is a self-contained transceiver unit that houses both radio and networking electronics. The main hardware components of the PMP/PTP 450b Retro Series are as follows:

- PMP/PTP 450b Connectorized SM

The PMP/PTP 450b Connectorized Series is supplied in the following configuration:

Table 14: PMP/PTP 450b Connectorized Series hardware configurations

ODU	Frequency	ODU type	
PMP/PTP 450b Connectorized	4.9 to 5.925 GHz (support 4.9, 5.1, 5.2, 5.4 and 5.8 GHz)	Connectorized	External antenna

Supported interoperability for 450m/450i/450b/450 series

The supported interoperability among various 450m/450i/450 series hardwares are listed below:

Table 15: Supported interoperability for PMP

Band	AP	SM
4.9, 5.1, 5.2 and 5.9 GHz	PMP 450m AP	PMP 450i SM, PMP 450b SM , PMP 450b Retro SM and PMP 450b Connectorized SM
4.9, 5.1, 5.2 and 5.9 GHz	PMP 450i AP	PMP 450i SM, PMP 450b SM , PMP 450b Retro SM and PMP 450b Connectorized SM
	PMP 450 MicroPoP	
5.4 and 5.8 GHz	PMP 450m AP	PMP 450i SM, PMP 450 SM, PMP 450d SM, PMP 450b SM, PMP 450b Retro SM, PMP 450b Connectorized SM and PMP 430 SM
	PMP 450i AP	
	PMP 450 AP	
	PMP 450 MicroPoP	
3.5 and 3.65 GHz	PMP 450 AP	PMP 450 SM, PMP 450i SM, PMP 450b SM
	PMP 450i AP	PMP 450i SM, PMP 450 SM, PMP 450b SM
	PMP 450m AP	PMP 450i SM, PMP 450 SM, PMP 450b SM
2.4 GHz	PMP 450 AP	PMP 450 SM
900 MHz	PMP 450i AP	PMP 450 SM

Table 16: Supported Interoperability for PTP

Band	BH
900 MHz	PTP 450/450i BHM and BHS
3.5 and 3.65 GHz	PTP 450/450b/450i BHM and BHS

Band	BH
4.9, 5.1, 5.2, 5.4 and 5.8 GHz	PTP 450b/450i/450b Retro BHM and BHS
5.4 and 5.8 GHz	PTP 450/450b/450i/450/450b Retro BHM and BHS

Typical deployment

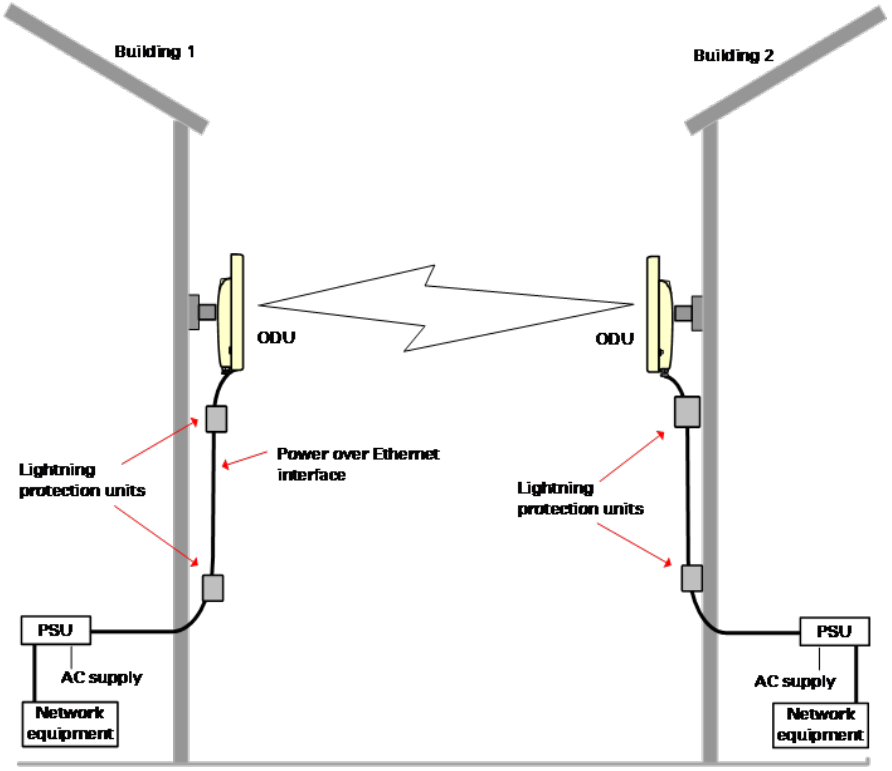
The 450 Platform Family is an “all outdoor” solution consisting of a wireless bridge across sites. Each site installation consists of an Integrated or Connectorized outdoor unit (ODU) and a power supply (PSU) (see). The ODU provides the following interfaces:

Ethernet port: This provides proprietary power over Ethernet and connection to the management and/or data networks.

Note

PMP 450m 3 GHz has a separate power and data interface.

Figure 1: *PMP/PTP 450 Platform Family typical bridge deployment*



Note

Lightning Protection and Power supply differs for different variants.

Point-to-Multipoint

The PMP configuration of 450 Platform Family consists of Access Point (AP) and Subscriber Module (SM) ODU. The radio link operates on a single frequency channel in each direction using Time Division Duplex (TDD). The AP operates in TDMA mode to service multiple SMs.

Applications for the PMP Series include:

- High throughput enterprise applications
- nLOS video surveillance in metro areas
- Urban area network extension
- Network extension into areas with foliage

Point-to-Point (Backhaul)

The PTP configuration of 450 Platform Family consists of two BH (Backhaul) ODUs. The customer can decide, via software configuration, if this unit is a BHM (Backhaul Master) or a BHS (Backhaul Slave). The radio link operates on a single frequency channel using Time Division Duplex (TDD). The BHM operates in TDMA mode to service the BHS.

Applications for the PTP Series include:

- Enterprise Access
- nLOS video surveillance
- Leased line replacements and backup solutions
- Network extension

Product variants

The 450 Platform Family is available in the following product variants:

- The ODU is supplied in the following regional variants:
  - FCC, intended for deployment in the USA
  - IC, intended for deployment in Canada
  - EU, intended for deployment in countries of the European Union or other countries following ETSI regulations
  - Rest of the World (RoW), intended for deployment in countries other than USA and EU countries.
- Integrated, connectorized ODUs:
  - Integrated units contain an integrated antenna.
  - Connectorised units are designed to connect to an external antenna.
  - 450b High Gain units operate with a purpose designed dish.
- Standard or ruggedized ODUs:
  - APs and SMs are supplied in either ruggedized or standard versions.
  - 450b range are supplied to the IP55 standard, but an IP67 conversion kit is available for the High Gain units.
- Encryption:
  - Most ODU variants in the range support AES 128 or AES 256 encryption.
  - ODU variants are available with weaker or no encryption for export purposes.
- Power supply modules: A variety of Power Supplies / Power-over-Ethernet (PoE) supplies are available
  - All power injectors / power supplies in the Cambium Networks range are designed for an indoor environment.
  - Different ODUs require different power requirements, so be sure to select the correct power supply.
- Surge protection units: A range of surge protectors is available to suit different ODUs
  - The Gigabit Surge Suppressor provides a path to ground (Protective Earth) that protects connected radio equipment from near-miss lightning strikes.
  - Lightning protection unit (LPU): LPUs are installed in the ports copper drop cables to provide transient voltage surge suppression.
  - A DC lightning protection unit (LPU) provides transient voltage surge suppression for 3 GHz PMP 450.
- Cabling:
  - AC line cords: AC line cords are supplied separately from the power supply. Regional variants are available.
  - Antennas and antenna cabling: Connectorized ODUs require RF cables to connect to external antennas.
  - Ethernet cabling: All configurations require a copper Ethernet Cat5e connection from the ODU (Ethernet port) to the PoE.

- Ground cables: ODU, LPUs and outdoor copper Ethernet cables are bonded to the site grounding system using ground cables.

For more information about these components, including interfaces, specifications and Cambium part numbers, refer to Chapter 2: System hardware.

Wireless operation

This section describes how the 450 Platform Family wireless link is operated, including modulation modes, power control and security.

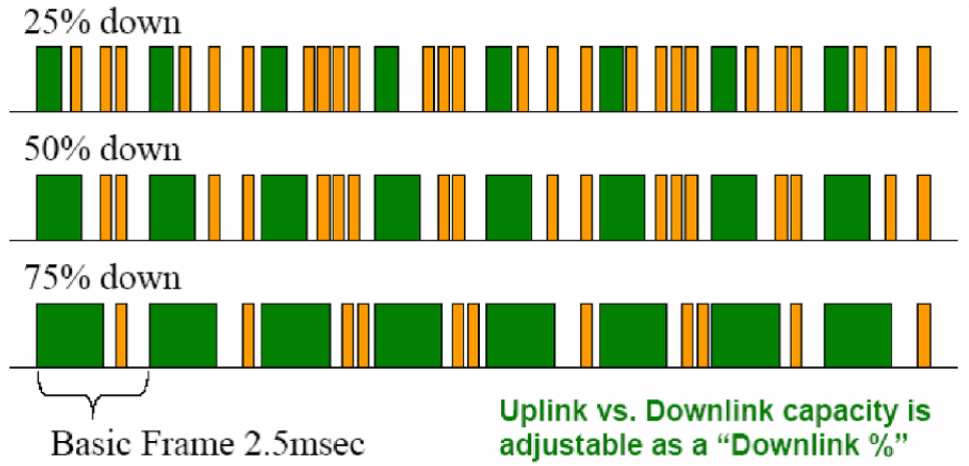
Time division duplexing

The system uses Time Division Duplexing (TDD) – one channel alternately transmits and receives rather than using one channel for transmitting and a second channel for receiving. The radio link operates on a single frequency channel in each direction using TDD. The AP operates in TDMA mode to service multiple SMs. To accomplish TDD, the AP/BHM must provide sync to its SM/BHS. Furthermore, collocated APs/BHMs must be synced together – an unsynchronized AP/BHM that transmits during the receive cycle of a collocated AP/BHM can prevent a second AP/BHM from being able to decode the signals from its APs/BHSs. In addition, across a geographical area, APs/BHMs that can "hear" each other benefit from using a common sync to further reduce self-interference within the network.

Modules use TDD on a common frequency to divide frames for uplink (orange) and downlink (green) usage, as shown in the figure below.

For more information on synchronization configuration options, see GPS synchronization on page 1.

Figure 2: *TDD frame division*



TDD frame parameters

The TDD burst duration varies depending on the following:

- Channel Bandwidth
- Cyclic Prefix
- Frame Period

- Frame configuration - Downlink Data
- Link operation – Dynamic Rate Adaptation

OFDM and Channel Bandwidth

The PMP/PTP 450 Platform Family transmits using Orthogonal Frequency Division Multiplexing (OFDM). This wideband signal consists of many equally spaced sub-carriers. Although each sub carrier is modulated at a low rate using conventional modulation schemes, the resultant data rate from the sub-carriers is high. OFDM works exceptionally over a Non-Line-of-Sight (NLoS) channel.

The channel bandwidth of the OFDM signal is configurable to one of the following values: 5, 7, 10, 15, 20, 30, and 40 MHz. Higher bandwidths provide greater link capacity at the expense of using more bandwidth. Systems configured for a narrower channel bandwidth provide better receiver sensitivity and can also be an appropriate choice in deployments where the amount of free spectrum is limited.

Note

The channel bandwidth must be configured to the same value at both ends of the link. Not all channel bandwidths are available in all regulatory bands.

Cyclic Prefix

OFDM technology uses a cyclic prefix, where a portion of the end of a symbol (slot) is repeated at the beginning of the symbol (slot) to allow multi-pathing to settle before receiving the desired data. A 1/16 cyclic prefix means that for every 16 bits of throughput data transmitted, an additional bit is used. For your convenience, the 450 Platform Family ODUs have been locked to a 1/16 CP.

Frame Period

The frame period or frame duration is the time between the beginning of a frame and the end of the frame. The 450 Platform Family supports two frame periods: 2.5 ms and 5 ms.

The 5ms frame period configuration provides higher throughput as a result of reduced frame overhead during transmission. In turn, the 2.5 ms frame period configuration affords reduced latency in the system, half of that introduced by the 5 ms frame configuration.

Frame configuration - Downlink Data

The percentage of frame assigned to transport downlink data. The downlink data specifies the percentage of the aggregate throughput for the downlink (frames transmitted from the AP/BHM to the subscriber). The configurable range is 15% to 85%.

Note

For all 450 platform APs, the maximum configurable range is 34% to 66% for 40 MHz with 5 ms frame.

Link operation – Dynamic Rate Adapt

The 450 Platform Family ODUs offer eight levels or speeds of operation – 2X MIMO-B and 1X MIMO-A (QPSK), 4X MIMO-B and 2X MIMO-A (16-QAM), 6x MIMO-B and 3X MIMO-A (64-QAM) and 8X MIMO-B and 4X MIMO-A (256-QAM). If received power varies due to distance between the AP/BHM and the SM/BHS or due to obstructions, or if interference affects the RF environment, the system automatically and dynamically adjusts the links to the best operation level.

The system chooses its modulation rate dynamically, based on an internal ARQ (Automatic Repeat reQuest) error control method. With ARQ, every data slot of every frame sent over the air (except downlink broadcast) is expected to be acknowledged by the receiver, and if acknowledgement is not received, the data is resent. The sending unit monitors these re-sends and adjusts the modulation rate accordingly. It is normal to have links that change levels of operation as the RF environment changes. Furthermore, the uplink or downlink portions of TDD duty cycle operate independently.

The various modulation levels used by 450 Platform Family are shown in below table.

Table 17: Modulation levels

Rate	MIMO-B	MIMO-A
QPSK	2X MIMO-B	1X MIMO-A
16-QAM	4X MIMO-B	2X MIMO-A
64-QAM	6X MIMO-B	3X MIMO-A
256-QAM	8X MIMO-B	4X MIMO-A

Note

MIMO-A achieves half the throughput of MIMO-B but adds a combining diversity (gain) which enhances the link budget or availability.

Encryption

The 450 Platform Family supports optional encryption for data transmitted over the wireless link. The 450 Platform Family supports 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 and 256-bit key size to establish a higher level of security. AES products are certified as compliant with the Federal Information Processing Standards (FIPS 197) in the U.S.A.

The default setting on an AP is "Disabled".

MIMO

Multiple-Input Multiple-Output (MIMO) techniques provide protection against fading and increase the probability that the receiver decodes a usable signal. When the effects of MIMO are combined with those of OFDM techniques and a high link budget, there is a high probability of a robust connection over a non-line-of-sight path.

The sub-features that comprises the MIMO techniques utilized in the 450 Platform Family ODUs are:

- MIMO-A: This technique enables 450 Platform Family radio to use a scheme that optimizes coverage by transmitting the same data over both antennas. This redundancy improves the signal to noise ratio at the receiver making it more robust.
- MIMO-B: This technique provides the ability to double the throughput of a radio transmission under proper RF conditions. Different data streams are transmitted simultaneously on two different antennas.

MU-MIMO

Multiple-input multiple-output, or MIMO, is a range of technologies used to multiply the capacity of a wireless connection without requiring more spectrum.

Although traditional MIMO techniques are focused on increasing the bandwidth available between two wireless nodes, multi-user MIMO (MU-MIMO) applies these technologies to increase overall wireless network capacity by allowing an access point to communicate wirelessly with more than one wireless node at once.

A MU-MIMO access point features an array of antennas. When the AP decides to communicate with multiple nodes at the same time, it creates or receives multiple simultaneous beams between each node.

This is in contrast to a traditional wireless system, where two wireless nodes cannot communicate on the same channel to the same access point at the same time, without causing significant self-interference and degrading the overall wireless network performance.

A MU-MIMO access point estimates and measures what a transmission from each wireless node 'sounds like', by applying knowledge of the wireless path characteristics between the access point and node. Known as channel estimation, this process is of vital importance; without it, the access point cannot distinguish properly between wireless nodes, affecting performance.

Channel estimation is achieved at the access point in the downlink direction by sending a specific signal to a wireless node, which the node then reports back. The uplink channel estimates are made in a similar manner at the access point, by measuring the normal uplink communication to each node. These measurements between the access point and the nodes provide a measure of the wireless conditions and can be applied to other communications to/from the node and is known as channel sounding.

Channel estimation and sounding must be regularly repeated to ensure wireless network performance remains high; the speed at which a system is able to accurately estimate the channel has a large impact on performance.

Once channel estimation is completed for a wireless node, the MU-MIMO access point can electrically tune each antenna to provide the highest performance for that node. The access point uses beamforming to create a radio beam to that node which is tuned for optimum performance and avoids beams directed to other nodes, reducing interference and helping to improve overall wireless network capacity.

A MU-MIMO access point can communicate to multiple wireless nodes simultaneously using this process. As the majority of nodes are unable to make full use of the whole access point capacity at once, communicating with several nodes simultaneously can greatly improve the overall capacity achieved in the wireless network.

System management

This section introduces the 450 Platform Family management system, including the web interface, installation, configuration, alerts and upgrades.

Management agent

The 450 Platform Family radios are managed through an embedded management agent.

Management workstations, network management systems or PCs can be connected to this agent using the module's Ethernet port or over-the air (SM/BHS)

The management agent supports the following interfaces:

- Hypertext transfer protocol (HTTP)
- Hypertext transfer protocol secure (HTTPS)
- RADIUS authentication
- Simple network management protocol (SNMP) – v2c and v3

- Network time protocol (NTP)
- System logging (Syslog)
- Wireless Manager (WM) software
- Canopy Network Updater Tool (CNUT) software
- cnMaestro™

Web server

The 450 Platform Family management agent contains a web server. The web server supports access via the HTTP/HTTPS interface.

Web-based management offers a convenient way to manage the 450 Platform Family radios from a locally connected computer or from a network management workstation connected through a management network, without requiring any special management software. The web and SNMP are the interfaces supported for installation of 450 Platform Family radios and for the majority of configuration management tasks.

Web pages

The web-based management interfaces provide comprehensive web-based fault, configuration, performance and security management functions organized into the following groups:

Access Point or Backhaul Master:

- Home
- Configuration
- Statistics
- Tools
- Logs
- Accounts
- Quick Start
- Copyright

Subscriber Module or Backhaul Slave

- Home
- Configuration
- Statistics
- Tools
- Logs
- Accounts

- PDA
- Copyright

Identity-based user accounts

- When identity-based user accounts are configured, a security officer can define from one to four user accounts, each of which may have one of the four possible roles:
- 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.

See Managing module access by passwords for detailed information on account permissions.

Remote Authentication Dial-in User Service (RADIUS)

The PMP configuration of 450 Platform Family includes support for RADIUS (Remote Authentication Dial In User Service) protocol functionality including:

- SM Authentication: Allows only known SMs onto the network (blocking “rogue” SMs), and can be configured to ensure SMs are connecting to a known network (preventing SMs from connecting to “rogue” APs). RADIUS authentication is used for SMs, but not used for APs.
- SM Configuration: Configures authenticated SMs with MIR (Maximum Information Rate), High Priority, and VLAN (Virtual LAN) parameters from the RADIUS server when a SM registers to an AP.
- User Authentication allows users to configure a separate User authentication server along with the SM authentication server. If firmware is upgraded while using this functionality and no User authentication servers are configured, then AP continues to use the SM authentication server for User authentication
- SM Accounting provides support for RADIUS accounting messages for usage-based billing. This accounting includes indications for subscriber session establishment, subscriber session disconnection, and bandwidth usage per session for each SM that connects to the AP.
- Centralized AP and SM user name and password management: Allows AP and SM usernames and access levels (Administrator, Installer, Technician and Read-Only) to be centrally administered in the RADIUS server instead of on each radio and tracks access events (logon/logoff) for each username on the RADIUS server. This accounting does not track and report specific configuration actions performed on radios or pull statistics such as bit counts from the radios. Such functions require an Element Management System (EMS) such as Cambium Wireless Manager. This accounting is not the ability to perform accounting functions on the subscriber/end user/customer account.

- Framed-IP-Address: Operators may use a RADIUS server to assign management IP addressing to SM modules. SNMP

The management agent supports fault and performance management by means of an SNMP interface. The management agent is compatible with SNMP v2c and SNMP v3 using Management Information Base (MIB) files which are available for download from the Cambium Networks Support website:

https://support.cambiumnetworks.com/files/ptp450

https://support.cambiumnetworks.com/files/pmp450

Network Time Protocol (NTP)

The clock supplies accurate date and time information to the system. It can be set to run with or without a connection to a network time server (NTP). It can be configured to display local time by setting the time zone and daylight saving in the Time web page.

If an NTP server connection is available, the clock can be set to synchronize with the server time at regular intervals. The 450 Platform Family radios may receive NTP data from a CMM4 module or an NTP server configured in the system's management network.

The Time Zone option is configurable on the AP's/BHM's Time Configuration page, and may be used to offset the received NTP time to match the operator's local time zone. When set on the AP/BHM, the offset is set for the entire sector (AP/BHSs is notified of the current Time Zone upon initial registration). If a Time Zone change is applied, the AP/BHSs are notified of the change in a best effort fashion, meaning some AP/BHSs may not pick up the change until the next re-registration. Time Zone changes are noted in the Event Log.

An AP/BHM which is receiving NTP date and time information from an NTP server or from a GPS synchronization source may be used as an NTP server. Any client which has IP connectivity to the BHM may request NTP date and time information from the AP/BHM. No additional configuration (other than the AP/BHM receiving valid NTP data) is required to use the AP/BHM as an NTP server.

cnMaestro™

cnMaestro™ is a cloud-based or on-premises platform specialized for secure, end-to-end network lifecycle management: inventory management, device onboarding, daily operations, and maintenance and is recommended for managing 450 Platform Family networks. The cnMaestro wireless network manager simplifies device management by offering full network visibility. Network operators can have a real-time view of their complete end-to-end network and perform a full suite of wireless network management functions to optimize system availability, maximize throughput, and meet emerging needs of business and residential customers. In addition, the cnMaestro wireless network manager collects and displays compliance with service level agreements.

To learn about cnMaestro™, please visit http://www.cambiumnetworks.com/products/software-tools/cnmaestro/

See Configuring cnMaestroTM Connectivity in Configuration Guide for details.

Wireless Manager (WM)

Cambium Networks Wireless Manager 4.0 is also used for managing 450 Platform Family networks. You can achieve better uptime through better visibility of your network with the Cambium Wireless Manager. This network management software tool offers breakthrough map-based visualization capabilities using embedded Google maps, and combined with advanced configuration, provisioning, alerting and reporting features you can control your entire outdoor wireless network including Point-to-Multipoint and Point-to-Point solutions as well as other SNMP enabled devices. With its powerful user interface, not

only you can control your network's access, distribution and backhaul layers, but you can also view WLAN sites and be able to quickly launch indoor network management systems. Some key features of Wireless Manager are:

- Template-Based Configuration: With Wireless Manager's user-defined templates you can accelerate the process for the configuration of the devices you add to your network resulting in quicker and easier deployments. The template-based functionality provides an automated way to configure large numbers of network devices with just a few mouse clicks and can be scheduled to occur at any time via Wireless Manager's Task Scheduler.
- Ultralight Thin Client: With the growing mobile workforce it is important to have access to the status of your network at any time. With Wireless Manager you can view the status and performance of your entire wireless network via a compact web interface accessible by your smart phone.
- Map-Based Visualization: Wireless Manager overlays sophisticated real-time information about your network elements onto building layouts and dynamic Google maps. Visuals can be scaled to view an entire city or building or a specific area, floor or link.
- High Availability Architecture Support: Wireless Manager offers a high availability option, providing a highly reliable and redundant network management solution that ensures you always have management access to your network.
- High Scalability: The enhanced Wireless Manager offers you server scalability with support for up to 10,000 nodes as well as support for distributed server architecture.

Cambium's Wireless Manager 4.0 available for download at:

https://www.cambiumnetworks.com/products/software-tools/wireless-manager/

Canopy Network Updater Tool (CNUT)

CNUT (Canopy Network Updater Tool) is the stand-alone software update tool for 450 Platform Family ODUs. The CNUT 4.11.2 should be used for 450 Platform Family ODUs.

The Canopy Network Updater Tool has the following features:

- Automatically discovers all network elements
- HTTP and HTTPS
- Executes UDP command that initiates and terminates the Auto-update mode within APs/BHMs. This command is both secure and convenient:
  - For security, the AP/BHM accepts this command from only the IP address that specified in the Configuration page of ODU.
  - For convenience, Network Updater automatically sets this Configuration parameter in the AP/BHM to the IP address of the Network Updater server when the server performs any of the update commands.
- Allows you to choose among updating:
  - Entire network.
  - Only elements that you select.
  - Only network branches that you select.

- Provides a Script Engine that you can use with any script which:
  - The user can define.
  - Cambium supplies.

CNUT is available at:

https://www.cambiumnetworks.com/products/management/cambium-network-updater-tool/

Radio recovery mode

The 450 Platform Family recovery mode provides a means to recover from serious configuration errors including lost or forgotten passwords and unknown IP addresses.

The recovery procedure for 450m/450i/450b series and 450 series ODUs differ due to difference in hardware. This procedure for 450i/450m Series is known as Radio Recovery Console and for 450 Series is known as Default mode (or Default/Override Plug). MicroPoP Omni/Sector/Connectorized supports an external Reset push button for recovery.

Radio Recovery Console – 450i, 450b 450m, MicroPoP and Retro Series

The Radio Recovery Console mode supports:

- Restoring factory default IP address 169.254.1.1 and password
- Boot with factory default Canopy system software settings
- Load previously installed SW images

See Radio Recovery Console-PMP/PTP 450i/450b and PMP 450m in Configuration Guide for more details.

Default Mode (or Default Plug) – 450 Series

A default plug is available to provide access to a module whose password and/or IP address have been forgotten.

This plug allows the 450 Series ODUs to be accessed using IP address 169.254.1.1 and no password. During the override session, you can assign any new IP address and set either or both user passwords (display-only and/or full access) as well as make other parameter changes.

See Default Mode (or Default/Override Plug) – PMP/PTP in *Configuration Guide* for more details.

Chapter 2: System hardware

This chapter describes the hardware components of a 450 Platform Family series..

The following topics are described in this chapter:

- System Components describes system components of PTP and PMP including its accessories.
- MicroPoP Lightning Arrester details describes about various cables.
- Lightning protection unit (LPU) and grounding kit describes about lightning protection and grounding kit.
- Antennas and antenna cabling describes supported antennas and its accessories.
- GPS synchronization describes UGPS, CMM4.and CMM5.
- Ordering the components specifies Cambium part numbers for 450 Platform Family components

System Components

Point-to-Multipoint (PMP)

The PMP radio is a transceiver device. It is a connectorized or radiated outdoor unit containing all the radio, networking, and surge suppression electronics. It can be purchased as:

- Access Point Module (AP)
- Subscriber Module (SM)

PMP 450 Platform Family Integrated or Connectorized ODU

The PMP 450i Series, PMP 450b Series, PMP 450 MicroPoP Series and PMP 450 Series ODUs are supplied in Integrated or Connectorized configurations. The PMP 450m Series AP is supplied in Integrated configuration only.

See PMP 450m Series hardware configurations

See PMP/PTP 450i Series hardware configurations

See PMP/PTP 450b Series hardware configurations

See PMP/PTP 450 Series hardware configurations

See PMP 450 MicroPoP Series hardware configurations

See PMP/PTP 450b Retro Series hardware configurations

See PMP/PTP 450b Connectorized Series hardware configurations

Product variants

Table 18: PMP 450m Series variants

Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max EIRP
5 GHz PMP 450m AP	FCC	90° integrated sector array, 14x14 MIMO system,	5150 – 5925 MHz	5, 10, 15, 20, 30, 40 MHz	48 dBm
	RoW				
	EU				
	IC				
	No Encryption				
3 GHz PMP 450m AP	Global	90° integrated sector array, 8x8 MIMO system,	3300 – 3900 MHz	5, 7, 10, 15, 20, 30, 40 MHz	52 dBm
	Global (No Encryption)				

Table 19: PMP 450i Series variants

Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power
900 MHz PMP 450i AP	FCC	Connectorized	902 - 928 MHz	5, 7, 10, 15, 20 MHz	25 dBm
3 GHz PMP 450i AP	All, No Encryption	Connectorized	3300 – 3900 MHz	5, 7, 10, 15, 20, 30, 40 MHz	25 dBm
		Integrated 16 dBi			
5 GHz PMP 450i AP	FCC, IC, EU, RoW, No Encryption	Connectorized	4900 – 5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm
		Integrated 16 dBi 90 degree			

Table 20: PMP/PTP 450b Series variants

Frequency Variant	Variant	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power
5 GHz 450b	Mid-Gain	16 dBi integrated antenna	4900 – 5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm
	High Gain	23 dBi dish			
3 GHz 450b	High Gain	20 dBi dish	3300 – 3900 MHz	5, 7, 10, 15, 20, 30, 40 MHz	29 dBm

Note

The Transmit power is limited based on regional setting.

Table 21: PMP 450 MicroPoP Series variants

Frequency Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power
5 GHz PMP 450 MicroPoP Omni AP	FCC, RoW, Canada, RoW no encryption, Europe	9 dBi integrated	4900-5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm
5 GHz PMP 450 MicroPoP Sector AP		13 dBi integrated	4900-5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm
5 GHz PMP 450 MicroPoP Connectorized AP		External antenna	4900-5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm

Table 22: PMP 450b Retro Series variants

Frequency Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power
5 GHz 450b Retro SM	FCC, RoW, Canada, RoW no encryption, Europe	8 dBi integrated	4900-5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm

Table 23: 5 GHz PMP 450b Connectorized SM variants

Frequency Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power
5 GHz 450b Connectorized SM	FCC, RoW, Canada, RoW no encryption, Europe	External antenna	4900-5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm

Note

The Transmit power is limited based on regional setting.

Table 24: PMP 450 Series variants

Variant	Region	Antenna	Frequency Range	Frequency Range	Channel Bandwidth	Max Tx Power
900 MHz PMP 450 SM	FCC	Connectorized	902 - 928 MHz	902 - 928 MHz	5, 7, 10, 15, 20 MHz	25 dBm
2.4 GHz PMP 450 AP	FCC ISM	Connectorized	2400 – 2483.5 MHz	2400 – 2483.5 MHz	5, 10, 15, 20 MHz	22 dBm
		Integrated 18 dBi				
2.4 GHz PMP 450 SM	FCC ISM	Connectorized	2400 – 2483.5 MHz	2400 – 2483.5 MHz	5, 10, 15, 20 MHz	22 dBm
		Integrated 7 dBi				
3.5 GHz PMP 450 AP	FCC ISM	Connectorized	3300 – 3600 MHz	3300 – 3600 MHz	5, 7, 10, 15, 20, 30, 40 MHz	25 dBm
		Integrated 16 dBi				
3.5 GHz PMP 450 SM	FCC ISM	Connectorized	3300 – 3600 MHz	3300 – 3600 MHz	5, 7, 10, 15, 20, 30, 40 MHz	25 dBm
		Integrated 8 dBi				
		Integrated 19 dBi				
3.65 GHz PMP 450 AP	FCC ISM	Connectorized	3500 – 3850 MHz	3500 – 3850 MHz	5, 7, 10, 15, 20, 30, 40 MHz	25 dBm
		Integrated 16 dBi				

Variant	Region	Antenna	Frequency Range	Frequency Range	Channel Bandwidth	Max Tx Power
3.65 GHz PMP 450 SM	FCC ISM	Connectorized	3500 – 3850 MHz	3500 – 3850 MHz	5, 7, 10, 15, 20, 30, 40 MHz	25 dBm
		Integrated 8 dBi				
		Integrated 19 dBi				
5.4/5.8 GHz PMP 450 AP	FCC, RoW, RoW DES	Connectorized	5470 – 5875 MHz	5470 – 5875 MHz	5, 10, 15, 20, 30, 40 MHz (5, 15 and 30 MHz not available in DFS regions)	22 dBm
		Integrated 17 dBi				
5.4/5.8 GHz PMP 450 SM	FCC, ROW, RoW DES	Connectorized	5470 – 5875 MHz	5470 – 5875 MHz	5, 10, 15, 20, 30, 40 MHz (5, 15 and 30 MHz not available in DFS regions)	22 dBm
		Integrated 9 dBi				
		Integrated 25 dBi				

Note

The Transmit power is limited based on regional setting.

Backhaul (PTP)

The Backhaul radio is a transceiver device. It is a connectorized or integrated outdoor unit containing all the radio, networking, and surge suppression electronics. It can be configured as:

- Backhaul Master (BHM)
- Backhaul Slave (BHS)

PTP 450 Platform Family Integrated or Connectorized ODU

See PMP/PTP 450i Series hardware configurations

See PMP/PTP 450b Series hardware configurations

See PMP/PTP 450 Series hardware configurations

See PMP/PTP 450b Retro Series hardware configurations

See PMP/PTP 450b Connectorized series hardware configurations

Product variants

Table 25: PTP 450i Series variants

Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power	Notes
3 GHz PTP 450i	FCC, RoW, Canada, Row DES, Europe	Connectorized	3300 - 3900 MHz	5, 7, 10, 15, 20, 30, 40 MHz	25 dBm	Transmit power limited based on regional setting
		Integrated 23 dBi				
5 GHz PTP 450i	FCC, RoW, Canada, Row DES, Europe	Connectorized	4900 – 5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm	Transmit power limited based on regional setting
		Integrated 23 dBi				

Table 26: PTP 450b Series variants

Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power	Notes
3 GHz PTP 450b	FCC, RoW, Canada, Row DES, Europe	20 dBi Dish antenna	3300 - 3900 MHz	5, 7, 10, 15, 20, 30, 40 MHz	29 dBm	Transmit power limited based on regional setting
5 GHz PTP 450b	FCC, RoW, Canada, Row DES, Europe	Integrated 16 dBi	4900 – 5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm	Transmit power limited based on regional setting
		23 dBi Dish antenna				

Table 27: PTP 450 Series variants

Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power
900 MHz PTP 450 BH	FCC	Connectorized	902 – 928 MHz	5, 7, 10, 15, 20 MHz	25 dBm
3.5 GHz PTP 450 BH	ROW	Connectorized	3300 – 3600 MHz	5, 7, 10, 15, 20, 30, 40 MHz	25 dBm
		Integrated 16 dBi			
		Integrated 19 dBi			
3.65 GHz PTP 450 BH	ROW	Connectorized	3500 – 3850 MHz	5, 7, 10, 15, 20, 30, 40 MHz	25 dBm
		Integrated 16 dBi			
		Integrated 19 dBi			
5.4/5.8 GHz PTP 450 BH	FCC, RoW, RoW DES	Connectorized	5470 – 5875 MHz	5, 10, 15, 20, 30, 40 MHz	22 dBm
		Integrated 9 dBi			
		Integrated 25 dBi			

Note

The Transmit power is limited based on regional setting.

Table 28: PTP 450b Retro Series variants

Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power
5 GHz PTP 450b Retro BH	FCC, RoW, Canada, RoW no encryption, Europe	Integrated 8 dBi	4900-5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm

Table 29: 5 GHz PTP 450b Connectorized BH variants

Frequency Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power
5 GHz PTP 450b Connectorized BH	FCC, RoW, Canada, RoW no encryption, Europe	External antenna	4900-5925 MHz	5, 10, 15, 20, 30, 40 MHz	27 dBm

450 Platform Family ODU interfaces

PMP 450m Series interfaces AP – 3 GHz

The 3 GHz 450m Series AP interfaces are illustrated below.

Figure 3: *3 GHz PMP 450m Series interfaces*

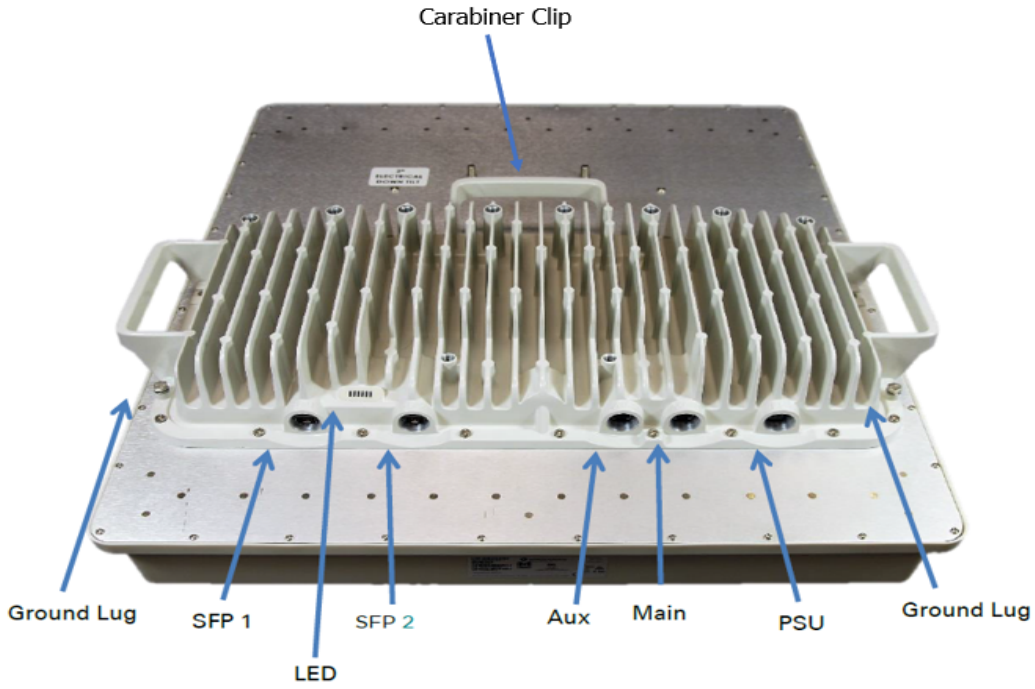


Table 30: PMP 3 GHz 450m Series AP interface descriptions and cabling

Interface	Function	Connector/Cabling
PSU	DC power input, 40 – 60 V. Future support for Cambium Sync-over-power	4 pin/4-core (2 twisted pairs)
MAIN	10/100/1000BASE-T Ethernet, plus Cambium Sync-over-data	RJ45/Cat 5e
AUX	10/100BASE-T Ethernet with PoE out	RJ45/custom Cat 5e
	GPS synchronization input and output, UGPS/cnPulse power output	
SFP 1	Accepts SFP module. Currently not used when operating a 3 GHz 450m as an AP. For future use when operating 3 GHz 450m as an LTE RRH.	Fiber or copper
SFP 2	Accepts SFP module (single or dual). This SFP port may be used as an alternative to the MAIN Ethernet port on the 3 GHz 450m AP.	
Ground Lugs	Unit chassis ground - see installation instructions	10 AWG copper wire

PMP 450m Series interfaces AP - 5 GHz

The 5 GHz 450m Series AP interfaces are illustrated below.

Figure 4: *5 GHz PMP 450m Series interfaces*

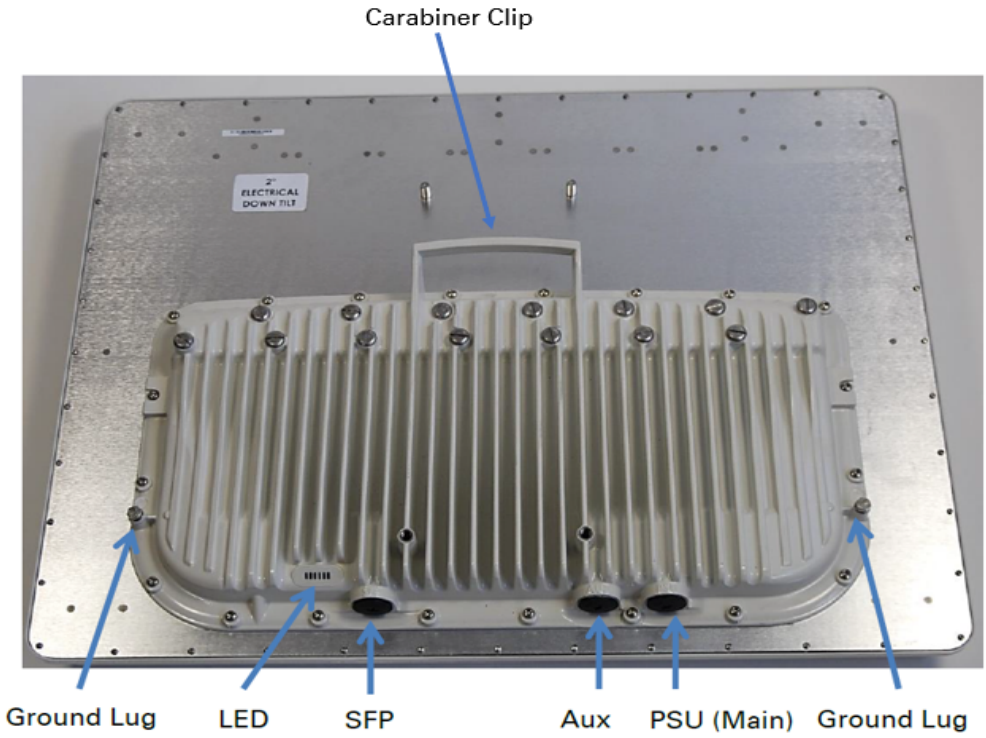


Table 31: PMP 5 GHz 450m Series AP interface descriptions and cabling

Interface	Function	Connector/Cabling
PSU	Power over Ethernet 40 - 60 V DC, 10/100/1000BASE-T Ethernet, plus Cambium Sync-over-power	RJ45/Cat 5e
AUX	10/100BASE-T Ethernet with PoE out	RJ45/custom Cat 5e
	GPS synchronization input and output, UGPS/cnPulse power output	
SFP	Accepts SFP module. This SFP port may be used as an alternative to the MAIN Ethernet port on the 5 GHz 450m AP.	Fiber or copper
Ground Lugs	Unit chassis ground - see installation instructions	10 AWG copper wire

Note

For PMP 450m AP, the Sync-Over-Power is supported with CMM5 only.

For PMP 450m AP, the Sync-Over-Power will not work with CMM4 like PMP 450/450i Series.

Note

SFP kits (Single Mode Optical SFP Interface per ODU (part number C000065L008A), Multi-mode Optical SFP Interface per ODU (part number C000065L009A), and 2.5GBASE-T Copper SFP Interface per ODU (part number C000065L011A)) are required for SFP port connectivity.

PMP/PTP 450i Series interfaces – AP/SM/BH

The AP/SM/BH interfaces are illustrated below.

Figure 5: *PMP/PTP 450i interfaces*

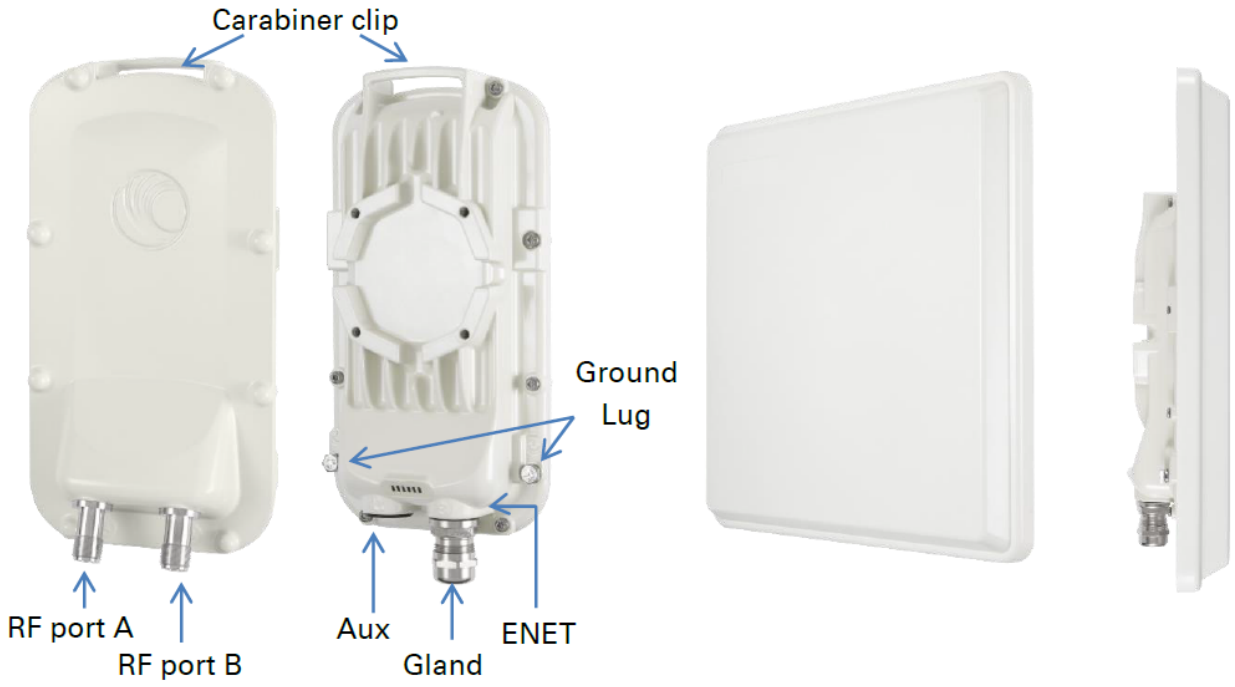


Table 32: PMP/PTP 450i Series - AP/SM/BH interface descriptions and cabling

Interface	Function	Connector/Cabling
PSU	Power over Ethernet 48 - 59 V DC, 802.3at compatible. 10/100/1000BASE-T Ethernet, plus Cambium/Canopy Sync-over-power.	RJ45/Cat 5e
AUX	10/100Base-T Ethernet with PoE out	RJ45/custom Cat 5e
	GPS synchronization input and output, UGPS/cnPulse power output	
	Alignment tone audio output	
RF Port A	Vertically polarized RF connection to antenna	N-type/50 Ohm coaxial

Interface	Function	Connector/Cabling
RF Port B	Horizontally polarized RF connection to antenna	N-type/50 Ohm coaxial
Ground Lugs	Unit chassis ground - see installation instructions	10 AWG copper wire

Note

If the Aux port will be used, a second Ethernet Gland will need to be ordered (Part Number: N000065L033A).

Warning

The PMP 450 Ruggedized High Gain integrated Subsciber Module (Cambium part nubers CO35045CO14A and CO36045CO14A), while encapsulated in a 450i-type enclosure, contains 450 circuitry which must be powered via 30 V DC. Powering these SMs with a 56 V DC supply will damage the device.

PMP/PTP 450b Mid-Gain Series interfaces - SM/BH

The PMP/PTP 450b Series - SM/BH interfaces are illustrated below.

Figure 6: *PMP 450b Mid-Gain Series interfaces*

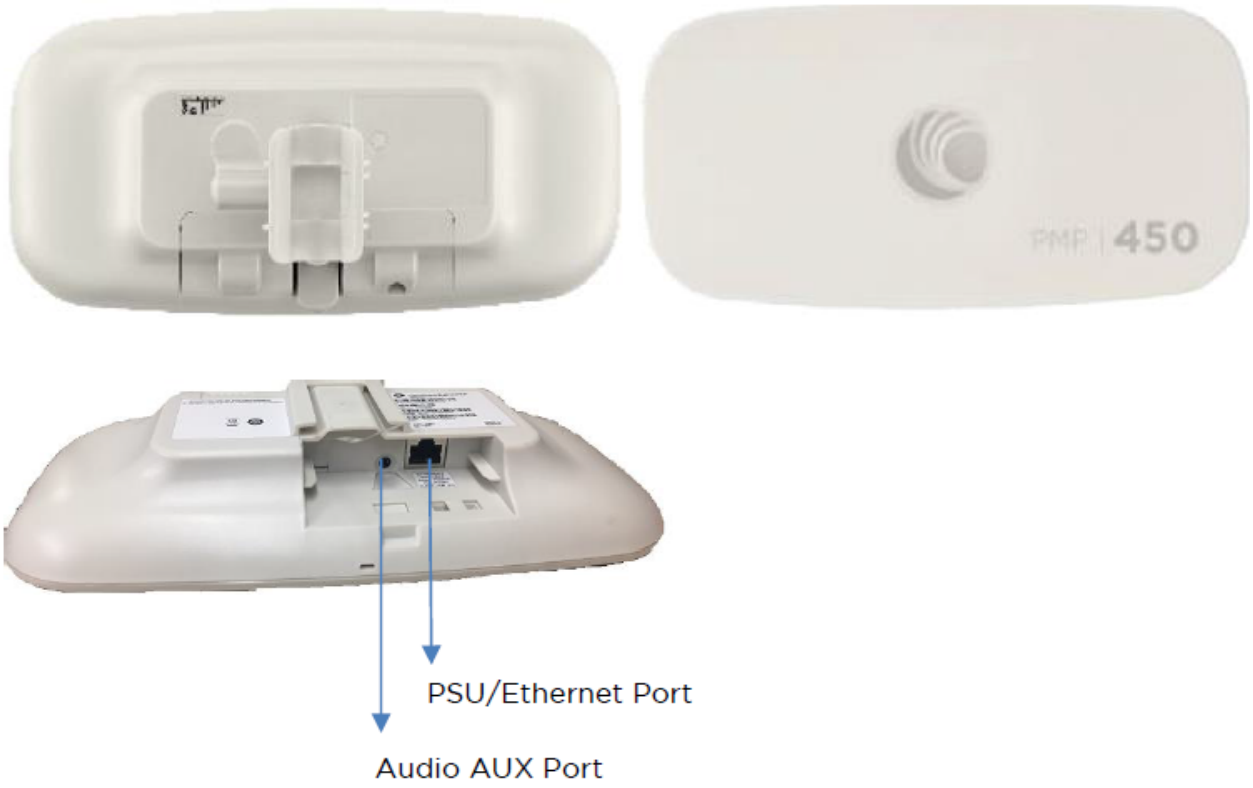


Table 33: PMP/PTP 450b Series - SM/BH (Mid-Gain) interface descriptions and cabling

Interface	Function	Connector/Cabling
Main/Power Port	Canopy-style Power over Ethernet 20 - 32 V DC, 10/100/1000BASE-T Ethernet, plus Canopy Sync-over-power.	RJ45/Cat 5e
Aux Port	GPS synchronization input and output, UGPS/cnPulse power output, alignment tone audio output.	3.5 mm TRRS audio/standard headphones or custom sync cable

PMP/PTP 450b High Gain Series interfaces - SM/BH

The 450b Series products are illustrated below. The interfaces are accessible from the rear of the dish and are located under the cover shown.

Figure 7: *5 GHz 450b Series interfaces (High Gain)*

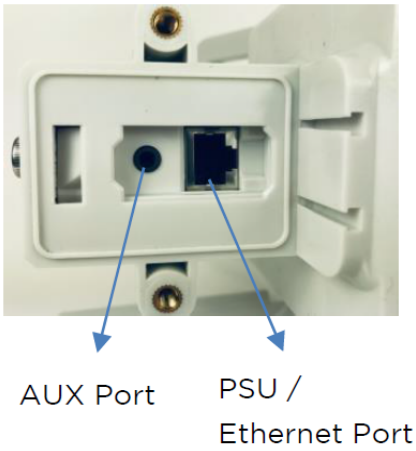


Figure 8: *3 GHz 450b Series interfaces (High Gain)*

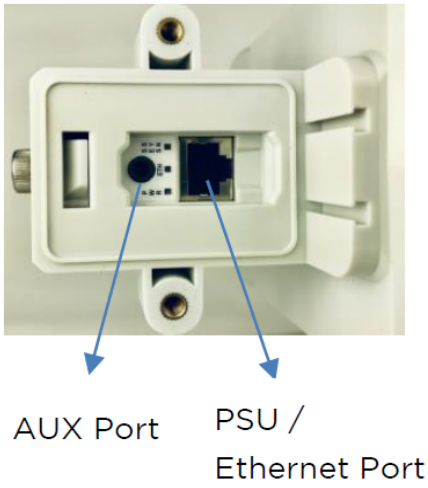


Table 34: PMP/PTP 450b Series (High Gain) SM/BH interface descriptions and cabling

Interface	Function	Connector/Cabling
Main/Power Port	Canopy-style Power over Ethernet 20 - 32 V DC, 10/100/1000BASE-T Ethernet, plus Canopy Sync-over-power	RJ45/Cat 5e
Aux Port	GPS synchronization input and output, UGPS/cnPulse power output, alignment tone audio output	3.5 mm TRRS audio/standard headphones or custom sync cable

PMP/PTP 450b Retro SM/BH interfaces

The PMP/PTP 450b Retro interfaces are illustrated below.

Figure 9: *PMP/PTP 450b Retro SM/BH interface*

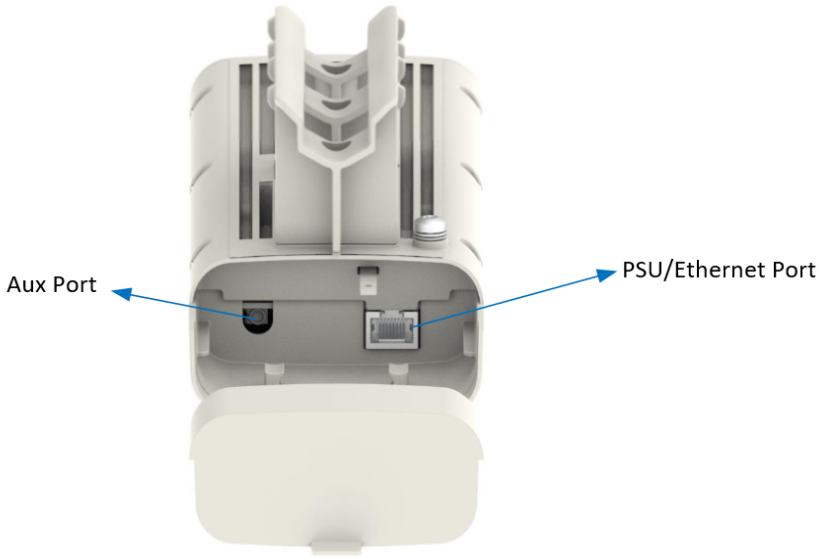


Table 35: PMP/PTP 450b Retro SM/BH interface descriptions and cabling

Interface	Function	Connector/Cabling
Main/Power Port	Canopy-style Power over Ethernet 20 - 32 V DC, 10/100/1000BASE-T Ethernet, plus Canopy Sync-over-power.	RJ45/Cat 5e
Aux Port	GPS synchronization input and output, UGPS/cnPulse power output, alignment tone audio output.	3.5 mm TRRS audio/standard headphones or custom sync cable
Ground Lugs	Unit chassis ground - see installation instructions.	10 AWG copper wire

PMP/PTP 450b Connectorized Interfaces - SM/BH

The PMP 450b Connectorized SM/BH interfaces are illustrated below.

Figure 10: *PMP 450b Connectorized interfaces*

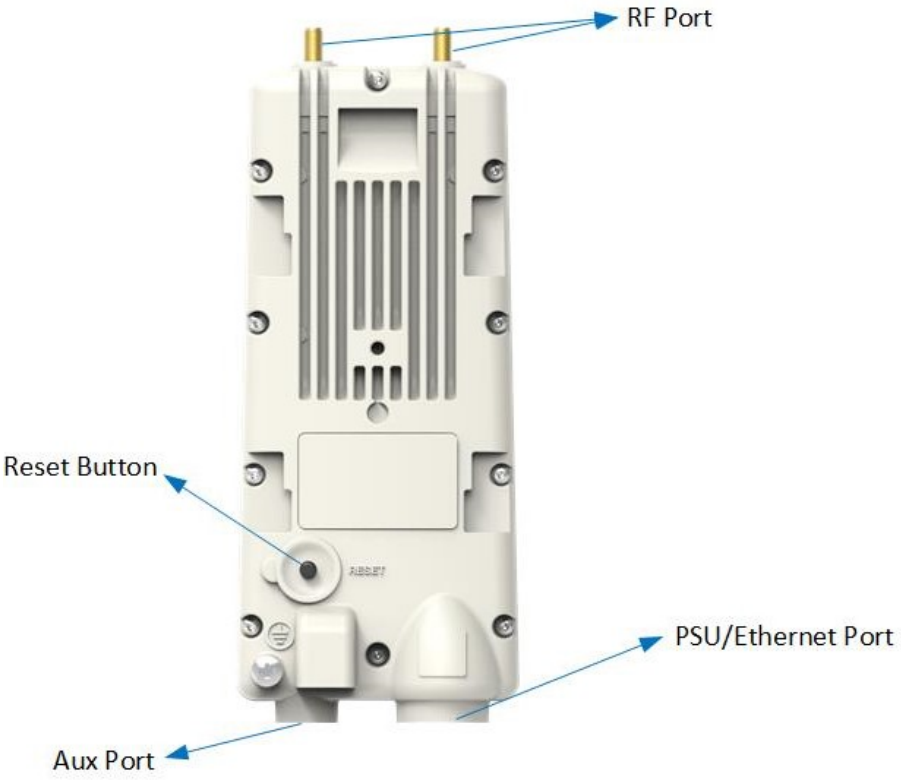


Table 36: PMP 450b Connectorized - SM/BH interface descriptions and cabling

Interface	Function	Connector/Cabling
Main/Power Port	Canopy-style Power over Ethernet 20 - 32 V DC, 10/100/1000BASE-T Ethernet, plus Canopy Sync-over-power.	RJ45/Cat 5e
Aux Port	GPS synchronization input and output, UGPS/cnPulse power output, alignment tone audio output.	3.5 mm TRRS audio/standard headphones or custom sync cable
RF Ports	Horizontally and vertically polarized RF connections to SM/BH antenna	Reverse polarity SMA/50 Ohm coaxial
Ground Lugs	Unit chassis ground - see installation instructions.	10 AWG copper wire

Note 1: GUI option "Sync Aux Port Configuration" controls the behavior of the Aux port.

Note 2: Pin-out detail for Aux port: -

Tip:	Alignment Tone (Default) / GPS Sync 1PPS IN (cnPulse) or GPS Sync 1PPS Out (Remote AP).
Ring 1:	cnPulse +5 V Power Out / Alignment Tone Stereo Out.

Ring 2:	cnPulse Serial Data In.
Sleeve:	Ground

PMP/PTP 450 Series interfaces - AP

The PMP 450 Series - AP interfaces are illustrated below.

Figure 11: *PMP/PTP 450 Series - AP interfaces*

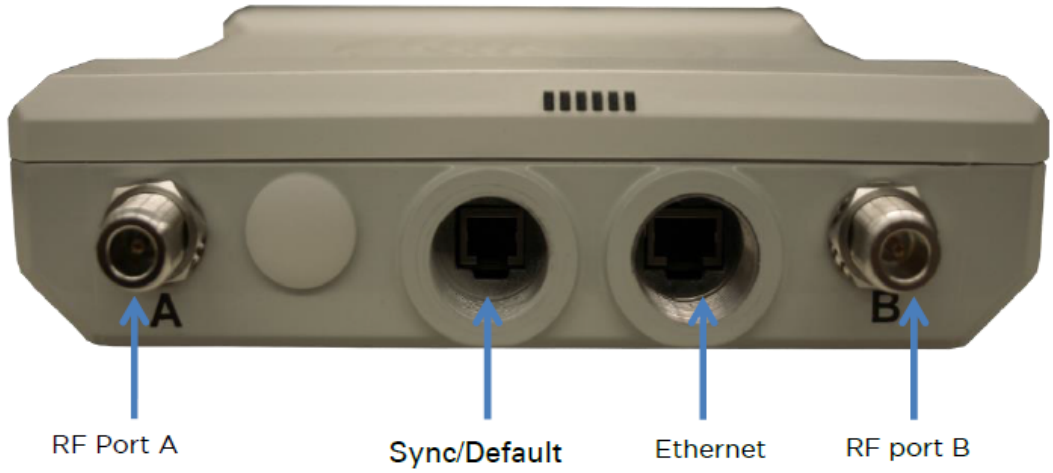


Table 37: PMP/PTP 450 Series - AP interface descriptions and cabling – 2.4 GHz and 5 GHz

Interface		Function	Connector/Cabling
Main/Power Port		Canopy-style Power over Ethernet 22 - 32 V DC, 10/100/1000BASE-T Ethernet, plus Canopy Sync-over-power.	RJ45/Cat 5e
Aux Port		GPS synchronization input and output, UGPS/cnPulse power output. Default plug port.	RJ12/custom Cat 5e
RF Port A	2.4 GHz, 3 GHz	-45 degree polarized RF connection to AP antenna	N-type/50 Ohm coaxial
	5 GHz	Vertically polarized RF connection to AP antenna	
RF Port B	2.4 GHz, 3 GHz	+45 degree polarized RF connection to AP antenna	N-type/50 Ohm coaxial
	5 GHz	Horizontally polarized RF connection to AP antenna	
Ground Lug		Unit chassis ground - see installation instructions	10 AWG copper wire

PMP/PTP 450 Series interfaces – SM/BH

The PMP 450 Series SM/BH interfaces are illustrated below.

Figure 12: *PMP/PTP 450 Series – SM/BH Integrated interfaces*

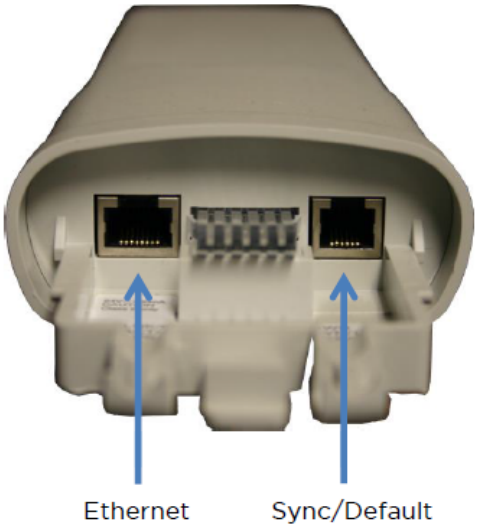


Figure 13: *PMP/PTP 450 Series – SM/BH Connectorized interfaces*

Note

As per Underwriters Laboratory (UL) guidelines, the Ground Lug on the radiated SM is not required.

Figure 14: *PMP 450d Series - SM Integrated Dish*

Figure 15: *PMP 450 Series – SM 3 GHz Integrated*

Figure 16: *PTP 450 Series – BHM/BHS*

Table 38: PMP/PTP 450 Series interfaces – SM/BH interface descriptions and cabling

Interface		Function	Connector/Cabling
ETHERNET		Canopy-style Power over Ethernet 24 - 30 VDC, 10/100BASE-T Ethernet	RJ45/Cat 5e
AUX		GPS synchronization input and output, alignment tone audio output. Default plug port	RJ12/custom Cat 5e
RF Port A	2.4 GHz, 3 GHz	-45 degree polarized RF connection to AP antenna	N-type/50 Ohm coaxial
	5 GHz	Vertically polarized RF connection to AP antenna	
RF Port B	2.4 GHz, 3 GHz	+45 degree polarized RF connection to AP antenna	N-type/50 Ohm coaxial
	5 GHz	Horizontally polarized RF connection to AP antenna	
Ground Lug		Unit chassis ground - see installation instructions	10 AWG copper wire

PMP 450 MicroPoP Series (Omni, Sector and Connectorized) interfaces - AP

Omni and Sector AP interfaces

The PMP 450 MicroPoP Series Omni and Sector AP interfaces are illustrated below.

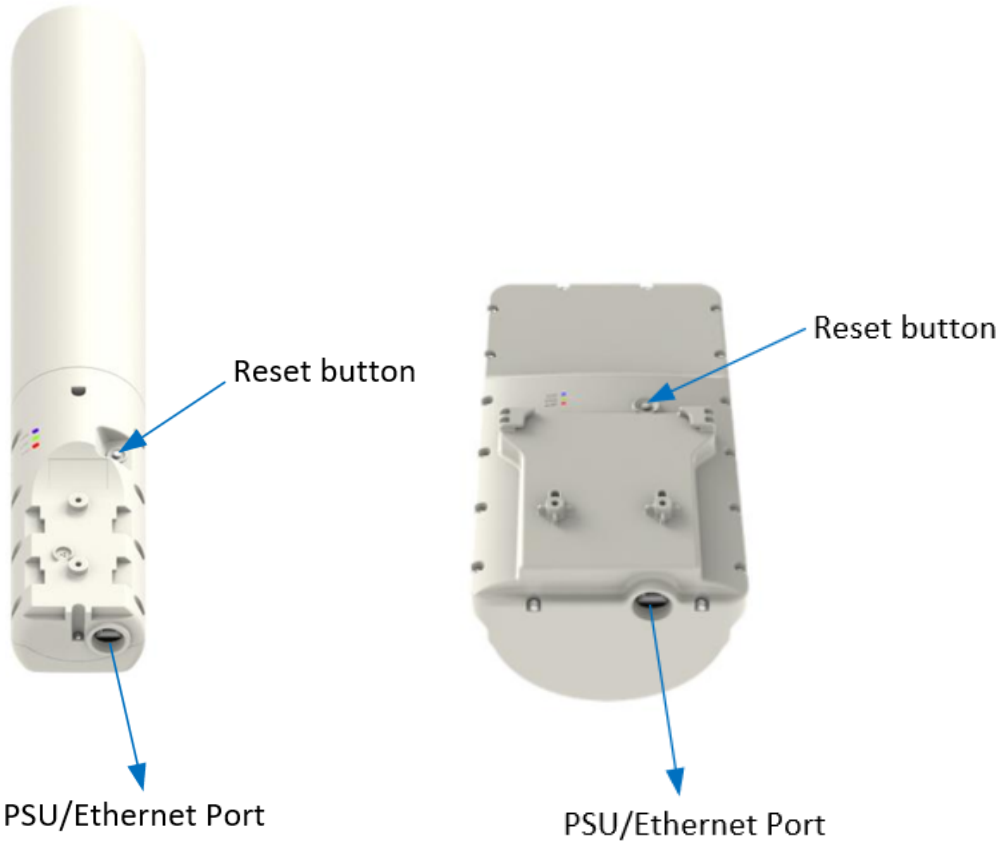


Table 39: PMP 450 MicroPoP Series Omni/Sector interface details

Interface	Function	Connector/Cabling
Main/Power Port	Power over Ethernet 46 - 59 V DC 802.3af compatible, 10/100/1000BASE-T Ethernet, plus Cambium/Canopy Sync-over-power.	RJ45/Cat 5e
Reset button	• Short press: Reboot the device • Long press: Recovery mode	-

Connectorized AP interfaces

The PMP 450 MicroPoP Series Connectorized AP interfaces are illustrated below.

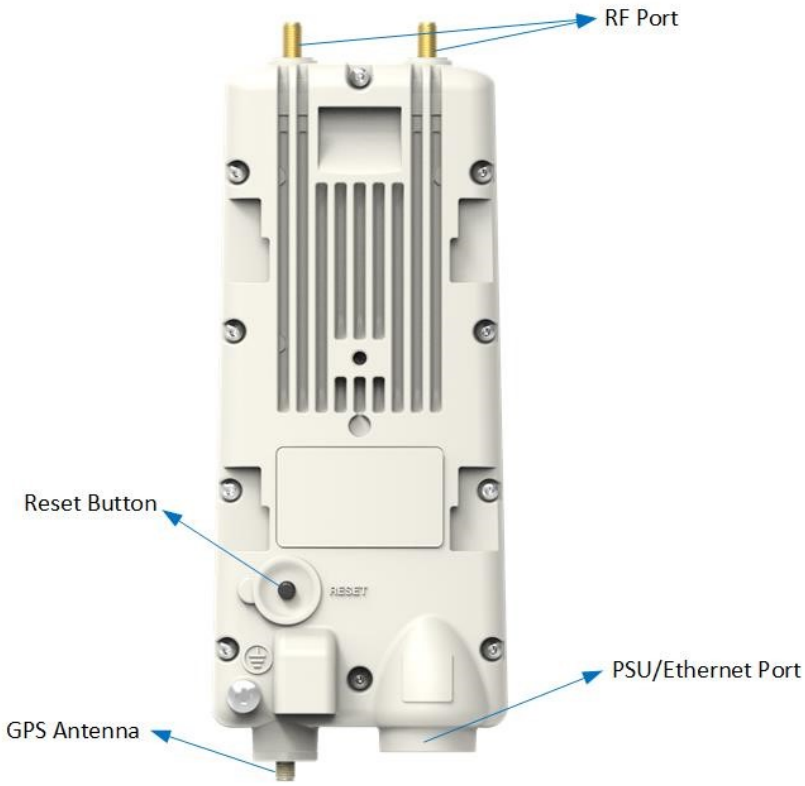


Table 40: PMP 450 MicroPoP Series Connectorized interface details

Interface	Function	Connector/Cabling
Main/Power Port	Power over Ethernet 46 - 59 V DC 802.3af compatible, 10/100/1000BASE-T Ethernet, plus Cambium/Canopy Sync-over-power.	RJ45/Cat 5e
Reset button	• Short press: Reboot the device • Long press: Recovery mode	-
GPS Antenna	Connect to external GPS active antenna puck	GPS antenna with SMA connector
RF Ports	Horizontally and vertically polarized RF connections to AP antenna	Reverse polarity SMA/50 Ohm coaxial
Ground Lug	Unit chassis ground - see installation instructions.	10 AWG copper wire

ATEX/HAZLOC variants

PTP/PMP 450i series products are available in ATEX/Hazloc variants for operation in locations where explosive gas hazards exist, as defined by Hazloc (USA) and ATEX (Europe). ATEX/HAZLOC variants are similar to the standard product except that:

- ODUs are supplied with the Full capacity license
- The frequency range is restricted to 4940 MHz to 5850 MHz
- The maximum EIRP generated by ODU is restricted to comply with the ATEX and HAZLOC standards

In order to meet specific radio regulations in the USA, Canada and the EU, Cambium supplies products approved for USA, Canada, EU and the rest of the world under different models and part numbers. These models and part numbers are shown in PMP 450i Integrated ODU models/part numbers and PTP 450i Series – Con ODU part numbers.

Diagnostic LEDs

The diagnostic LEDs of 450 Platform Family ODUs are as shown below.

Note

The colors shown in the diagram may differ from the actual color displayed by the AP/BHM, depending on its current status.

AP/BHM LEDs

The diagnostic LEDs report the information about the status of the AP/BHM.

Table 41: 450m AP, 450i AP/BHM and 450 AP/BHM diagnostic LEDs

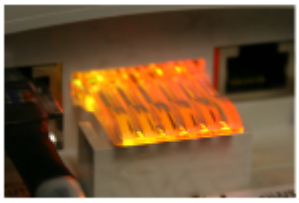
ODU LED Display	LED Labels					
PMP 450m Series - AP						
	MAIN LNK+ACT/5	AUX LNK+ACT/4	GPS/3	SES/2	SYN/1	PWR
PMP/PTP 450i Series - AP/BHM						
	MAIN LNK/5	ACT/4	GPS/3	SES/2	SYN/1	PWR
PMP/PTP 450 Series - AP/BHM						
	MAIN LNK/5	ACT/4	GPS/3	SES/2	SYN/1	PWR
PMP/PTP 450 Series - AP						
	MAIN LNK/5	ACT/4	GPS/3	SES/2	SYN/1	PWR
PMP/PTP 450 Series - BHM						
	ACT/4	GPS/3	SES/2	SYN/1	PWR	MAIN LNK/5

Table 42: 450m AP, 450i AP/BHM and 450 AP/BHM LED descriptions

LED	Color when active	Status information provided	Notes
PWR	Red	DC power	Always lit after 10-20 seconds of power on.
SYN/1	Yellow	Presence of sync	-
SES/2	Green	Unused	-
GPS/3	Red	Pulse of sync	Lit when the AP/BHM is getting a sync pulse from a GPS source goes along with SYN/1
ACT/4	For 450 and 450i Yellow	Presence of data activity on the Ethernet link	Flashes during data transfer. Frequency of flash is not a diagnostic indication.
AUX LNK + ACT/4	For 450m Series Red/ Green (bi-colored for 10/100)	Aux port link speed and activity	Flashes to indicate Ethernet activity on Aux port. Indicates speed based on the following colors: • 10BASE-T : Red • 100BASE-T : Green
MAIN LNK/5	For 450i Red/ Green/Orange (bi-colored for 10/100/1000)	Activity on Main port link	Continuously lit when link is present. Indicates speed based on the following colors: • 10BASE-T = Red • 100BASE-T = Green • 1000BASE-T = Orange
	For 450 AP Orange/Green/Yellow (10/100/1000)	Ethernet link	Continuously lit when link is present. • 10BASE-T = Orange • 100BASE-T = Green • 1000BASE-T = Yellow
	For 450 BHM Green		Continuously lit when link is present. • 10BASE-T = Green • 100BASE-T = Green
MAIN LNK + ACT/5	For 450m Series Red/ Green/Orange(bi-colored for 10/100/1000)	Main port link speed and activity	Flashes to indicate data transfer speed and activity.

Table 43: 5 GHz 450b Mid-Gain and High Gain BHM diagnostic LEDs

ODU LED Display	LED Labels				
PTP 450b Mid-Gain Series – BHM					
	ETH	GPS	SES	SYNC	POWER
PTP 450b 5 GHz High Gain Series – BHM					
	ETH	GPS	SES	SYNC	POWER

Table 44: 5 GHz 450b Mid-Gain and High Gain BHM LED descriptions

LED	Color when active	Status information provided	Notes
POWER	Blue	DC power	Always lit after 10-20 seconds of power on.
SYNC	Green	Presence of sync	-
SES	Yellow	Unused	-
GPS	Red	Pulse of sync	Lit when the BHM is getting a sync pulse from a GPS source goes along with SYNC.
ETH	Red/Green/Orange (multi-colored for 10/100/1000).	Presence of data activity on the Ethernet link	Lit when link is present: • 10BASE-T = Red • 100BASE-T = Green • 1000BASE-T = Orange Flashes during data transfer. Frequency of flash is not a diagnostic indication.

Table 45: 3 GHz 450b High Gain BHM, 5 GHz 450 MicroPoP Omni/Sector/Connectorized AP, 5 GHz 450b Retro BHM and 5 GHz 450b Connectorized BHM diagnostic LEDs

ODU LED Display	LED Labels		
3 GHz 450b High Gain BHM			
	ETH	SES/SYN	PWR
5 GHz 450 MicroPoP Omni/Sector/Connectorized AP			
	PWR	SYNC	ENET
5 GHz 450b Retro BHM			
	PWR	SYNC	ENET
5 GHz 450b Connectorized BHM			
	PWR	SYNC	ENET

Table 46: 3 GHz 450b High Gain BHM LED descriptions

LED	Color when active	Status information provided	Note
PWR	Blue	DC power	Always lit after power on
ETH	Red/Green/Orange	Flashes in presence of data activity on the Ethernet link	• 10BASE-T = Red • 100BASE-T = Green • 1000BASE-T = Orange
SES/SYN	Yellow/Green	Sync status: • Generating sync = Yellow • Receiving sync = Green • Solid = Unit transmitting • Blinking = Unit synchronized, but not transmitting	

Table 47: 5 GHz 450 MicroPoP Omni/Sector/Connectorized AP, 5 GHz 450b Retro BHM and 5 GHz 450b Connectorized BHM LED descriptions

LED	Color when active	Status information provided	Note
PWR	Blue	DC power	Always lit after power on
ENET	Red/Green/Orange	Flashes in presence of data activity on the Ethernet link	• 10BASE-T = Red • 100BASE-T = Green • 1000BASE-T = Orange
SYNC	Yellow/Green	Sync status: • Generating sync = Yellow • Receiving sync = Green • Solid = Unit transmitting • Blinking = Unit synchronized, but not transmitting	

SM/BHS LEDs

The SM/BHS LEDs provide different status of radio based on the operating modes. A SM/BHS in “operating” mode registers and passes traffic normally. A SM/BHS in “aiming” mode does not register or pass the traffic but displays (via LED panel) the strength of received radio signals (based on radio channel selected via **Tools -> Alignment**).

Table 48: 450i and 450 SM/BHS diagnostic LEDs

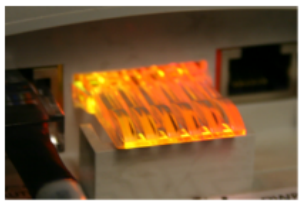
ODU LED Display	LED Labels					
PMP/PTP 450i Series - SM/BHS						
	MAIN LNK/5	ACT/4	GPS/3	SES/2	SYN/1	PWR
PMP/PTP 450 Series - SM/BHS						
	MAIN LNK/5	ACT/4	GPS/3	SES/2	SYN/1	PWR

Table 49: 450i and 450 SM/BHS LED descriptions

Status information provided				
LED	**Color when active**	**SM / BHS in "Operating" Mode**	**SM / BHS in "Aiming" Mode**	**Note**
PWR	Red	DC power		Always lit after 10-20 seconds of power on.
SYN/1	Yellow	Presence of sync	These three LEDs act as a bar graph to indicate the relative quality of alignment. As power level improves during alignment, more of these LEDs are lit.	Lit when SM/BHS is in sync with an AP/BHM.
SES/2	Green	Session Indicator		Lit when SM/BHS is in session.
GPS/3	Red	Unused		Unused
ACT/4	Yellow	Presence of data activity on the Ethernet link	Presence of data activity on the Ethernet link	Flashes during data transfer. Frequency of flash is not a diagnostic indication.
MAIN LNK/5	For 450i Series Red/ Green/Orange (bi-colored for 10/100/1000)	Ethernet link		Continuously lit when link is present. • 10BASE-T : Red • 100BASE-T : Green • 1000BASE-T : Orange

Status information provided				
LED	Color when active	SM / BHS in “Operating” Mode	SM / BHS in “Aiming” Mode	Note
	For 450 Series Green	Ethernet link		Continuously lit when link is present.

Table 50: 5 GHz 450b Mid-Gain and High Gain SM/BHS diagnostic LEDs

ODU LED Display	LED Labels				
PTP 450b Mid-Gain Series – SM/BHS					
					
	ETH	GPS	SES	SYNC	POWER
PTP 450b 5 GHz High Gain Series – SM/BHS					
					
	ETH	GPS	SES	SYNC	POWER

Table 51: 5 GHz High Gain and Mid-Gain 450b SM/BHS LED descriptions

Status information provided				
LED	Color when active	SM / BHS in “Operating” Mode	SM / BHS in “Aiming” Mode	Note
POWER	Blue	DC power		Flashes Yellow during boot-up. Flashes Blue when operating. Always lit after 10-20 seconds of power on.

Status information provided				
LED	Color when active	SM / BHS in "Operating" Mode	SM / BHS in "Aiming" Mode	Note
SYNC	Green	Presence of sync	These three LEDs act as a bar graph to indicate the relative quality of alignment. As power level improves during alignment, more of these LEDs are lit.	Lit when SM/BHS is in sync with an AP/BHM.
SES	Yellow	Session Indicator		Lit when SM/BHS is in session.
GPS	Red	Unused		Unused
ETH	Red/Green/Orange (10/100/1000)	Ethernet Link		Flashes during data transfer. Frequency of flash is not a diagnostic indication. • 10BASE-T = Red • 100BASE-T = Green • 1000BASE-T = Orange

Table 52: 3 GHz 450b High Gain SM/BHS, 5 GHz 450b Retro SM/BHS and 5 GHz 450b Connectorized SM/BHS diagnostic LEDs

ODU LED Display	LED Labels		
PMP/PTP 450b 3 GHz High Gain Series – SM/BHS			
	ETH	SES/SYN	PWR
5 GHz 450b Retro SM/BHS			
	PWR	SYNC	ENET
5 GHz 450b Connectorized SM/BHS			
	PWR	SYNC	ENET

Note

The 3 GHz 450b has its status LEDs located beneath the cover behind the dish. During installation, the LEDs can be viewed by unclipping the rear most door.

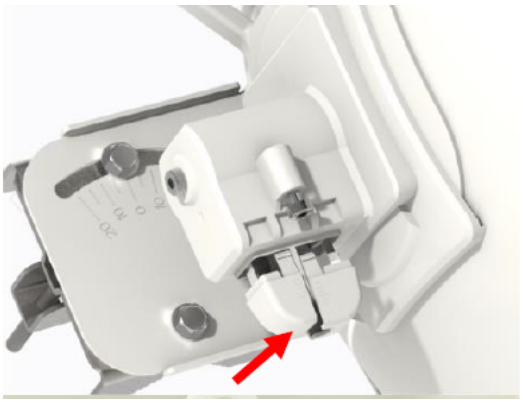


Table 53: 3 GHz 450b High Gain SM/BHS LED descriptions

Status information provided				
LED	**Color when active**	**SM / BHS in "Operating" Mode**	**SM / BHS in "Aiming" Mode**	**Note**
PWR	Blue	DC power		Always lit after power on
ETH	Red / Green / Orange(10 / 100 / 1000)	Ethernet Link		Flashes during data transfer. Frequency of flash is not a diagnostic indication. 10Base-T = Red • 100BASE-T = Green • 1000BASE-T = Orange
SES/ SYN	Yellow / Green	Session status: - Scanning = Blinking yellow Registering = Solid yellow Registered = Solid green	This LED indicates when the signal level is sufficient for normal operation. When the power rises above this threshold, the LED color changes from Yellow to Green.	

Table 54: 5 GHz 450b Retro SM/BHS and 5 GHz 450b Connectorized SM/BHS LED descriptions

Status information provided				
LED	**Color when active**	**SM / BHS in "Operating" Mode**	**SM / BHS in "Aiming" Mode**	**Note**
PWR	Blue/ Yellow	DC power		Always lit after power on
SYNC	Green / Yellow	Session status: - Scanning = Blinking green Registering = Solid green Registered = Solid yellow	This LED indicates when the signal level is sufficient for normal operation. When the power rises above this threshold, the LED color changes from Green to Yellow.	
ENET	Red / Green / Orange (10/100/1000)	Ethernet Link		Flashes during data transfer. Frequency of flash is not a diagnostic indication. 10BASE-T = Red 100BASE-T = Green 1000BASE-T = Orange

Operating Mode

- Scanning:
    - For hardware with 5 and 6 LEDs: If the SM/BHS is not registered to AP/BHM, then these LEDs cycle on and off from left to right (SYN/1, SES/2 and GPS/3).
    - For hardware with 3 LEDs: If the SM/BHS is not registered to AP/BHM, then SES/SYN session blinks yellow.
- Ethernet Link:
    - For 450m AP, the MAIN LNK + ACT/5 LED is active when the Main port link is present and the AUX LNK + ACT/4 LED is active when the Aux port link is present.
    - For 450/450i AP/BHM/BHS, the MAIN LNK/5 LED is lit continuously when the link is present.
- Data Transfer:
    - For 450m AP, the MAIN LNK + ACT/5 LED flashes to indicate data transfer speed and activity on the Main port and the AUX LNK + ACT/4 LED flashes to indicate data transfer speed and activity on the Aux port.
    - For 450/450i AP/BHM, the ACT/4 LED flashes during data transfer.
    - For 450/450i SM/BHS, the ACT/4 LED flashes during data transfer.

- For 450b 3 GHz and 5 GHz, the ETH LED flashes during data transfer.
- For MicroPoP 5 GHz, the ETH LED flashes during data transfer.

Aiming Mode

For hardware with 5 and 6 LEDs, the 3 LEDs (SYN/1, SES/2, and GPS/3) are turned into a 3-position bar graph. The more LEDs that are lit, the better the received power the module is seeing. For hardware with 3 LEDs, the SES/SYN LED indicates when the signal level is sufficient for normal operation. When the power rises above this threshold, the LED color changes from yellow to green. The colors of the LEDs have no particular meaning other than to assist is distinguishing one position from the next.

Power supply options

Power is supplied to the ODU by a PoE injector, except for 3 GHz PMP 450m where power and data are supplied separately. All power injectors / power supplies in the Cambium Networks range are designed for an indoor environment. The following table summarizes the Cambium Networks power supply variants available for each 450 radio model. The power injector is connected to the ODU and network terminating equipment using Cat 5e cable with RJ45 connectors.

Model	30 V DC	56 V DC	802.3af	802.3at	N000900L001B/C Gigabit (15W)	N000900L002A 100 Base T (15W) - obsolete	N000000L034A (AC) – 30W, 56VDC	N000065L001C (AC) – 60W	C000065L002C (AC+DC) – 100W	N000000L054B (AC) 54V 240W
PMP 450 AP	X	-	-	-	X	X*	-	-	-	-
PMP 450 SM	X	-	-	-	X*	X*	-	-	-	-
PTP 450	X	-	-	-	X*	X*	-	-	-	-
PMP / PTP 450b	X	-	-	-	X	X*	-	-	-	-
PMP 450i AP	-	X	-	X	-	-	X	X	X	-
PMP 450i SM	-	X	-	X	-	-	X	X	X	-
PTP 450i	-	X	-	X	-	-	X	X	X	-
5 GHz PMP 450m	-	X	-	-	-	-	-	-	X	-
3 GHz PMP 450m	-	-	-	-	-	-	-	-	-	X
PMP 450 MicroPoP	-	X	-	X	-	-	X	X	X	-

*100 Base T-mode only (no Gigabit)

The AC line cord is supplied separately from the power supply. Regional variants are available.

Power supply – PMP 450m Series

The PMP 450m Series - 5 GHz AP supports powering from the following power sources:

- AC+DC Enhanced Power Injector (see AC+DC Enhanced Power Injector C000065L002C)
- CMM5 56 V power and sync injector module with external 240 W or 600 W power supply

PSU part numbers

Table 55: PSU part numbers for PMP 450m AP (5/3 GHz)

AP Model	Cambium description	Cambium part number
5 GHz	AC+DC Enhanced Power Injector	C000065L002C
3 GHz	Power Supply, AC, 54 V 240 W	N000000L054B

Power supply – PMP/PTP 450i Series

The PMP/PTP 450i Series supports powering from the following powering sources:

- Power Supply, 60 W, 56 V with 1000BASE-T or GigE
- AC+DC Enhanced Power Injector
- Power over Ethernet midspan, 60 W, -48 V DC Input
- CMM4 with external 56 V power supply and CMM4 to 450i Series ODU cable (Dongle)
- CMM5 56 V power and sync injector module with external 240 W or 600 W power supply
- IEEE802.3at power injector

Note

The 900 MHz SM is based off of the 450 Series , please see Power supply – PMP/PTP 450 Series .

Warning

Always use an appropriately rated and approved AC supply cord-set in accordance with the regulations of the country of use.

Warning

The PMP 450 Ruggedized High Gain Integrated Subscriber Module (Cambium part numbers C035045C014A and C036045C014A), while encapsulated in a 450i-type enclosure, contains 450 circuitry which must be powered via 30 V DC. Powering these SMs with a 56 V DC will damage the device.

Please refer to MicroPoP Lightning Arrester details for details on maximum cable lengths between power injector and PMP/PTP 450i.

PSU part numbers

Table 56: PSU part numbers for PMP/PTP 450i Series

Cambium description	Cambium part number
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 V DC Input	N000000L036A
Power supply, 30 W, 56 V – Gbps support	N000000L034A

AC Power Injector N000065L001B

The AC Power Injector interfaces are shown in AC Power Injector interfaces and described in AC Power Injector interface functions.

Figure 17: *AC Power Injector interfaces*

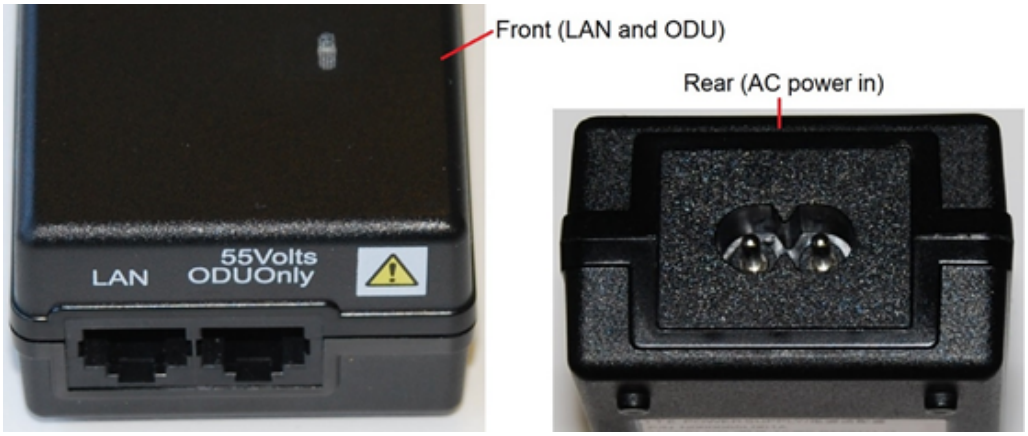


Table 57: AC Power Injector interface functions

Interface	Function
AC power in	AC power input (main supply)
ODU	RJ45 socket for connecting Cat5e cable to ODU
LAN	RJ45 socket for connecting Cat5e cable to network
Power (green) LED	Power supply detection

AC+DC Enhanced Power Injector C000065L002C

The AC+DC Enhanced Power Injector interfaces are shown in AC+DC Enhanced Power Injector interfaces and described in AC+DC Enhanced Power Injector interface functions.

Figure 18: *AC+DC Enhanced Power Injector interfaces*

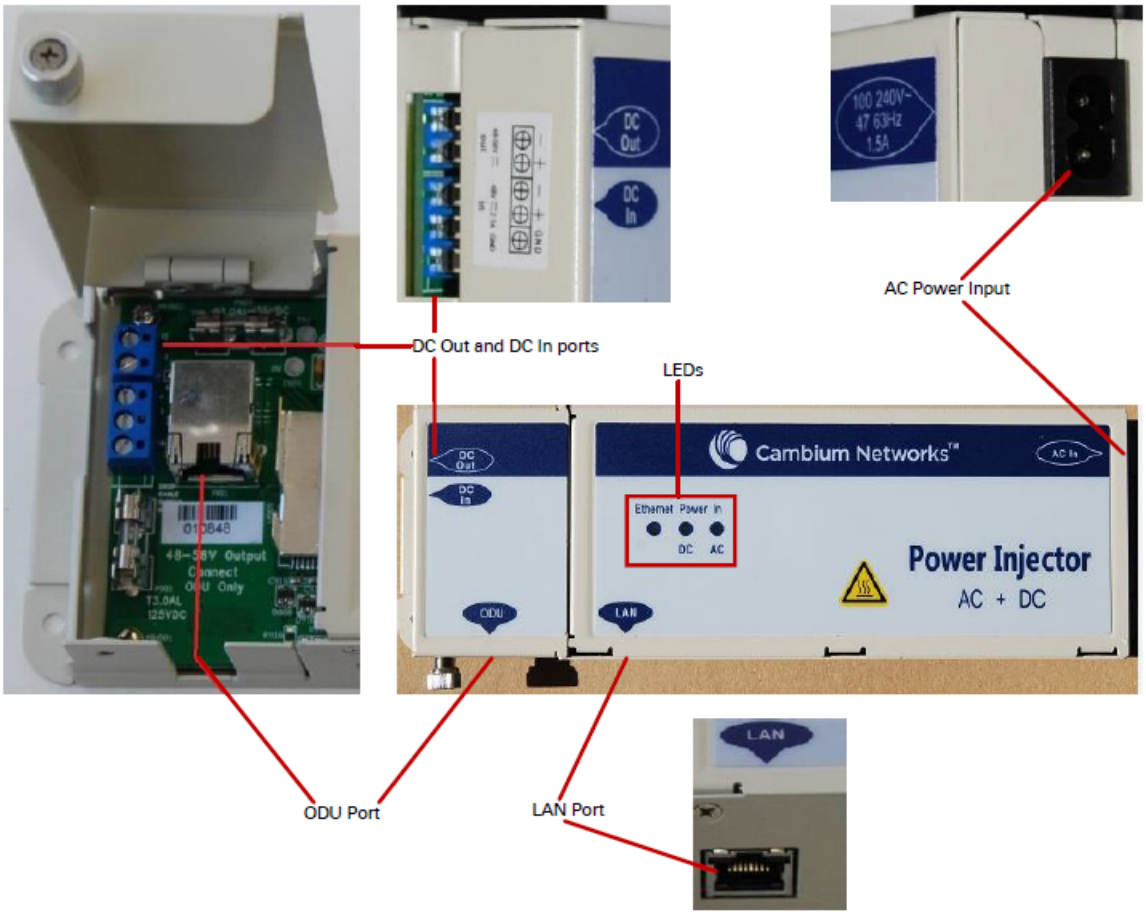


Table 58: AC+DC Enhanced Power Injector interface functions

Interface	Function
100-240V 47-63Hz 1.7A	AC power input (main supply)
DC In	Alternative DC power supply input
DC Out	DC power output to a second PSU (for power supply redundancy) or to a NIDU
ODU	RJ45 socket for connecting Cat5e cable to ODU
LAN	RJ45 socket for connecting Cat5e cable to network
Power - AC (green) LED	Indicates power is applied at the AC power input

Interface	Function
Power - DC (green) LED	Indicates power is applied at the DC In port
Ethernet (yellow) LED	Detects Ethernet traffic and it is used with PTP 650 and PTP 700 families only. It does not operate with the 450 platform products.

Note

The earlier power injector models only had a single power LED that combined the AC+DC indications.

-48 V DC Power Injector N000000L036A

The DC Power Injector interfaces are shown in -48 V DC Power Injector interfaces and described in -48 V DC Power Injector interfaces.

Figure 19: *-48 V DC Power Injector interfaces*

Table 59: -48 V DC Power Injector interfaces

Interface	Function
DC input	36 to 60 V, 2 A
RJ45 Sockets	Two (Data In and Data & Power Out)
LEDs	Two (AC and Port)

Power supply – PMP/PTP 450b Series

The PMP/PTP 450b Series support powering from the following powering sources:

- Gigabit Ethernet Capable Power Supply – 20 to 32 V DC, 15 W
- CMM4 with external 29 V power supply
- CMM5 29 V power and sync injector module with external 240 W or 600 W power supply

Figure 20: *-20 to 32 V DC Power Injector interfaces*

Table 60: Power Injector interfaces

Interface	Function
PSU/Ethernet	20 to 32 V DC, 2A

PSU part numbers

Table 61: PSU part numbers for PMP/PTP 450b SM

Cambium description	Cambium part number
Gigabit Ethernet Capable Power Supply - 20 - 32 V DC, 15 W	N000900L001C

Power supply – PMP/PTP 450 Series

The PMP/PTP 450 Series support powering from the following powering sources:

- Gigabit Ethernet Capable Power Supply – 30 V DC, 15 W
- CMM4 with external 29 V power supply
- CMM5 29 V power and sync injector module with external 240 W or 600 W power supply

Warning

The PMP 450 Ruggedized High Gain Integrated Subscriber Module (Cambium part numbers C035045C014A and C036045C014A), while encapsulated in a 450i-type enclosure, contains 450 circuitry which must be powered via 30 V DC. Powering these SMs with a 56 V DC will damage the device.

PSU part numbers

Table 62: PSU part numbers for PMP/PTP 450 Series

Cambium description	Cambium part number
Gigabit Enet Capable Power Supply - 30 V DC, 15 W	N000900L001C
Cable, UL Power Supply Cord Set, US	N000900L007A
Cable, UL Power Supply Cord Set, EU	N000900L008A
Cable, UL Power Supply Cord Set, UK	N000900L009A
Cable, UL Power Supply Cord Set, Brazil	N000900L010A

Gigabit Ethernet Capable Power Supply

The Gigabit Enet Capable power supply interfaces are described in Gigabit Enet Capable power supply. This power supply requires procurement of an AC line cord that connects the outlet of the same (using IEC-60320 Type 5 connector). A list of available power supply cord options from Cambium Networks are given in PSU part numbers for PMP/PTP 450 Series.

Table 63: Gigabit Enet Capable power supply

Interface	Function
AC Input	90-264 V AC, 0.5 A rms @120 V AC/ 0.25 A rms @240 V AC, 47 to 63 Hz
DC Output	30.0 V DC +/-5%, 15 W, 500 mA max
Sockets	Two (Data In and Data & Power Out)
LEDs	Green,: LED Intensity determined by Level 5 efficiency

Figure 21: *Gigabit Enet Capable power supply*

Power supply – PMP 450 MicroPoP Series

The PMP 450 MicroPoP Series supports powering from the following powering sources:

- Power Supply, 15 W or 30 W, 56 V with 1000BASE-T or GigE
- AC+DC Enhanced Power Injector
- Power over Ethernet midspan, 60 W, -48 V DC Input
- CMM4 with external 56 V power supply and CMM4 to 450i Series ODU cable (Dongle)
- CMM5 56V power and sync injector module with external 240 W or 600 W power supply
- IEEE802.3at power injector

PSU part numbers

Table 64: PSU part numbers for PMP 450 MicroPoP Series

Cambium description	Cambium part number
Power supply, 30 W, 56 V, GbE DC injector, Indoor, Energy Level 6 supply, accepts C5 connector	N000000L034A
AC+DC Enhanced Power Injector 58 V	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 V DC Input	N000000L036A

AC Power Injector N000065L001B

The AC Power Injector interfaces are shown in AC Power Injector interfaces and described in AC Power Injector interface functions.

Figure 22: *AC Power Injector interfaces*

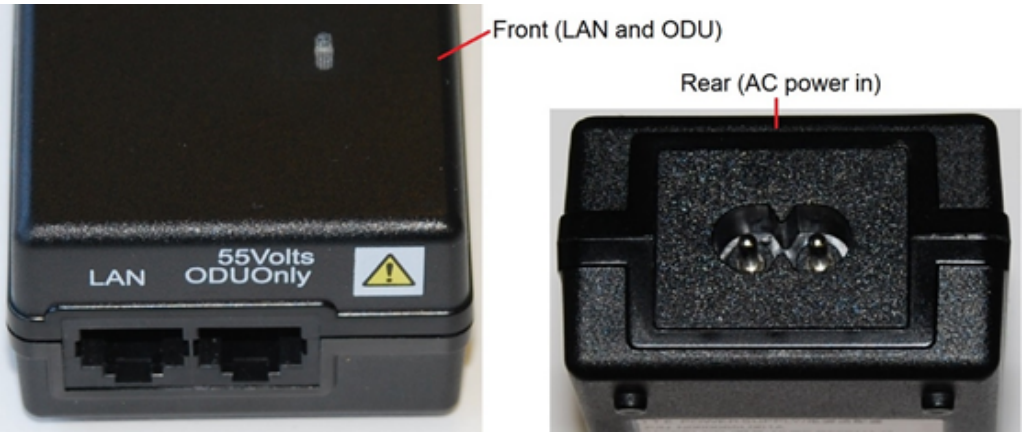


Table 65: AC Power Injector interface functions

Interface	Function
AC power in	AC power input (main supply)
ODU	RJ45 socket for connecting Cat5e cable to ODU
LAN	RJ45 socket for connecting Cat5e cable to network
Power (green) LED	Power supply detection

ODU mounting brackets & accessories

The list of supported brackets is provided in Accessories part numbers.

- The "Tilt bracket assembly" is the recommended bracket for the AP, SM or BH integrated units.
- The "Mounting Bracket (Connectorized)" can be used where a low profile and ease of assembly of Connectorized AP, SM or BH is required.
- The "Mounting Bracket (Integrated)" provide a wider range of adjustment for AP, SM and BH integrated devices.

Table 66: Accessories part numbers

Cambium description	Cambium part number
Mounting brackets	
Tilt Bracket Assembly	N000045L002A
Mounting Bracket (Integrated)	N000065L031A
Mounting Bracket (Connectorized)	N000065L032A
Miscellaneous	
Ethernet cable adapter for CMM4 (Dongle)	N000045L001A

Cambium description	Cambium part number
RJ45 Gland Spare – PG16 style (QTY 10)	N000065L033A
Blanking Plug Pack (Qty 10)	N000065L036A

Lightning protection

The 450 Platform Family supports the lightning protection units listed in below table.

The LPU offers the highest level of protection and is the recommended device. Where low cost deployment is essential, for example for SM in residential application, the Gigabit Surge Suppressor may be used instead.

Table 67: Lightning protection part numbers

Model	30 V DC	56 V DC	C000000L065A Gigabit Ethernet Surge Suppressor	600SSH (100 BASE T)	C000000L033A Gigabit Ethernet Surge Suppressor	C000065L007B Lightning Protection Unit kit	C000000L114A DC Lightning Protection Unit kit
PMP 450 AP	X	-	X	X	-	-	-
PMP 450 SM	X	-	X	X	-	-	-
PTP 450	X	-	X	X	-	-	-
PMP 450b	X	-	X	X	-	-	-
PMP 450i AP	-	X	-	-	X	X	-
PMP 450i SM	-	X	-	-	X	X	-
PTP 450i	-	X	-	-	X	X	-
5 GHz PMP 450m AP	-	X	-	-	-	X	-
*3 GHz PMP 450m AP	-	-	-	-	-	X	X
PMP 450 MicroPoP	-	X	-	-	X	X	-

***Note**

The 3 GHz PMP 450m AP requires use of the C000065L007B Lightning Protection Unit kit for the Main port Ethernet connection and the C000000L114A DC Lightning Protection Unit kit for the DC PSU port.

Cambium Networks does NOT recommend deploying Gas Discharge Tube-based surge protection on PMP 450i, PMP 450b or PMP 450 MicroPoP platforms.

MicroPoP Lightning Arrester details

By lowering the omni (mast O.D. 2.125 inches) on the mast such that the mast is 0.5m higher than the product will work for lightning protection but hurts the omni pattern as shown Figure 1 in orange trace. The 2.125" mast is at 270 degrees and you are looking top down onto the mast. The orange pattern has major ripple due to the mast being beside the omni antenna and causing reflections. If the lightning rod diameter is smaller such as 0.3 to 0.625 (5/8) inches maximum, then the omni pattern is not effected (ripple is no worse than the base line plastic mast), that is the light blue and blue traces shown below, horizontal polarity pattern is to the left, taken at 5.850 GHz. 5.15 and 5.55 GHz were measured and had very similar results as at 5.85 GHz.

The below Figure 23 andFigure 24 shows the desired implementation, using a 4-foot minimum lighting rod opposite of the omni radio.

Note

The 2.125 inch pipe does not extend any more than three inches above the omni mast bracket.

The locally sourced steel lightning rod needs to be minimum 4 feet long, maximum 5/8 inches thick and secured with two separate hose clamps and should be at least 0.5m higher than the top of the omni, with 3 feet (1m) over the top as a maximum. Either type of lightning rod can be used, the single blunt tip version or having a dissipator on top (the dissipator concept has many smaller rods clustered together so they have many weak streamers instead of one large streamer which would attract a lighting hit better). Below is a recommended example from the LBA Group, 5 feet long, 5/8" O.D model DAT-160SS.

It is mandatory to have the mast grounded, if this is not possible a 6 -8 AWG Cu ground wire needs to attach to the lightning rod base and run down to the ground (PE) bonding point.

Figure 23: *MicroPoP Omni antenna implementation pattern (Horizontal)*

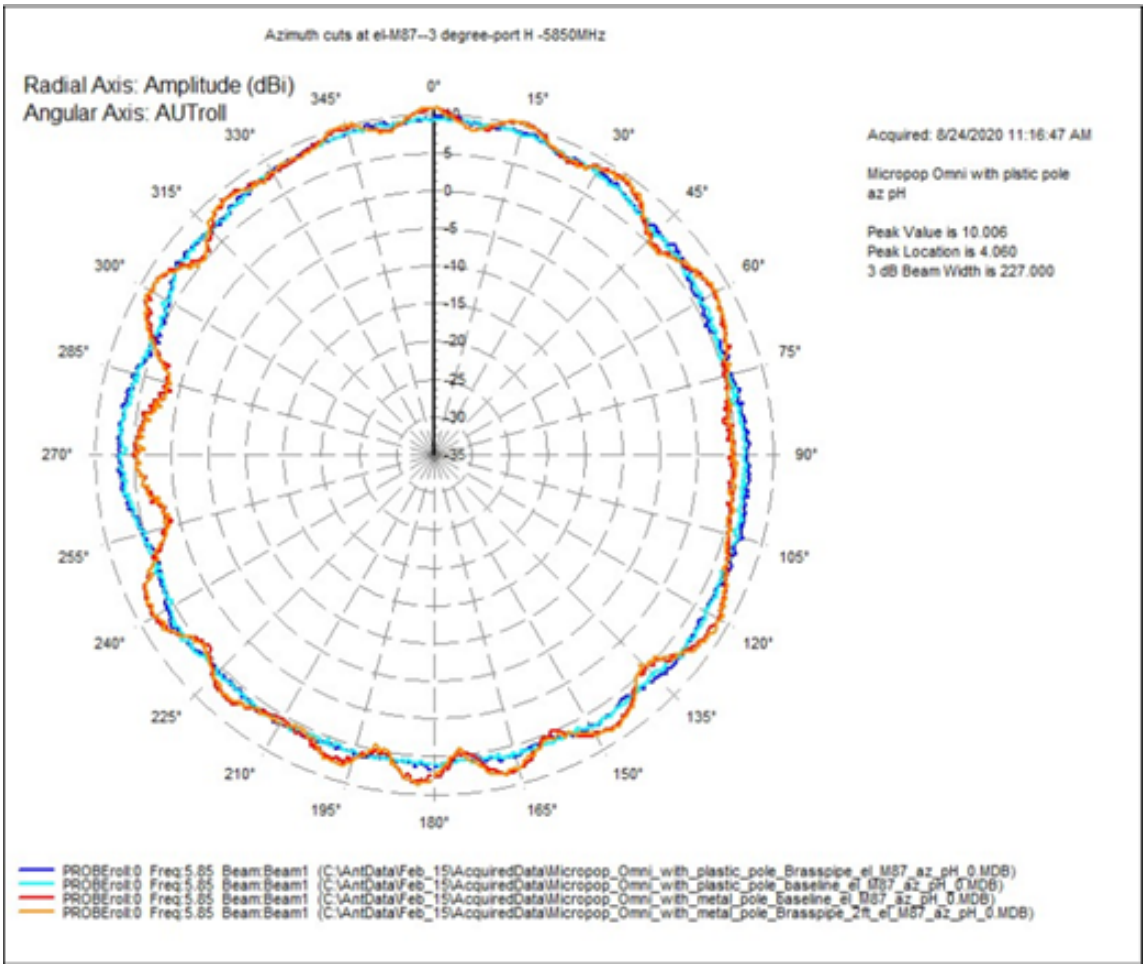


Figure 24: *MicroPoP Omni antenna implementation pattern (Vertical)*

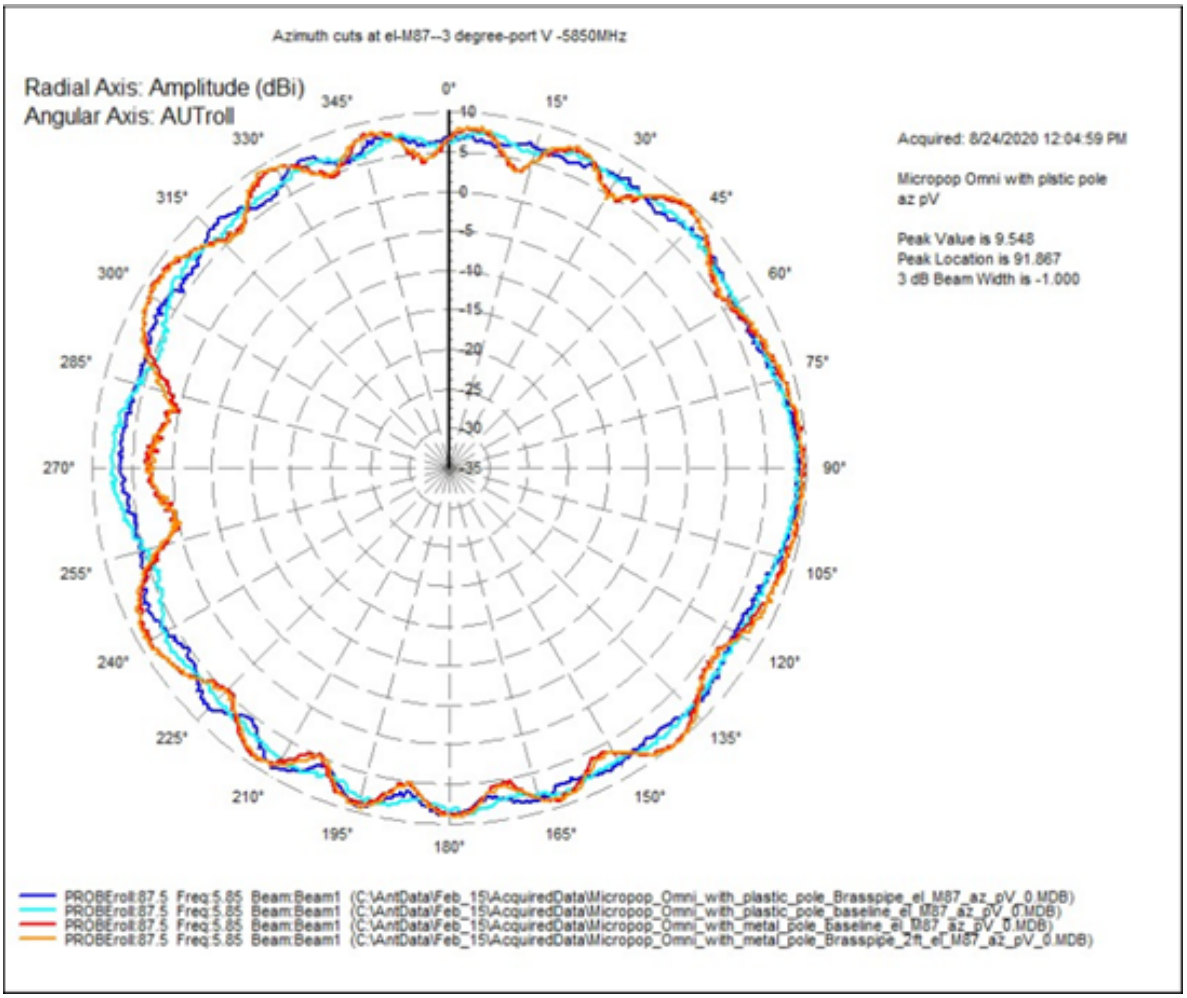
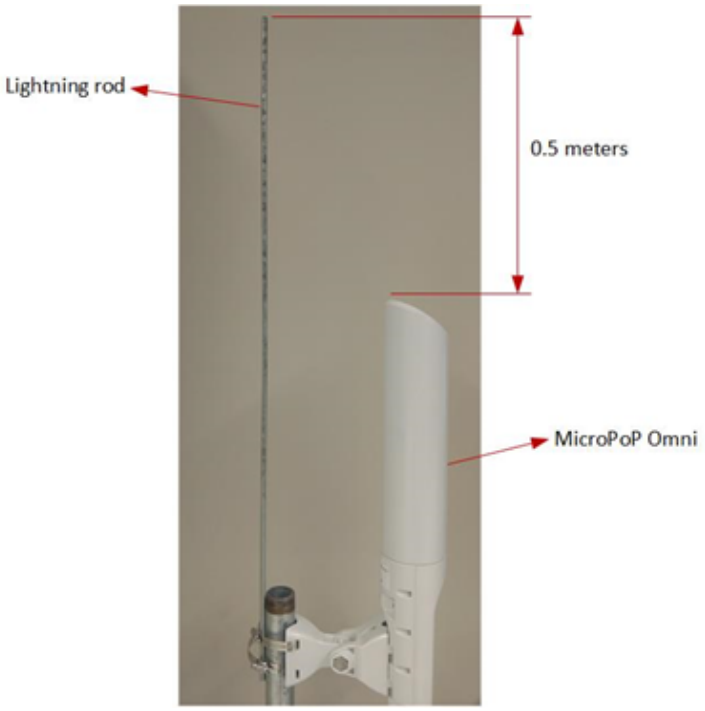


Figure 25: *MicroPoP Omni with Lightning rod*



Cabling

450b AUX Port synchronization cables

When configured as a Backhaul Master, the 450b can accept synchronization signals from cnPulse or UGPS. The cnPulse / UGPS unit provides 1PPS from its AUX output and connects to the 450b AUX port.

Note

Aux port can also be configured to provide Sync out.

Cambium Networks provide a 3 meter accessory cable, N000000127A, which operates with cnPulse only. If a longer cable is desired, please source a shielded outdoor 4 core cable and wire according to the table below.

Table 68: Connections for cnPulse to 450b Aux port

cnPulse RJ45 pin	450b 3.5 mm TRRS jack	Signal description
4	Ring 1	GPS power out (+5 V DC)
5	Ring 2	GPS serial data in
7	Shield / Ground	GPS 0 V (return)
8	Tip	GPS Sync in (1PPS)

Table 69: Connections for UGPS to 450b Aux port

UGPS RJ11 pin	450b 3.5 mm TRRS jack	Signal description
1	Tip	GPS Sync in (1PPS)
3	Ring 2	GPS serial data in
4	Ring 1	GPS power out (+5 V DC)
6	Shield/Ground	GPS 0 V (return)

Ethernet standards and cable lengths

All configurations require a copper Ethernet connection from the ODU (Main PSU port) to the Power supply.

Table 70: PSU drop cable length restrictions

System configuration		Maximum cable length (m/ft)	
Power supply	**PoE powered device on AUX/SYNC port**	**From power supply to ODU**	**From ODU to PoE device on AUX/SYNC port**
Power supply (30 W)	None	100 m	N/A
	IEEE 802.3at Type 2	Not supported	
AC Power Injector (60 W)	None	100 m	N/A
	IEEE 802.3at Type 2	100 m in total	
AC+DC enhanced Power Injector	None	100 m	N/A
	IEEE 802.3at Type 2	100 m in total	
-48 V DC power injector	None	100 m	N/A
	IEEE 802.3at Type 2	100 m in total	
CMM4/CMM5 with 56 V supply	None	100 m	N/A
	IEEE 802.3at Type 2	Not supported	
IEEE802.3at compliant supply	None	100 m	N/A
	IEEE 802.3at Type 2	Not supported	

Note

The Ethernet connectivity for CMM4 requires the part “Ethernet cable adapter for CMM4 – N000045L001A”.

Outdoor copper Cat 5e Ethernet cable

Outdoor Cat 5e cable is used for all connections that terminate outside the building. For example, connections between the ODU, surge suppressors (if installed), UGPS receivers (if installed) and the power supply injector. This is known as a “drop cable” (Outdoor drop cable).

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

- Use only shielded cables and connectors to resist interference and corrosion.
- 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.

Order Superior Essex type BBDGe cable from Cambium Networks (Drop cable part numbers). Other lengths of this cable are available from Superior Essex.

Figure 26: *Outdoor drop cable*

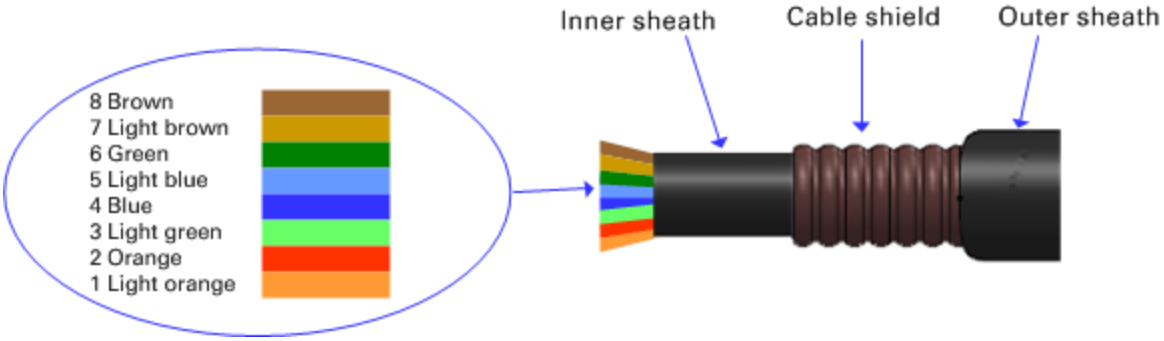


Table 71: Drop cable part numbers

Cambium description	Cambium part number
1000 ft Reel Outdoor Copper Clad CAT5E	WB3175
328 ft (100 m) Reel Outdoor Copper Clad CAT5E	WB3176

SFP module kits

SFP module kits allow connection of a PMP 450 Series ODU to a network over an Optical Gigabit Ethernet interface (1000BASE-LX or 1000BASE-SX) full-duplex mode.

Note

PMP 450m supports Fiber SFPs from system release 15.0.3.

Order SFP module kits from Cambium Networks (SFP module kit part numbers).

Table 72: SFP module kit part numbers

Cambium description	Cambium part number
Single Mode Optical SFP Interface per ODU	C000065L008A
Multi-mode Optical SFP Interface per ODU	C000065L009A
2.5GBASE-T Copper SFP Interface per ODU	C000065L011A

To compare the capabilities of the two optical SFP modules, refer to Single Mode Optical SFP Interface per ODU (part number C000065L008) and Multi-mode Optical SFP Interface per ODU (part number C000065L009).

Table 73: Single Mode Optical SFP Interface per ODU (part number C000065L008)

Core/ cladding (microns)	Mode	Bandwidth at 1310 nm (MHz/km)	Maximum length of optical interface	Insertion loss (dB)
62.5/125	Multi	500	550 m (1800 ft)	1.67
50/125	Multi	400	550 m (1800 ft)	0.07
50/125	Multi	500	550 m (1800 ft)	1.19
10/125	Single	N/A	5000 m (16400 ft)	0.16

Table 74: Multi-mode Optical SFP Interface per ODU (part number C000065L009)

Core/ cladding (microns)	Mode	Bandwidth at 850 nm (MHz/km)	Maximum length of optical interface	Insertion loss (dB)
62.5/125	Multi	160	220 m (720 ft)	2.38
62.5/125	Multi	200	275 m (900 ft)	2.6
50/125	Multi	400	500 m (1640 ft)	3.37
50/125	Multi	500	550 m (1800 ft)	3.56

The upgrade kits contain the following components:

- Optical SFP transceiver module (MicroPoP Lightning Arrester details)
- Long EMC strain relief cable gland (Long cable gland)
- The Ethernet SFP Module Installation Guide
- License key instructions and an entitlement key

Figure 27: *Optical SFP transceiver module*

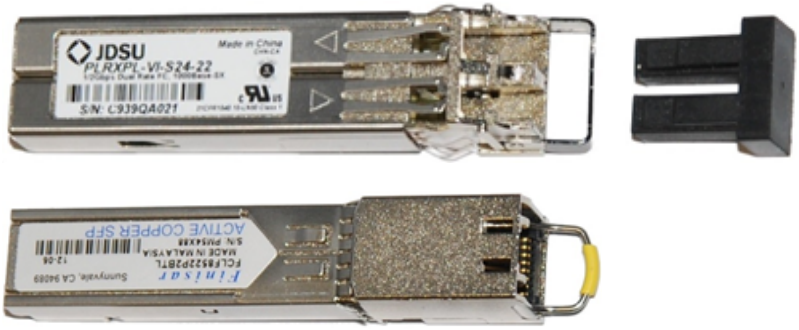


Figure 28: *Long cable gland*

Main Ethernet port

The PoE cable pinout diagram for Main port is given below.

Table 75: Main port PoE cable pinout

RJ45 pin	Interface	Ethernet description	PoE input description
1	1000 BaseT Ethernet with PoE In	+TxRx0	+Ve or -Ve
2		–TxRx0	
3		+TxRx1	+Ve or –Ve
6		–TxRx1	
4		+TxRx2	+Ve or –Ve
5		–TxRx2	
7		+TxRx3	+Ve or –Ve
8		–TxRx3	

Note

The PoE input on the Main port accepts any polarity.

Aux port

Table 76: Aux port PoE cable pinout

RJ45 pin	Interface	Signal description	PoE output description
1	100BASE-T Ethernet with PoE Out (see note below)	+TxRx0	-Ve
2		–TxRx0	
3		+TxRx1	+Ve
6		–TxRx1	
4	GPS and alignment tone	GPS power out, Alignment tone out, GPS data out	N/A
5		GPS data in	
7		GPS 0 V	
8		GPS Sync in	

Note

If the Aux port will be used, a second Ethernet gland will need to be ordered (Part Number: N000065L033A).

Aux port to alignment tone headset wiring

A standard 32 ohms stereo headset can be connected to the Aux port to use the audio alignment tool. The diagrams of the adapters for RJ45 and RJ12 are provided in Alignment Tone Cable and RJ12 Alignment Tone Cable respectively. The recommended values for both resistors are 220 ohms, 0.25 W. Different resistor values can be used to optimize the level of the audio signal depending on the headset characteristics and the level of ambient noise.

Figure 29: *Alignment Tone Cable*

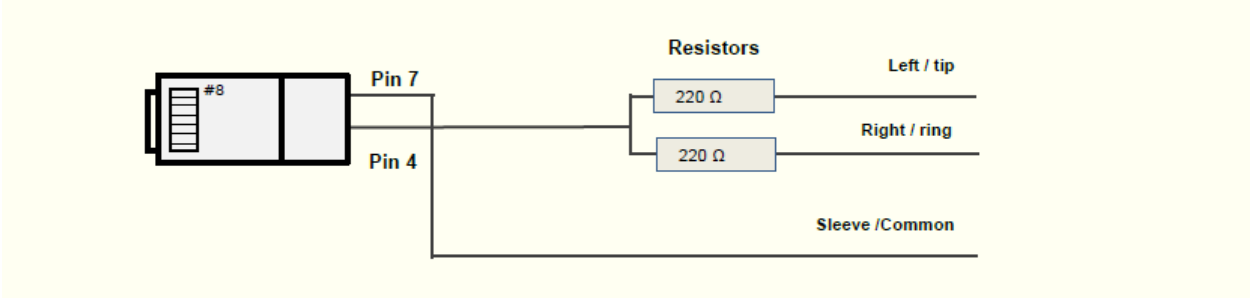


Table 77: Aux port PoE cable pinout

RJ45 pin (Aux port)	Signal description	Serial component	Jack socket (to jack plug of headset)
4	Alignment tone out	220 ohms resistor	Ring
		220 ohms resistor	Tip
7	GPS 0 V	None	Sleeve

Figure 30: *RJ12 Alignment Tone Cable*

Table 78: RJ12 Aux port PoE cable pinout

RJ12 pin (Aux port)	Signal description	Jack socket (to jack plug of headset)
5	Alignment tone out	Tip
6	Alignment tone out	Ring

Alternatively, a readymade headset adapter can be ordered from Best-Tronics (http://btpa.com/Cambium-Products/) with the following part number:

Table 79: Alignment tone adapter third party product details

Reference	Product description
BT-1277	Headset alignment cable (RJ45) for the PMP/PTP 450i Series products
BT-0674	Headset alignment cable (RJ12) for the PMP/PTP 450 Series products.

RJ45 connectors and spare glands

RJ45 connectors are required for plugging Cat 5e cables into ODUs, LPUs, PSUs and other devices. Order RJ45 connectors and crimp tool from Cambium Networks (RJ45 connector and spare gland part numbers).

The ODU for 5 GHz 450m is supplied with one environmental sealing gland and 3 GHz 450m is supplied with two sealing glands for the drop cable. This gland is suitable for cable diameters from 5 mm to 9 mm.

- Tighten the gland body into the radio enclosure with a torque of 5 Nm (3.69 lb-ft).

Caution

To avoid damage to the drop cable, prevent the cable from rotating while tightening the sealing cap of the cable gland.

- Tighten the sealing cap into the gland body until the rubber inside the cap starts to bulge outwards.

Figure 31: *Cable gland*

Table 80: RJ45 connector and spare gland part numbers

Cambium description	Cambium part number
Tyco/AMP, Mod Plug RJ45, 100 pack	WB3177
Tyco/AMP Crimp Tool	WB3211
RJ45 Spare Grounding Gland - PG16 size (Qty. 10)	N000065L033

Breather Vent

Breather vent is required for plugging into the spare ports of the ODUs.

Identify the spare port and remove the black sealing cap from the ODUs.

Install the breather vent screw head into the spare port with a torque of 5 Nm (3.69 lb-ft).

Figure 32: *Breather vent*

Table 81: Breather vent part number

Cambium description	Cambium part number
Breather Vent - PG16 size (Qty. 10)	N000000L141A

Ethernet cable testing

This section describes a procedure for testing the RJ45 Ethernet cables used for Main and Aux port connectivity on 450i and 450m radios.

To test a cable, perform the following instructions:

1. Check the resistances of the cable and radio installation using a digital multimeter (DMM).
2. Disconnect the drop cable from the power source (EPI or mains adapter) first; keep the radio connected and test the resistances looking towards the radio. Test access can be made via any of the following:
   - Directly onto the pins of the RJ45 plug.
   - Using a commercially available RJ45 breakout board.

Measure between	Approximate resistance	Example
Wire 1 and wire 2 Wire 3 and wire 6 Wire 4 and wire 5 Wire 7 and wire 8	1 ohm + 2 ohms per 10 m of cable Maximum difference between any two readings 0.3 ohms + 0.3 ohms per 10 m of cable A cable with a single LPU but no radio will read about 3,600 ohms. A cable with a single 1000SS but no radio will read about 7,200 ohms.	For a 20 m cable: Approximate resistance = 1 ohm + 2x 2 ohms = 5 ohms Maximum difference between readings = 0.3 ohms + 2x 0.3 ohms = 0.9 ohms
Wire 1 and wire 3 Wire 1 and wire 4 Wire 1 and wire 7 Wire 3 and wire 4 Wire 3 and wire 7 Wire 4 and wire 7	> 20 Kohms	

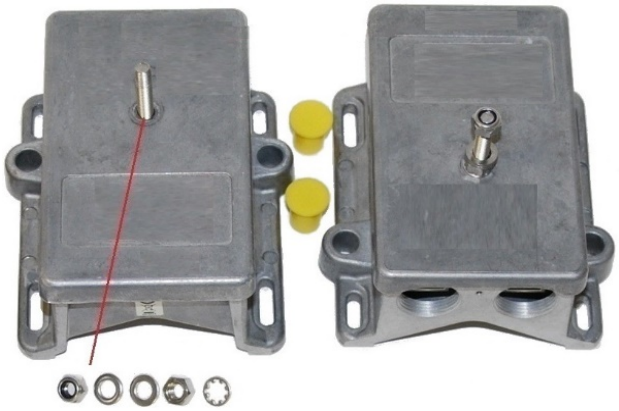
Note

These figures should be indicative only rather than hard limits. The measurement must be done with a low-voltage DMM, not a high-voltage insulation tester.

Lightning protection unit (LPU) and grounding kit

450i and 450m Series LPUs provide transient voltage surge suppression for ODU installations. Each cable requires two LPUs, one near the ODU and the other near the linked device, usually at the building entry point (LPU and grounding kit contents).

Table 82: LPU and grounding kit contents

Lightning protection units (LPUs) LPU grounding point nuts and washers 	ODU to top LPU drop cable (600 mm) EMC strain relief cable glands 
U-bolts, nuts and washers for mounting LPUs 	ODU to top LPU ground cable (M6-M6) 

Bottom LPU ground cable (M6-M10)	ODU to ground cable (M6-M10
	

One LPU and grounding kit (LPU and grounding kit contents) is required for the PSU drop cable connection to the ODU. If the ODU is to be connected to an auxiliary device, one additional LPU and grounding kit is required for the Aux drop cable. Order the kits from Cambium Networks (LPU and grounding kit part number).

Table 83: LPU and grounding kit part number

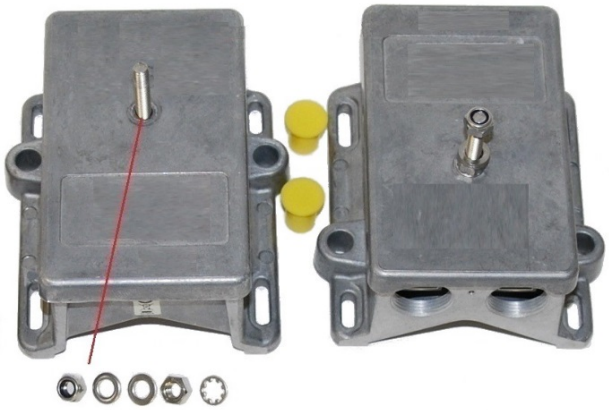
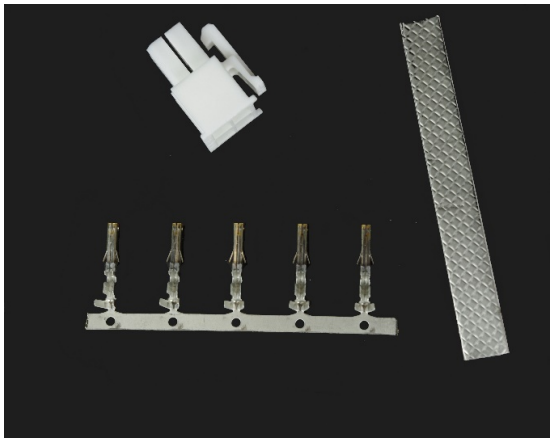
Cambium description	Cambium part number
Aux ports LPU and Grounding Kit (One Kit Per End)	C000065L007B

When using LPUs on the Ethernet Ports of the 3 GHz 450m, a separate PoE power supply must be used at the bottom of the mast to forward bias the diodes in the LPUs. This should be placed in the same position as used in a PoE Ethernet Port. If this is not done, CRC errors will occur on the Ethernet interface.

DC LPU and Grounding Kit

450m 3 GHz LPUs provide transient voltage surge suppression for ODU installations. Each cable requires two LPUs, one near the ODU and the other near the linked device, usually at the building entry point.

Table 84: DC LPU and grounding kit contents

Lightning protection units (LPUs) LPU grounding point nuts and washers 	EMC strain relief cable glands 
U-bolts, nuts and washers for mounting LPUs 	ODU to top LPU ground cable (M6-M6), bolt and washers 
ODU to grounding system ground cable, bottom LPU ground cable (2pcs, M6 and M10 lugs), bolt and washers	4-pin connector kits (4 kits, one shown) 

One LPU and grounding kit (LPU and grounding kit contents) is required for the PSU drop cable connection to the ODU. If the ODU is to be connected to an auxiliary device, one additional LPU and grounding kit is required for the Aux drop cable. Order the kits from Cambium Network (DC LPU and grounding kit part number).

Note

When installing LPUs, use only EMC cable glands supplied in the ODU and LPU kits (with black caps). Do not use the non-EMC cable glands supplied in other kits (with silver caps), as these may only be used in ODU installations without LPUs.

Caution

To provide adequate protection, all grounding cables must be a minimum size of 10 mm^2 csa (8AWG), preferably 16 mm^2 csa (6AWG), or 25 mm^2 csa (4AWG).

Table 85: DC LPU and grounding kit part number

Cambium description	Cambium part number
DC LPU and Grounding Kit	C000000L114A

Cable grounding kit

Copper drop cable shields must be bonded to the grounding system in order to prevent lightning-strike arcing (resulting in fire risk and damage to equipment).

One grounding kit (Cable grounding kit) is required for each grounding point on the cable. Order cable grounding kits from Cambium Networks (LPU and grounding kit part number).

Figure 33: *Cable grounding kit*

Table 86: Cable grounding kit part numbers

Cambium description	Cambium part number
Cable Grounding Kits For 1/4" And 3/8" Cable	01010419001

Antennas and antenna cabling

Antenna requirements

Each connectorized ODU requires one external antenna (normally dual-polar).

For connectorized units operating in the USA or Canada 900 MHz, 4.9 GHz, 5.1 GHz, 5.2 GHz, 5.4 GHz or 5.8 GHz bands, choose external antennas which are recommended by Cambium Networks. Do not install any other antennas.

Supported external AP antennas

The recommended AP external antennas are listed in List of AP external antennas .

Table 87: List of AP external antennas

Cambium description	Cambium part number
900 MHz 13 dBi 65 degree Sector Antenna (Dual Slant)	N009045D001A
5 GHz Horizontal and Vertical Polarization Antenna for 90 Degree Sector	85009324001
5 GHz Horizontal and Vertical Polarization Antenna for 60 Degree Sector	85009325001

Note

LINKPlanner, Cambium Networks, planning tool, contains an up-to-date, exhaustive list of antennas that can be used with Cambium Products.

Supported external BH/SM antenna

The recommended PTP 450i Series BH or PMP 450/450i Series SM external antenna is listed in PTP 450i Series BH or PMP 450/450i Series SM external antenna.

Table 88: PTP 450i Series BH or PMP 450/450i Series SM external antenna

Cambium description	Cambium part number
900 MHz 12 dBi gain directional antenna (Dual Slant)	N009045D003A

RF cable and connectors

RF cable of generic type LMR-400 is required for connecting the ODU to the antenna. N type male connectors are required for connecting the RF cables to the connectorized ODU. Two connectors are required per ODU. Use weatherproof connectors, preferably ones that are supplied with adhesive lined heat shrink sleeves that are fitted over the interface between the cable and connector. Order CNT-400 RF cable and N type male connectors from Cambium Networks (RF cable and connector part numbers).

Table 89: RF cable and connector part numbers

Cambium description	Cambium part number
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

Antenna accessories

Connectorized ODUs require the following additional components:

- Cable grounding kits: Order one cable grounding kit for each grounding point on the antenna cables. Refer to Ethernet cable testing .
- Self-amalgamating and PVC tape: Order these items to weatherproof the RF connectors

- Lightning arrestors: When the connectorized ODU is mounted indoors, lightning arrestors (not LPUs) are required for protecting the antenna RF cables at building entry. One arrestor is required per antenna cable. One example of a compatible lightning arrestor is the Polyphaser LSXL-ME or LSXL (not supplied by Cambium Networks).

GPS synchronization

GPS synchronization description

Cambium offers GPS synchronization to limit the network's own self-interference. The Cluster Management CMM provides Global Positioning System (GPS) synchronization to the Access Point (AP) and all associated Subscriber Modules (SM). Network operators have a choice of UGPS and CMM solutions to select the option that works best for the environment.

Universal GPS (UGPS)

The UGPS provides network synchronization for smaller networks where a CMM may not be cost effective. The UGPS provides synchronization for one or two modules so that even remote areas at the edge of the network can operate with synchronization for improved performance. The UGPS works with all Cambium PMP radios. The UGPS has a small footprint and is easy to deploy.

Figure 34: *UGPS*

Note

PMP 450/450i/450m Series - APs can power up a UGPS via the Aux/Timing port.

Note

PMP 450i/450b/450m Series - If two units are to get sync from the UGPS, then an external power supply is required.

If the GPS position information is required to be visible on the web GUI, then the UGPS power must be enabled on the AP; and it is safe to use both AP power and external power for a single UGPS unit.

CMM5

The CMM5 (Cluster Management Module) is the latest generation of solutions for the distribution of TDD Sync signals and “Power-over-Ethernet (PoE)” in the field. The CMM5 is a modular design with individual 4-port power injectors and an optional controller used for remote management.

Key features of the CMM5 include:

- Support for Gigabit Ethernet (1000BaseT)
- Modular and scalable from 4 ports to 32 ports
- Direct +/- 48 V DC input (optional AC/DC power supplies are available from Cambium Networks)
- Uses Cambium Networks UGPS for a synchronization source
- Dual resilient power inputs
- Rack mountable
- Secure remote management when used with the optional CMM5 Controller Module
- Support for PMP 450m (cnMedusa™)
- Future support for integration into (cnMedusa™) for cloud or NOC-based management

It consists of four subsystems, described in the following sections:

- CMM5 Controller Module
- CMM5 Injector (29 volt and 56 volt versions)
- Power supply(s) (240/600 watt)
- UGPS

Cluster Management: Scenario 1

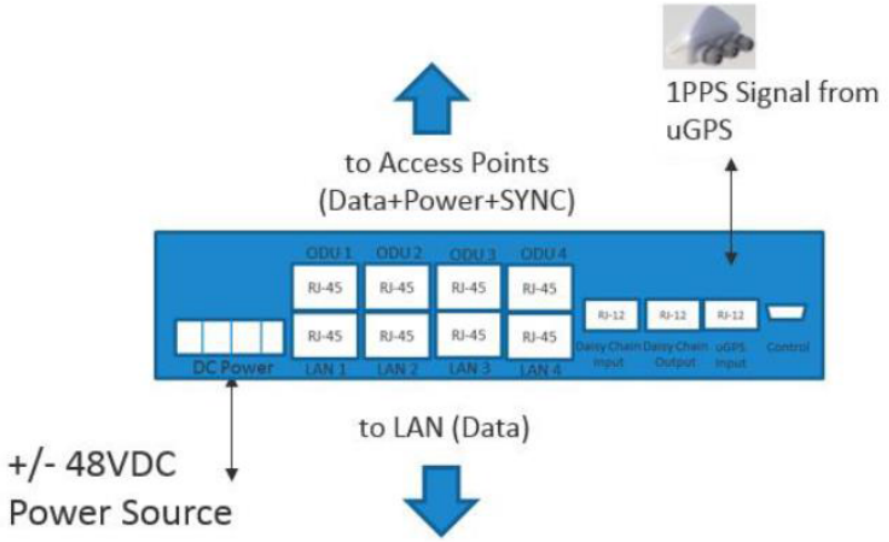
The following is a CMM5 Cluster Management scenario using four PMP 450i Access Points.

Table 90: CMM5 Cluster Management Scenario 1

Scenario	Equipment Needed	Features
Four PMP 450i Access Points	56 Volt Injector	• Gigabit Ethernet • Local Management Interface • +/- 48 V DC Input • Broad Device Support • Rack Mountable

Scenario	Equipment Needed	Features
• 48 V DC Available • No management or resilience required	UGPS	-

Figure 35: *Cluster Management: Scenario 1*



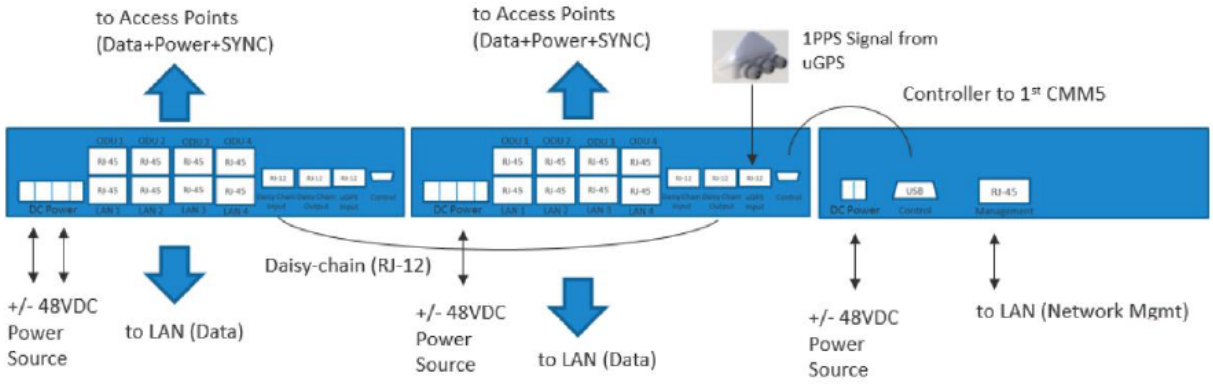
Cluster Management: Scenario 2

The following is a CMM5 Cluster Management scenario using four PMP 450i Access Points and four PMP 450 Access Points.

Table 91: CMM5 Cluster Management Scenario 2

Scenario	Equipment Needed	Features
Four PMP 450i Access Points Four PMP 450 Access Points	• 56 Volt Injector • 29 Volt Injector • 1 CMM5 Controller • One UGPS	• Gigabit Ethernet support • Local Management Interface • +/- 48 V DC Input • Broad Device Support • Rack Mountable
AC only environments	Two UGPS AC-to-48 V DC Power Supplies	Resilient power sources
Management required Resilience required	-	Secure, Remote Management (https) Scalable to 32 devices

Figure 36: *Cluster Management: Scenario 2*

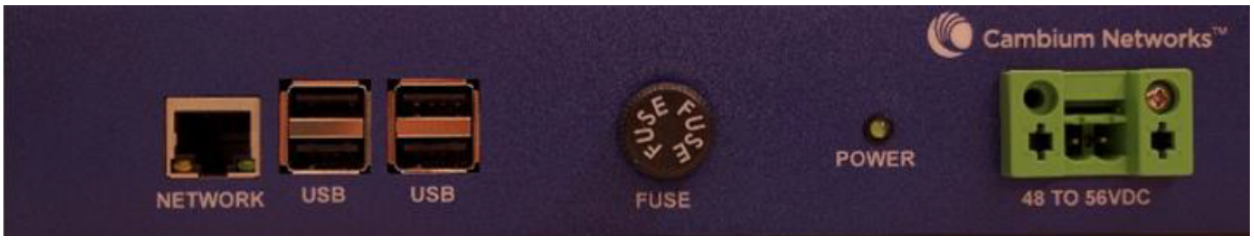


CMM5 Controller Module

The major features of the CMM5 Controller Module are:

- Auto-detect/control up to 8 Power Injectors
- Monitor SYNC/Power/GPS status
- Manage (up/down ports)
- Web (HTTPS) and SNMPv2/v3 management (SNMP on roadmap)
- 1U/ half-width rack-mount

Figure 37: *Controller Module*



CMM5 Injector Module

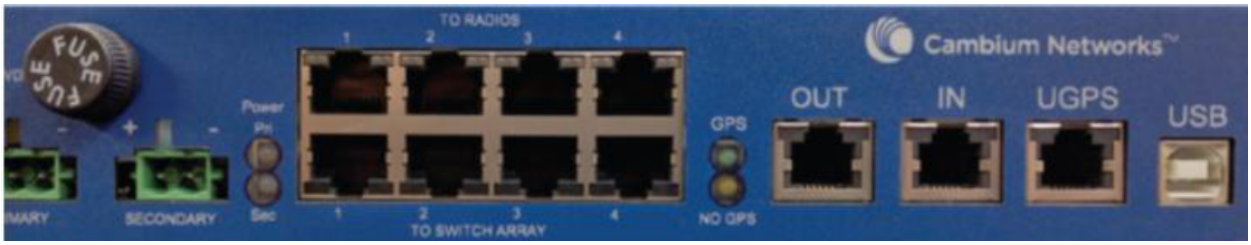
The CMM5 Injector Module has the following features:

- Stand-alone mode or used with controller for mgmt.
- +/- 48 V DC input with green/amber LED's for status
- Injects SYNC pulse from UGPS
- 2U / half-width rack-mount

Note

There are two different versions of the injector module (56 V and 29 V). You must select the correct injector for the types of radios that you will be powering. In both cases, the injectors use the same input power supplies or can be powered with +/- 48 V DC. The output power is different and the type of SYNC signal used is different between the two types of injectors. Systems can have 29 V and 56 V injectors deployed alongside each other.

Figure 38: *Injector Module*



CMM5 Injector Compatibility Matrix

The following table provides the Injector compatibility matrix.

Table 92: Injector Compatibility Matrix

Product	Power/Injector Module	Sync
PMP 450m	Yes/56 V	Yes
PMP/PTP 450i	Yes/56 V	Yes
PMP/ PTP 450b	Yes/29 V	Yes
PMP 450/PTP 450	Yes/29 V	Yes
PMP 100/PTP 100	Yes/29 V	Yes

CMM5 Specifications

The following table provides specifications for the CMM5 Power & Sync Injector (56 Volts).

Table 93: CMM5 Specifications

CMM5 Power and Sync Injector 56 Volts	
Model Number	C000000L556B
Data Interface	4 each RJ45 Gigabit Powered output ports “To Radios” 4 each RJ45 Gigabit Data input ports “To Switch Array” 1 each GPS timing port (RJ-12) 1 each CMM5 USB Serial port for local administration 1 each RJ12 Daisy Chain port “IN” 1 each RJ12 Daisy Chain port “OUT”

CMM5 Power and Sync Injector 56 Volts	
Surge Suppression	Lightning Suppression for each “To Radios” RJ45 Port
Power	Input Voltage: + or - 48 V DC Input Power Consumption: 400 watts Output Voltage: + or - 55 V DC Output Current: 0 - 1.8 A per channel Output Power: 0 - 90 Watts per channel
Cabinet Temperature	-40° C to +55° C (-40° F to +131° F), 90% humidity, condensing
Physical	Max Distance from Managed Radios: 328 cable feet (100m) Max Distance to GPS Antenna: 100 cable feet (30.5m)
Dimensions	8.85” W x 15.75” D x 1.65” H (225mm x 400mm x 42mm)
Unit Weight	6.6 pounds (3kg)
Power Interface Terminals	2 Power input ports for 48 V DC Power (Power supplies sold separately)

Note

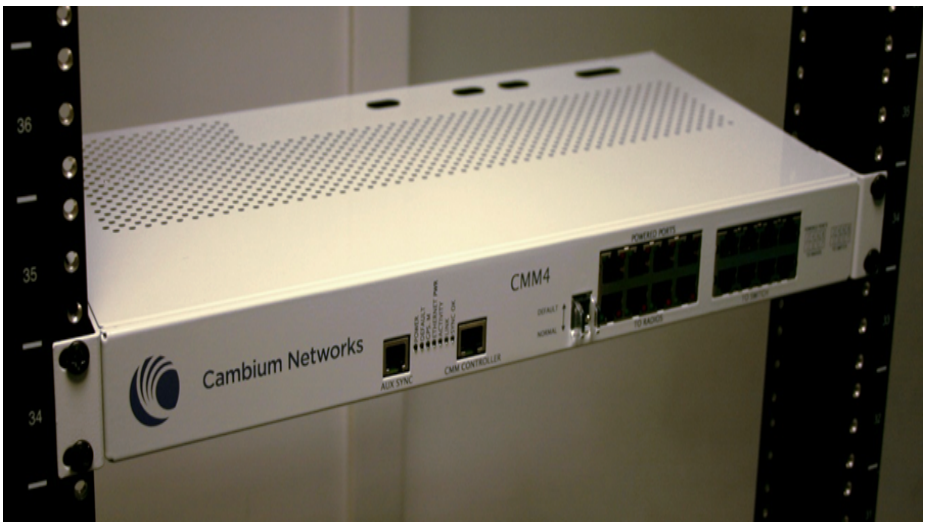
DC Power Input requirement is +/- 48 V DC and must not exceed 100 V surges. If surges above 100 V DC are expected, a suitable in-line DC surge suppressor with 48 V DC nominal voltage is required.

CMM4 (Rack Mount)

The Cluster Management Module (CMM) is the heart of the Cambium system’s synchronization capability, which allows network operators to reuse frequencies and add capacity while ensuring consistency in the quality of service to customers.

For operators who prefer indoor CMM mounting, Cambium offers the Rack-Mounted Cluster Management Module 4. The unit is designed to be mounted onto a standard 19-inch telecommunications rack and to allow the Cambium CMM4 to be co-located with other telecommunications equipment.

Figure 39: *CMM4 (Rack Mount)*



The CMM4 has two DC power inputs, one 29 V and one 56 V. It can be used to power and synchronize both 29 V legacy products such as the PMP 450 Series and 56V products such as the PMP 450i Series simultaneously.

If the 29 V legacy products are connected to the CMM4, a 29 V power supply needs to be connected.

If the 450i Series is connected to the CMM4, a 56 V power supply needs to be connected. The CMM4 supports having two of the 56 V and two of the 29 V supplies for redundancy.

Warning

PMP 450i Series requires different wiring between the CMM4 and device. If a PMP 450 Series ODU is replaced by a PMP 450i Series and the existing drop cable needs to be re-used, the Ethernet cable adapter for CMM4 - N000045L001A" must be used between the CMM4 and the existing drop cable.

Figure 40: *CMM4 56 V power adapter (dongle)*

CMM4 56 V power adapter cable pinout

Figure 41: *CMM4 power adapter cabling diagram*

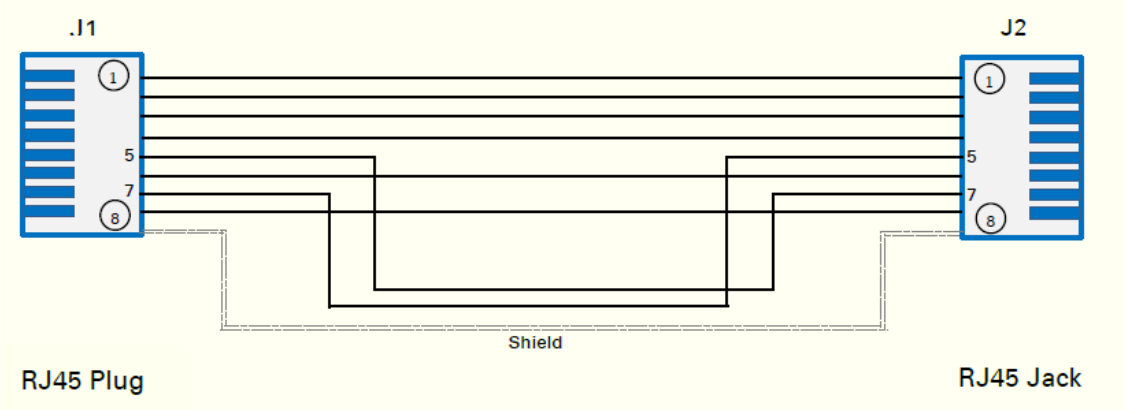


Table 94: CMM4 power adapter cable pinout

Plug J1 pin	Jack J2 pin
1	1
2	2
3	3
4	4
5	7
6	6
7	5
8	8
Screen	Screen

Note

Pins 5 and 7 are wired in a cross-over configuration.

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 RJ45 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 in Configuration Guide for more details.
- 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 CMM3 and Pole mounted CMM3.

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

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

- Mounting the GPS receiver
- Cabling the GPS Antenna
- Installing and connecting the GPS LPU

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.

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.
- 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.

Mounting the GPS receiver module on the equipment building

If mounting the GPS receiver on the equipment building (GPS receiver wall installation), 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 (GPS receiver tower or mast installation), 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 (GPS receiver wall installation) or a metal tower or mast (GPS receiver tower or mast installation).

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 20º 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 Wall installation
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.

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

Table 95: 3 GHz PMP 450m Series ODU part numbers

Cambium description	Superseded Sales SKU	Revised SKU suffix
3 GHz PMP 450m AP (Access Point)		
3 GHz PMP 450m Integrated Access Point, 90°	C030045A101A	C030045A101B
3 GHz PMP 450m Integrated Access Point, 90°	C030045A104A (No Encryption)	C030045A104B (No Encryption)
3 GHz PMP 450m Integrated Access Point, 90°	C030045A111A (Limited)	C030045A111B (Limited)
3 GHz PMP 450m Integrated Access Point, 90°	C030045A114A (Limited, No Encryption)	C030045A114B (Limited, No Encryption)

Table 96: 5 GHz PMP 450m Series ODU part numbers

Cambium description	Cambium part number
5 GHz PMP 450m AP (Access Point)	
5 GHz PMP 450m Integrated Access Point, 90° (ROW)	C050045A101A
5 GHz PMP 450m Integrated Access Point, 90° (FCC)	C050045A102A
5 GHz PMP 450m Integrated Access Point, 90° (EU)	C050045A103A
5 GHz PMP 450m Integrated Access Point, 90° (DES Only)	C050045A104A
5 GHz PMP 450m Integrated Access Point, 90° (IC)	C050045A105A
5 GHz PMP 450m Integrated Access Point, 90° (ROW)	C050045A111A (Limited)
5 GHz PMP 450m Integrated Access Point, 90° (FCC)	C050045A112A (Limited)
5 GHz PMP 450m Integrated Access Point, 90° (EU)	C050045A113A (Limited)
5 GHz PMP 450m Integrated Access Point, 90° (DES Only)	C050045A114A (Limited)
5 GHz PMP 450m Integrated Access Point, 90° (IC)	C050045A115A (Limited)

PMP 450i

Table 97: PMP 450i Series ODU part numbers - Connectorized

Cambium description	Superseded Sales SKU	Revised SKU suffix
ODU model		
450i Connectorized	5085CHH	5085CJH
450i Integrated 90° sector	5082JH	5082KH
450i Integrated High Gain Directional	5092JH	5092KH
450i Connectorized ATEX/HAZLOC - ATEX CONTROLLED ITEM	5085CHH	5085CJH
450i Integrated 90° sector ATEX/HAZLOC - ATEX CONTROLLED ITEM	5085HH	5085JH
450i Integrated High Gain Directional ATEX/HAZLOC - ATEX CONTROLLED ITEM	5095HH	5095JH
PMP 450i AP (Access Point)		
900 MHz PMP 450i Connectorized Access Point	C009045A001A	
3 GHz PMP 450i Connectorized Access Point	C030045A001A	
3 GHz PMP 450i Integrated Access Point, 90°	C030045A002A	
3 GHz PMP 450i Connectorized Access Point, DES Only	C030045A003A	
3 GHz PMP 450i Integrated Access Point, 90°, DES Only	C030045A004A	
5 GHz PMP 450i Connectorized Access Point (RoW)	C050045A001A*	C050045A001B**
5 GHz PMP 450i Connectorized Access Point (FCC)	C050045A002A*	C050045A002B**
5 GHz PMP 450i Connectorized Access Point (EU)	C050045A003A*	C050045A003B**
5 GHz PMP 450i Connectorized Access Point (DES Only)	C050045A004A*	C050045A004B**
5 GHz PMP 450i Connectorized Access Point (IC)	C050045A015A*	C050045A015B**
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° (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	
PMP 450i SM (Subscriber Module)		
3 GHz PMP 450i Connectorized Subscriber Module	C030045C001A	

Cambium description	Superseded Sales SKU	Revised SKU suffix
3 GHz PMP 450i SM, Integrated High Gain Antenna	C030045C002A	
5 GHz PMP 450i Connectorized Subscriber Module	C050045C001A*	C050045C001B**
5 GHz PMP 450i SM, Integrated High Gain Antenna	C050045C002A	

* Previous model end (April 2019)

** Revised model starts (May 2019)

Note

The 450i SM does not have license keys.

Table 98: PMP 450i Integrated ODU models/part numbers

Cambium description	Superseded Sales SKU	Revised SKU suffix
ODU model		
450i Connectorized	5085CHH	5085CJH
450i Integrated 90 Deg Sector	5082JH	5082KH
450i Integrated High Gain Directional	5092JH	5092KH
450i Connectorized ATEX/HAZLOC - ATEX CONTROLLED ITEM	5085CHH	5085CJH
450i Integrated 90 Deg Sector ATEX/HAZLOC - ATEX CONTROLLED ITEM	5085HH	5085JH
450i Integrated High Gain Directional ATEX/HAZLOC - ATEX CONTROLLED ITEM	5095HH	5095JH
Part Number		
5 GHz PMP 450i Conn Access Point (ROW), ATEX/HAZLOC	C050045A009A	C050045A009B
5 GHz PMP 450i Conn Access Point (FCC), ATEX/HAZLOC	C050045A010A	C050045A010B
5 GHz PMP 450i Conn Access Point (EU), ATEX/HAZLOC	C050045A011A	C050045A011B
5 GHz PMP 450i Integrated Access Point, 90 degree (ROW), ATEX/HAZLOC	C050045A012A	C050045A012B
5 GHz PMP 450i Integrated Access Point, 90 degree (FCC), ATEX/HAZLOC	C050045A013A	C050045A013B
5 GHz PMP 450i Integrated Access Point, 90 degree (EU), ATEX/HAZLOC	C050045A014A	C050045A014B
5 GHz PMP 450i Conn Access Point (IC), ATEX/HAZLOC	C050045A017A	C050045A017B

Cambium description	Superseded Sales SKU	Revised SKU suffix
5 GHz PMP 450i Integrated Access Point, 90 degree (IC), ATEX/HAZLOC	C050045A018A	C050045A018B
5 GHz PMP 450i Conn Access Point (DES Only), ATEX/HAZLOC	C050045A019A	C050045A019B
5 GHz PMP 450i Integrated Access Point, 90 degree (DES Only), ATEX/HAZLOC	C050045A020A	C050045A020B
5 GHz PMP 450i Conn Subscriber Module, ATEX/HAZLOC	C050045C003A	C050045C003B
5 GHz PMP 450i Integrated High Gain Antenna, ATEX/HAZLOC	C050045C004A	C050045C004B
5 GHz PMP 450i Integrated Access Point, 90 degree (ROW)	C050045A005B	C050045A005C
5 GHz PMP 450i Integrated Access Point, 90 degree (FCC)	C050045A006B	C050045A006C
5 GHz PMP 450i Integrated Access Point, 90 degree (EU)	C050045A007B	C050045A007C
5 GHz PMP 450i Integrated Access Point, 90 degree (DES Only)	C050045A008B	C050045A008C
5 GHz PMP 450i Integrated Access Point, 90 degree (IC)	C050045A016B	C050045A016C
5 GHz PMP 450i Integrated Narrow Beam Access Point, 10 degree (ROW)	C050045A049A	C050045A049B
5 GHz PMP 450i SM, Integrated High Gain Antenna	C050045C002B	C050045C002C
5 GHz PMP 450i Integrated High Gain Antenna (Eolo)	C050045C009A	C050045C009B

PTP 450i

Table 99: PTP 450i Series – Con ODU part numbers

Cambium description	Superseded Sales SKU	Revised SKU suffix
450i Connectorized	5085CHH	5085CJH
450i Integrated 90 Deg Sector	5082JH	5082KH
450i Integrated High Gain Directional	5092JH	5092KH
450i Connectorized ATEX/HAZLOC - ATEX CONTROLLED ITEM	5085CHH	5085CJH
450i Integrated 90 Deg Sector ATEX/HAZLOC - ATEX CONTROLLED ITEM	5085HH	5085JH
450i Integrated High Gain Directional ATEX/HAZLOC - ATEX CONTROLLED ITEM	5095HH	5095JH

Cambium description	Superseded Sales SKU	Revised SKU suffix
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*	C050045B001B**
5 GHz PTP 450i END, Connectorized (FCC)	C05004B003A*	C050045B003
5 GHz PTP 450i END, Connectorized (EU)	C050045B005A*	C050045B005B**
5 GHz PTP 450i END, Connectorized (DES only)	C050045B007A*	C050045B007B**
5 GHz PTP 450i END, Connectorized (IC)	C050045B015A*	C050045B015B**
5 GHz PTP 450i END, Integrated High Gain Antenna (RoW)	C050045B002A^	C050045B002B**
5 GHz PTP 450i END, Integrated High Gain Antenna (FCC)	C050045B004A	C050045B004B
5 GHz PTP 450i END, Integrated High Gain Antenna (EU)	C050045B006A	C050045B006B
5 GHz PTP 450i END, Integrated High Gain Antenna (DES only)	C050045B008A^	C050045B008B**
5 GHz PTP 450i END, Integrated High Gain Antenna (IC)	C050045B016A	C050045B016B
Ethernet cable adapter for CMM4	N000045L001A	

* Previous model end (April 2019)

^ Previous model end (May 2019)

** Revised model starts (May 2019)

Table 100: PTP 450i Integrated models/part numbers

Cambium description	Superseded Sales SKU	Revised SKU suffix
ODU model		
450i Connectorized	5085CHH	5085CJH
450i Integrated 90 Deg Sector	5082JH	5082KH
450i Integrated High Gain Directional	5092JH	5092KH
450i Connectorized ATEX/HAZLOC - ATEX CONTROLLED ITEM	5085CHH	5085CJH
450i Integrated 90 Deg Sector ATEX/HAZLOC - ATEX CONTROLLED ITEM	5085HH	5085JH

Cambium description	Superseded Sales SKU	Revised SKU suffix
450i Integrated High Gain Directional ATEX/HAZLOC - ATEX CONTROLLED ITEM	5095HH	5095JH
5 GHz PTP 450i END, Connectorized (ROW), ATEX/HAZLOC	C050045B009A	C050045B009B
5 GHz PTP 450i END, Integrated High Gain Antenna (ROW), ATEX/HAZLOC	C050045B010A	C050045B010B
5 GHz PTP 450i END, Connectorized (FCC), ATEX/HAZLOC	C050045B011A	C050045B011B
5 GHz PTP 450i END, Integrated High Gain Antenna (FCC), ATEX/HAZLOC	C050045B012A	C050045B012B
5 GHz PTP 450i END, Connectorized (EU), ATEX/HAZLOC	C050045B013A	C050045B013B
5 GHz PTP 450i END, Integrated High Gain Antenna (EU), ATEX/HAZLOC	C050045B014A	C050045B014B
5 GHz PTP 450i END, Connectorized (IC), ATEX/HAZLOC	C050045B017A	C050045B017B
5 GHz PTP 450i END, Integrated High Gain Antenna (IC), ATEX/HAZLOC	C050045B018A	C050045B018B
5 GHz PTP 450i END, Connectorized (DES Only), ATEX/HAZLOC	C050045B019A	C050045B019B
5 GHz PTP 450i END, Integrated High Gain Antenna (DES Only), ATEX/HAZLOC	C050045B020A	C050045B020B

PMP/PTP 450b

Table 101: PMP/PTP 450b Series ODU part numbers

Cambium description	Cambium part number
450b (PMP SM and PTP)	
5 GHz 450b - Mid-Gain – ROW	C050045B031A
5 GHz 450b - Mid-Gain – FCC	C050045B032A
5 GHz 450b - Mid-Gain – ISED	C050045B033A
5 GHz 450b - Mid-Gain – EU	C050045B034A
5 GHz 450b - Mid-Gain – No Encryption	C050045B035A
5 GHz 450b - High Gain – ROW – Radio Only	C050045B021A
5 GHz 450b - High Gain – FCC – Radio Only	C050045B022A
5 GHz 450b - High Gain – ISED – Radio Only	C050045B023A
5 GHz 450b - High Gain – EU – Radio Only	C050045B024A
5 GHz 450b - High Gain – No Encryption – Radio Only	C050045B025A
5 GHz 450b, 50 Mbps – High Gain – ROW – Radio Only	C050045B051A
5 GHz 4 Pack High Gain Antenna Assembly, IP55	N050045D002A
3 GHz 450b - High Gain – Radio Only	C030045B021A
3 GHz 450b - High Gain – No Encryption – Radio Only	C030045B025A
3 GHz High Gain Antenna Assembly, IP55 – 4-pack	N030045D001A
5 GHz 450b Retro - ROW	C050045B101A
5 GHz 450b Retro - FCC	C050045B102A
5 GHz 450b Retro - ISED	C050045B103A
5 GHz 450b Retro - EU	C050045B104A
5 GHz 450b Retro - No Encryption	C050045B105A

PMP 450

Table 102: PMP 450 Series ODU part numbers

Cambium description	Cambium part number
PMP 450 AP (Access Point)	
2.4 GHz PMP 450 Connectorized Access Point	C024045A001A
2.4 GHz PMP 450 Connectorized Access Point (No Encription)	C024045A003A

Cambium description	Cambium part number
3.5 GHz PMP 450 Connectorized Access Point	C035045A001A
3.5 GHz PMP 450 Connectorized Access Point (No Encription)	C035045A003A
3.6 GHz PMP 450 Connectorized Access Point	C036045A001A
3.6 GHz PMP 450 Connectorized Access Point (DES)	C036045A003A
PMP 450 AP Lite	
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
PMP 450 SM (Subscriber Module)	
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
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

Cambium description	Cambium part number
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 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

PMP 450 MicroPoP

Cambium description	Cambium part number
5 GHz 450 MicroPoP Omni - ROW	C050045A201A
5 GHz 450 MicroPoP Omni - FCC	C050045A202A
5 GHz 450 MicroPoP Omni - ISED	C050045A203A
5 GHz 450 MicroPoP Omni - EU	C050045A204A
5 GHz 450 MicroPoP Omni - No Encription	C050045A205A
5 GHz 450 MicroPoP Sector - 90° - ROW	C050045A206A
5 GHz 450 MicroPoP Sector - 90° - FCC	C050045A207A
5 GHz 450 MicroPoP Sector - 90° - ISED	C050045A208A
5 GHz 450 MicroPoP Sector - 90° - EU	C050045A209A
5 GHz 450 MicroPoP Sector - 90° - No Encription	C050045A210A
5 GHz 450 MicroPoP Connectorized - ROW	C050045A211A
5 GHz 450 MicroPoP Connectorized - FCC	C050045A212A
5 GHz 450 MicroPoP Connectorized - ISED	C050045A213A

Cambium description	Cambium part number
5 GHz 450 MicroPoP Connectorized - EU	C050045A214A
5 GHz 450 MicroPoP Connectorized - No Encription	C050045A215A
5 GHz 450b Connectorized - ROW	C050045B041A
5 GHz 450b Connectorized - FCC	C050045B042A
5 GHz 450b Connectorized - ISED	C050045B043A
5 GHz 450b Connectorized - EU	C050045B044A
5 GHz 450b Connectorized - No Encription	C050045B045A

PTP 450

Table 103: 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 104: PMP/PTP 450/450i Series Accessories

Cambium description	Cambium part number
PMP 450 AP Antenna Options	

Cambium description	Cambium part number
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
Power supplies	
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 V DC Input	N000000L036A
Power Supply, 30 W, 56 V – Gbps support	N000000L034A
Gigabit Enet Capable Power Supply - 30 V DC, 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
AP Optional Equipment	
CMM MICRO (Outdoor Enclosure) (450 only)	1070CKHH
CMM5 Controller	C000000L500B
CMM5 Power and Sync Injector 56 V	C000000L556B
CMM5 Power Supply, AC, 54 V 240 W	N000000L054B
CMM5 Power Supply AC, 48 V, 600 W	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

Cambium description	Cambium part number
Ethernet cable adapter for CMM4	N000045L001A
cnPulse – Sync Generator with CambiumSync	C000000L066B
RJ45 Gland Spare – PG16 style (QTY 10)	N000065L033A
Blanking Plug Pack (Qty 10)	N000065L036A
SM Optional Equipment	
Power Supply, 30 W, 56 V – Gbps support	N000000L034A
Gigabit Enet Capable Power Supply – 30 V DC, 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
IP67 doors and glands for 450b High Gain, 4-pack	N000000L135A
Accessories	
Surge Suppressor (30 V DC)	600SSH
Gigabit Surge Suppressor (56 V DC)	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
RJ45 Spare Grounding Gland - PG16 size (Qty. 10)	N000065L033
DC LPU and Grounding Kit	C000000L114A
Cable assy, Shielded, 4C Stereo Plug -3.5mm TO RJ45	N000000L127A
Mounting brackets	
Tilt Bracket Assembly	N000045L002A
Mounting Bracket (Integrated)	N000065L031A
Mounting Bracket (Connectorized)	N000065L032A

Cambium description	Cambium part number
Upgrade Keys	
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
PMP 450 20 To Uncapped MBPS Upgrade Key	C000045K007A
PMP 450 Lite AP to Full AP Upgrade Key	C000045K008A
Extended Warranty	
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

Chapter 3: System planning

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 contains diagrams illustrating typical PMP/PTP 450 Platform site deployments.
- Site planning describes factors to be considered when planning the proposed link end sites, including grounding, lightning protection and equipment location.
- Radio Frequency planning describes how to plan PMP/PTP 450 Platform links to conform to the regulatory restrictions that apply in the country of operation.
- Link planning describes factors to be taken into account when planning links, such as range, path loss and throughput.
- Planning for connectorized units 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 describes factors to be considered when planning PMP/PTP 450 Platform data networks.
- Network management planning describes how to plan for PMP/PTP 450 Platform links to be managed remotely using SNMP.
- Security planning describes how to plan for PMP/PTP 450 Platform links to operate in secure mode.
- Remote AP Deployment 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 (Mast or tower installation), wall installation (Wall installation) and roof installation (Roof installation).

Figure 46: *Mast or tower installation*

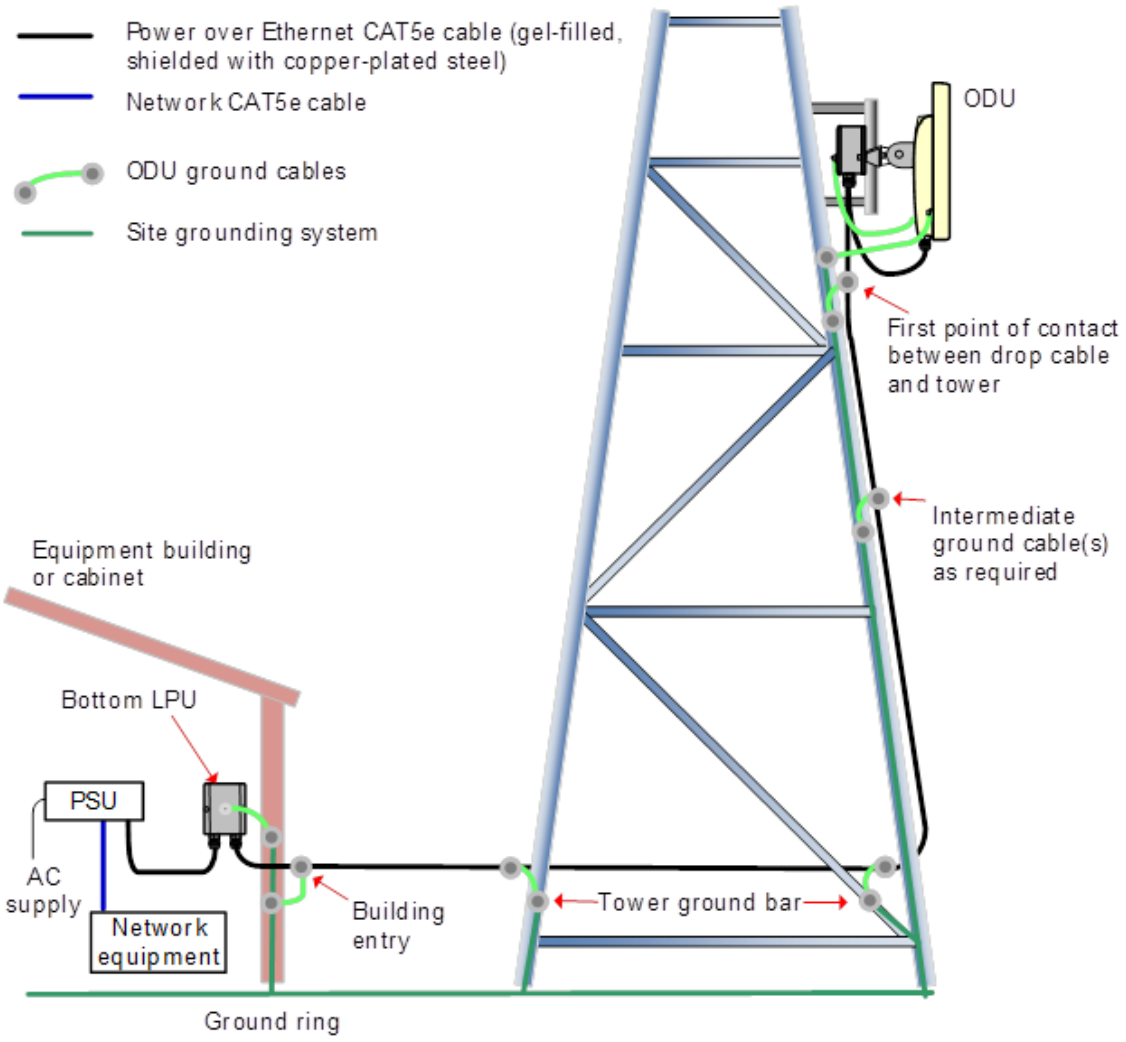


Figure 47: *Wall installation*

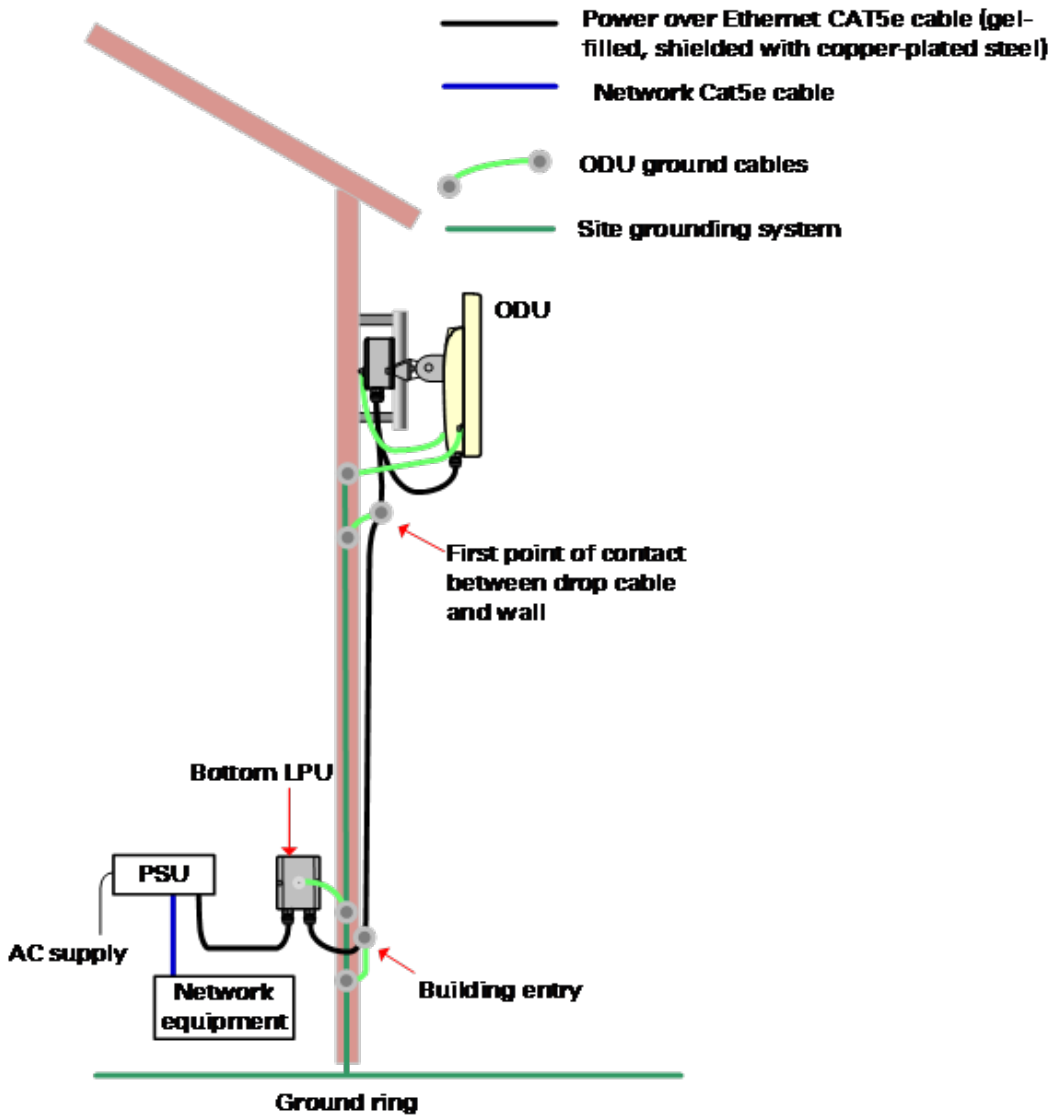


Figure 48: *Roof installation*

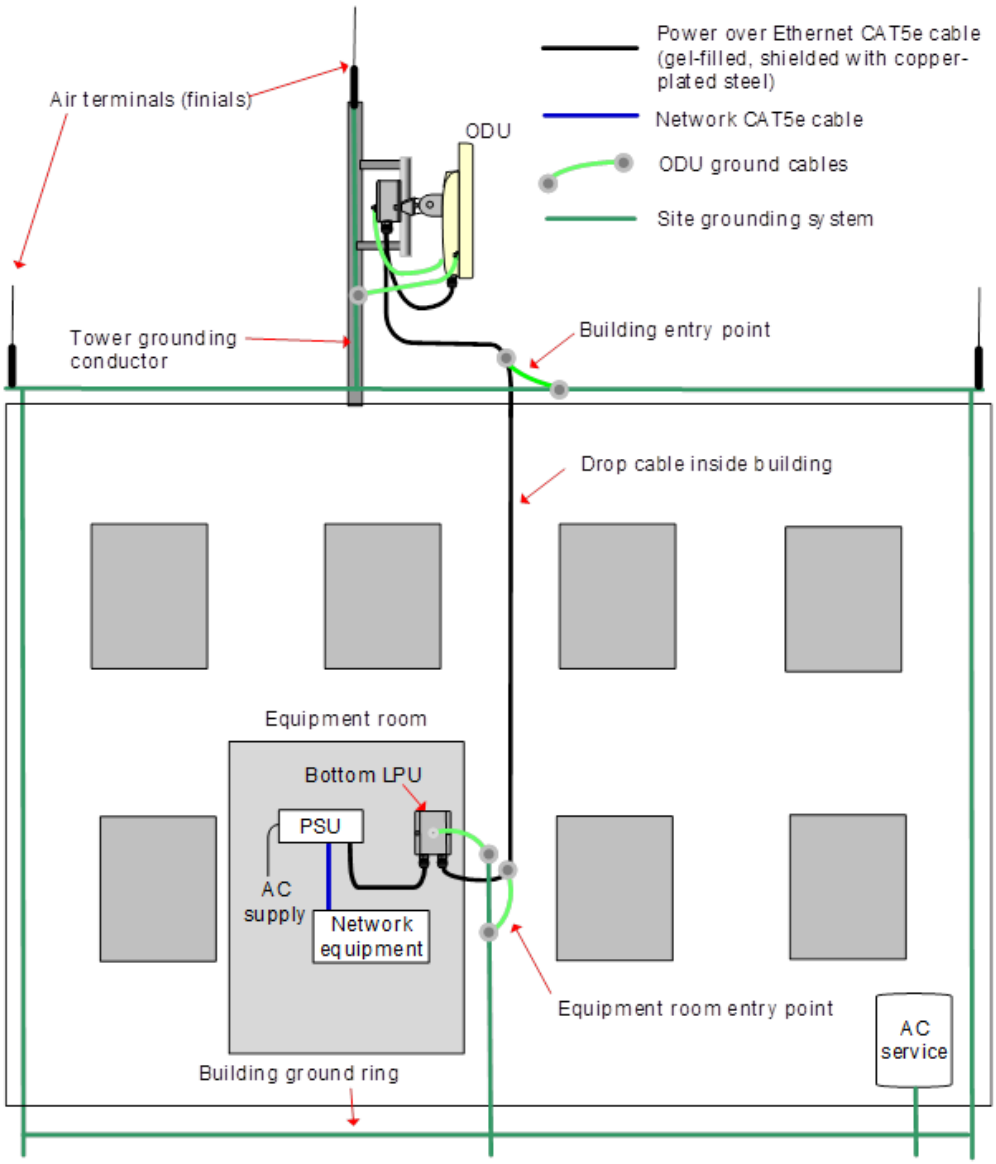


Figure 49: *GPS receiver wall installation*

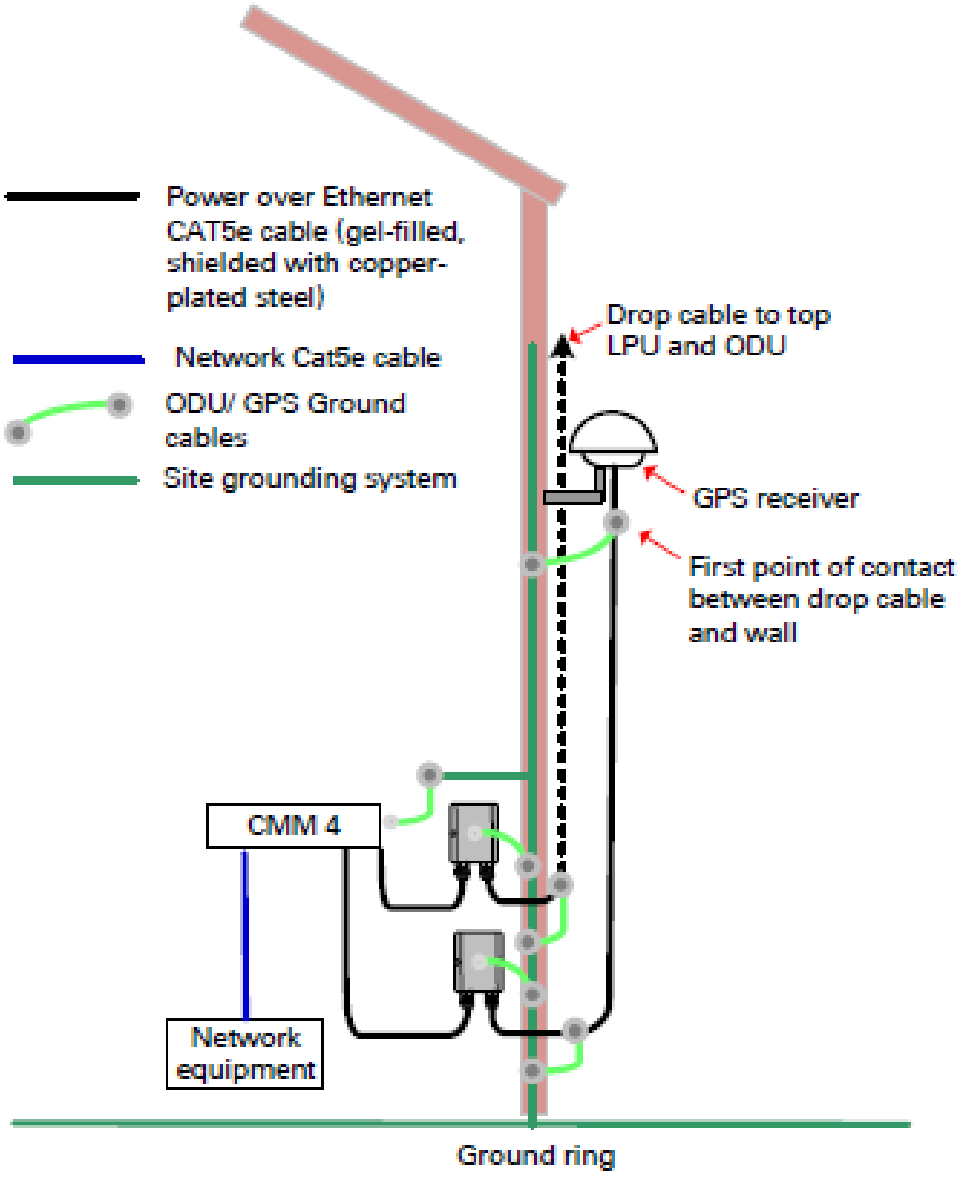
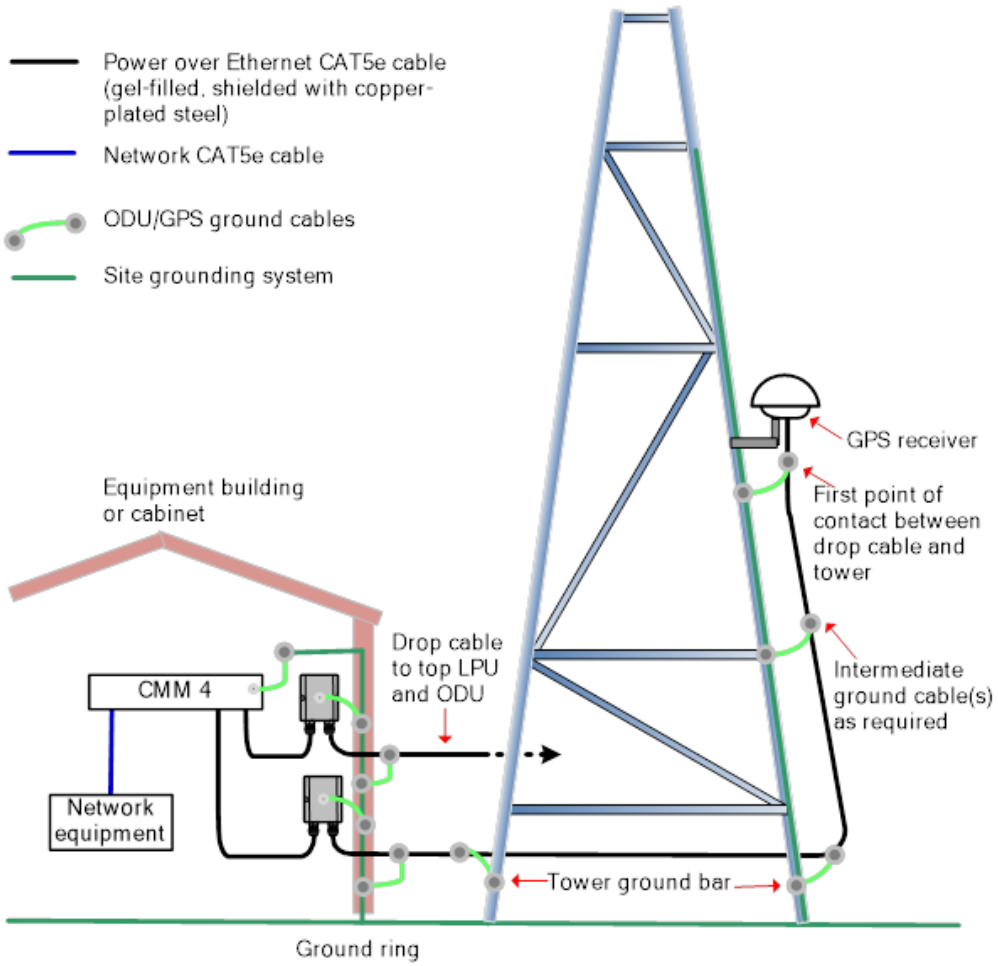


Figure 50: *GPS receiver tower or mast installation*



Site planning

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.
- 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 .
- Ability to meet the requirements specified in Grounding and lightning protection.
- Aesthetics and planning permission issues.

- Cable lengths; see Ethernet standards and cable lengths.
- The effect of strong winds on the installation; see ODU wind loading.

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.

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 3 GHz PMP 450M ODU can use a 1.0 mm 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.

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.

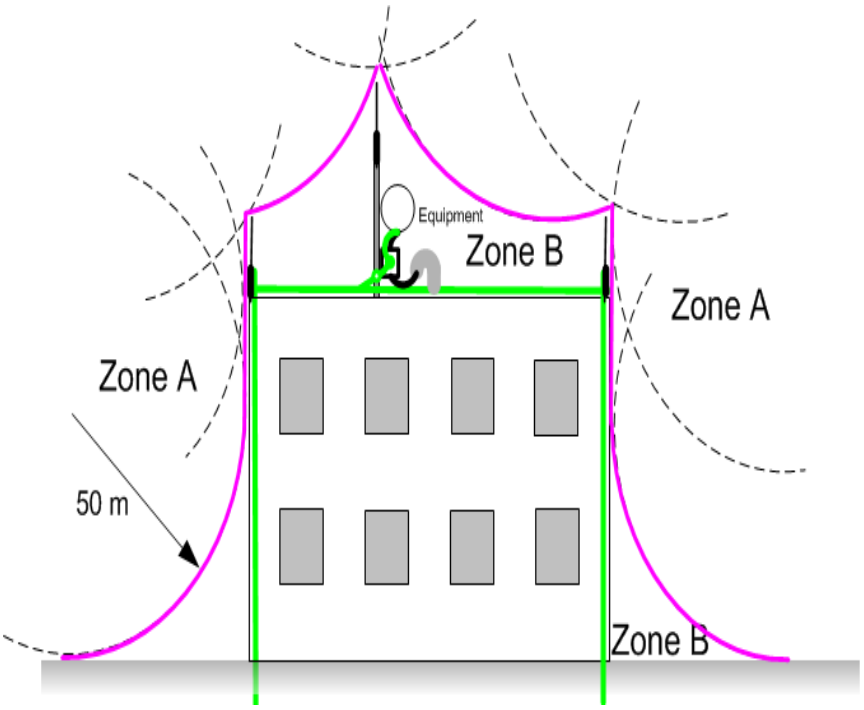
Warning

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

Lightning protection zones

Use the rolling sphere method (Rolling sphere method to determine the lightning protection zones) 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.

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 (Roof installation), 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 in Legal and Open Source Guide.
- 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 Series – 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
- Up to 124 mph (200 kph) for PMP 450 MicroPoP Series - AP 5 GHz
- Up to 124 mph (200 kph) for PMP/PTP 450b Retro Series - 5 GHz

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 105: PMP 450m Series wind loading (Newton)

Type of ODU	Max surface area (square feet)	Wind speed (kilometer per hour)				
		160	170	180	190	200
Integrated 90º sector antenna	0.331	671	757	849	946	1048

Table 106: PMP/PTP 450i Series wind loading (Newton)

Type of ODU	Max surface area (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

Type of ODU	Max surface area (square meters)	Wind speed (kilometer per hour)				
		External 65º sector antenna – 900 MHz	0.253	677	764	857
Directional antenna – 3.x GHz	0.1	142	160	180	200	222
Integrated 90º sector antenna -3.x GHz	0.18	83	94	105	117	130
Directional antenna – 5 GHz	0.093	249	281	315	351	389
Integrated 90º sector antenna - 5 GHz	0.126	337	381	427	475	527

Table 107: PMP 450m Series wind loading (lb force)

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

Table 108: PMP/PTP 450i Series wind loading (lb force)

Type of ODU	Max surface area (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 90º sector antenna - 5 GHz	1.356	57	63	69	75	82
Directional Yagi antenna - 900 MHz	0.27	11	13	14	15	16
External 65º 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 109: PMP/PTP 450 Series wind loading (Newton)

Type of ODU	Max surface area (square meters)	Wind speed (kilometer per hour)				
		160	170	180	190	200
External 60º sector antenna – 2.4 GHz AP	0.27	722	815	914	1019	1129
External 60º sector antenna – 5 GHz AP	0.066	177	199	223	249	276
External 90º 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 110: PMP/PTP 450 Series wind loading (lb force)

Type of ODU	Max surface area (square feet)	Wind speed (miles per hour)				
		100	105	110	115	120
External 60º sector antenna – 2.4 GHz AP	2.9	122	134	147	161	175
External 60º sector antenna – 5 GHz AP	0.71	29.8	33	37	39	43
External 90º 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 111: PMP 450b Series wind loading (Newton)

Type of ODU	Max surface area (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 112: PMP 450b Series wind loading (lb force)

Type of ODU	Max surface area (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 EIRP limits from ATEX and HAZLOC standards.

Table 113: 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

Table 114: Further reading

For information about...	Refer to...
Ordering Connectorized/ Integrated ATEX/HAZLOC ODUs	PMP 450i Integrated ODU models/part numbers and PTP 450i Series – Con ODU part numbers
ATEX/HAZLOC standards and type approval	Hazardous location compliance in Legal and Open Source Guide.
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 (Mast or tower installation , Wall installation, and Roof installation) 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 (Mast or tower installation), 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 (Roof installation), 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

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 in Configuratgion Guide 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

Co-location between OFDM (450 Series) and FSK (PMP/PTP 1x0)

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 Configuration Guide).

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) 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

For Cambium co-location tool refer section Cambium co-location tool in Configuration Guide.

Co-location between Cambium PMP 450 Series 3 GHz devices and LTE devices

When co-locating systems in the same geographical area it is important to select the correct system parameters in order to avoid interference. Both Cambium PMP and LTE are TDD systems, which means that the same frequency resources are used both in the downlink and in the uplink but multiplexed in time. A TDD cycle or frame, is the minimum amount of time used to communicate in both directions, including gaps for hardware turnaround and over the air propagation delays.

When multiple access points (APs) are deployed in the same geographical area, it is important that they all transmit and receive at the same time. If one AP transmits when another receives, the AP that is receiving might not be able to correctly decode the signal coming from the subscriber modules (SMs) communicating with it, because of the interfering signal coming from the other AP.

In order to avoid this type of interference, three aspects need to be considered:

1. The TDD cycle, or frame, needs to have the same length for all APs
2. The TDD cycle, or frame, needs to start at the same time for all APs
3. The frame parameters need to be selected in each AP so that there is no overlap between one AP transmitting and another receiving. An example of these parameters is the duty cycle, i.e. the ratio of the time dedicated to communication in the downlink direction over the total time frame. Ensure that these parameters do not need to be the same in all APs, but they need to be selected to avoid interference. These features are needed regardless of the technology used by the APs.

LTE frame configuration options

Below table summarizes the LTE frame configuration options.

LTE supports two frame lengths, 5 ms and 10 ms. Each 10 ms interval contains 10 subframes, which are labeled in the Table as D for downlink transmission, U for uplink transmission, and S for special subframe. The special subframe contains the turnaround time between downlink and uplink transmissions.

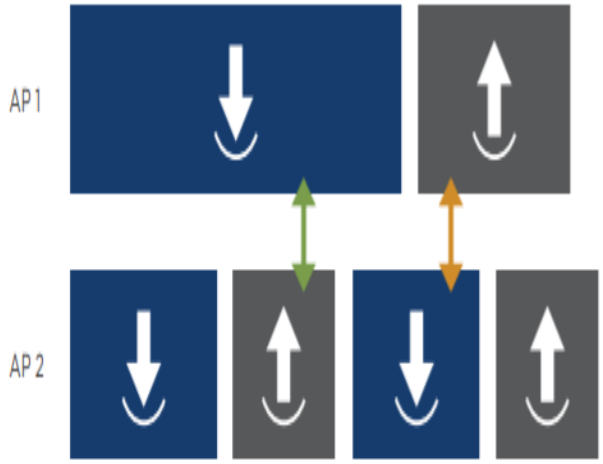
Configuration	Frame time	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D

Configuration	Frame time	Subframe number									
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

Frame length

TDD systems can be co-located only if they have the same frame length.

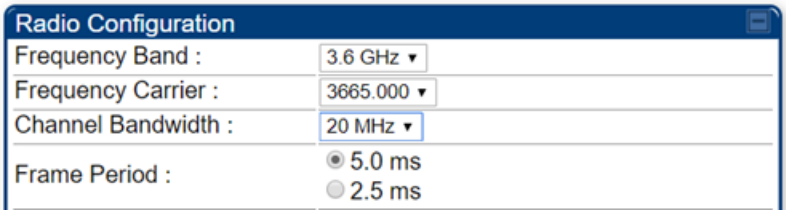
Below figure shows why it is not possible to co-locate APs supporting mismatched frame lengths.
Let us assume that AP1 operates with a 10 ms frame while AP2 operates with a 5 ms frame. Below figure shows that in a 10 ms interval AP1 has one transmit time and one receive time, while AP2 has two transmit times and two receive times.
The interference that mostly affects the system performance is the one at the AP receiver.
For example, in the time indicated with the green arrow in below figure, AP1 transmits when AP2 receives. This may completely corrupt the reception of AP2's uplink signal.
Also, in the time indicated with the orange arrow in below figure, AP2 transmits when AP1 receives. This may completely corrupt the reception of AP1's uplink signal.



As indicated above, LTE supports 5 ms and 10 ms frame lengths. Cambium PMP devices support 2.5 ms and 5 ms frame length. The only option for co-locating LTE and Cambium PMP devices is for both systems to operate with a 5 ms frame. This means that a Cambium PMP system can be co-located with an LTE system operating with Frame Configurations 0, 1 or 2.

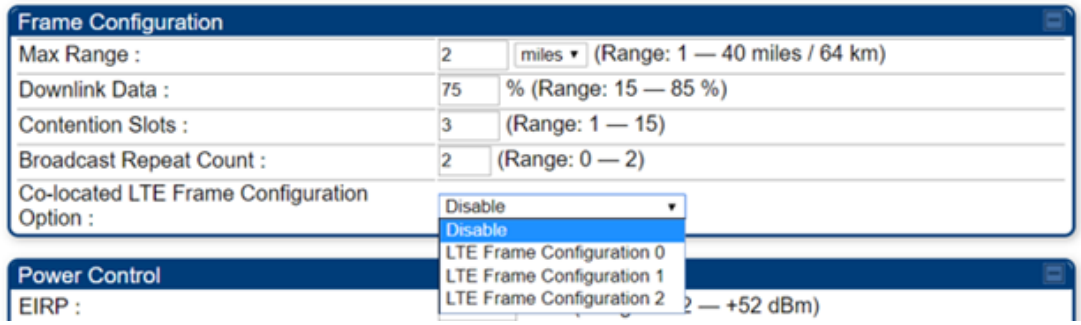
Ensure that frame configuration 6 also turns around twice in the 10 ms interval, and its frame length is 5 ms. However, the two 5 ms frames in the 10 ms interval are not identical.
Since in the Cambium PMP system all frames have the same downlink/uplink structure, the Cambium PMP system cannot be co-located with an LTE system operating with Frame Configuration 6.

In the Cambium PMP GUI the frame length is selected in the Configuration > Radio > Radio Configuration page under Frame Period, as shown in below figure.
This parameter must be configured to 5 ms.



Frame start

GPS synchronization is a way of guaranteeing that the frame start is the same for all APs. This is what is used by the Cambium PMP devices.
However, the timing between the GPS signal and the start of the TDD frame is not necessarily the same for all systems. The Cambium PMP devices and the LTE devices have different start time for their frames. The Cambium PMP Radio configuration page offers an LTE co-location option in the GUI Radio page, that allows the user to co-locate Cambium PMP devices with LTE devices by shifting the start of the PMP frame to match the start of the LTE frame.
This can be found under Configuration > Radio > Frame Configuration, as shown in below figure.



If the Co-located LTE Frame Configuration Option is selected as Disable, then the Cambium PMP frame start is not shifted from its legacy timing.
If any of the three other options (LTE Frame Configuration 0, 1 or 2) is selected, the Cambium PMP frame start is shifted to align to the LTE frame start. Additionally, each Frame Configuration has its frame start shifted by an integer number of subframes.

The Cambium PMP frame always starts with the downlink portion of the frame, followed by the turnaround time and then the uplink portion of the frame.
The LTE 10-ms interval however, always starts with subframes D, S and U as the first three subframes, but it may have additional downlink subframes in the same frame.
For example, in Frame Configuration 1 the 10 ms interval is composed of two repetitions of the following subframes: D, S, U, U, D. In order to align the Cambium PMP frame to this LTE frame, the downlink start has to align to the beginning of subframe 4, not subframe 0. With this shift, the sequence of subframes in the LTE frame becomes D, D, S, U, U, which is the same structure of the Cambium PMP frame (downlink, turnaround time, uplink).

When selecting one of the LTE Frame Configuration options from the Co-located LTE Frame Configuration Option drop-down menu, a shift is applied to the Cambium PMP frame in order to correctly line up with the selected LTE frame.

Frame parameters

After following the steps described above, the Cambium PMP and the LTE APs are synchronized, and their frame length is the same.
Next, the frame parameters have to be selected in order to avoid any overlap between one AP

transmitting and another receiving.
Figures X and Y shows one example of frames that do not interfere and one example of frames that do interfere. In both Figures the downlink time and the uplink time of the two APs are not identical.
In Figure X there is no overlap between one AP transmitting and another AP receiving, and the two APs can be co-located.
In Figure Y however, AP1 is still transmitting when AP2 is already receiving. This creates interference at the AP2's receiver and the APs cannot be co-located with these parameters.

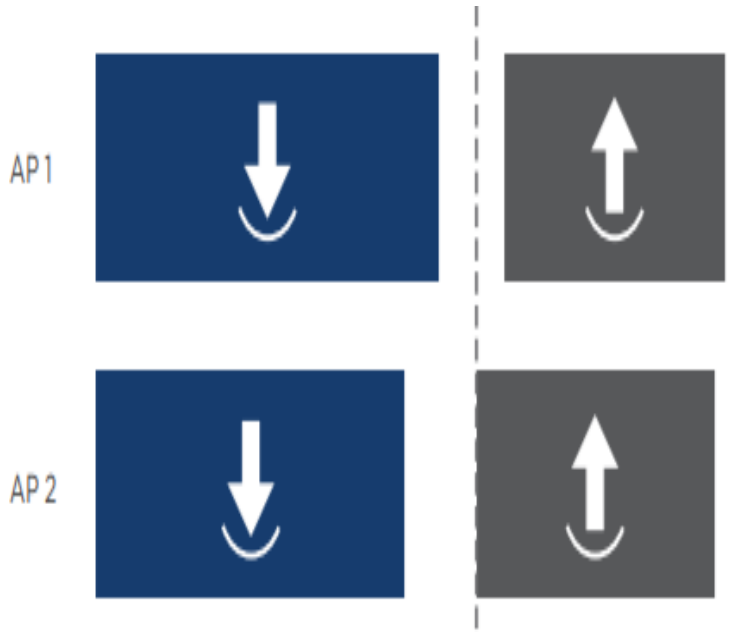


Figure X Example of APs that can be co-located

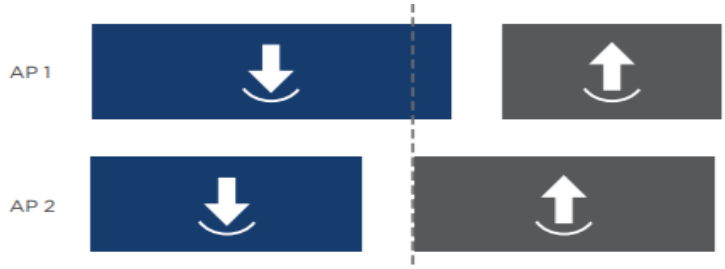


Figure Y Example of APs that cannot be co-located

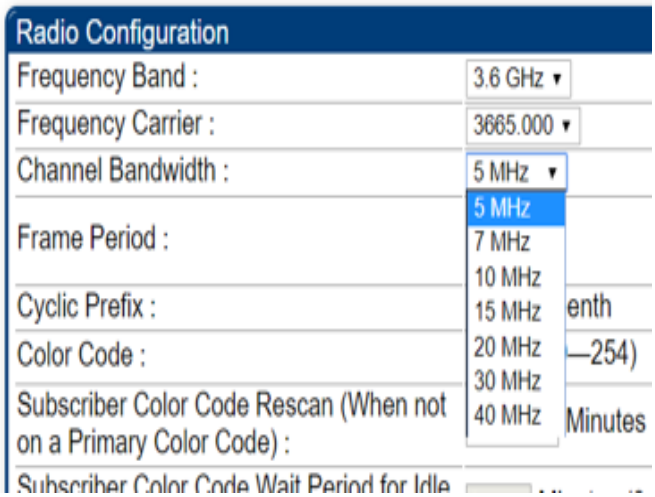
Once the LTE Frame Configuration is selected from the drop-down menu, the LTE downlink and uplink times are defined.

The Cambium PMP frame times are determined by the following configuration parameters:

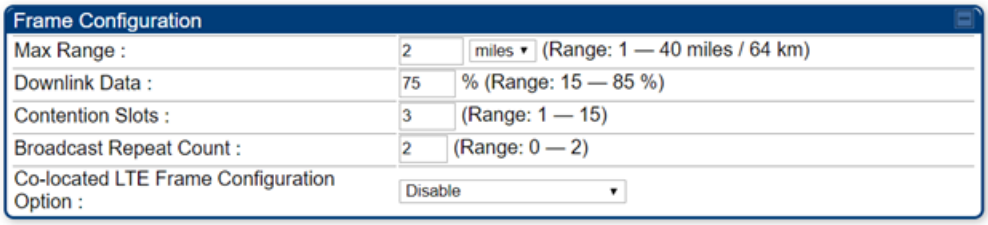
- Channel Bandwidth: amount of spectrum allocated for communication in the sector Options for the Channel Bandwidth in the 3 GHz band are 5 MHz, 7 MHz, 10 MHz, 15 MHz, 20 MHz, 30 MHz and 40 MHz.
- Max Range: distance between the AP and the farthest SM communicating with the AP Max Range is selected in miles, between 1 and 40.
- Downlink Data: duty cycle, ratio between the time dedicated to downlink transmission and the total frame time Downlink Data is selected as a percentage, between 15% and 85%.

- Contention Slots: time symbols reserved in the uplink portion of the frame for random access, registration and bandwidth request Contention Slots is a number between 1 and 15.

The Channel Bandwidth can be configured under Configuration > Radio > Radio Configuration, as shown in below figure.



All other parameters can be configured under Configuration > Radio > Frame Configuration, as shown in below figure.



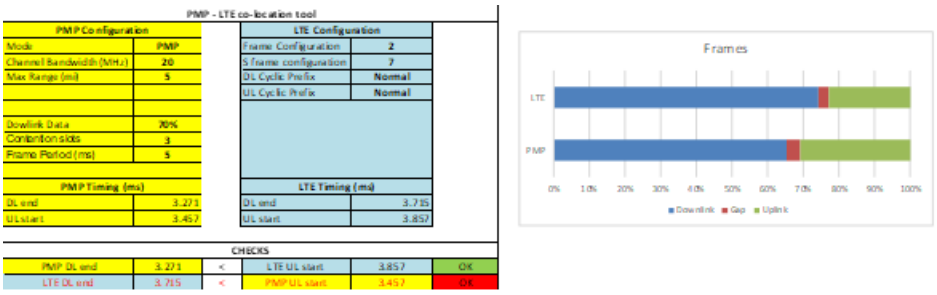
PMP – LTE co-location tool

The configuration parameters that affect the frame structure need to be selected in order to avoid any overlap between transmit and receive times.
In order to help with the selection of system parameters, Cambium Networks offers a PMP – LTE co-location tool, available at https://support.cambiumnetworks.com/files/colocationtool/

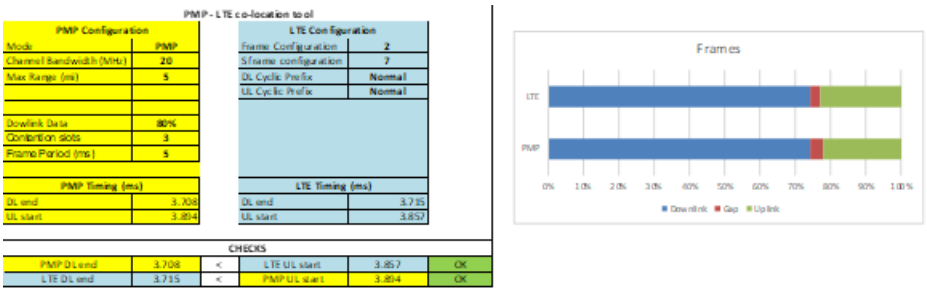
The PMP and LTE configuration parameters are entered in the spreadsheet, and the frame structure for the two systems is displayed on the right side.
The tool checks that there is no overlap between one AP transmitting and the other receiving.
This translates into two equations:

- The downlink time of AP1 ends before the uplink time of AP2 starts
- The downlink time of AP2 ends before the uplink time of AP1 starts

In the example in below figure the second equation is not satisfied, and the two systems cannot be co-located. The plot to the right also shows that with this frame configuration the LTE AP is still transmitting when the PMP AP is already receiving. This creates interference at the PMP AP receiver.



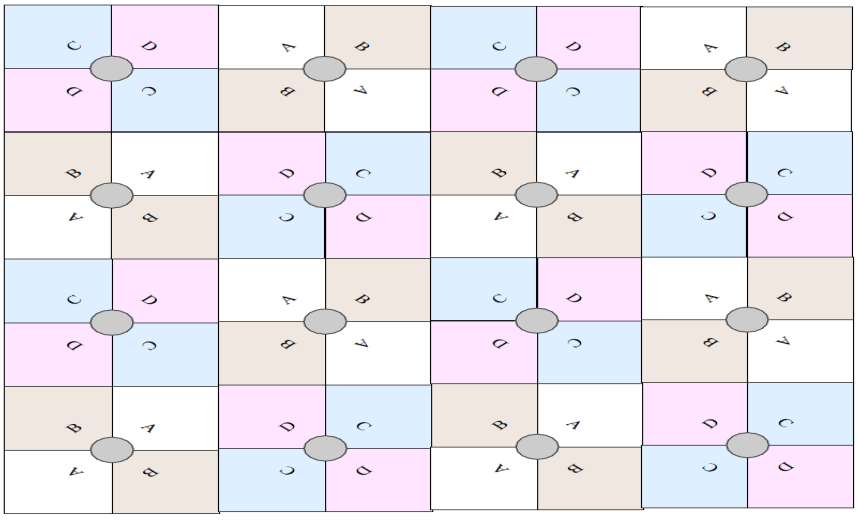
Using the tool, parameters can be updated in order to find a set of values that allows for co-location. For example, changing the duty cycle of the PMP AP from 70% to 80% makes both equations true, and there is no longer overlap between one AP transmitting and the other receiving.



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*

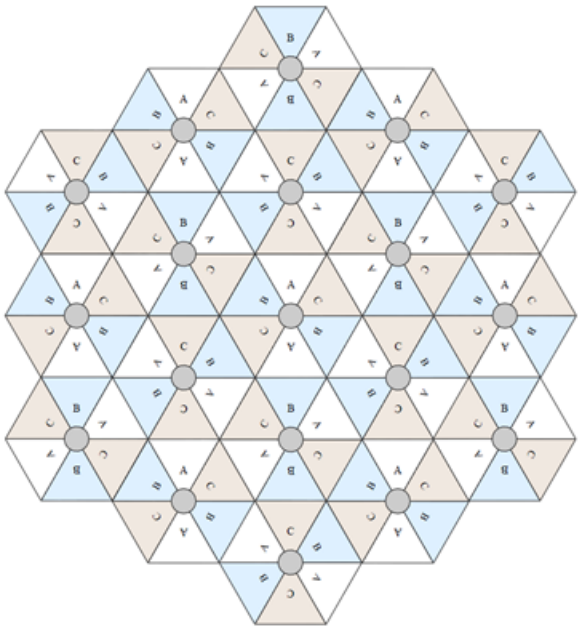


An example for assignment of frequency channels is provided in the following table.

Table 115: 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 116: 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 Example layout of 16 Access Point sectors (ABCD), 90-degree sectors. 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:

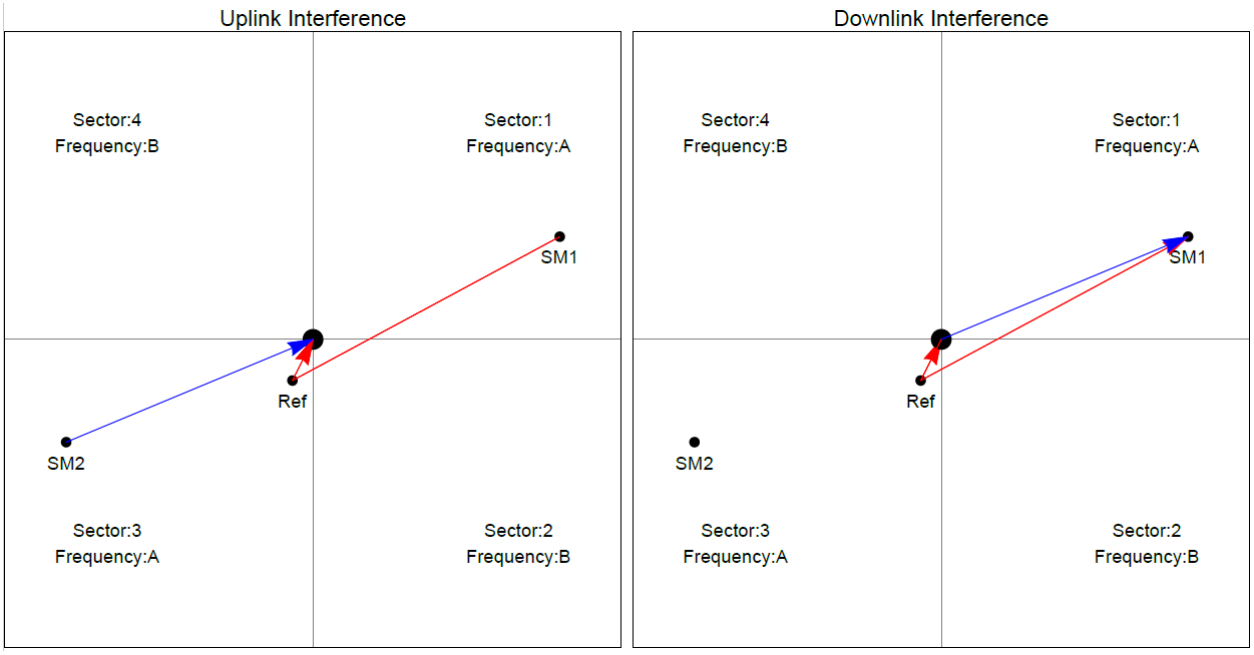
- GPS synchronization: all the access points transmit at the same time
- Uplink and Downlink timings across APs do not overlap: they can be adjusted using the frame calculators and co-location tools provided by Cambium
- Uplink power control to ensure that all signals are received on the uplink at the 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 Example layout of 16 Access Point sectors (ABCD), 90-degree sectors 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

Reflection 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.

Sector Antenna and cnMedusa Antenna 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.

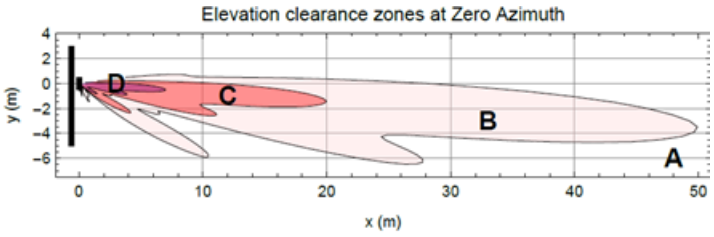
- object size 1: a flat building face with a clear reflecting property from sector to AP
- object size 2: random metalwork such as a wireless tower
- object size 3: a 0.5 X 0.5m flat metallic face or tree
- object size 4: a 0.2 X 0.2m random metal structure or 0.5 X 0.5m foliage.

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*



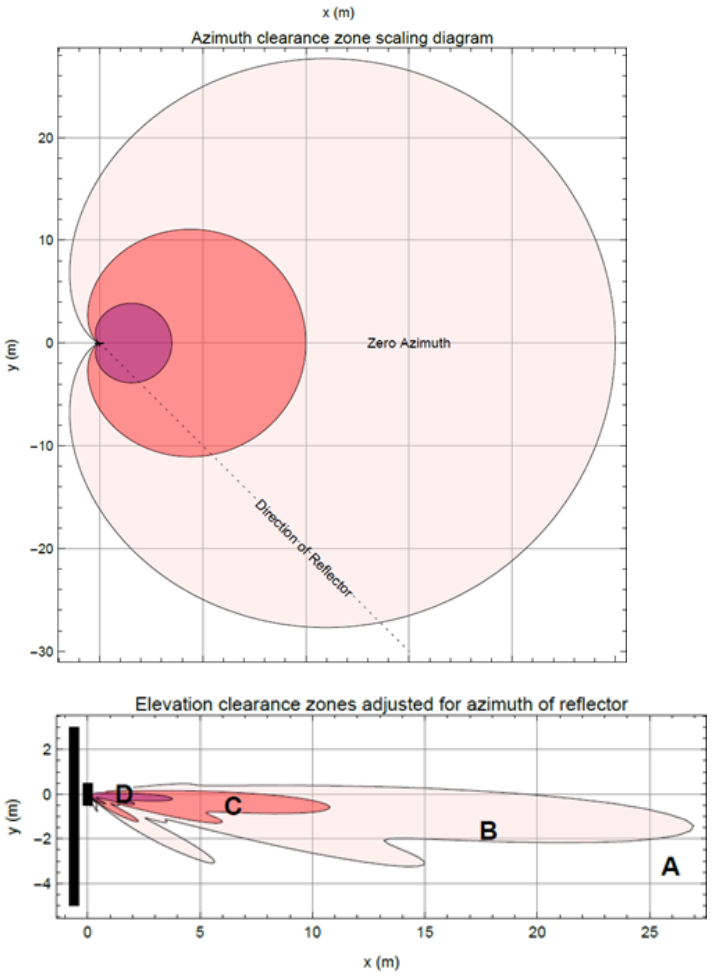
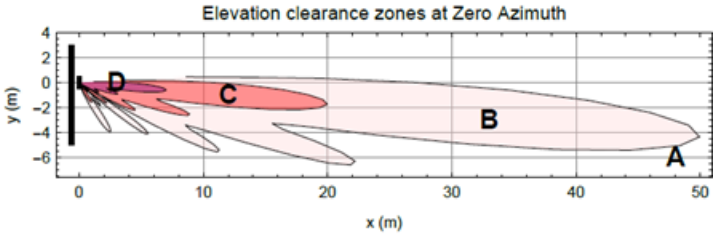
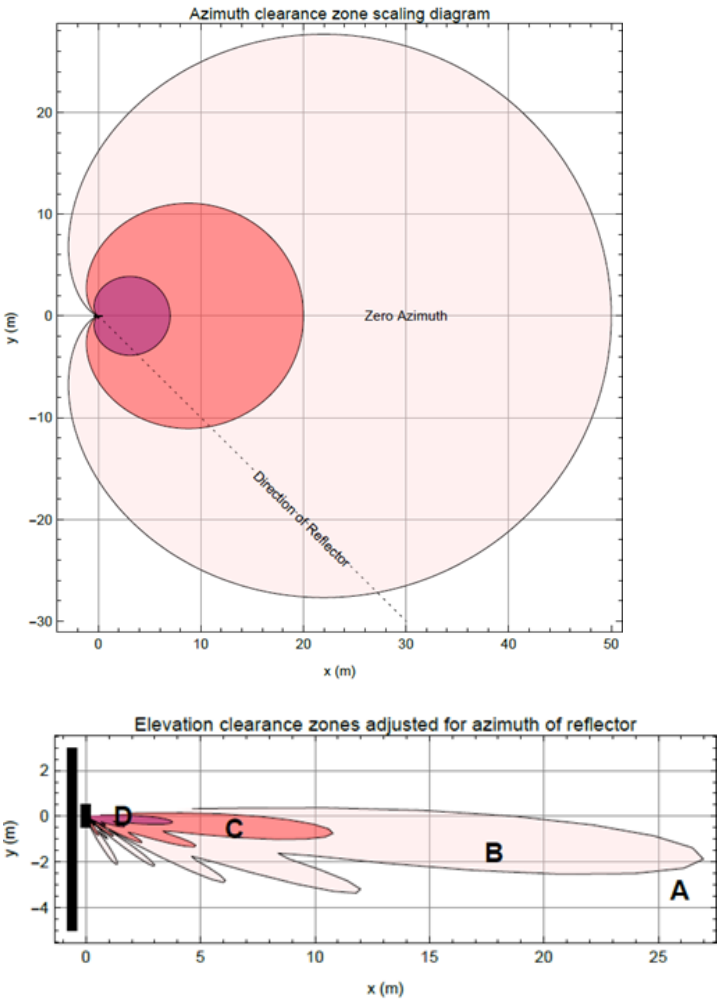


Figure 56: *cnMedusa Antenna*





Sector Antenna and cnMedusa Antenna each have three diagrams scaled in meters where Sector Antenna is for the sector antenna and cnMedusa Antenna 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 5 GHz 450m is a 14x14 MIMO system which allows simultaneous communication to up to seven SMs. The 3 GHz 450m is an 8x8 MIMO system which allows simultaneous communication to up to four SMs.

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 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)

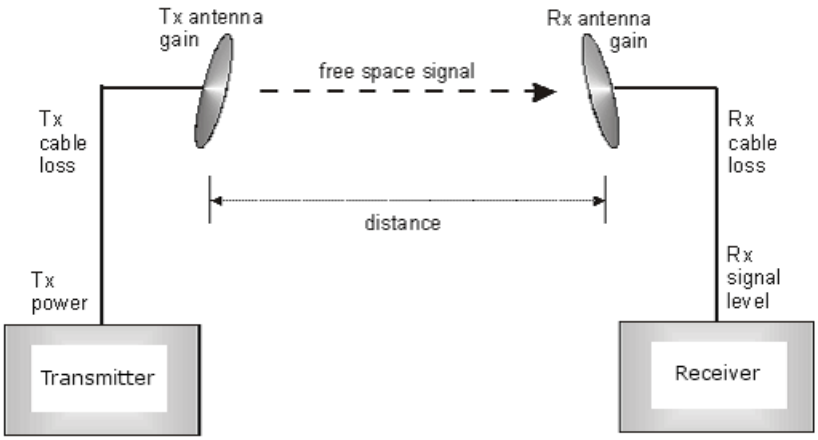
Calculating Link Loss

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

Link Loss (dB) = Transmit power of the remote wireless unit (dBm) − Tx Cable loss (dB) − Received power at the local unit (dBm) – Rx cable loss (dB) + Antenna gain at the remote unit (dBi) + Antenna gain at the local unit (dBi)

Calculating Rx Signal Level

The determinants in Rx signal level are illustrated in System planning. Below figure determinants in Rx signal level



Rx signal level is calculated as follows:

Rx signal level dB = Tx power − Tx cable loss + Tx antenna gain − free space path loss + Rx antenna gain − Rx cable loss

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:

System operating margin (fade margin) dB = Rx signal level dB – 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 Configuration Guide.

Planning for connectorized units

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 RF cable lengths required to achieve 1.2 dB loss at 5.8 GHz (source: Times Microwave). This data excludes connector losses.

Table 117: 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)

RF cable type	Minimum cable length
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)

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.

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.

When a DHCP server is not found

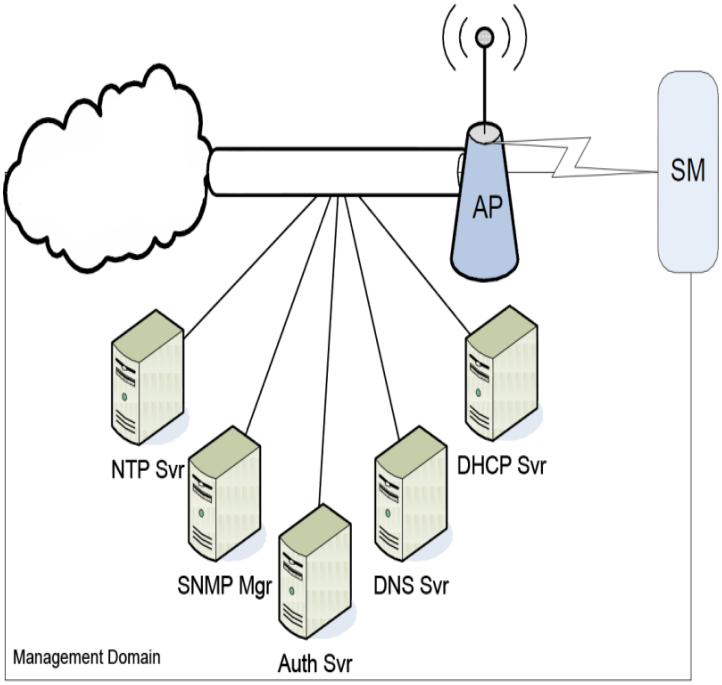
To operate on a network, a computer requires an IP address, a subnet mask, and possibly a gateway address. Either a DHCP server automatically assigns this configuration information to a computer on a network or an operator must input these items.

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 Cambium networks management domain). 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 58: *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 Example of IP address in Class B subnet, the first 16 bits of the 32-bit IP address identify the network:

Figure 59: *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.

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 118: 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 VLAN filters in point-to-multipoint modules.

Table 119: VLAN filters in point-to-multipoint modules

Where VLAN is active, if this parameter value is selected ...	then a frame is discarded if...		because of this VLAN filter in the software:
	entering the bridge/ NAT switch through...		
	Ethernet...	TCP/IP...	Ingress
any combination of VLAN parameter settings	with a VID not in the membership table		
any combination of VLAN parameter settings		with a VID not in the membership table	Local Ingress
Allow Frame Types: Tagged Frames Only	with no 802.1Q tag		Only Tagged

Allow Frame Types: Untagged Frames Only	with an 802.1Q tag, regardless of VID		Only Untagged
Local SM Management: Disable in the SM, or All Local SM Management: Disable in the AP	with an 802.1Q tag and a VID in the membership table		Local SM Management
	leaving the bridge/ NAT switch through...		
	Ethernet	TCP/IP	
any combination of VLAN parameter settings	with a VID not in the membership table		Egress
any combination of VLAN parameter settings		with a VID not in the 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 96 Q-in-Q Ethernet frame.

Table 96 Q-in-Q Ethernet frame

Ethernet Header	S-VLAN EthType 0x88a8	C-VLAN EthType 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

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).

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 HTTPS security material is available.

Table 120: 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 usernames 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 an 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

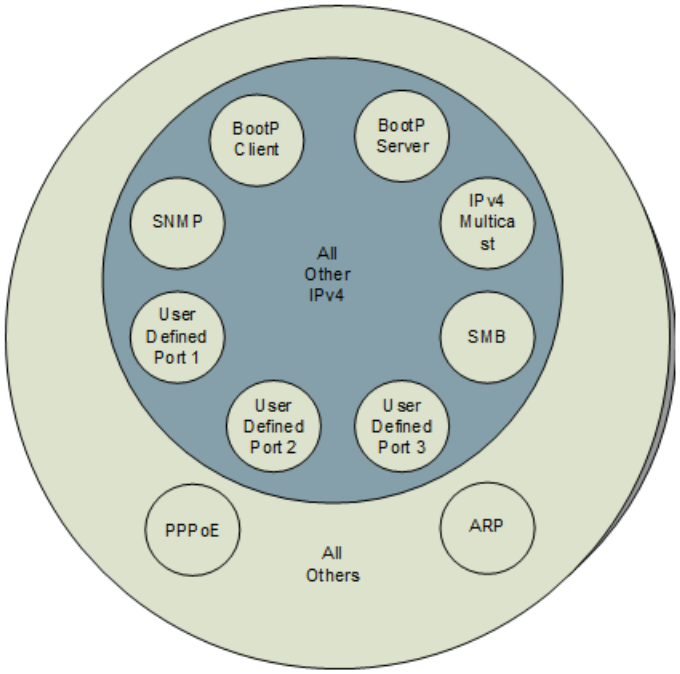
Where NAT is disabled on the SM/BHS, the filtering can be enabled for both protocols and the three user-defined ports. Using the check boxes on the interface, it can be either:

- 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
- 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
- Filter Direction – Upstream and Downstream
- ARP (Address Resolution Protocol)

Figure 60: *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 Ports filtered per protocol selections.

Table 121: Ports filtered per protocol selections

Protocol Selected	Port Filtered (Blocked)
SMB	Destination Ports UDP: 137, 138, 139, 445, 3702 and 1900 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

Protocol Selected	Port Filtered (Blocked)
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 122: 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 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.

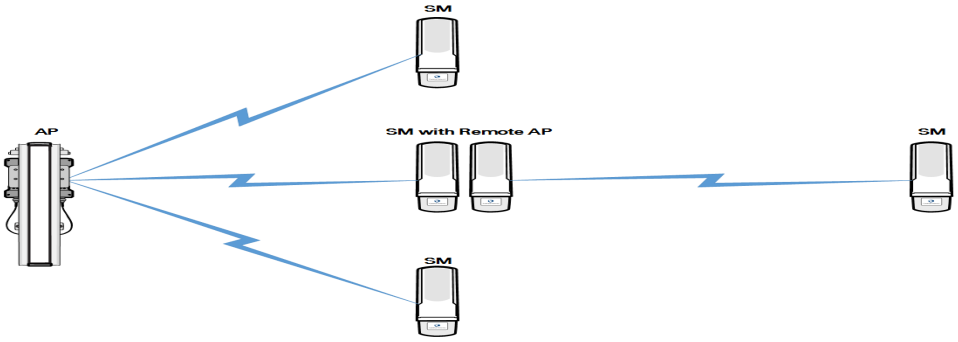
Remote AP Deployment

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 Remote AP deployment.

Figure 61: *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

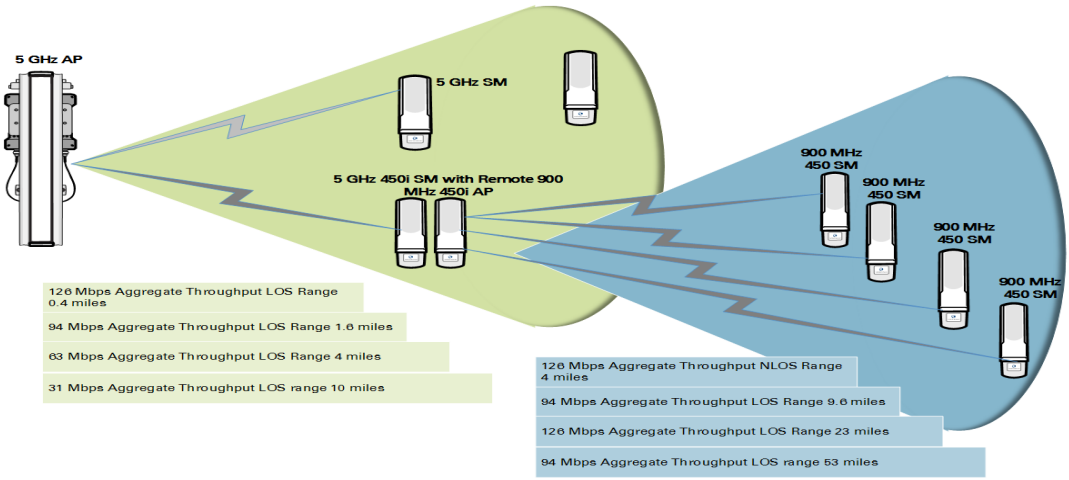
A remote AP can be used to provide last-mile access to a community where RF obstructions prevent SMs from communicating with the higher-level AP in cluster. For example, you may be able to use 900 MHz for the last mile between a remote AP and the outlying SMs where these subscribers cannot form good 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 Example for 900-MHz remote AP behind 5 GHz SM.

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 62: *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[1] 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

Examples of passing sync over cable are shown under Passing Sync in an Additional Hop.

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 Pins7 and 8 of the RJ-45 timing ports of the two modules.

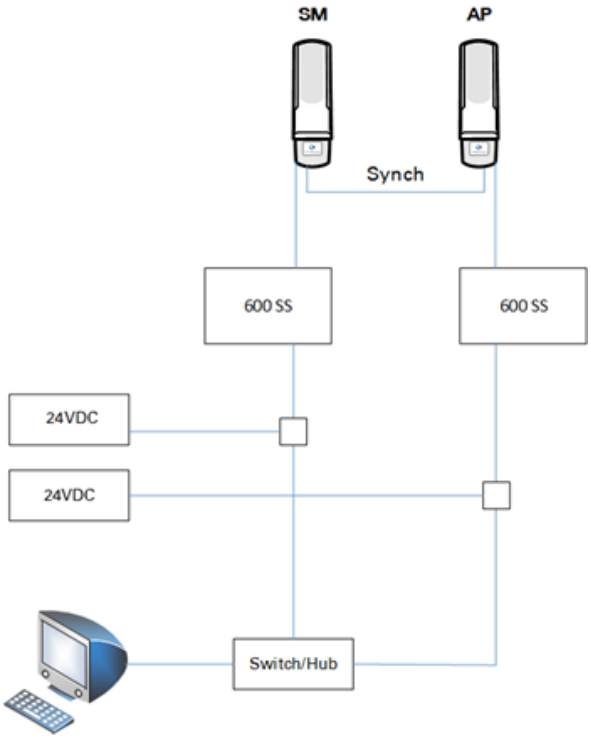
When connecting modules in this way, make sure the AP and SM are properly configured, as described in the Wiring to Extend Network Sync.

1

Physical Connections Involving the Remote AP

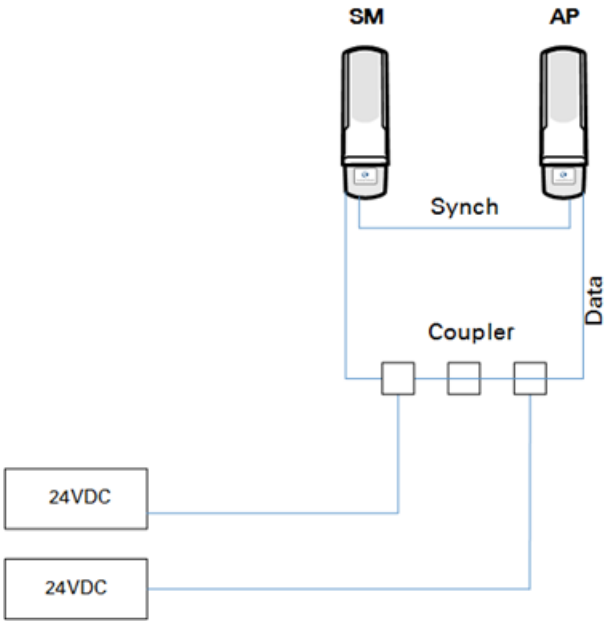
The SM to which a remote AP is connected to can be either an SM that serves a customer or an SM that simply serves as a relay. If the SM serves a customer, wire the remote AP to the SM as shown in Remote AP wired to SM that also serves a customer.

Figure 63: *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 Remote AP wired to SM that serves as a relay.

Figure 64: *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:

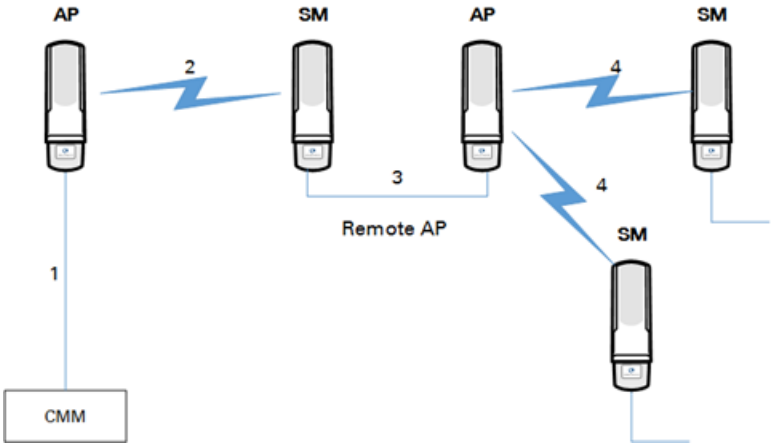
Note

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 Additional link to extend network sync, Design 3.

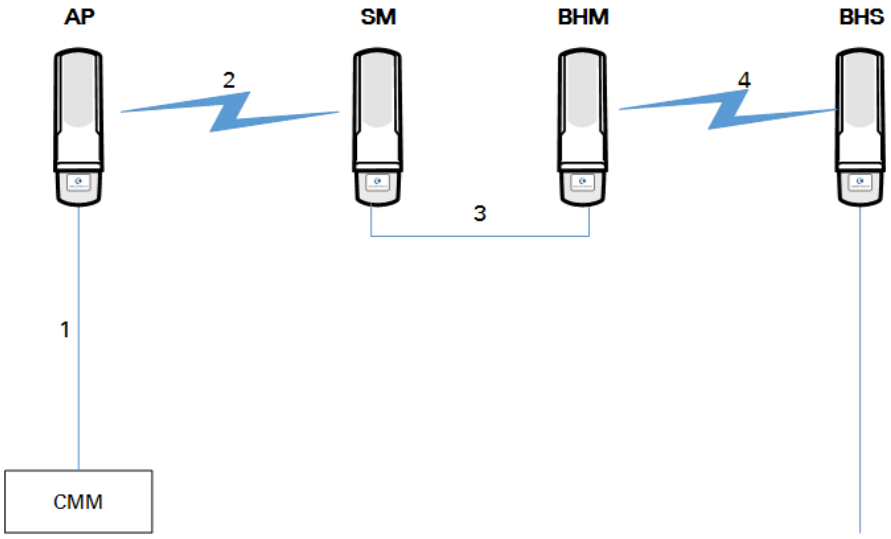
Figure 65: *Additional link to extend network sync, Design 3*



- 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 Additional link to extend network sync, Design 4.

Figure 66: *Additional link to extend network sync, Design 4*

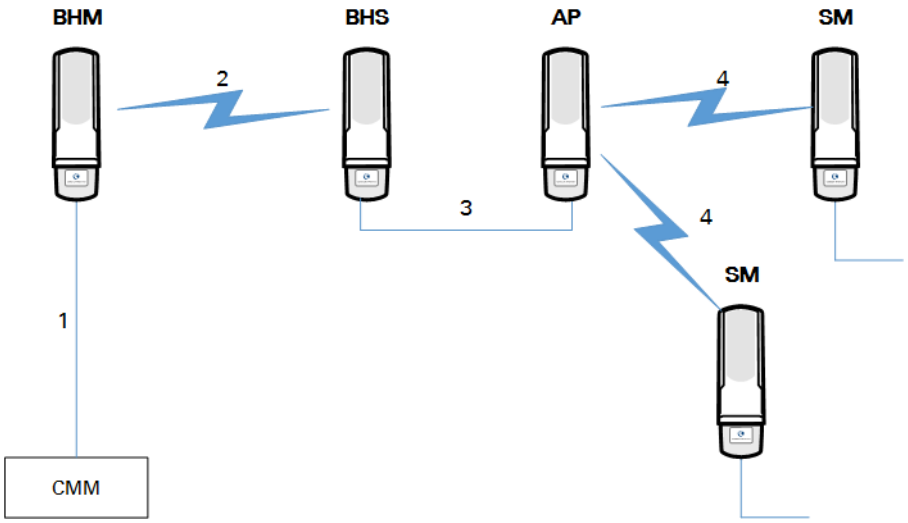


- **Design 5**
  - A CMM provides sync to a co-located BHM or the BHM generates timing.
  - This BHM sends the sync over the air to a BHS.
  - This BHS delivers the sync to a co-located AP.

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

This design is illustrated in Additional link to extend network sync, Design 5.

Figure 67: *Additional link to extend network sync, Design 5*



Wiring and configuration information for this sync extension is described under Wiring to Extend Network Sync.

Wiring to Extend Network Sync

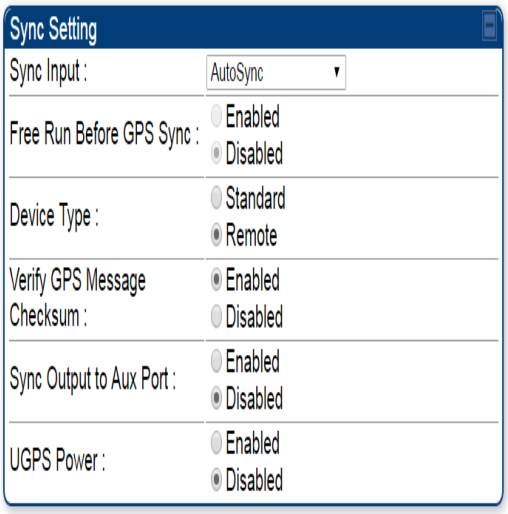
The following procedure can be used to extend network sync by one additional hop, as described under Passing Sync in an Additional Hop. When a co-located module receives sync over the air, the co-located modules can be wired to pass the sync as follows:

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 68: *Co-located AP or BH timing master Sync Setting configuration*



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.

Chapter 4: Preparing for installation

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

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

Safety

Hazardous locations

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.

Siting of ODU and soundness of structure

- Ensure that the Outdoor Unit (ODU) and the structure to which it is mounted can withstand the maximum wind speeds at a proposed site.
- See windloading guidance in ODU wind loading on page 1.

Working at heights and near power lines

- Exercise extreme care when working at heights.
- Observe national 'working at heights' regulations. Use trained competent staff.
- Exercise extreme care when working near power lines.

Power supply and power safety

- Always use a Cambium specified 450 Platform Family power supply unit (PSU) to power the ODU. Failure to use a Cambium supplied PoE could result in equipment damage and may cause a safety hazard.
- Ensure the equipment is not powered during installation.

- Always power down and disconnect the equipment from its power source before servicing.
- The ODU power supply is the primary disconnect device.

External cables

- Use outdoor rated cables for connections that will be exposed to the outdoor environment.
- Install Cambium recommended 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

Harmful levels of RF radiation are present close to the antenna when the transmitter is on.

- Observe the minimum safe distance limit for 450 products, see the Product leaflet or Configuration guide
- Ensure that equipment is installed in a position avoiding any radiation hazard to humans.
- Always turn off the power to the ODU before undertaking maintenance activities in front of the antenna.
- The units start to radiate RF energy as soon as they are powered up.

Grounding and lightning protection requirements

Structures, equipment and people must be protected against electrostatic discharge: -

- By siting ODU equipment in a lightning protection zone
    - 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 1.
    - Mounting in Zone A may put equipment, structures and life at risk.
- By installation of appropriate lightning conductors to conduct the surge current to ground via a separate preferential solid path.
- Ground bonding and transient voltage surge suppression is recommended. Use Cambium specified surge suppressors.
- Grounding conductor runs are as short, straight and smooth as possible, with bends and curves kept to a minimum.
    - 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 cables must not be installed with drip loops.
- 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.

Ensure that the installation meets the requirements defined in Grounding and lightning protection on page 1.

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.

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 1.

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.

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.

Preparing for installation

ODU pre-configuration

It is common practice to pre-configure the units during staging before site installation by performing the following tasks as explained in Configuration Guide.

- 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 1.
- 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 Configuring the management PC.

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 1

ODU diagnostic LEDs

See section AP/BHM LEDs on page 1.

- See section 5 GHz 450b BHM LED descriptions

LED	Color when active	Status information provided	Notes
POWER	Blue	DC power	Always lit after 10-20 seconds of power on.
SYNC	Green	Presence of sync	-
SES	Yellow	Unused	-
GPS	Red	Pulse of sync	Lit when the BHM is getting a sync pulse from a GPS source goes along with SYNC.
ETH	Red/Green/ Orange (multi-colored for 10/100/1000).	Presence of data activity on the Ethernet link	Lit when link is present: 10Base-T = Red 100Base-T = Green 1000Base-T = Orange Flashes during data transfer. Frequency of flash is not a diagnostic indication.

Table 123: 3 GHz 450b BHM LED descriptions

LED	Color when active	Status information provided	Note
POWER	Blue	DC power	Always lit after power on
ETH	Red / Green / Orange	Flashes in presence of data activity on the Ethernet link	10Base-T = Red 100Base-T = Green 1000Base-T = Orange
SES/ SYN	Yellow / Green	Sync status: - Generating sync = Yellow Receiving sync = Green Solid = Unit transmitting Blinking = Unit synchronized, but not transmitting	-

Recommended Tools for Installation

The following tools may be needed for installation:

Table 124: Tools for PMP and PTP 450 Platform ODU installation

Equipment to Be Installed	Tools Required
AP or BHM	• 3 mm Allen Wrench Used for connecting the antenna mating bracket to the rear of the AP housing • Crescent Wrench Pair

Equipment to Be Installed	Tools Required
	Used for tightening cable glands • Self-amalgamating and PVC Tape Used for weatherproofing N-type connections
AP or BHM or BHS Antenna	• 13 mm Spanner Wrench (or Ratchet Spanner Wrench) Pair Used for connecting the antenna (sector or omni for AP, or directional for BH) base to the pole/mast mounting bracket • Self-amalgamating and PVC Tape Used for weatherproofing N-type connections • N-type Torque Wrench (not required but recommended) Used for assuring proper tightening of N-type connectors terminating the RF cables
SM	• Wrench/driver (depending on operator's choice of clamps) Used for tightening clamps to the pole • Alignment tone adapter / headset Used for aligning the SM to the AP
Universal Global Positioning System	• Philips Screwdriver Used for attaching the UGPS unit to the pole/mast mounting bracket • 13mm Spanner Wrench (or Ratchet Spanner Wrench) Used for connecting the mounting bracket's U-bolt to the antenna or mast
Cabling	• Electrician's Scissors or Wire Cutters Used for cutting wire to length • RJ-11/RJ-45 Crimping Tool Used for stripping RJ-11/RJ-45 cables and for terminating cable ends • Cable Testing Device Used to ensure that cables are properly constructed

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:

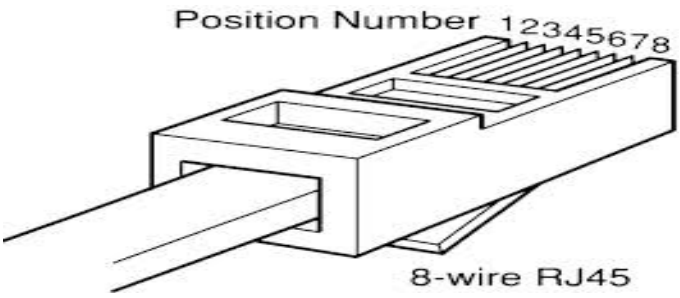
- Use only shielded cables to resist interference.
- For vertical runs, provide cable support and strain relief.
- Include a 2-ft (0.6-m) service loop on each end of the cable to allow for thermal expansion and contraction and to facilitate terminating the cable again when needed.
- Include a drip loop 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 69: *Pin 1 location*



Main port pinout

Table 125: Main port pinout

RJ45 pin	Description
1	+TxRx0
2	–TxRx0
3	+TxRx1
4	+TxRx2
5	–TxRx2
6	–TxRx1

RJ45 pin	Description
7	+TxRx3
8	–TxRx3

Aux port pinout

Table 126: 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 70: *Straight-through Ethernet Cable*

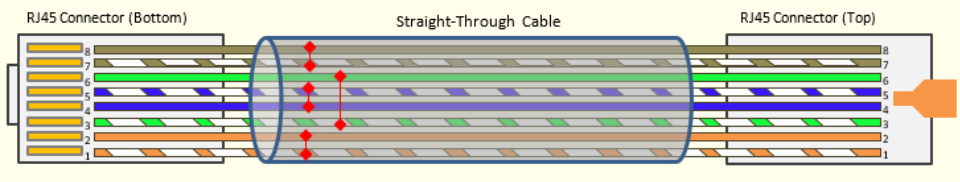


Table 127: RJ-45 pinout for straight-through Ethernet cable

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 71: *Crossover Ethernet Cable*

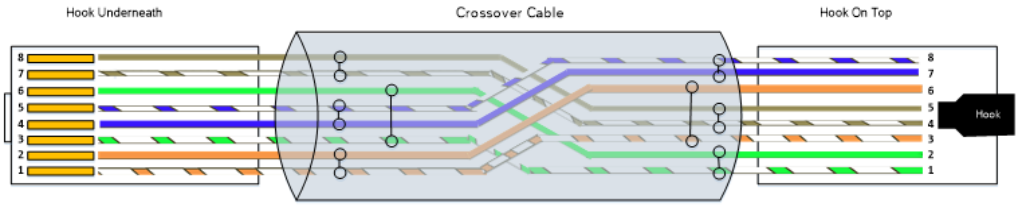


Table 128: RJ-45 pinout for crossover Ethernet cable

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 AP/BHM to UGPS cable pinout.

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 72: *AP/BHM to UGPS cable*

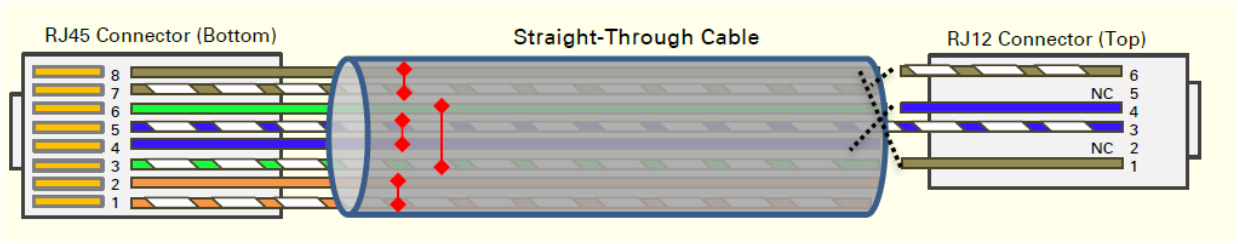


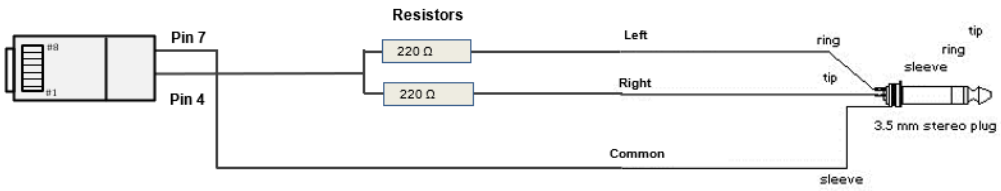
Table 129: AP/BHM to UGPS cable pinout

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 Alignment tone cable pin configuration

Figure 73: *Alignment tone cable pin configuration*



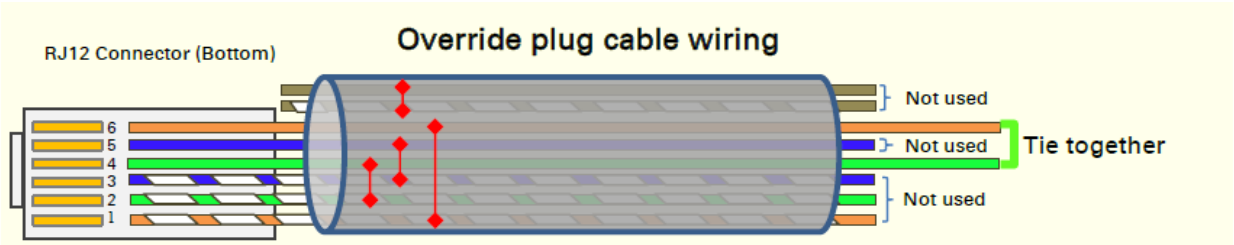
For more information, refer Aux port to alignment tone headset wiring.

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 74: *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.
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.

Using the Quick Start Configuration Wizard of the AP/BHM

See section Quick Link Setup section in Configuration Guide.

Chapter 5: 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 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 describes how to mount and ground an integrated or connectorized ODU, how to mount and ground the top LPU.
- Installation describes how to install the copper Cat5e power over Ethernet interface from the ODU to the PSU.
- Installing external antennas to a connectorized ODU describes how to install external antennas for a connectorized ODU.
- Installing ODU describes how to install PTP and PMP ODU radios.
- Installing the AC Power Injector describes how to install a power supply unit for the PMP/PTP 450 platform, either the AC Power Injector.
- Supplemental installation information 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.

ODU variants and mounting bracket options

Mounting bracket– PMP/PTP 450i Series

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

Table 130: 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.

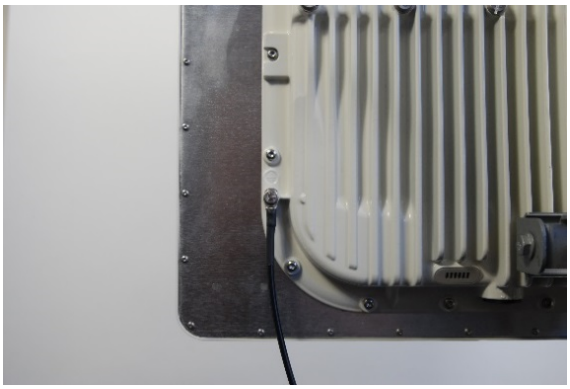
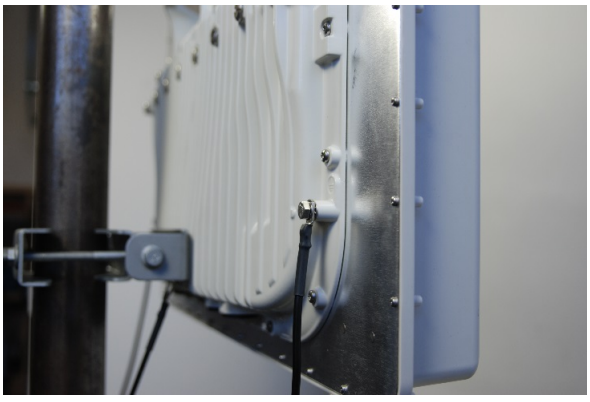
Mount the ODU, LPU and surge suppressor

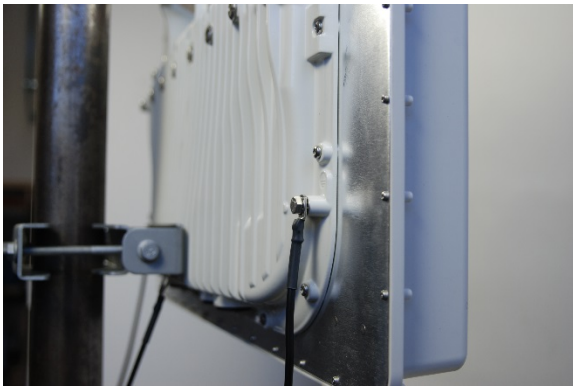
To install the ODU and top LPU, use the following procedures:

- Attach ground cables to the ODU
- Mount the ODU on the mast
- Mount the top LPU
- Mount the Surge Suppressor

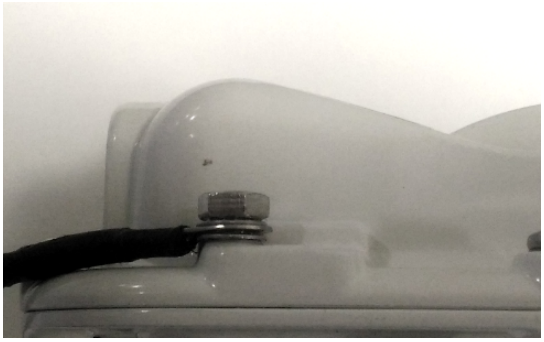
Attach ground cables to the ODU

PMP 450m Series – AP

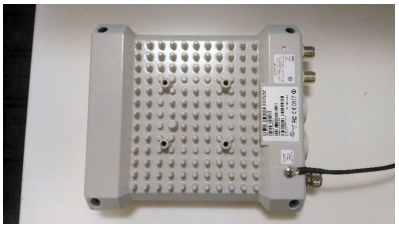
1	Fasten an AWG 10 (or 6mm^2) copper ground cable to each ODU grounding point using the M6 (small) lugs.	
2	Secure the M6 grounding bolts by applying 3 Nm torque.	

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

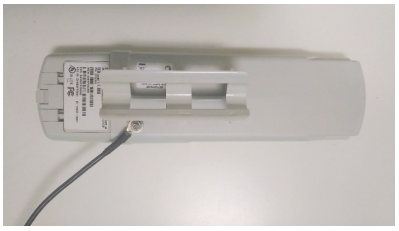
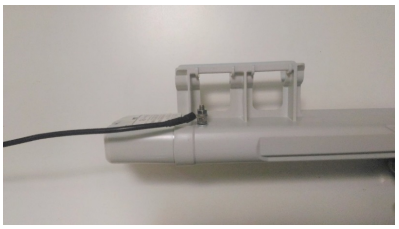
PMP/PTP 450i Series – AP/SM/BH, PMP 450 3 GHz Ruggedized SM

1	Fasten an AWG 10 (or 6mm^2) 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

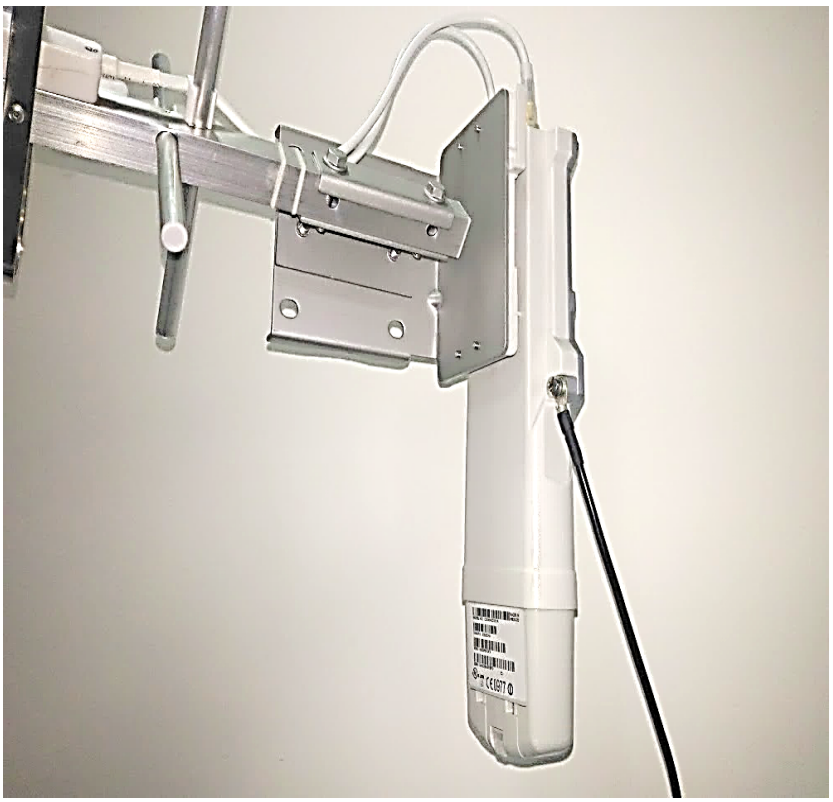
1	Fasten an AWG 10 (or 6mm^2) copper ground cable to each ODU grounding point using the M6 (small) lugs	
2	Tighten the Ground post locking nut in the copper wire	
3	Securely connect the copper wire to the grounding system (Protective Earth) according to applicable regulations.	

PMP 450 SM

1	Fasten an AWG 10 (or 6mm^2) 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.	

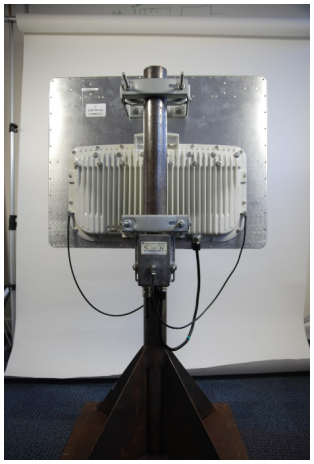
The grounding point on PMP 450 Series SM 900 MHz is different from 2.4, 3.5/3.65 and 5 GHz PMP 450 SMs as shown in PMP 450 900 MHz SM grounding.

Figure 75: *PMP 450 900 MHz SM grounding*



Mount the ODU on the mast

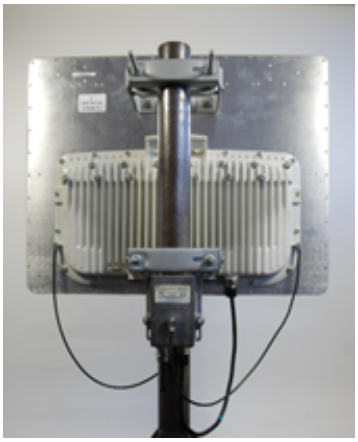
PMP 450m Series – AP

1	See - PMP 450m Series – 5 GHz AP 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	
5	Secure the bolts on four sides by applying 8 Nm torque as per the angle of the antenna.	

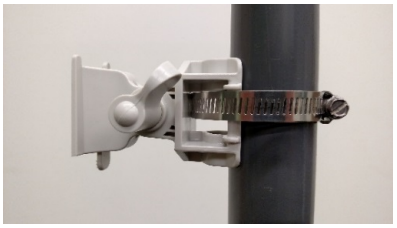
PMP/PTP 450i Series – AP/SM/BH, PMP 450 3 GHz Ruggedized SM

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

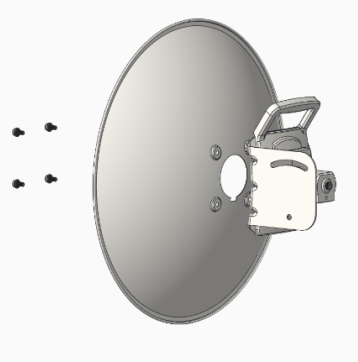
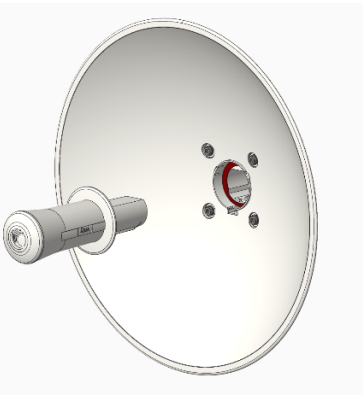
1	Use a stainless-steel hose clamp for the attachment.	
2	Attach the mounting bracket to the structure with the release tab facing downward. Tighten the hose clamp.	
3	Slide the 450b SM onto the mounting bracket. Press downwards until it clicks into place.	
4	Loosen the adjuster wingnut on the bracket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

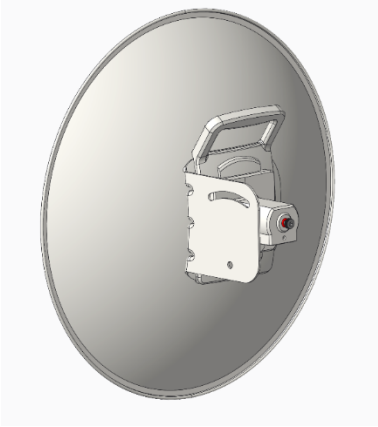
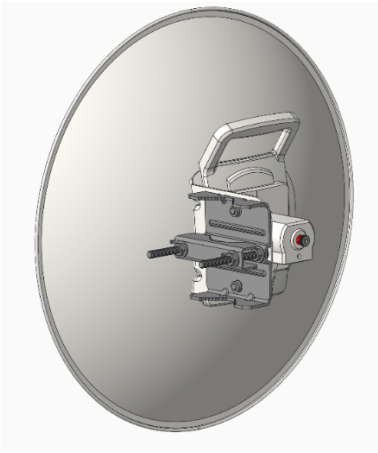
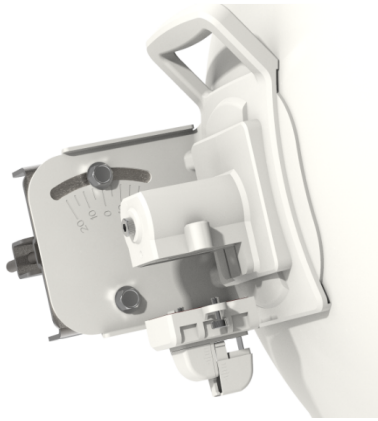
PMP 450b High Gain – IP55 Version

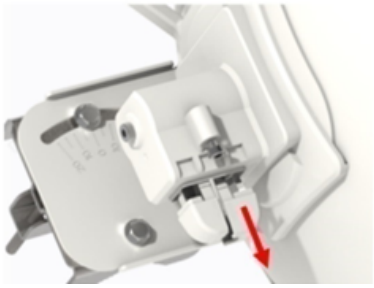
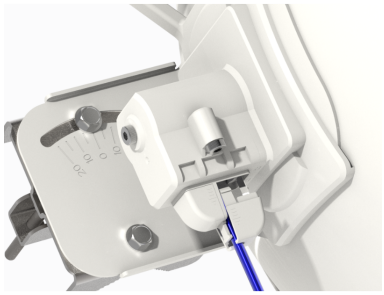
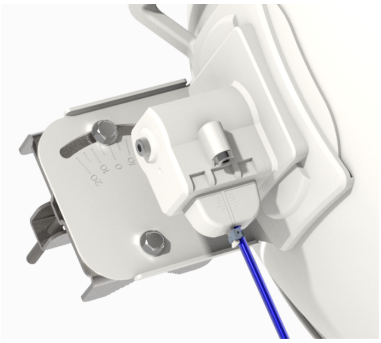
The 450b High Gain unit is supplied as an IP55 version from Q4 2019. Follow the assembly instructions below for the IP55 version. Conversion of an IP55 unit to IP67 requires the purchase of kit N000000L135A and assembly instructions are covered in subsequent sections.

Tools required are:

- 5mm Allen key
- 13mm wrench
- Torque wrench

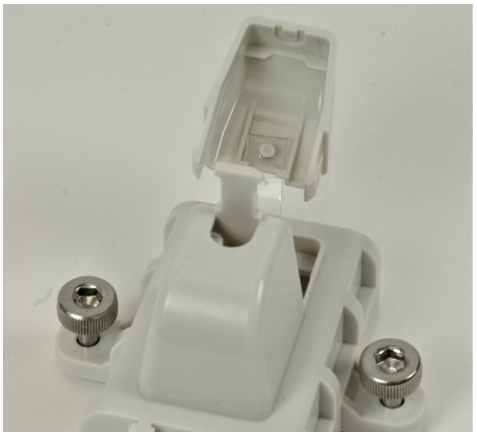
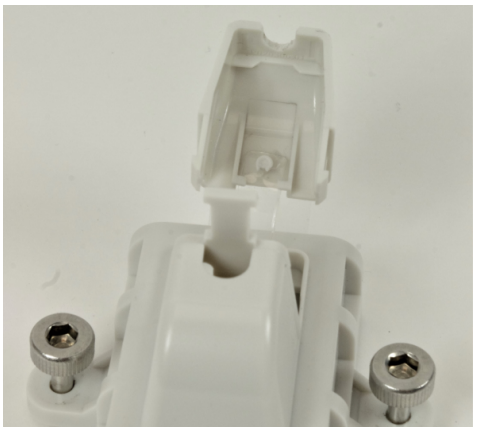
1	Snap in the rear housing assembly.	
2	Insert screws to hold the rear housing assembly to the dish and tighten to a 10 Nm torque.	
3	Snap in the center feed tube (radio) to the assembly.	

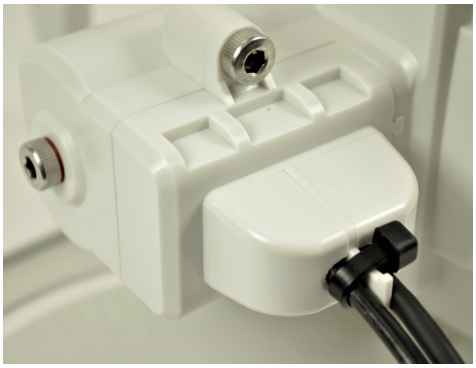
4	Tighten the center feed tube lock screw to a maximum of 5 Nm. Do not overtighten to avoid damaging the feed tube.	
5	Assemble the pole bracket to the Rear housing bracket, using the M8 bolts	
6	Slide the cover onto the body of the radio, ensuring that the two sliding rails engage with the slots in the dish body. Attach and tighten the two cover screws to the body. Tighten to 5 Nm torque.	

7	Unclip the door nearest the dish by squeezing at the two thumb marks.	
8	Connect the RJ45 connector to the radio and replace the door.	
9	Use a tie wrap to secure the Ethernet cable to center post of the cover.	
10	On the pole bracket, loosen the 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. After alignment, ensure that the two bracket bolts and two pole clamp nuts are tightened to 25 Nm.	

Fitting a synchronization cable to the aux port

For PTP Backhaul Master applications requiring synchronization, a synchronization cable may be fitted to the aux port as described below. Before installation of the 450b, prepare the cover as per the steps below:

1	Locate an IP55 cover from the dish kit.	
2	Unclip the rear door and locate the breakout.	
3	Use pincers to break out the piece of plastic and trim with a sharp blade. Check that synchronization cable fits the opening.	
4	Assemble unit as in steps 1 to 8 above.	
5	Connect the synchronization cable to the rear 3.5 mm jack socket and replace the door.	

6	Continue with steps 9 and 10 above ensuring both cables are secured to the center post with a tie wrap.	

PMP 450b High Gain – IP67

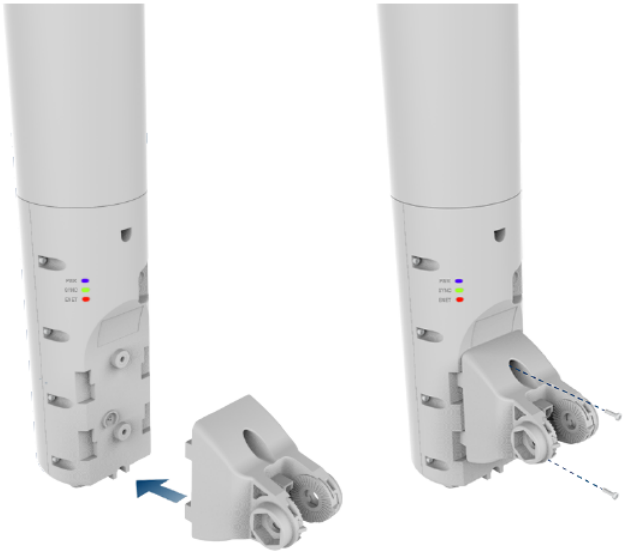
To convert an IP55 version of the PMP 450b High Gain to an IP67 version, kit N00000L135A is required. This kit contains 4 off IP67 door/ glands. Follow the fitting instructions 1-5 in section PMP 450b High Gain – IP55 Version above and then the steps below. Note that a permanent connection to the AUX port is not available when using this kit.

1	Locate an IP67 door/gland from kit N00000L135A.	
2	Remove the cable gland from bottom cover. Feed the RJ45 cable though the gland, bottom cover and connect to the radio.	

3	Keep part loose and screw gland to the bottom cover. Audio cable is not shown in the figure.	
4	Tighten gland, bottom cover screws and connect to the radio.	
5	On the pole bracket, loosen the 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. After alignment, ensure that the two bracket bolts and two pole clamp nuts are tightened to 25 Nm.	

PMP 450 MicroPoP - Omni

1. Assemble the pole mounting bracket to the radio with two screws.



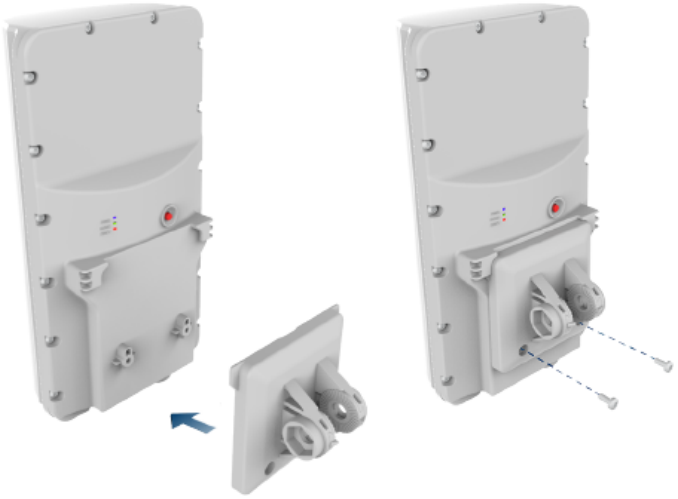
2. Secure pole mounting bracket to the radio with M8 nut and bolt by applying 3.0 Nm torque.

3. Insert hose clamps through the pole mounting bracket and attach to pole by applying 3.0 Nm torque.

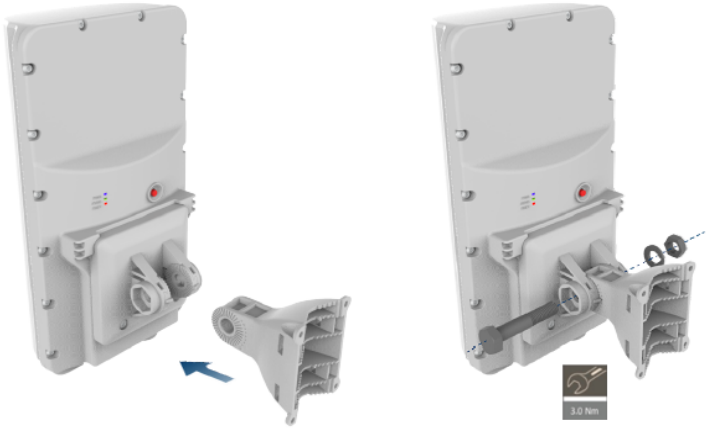
4. Remove the cable gland from bottom of the radio. Feed the RJ45 cable though the gland, bottom cover and connect to the radio.

PMP 450 MicroPoP - Sector

1. Assemble the pole mounting bracket to the radio with two screws.



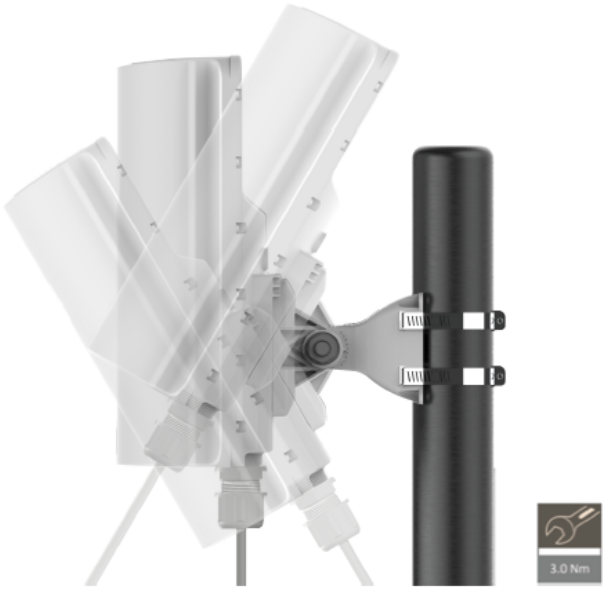
2. Secure pole mounting bracket with M8 nut and bolt by applying 3.0 Nm torque.



3. Insert hose clamps through pole mounting bracket and clamp to pole by applying 3.0 Nm torque.

4. Remove the cable gland from bottom of the radio. Feed the RJ45 cable though the gland, bottom cover and connect to the radio.

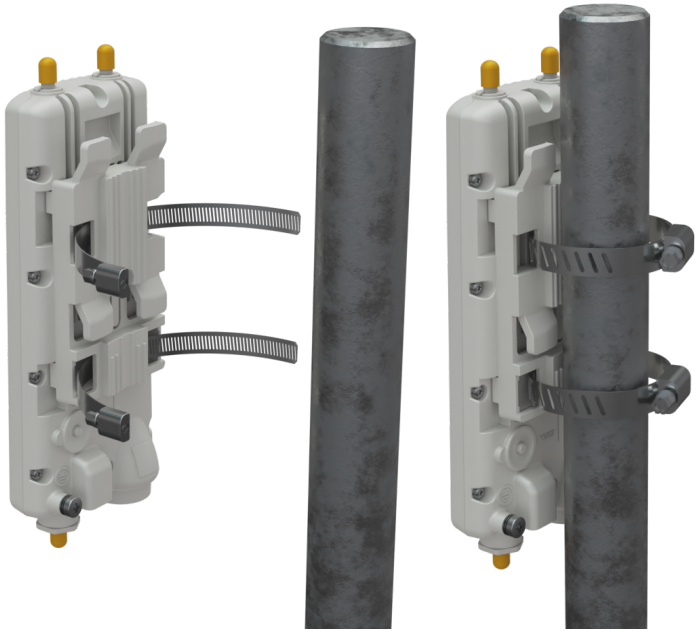
5. Align radio to required angle by tilting up and down. The maximum radio tilting angle is ±40°, with an incremental of 10°. Secure radio with max 5.0 Nm torque.



PMP 450 MicroPoP - Connectorized

1. Assemble the pole mounting bracket to the radio with two screws.
2. Secure pole mounting bracket to the radio with M8 nut and bolt by applying 3.0 Nm torque.

3. Insert hose clamps through the pole mounting bracket and attach to pole by applying 3.0 Nm torque.



4. Remove the cable gland from bottom of the radio. Feed the RJ45 cable though the gland, bottom cover and connect to the radio.

PMP 450b Retro

Pole Mount

1. Insert hose clamps on the device bracket and attach to the pole by applying 3.0 Nm torque.

2. Release the bottom cap and insert RJ45 cable on the bottom of the device.

3. Place the cap back on the device after the cable installation.

Dish Mount

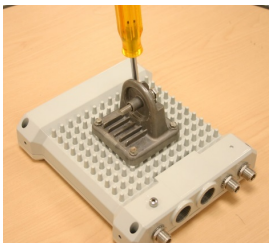
1. Slide the device into the dish slot as shown in the below figure.

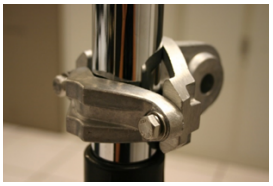
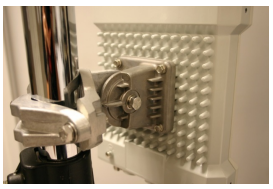
2. Insert hose clamps on the device bracket and attach to the dish by applying 3.0 Nm torque.

3. Release the bottom cap and insert RJ45 cable on the bottom of the device.

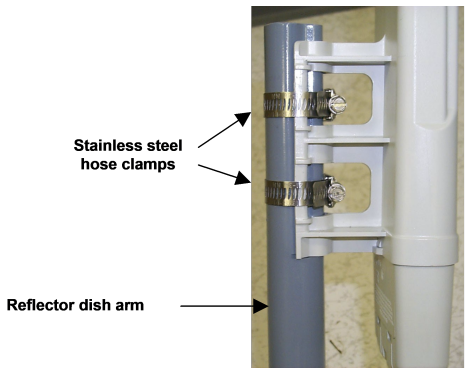
4. Place the cap back on the device after the cable installation.

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.	

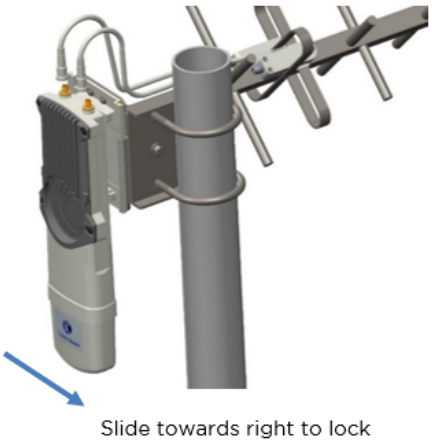
2	Using the included (depending on pole diameter): • M8 x 70mm hex cap bolts (2 quantity) or • M8 x 40mm hex cap bolts (2 quantity) and • M8 flat washers (2 quantity) • M8 coil washers (2 quantity) Attach the mounting bracket to the pole/mast. The mounting bracket is designed to attach to poles with 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)

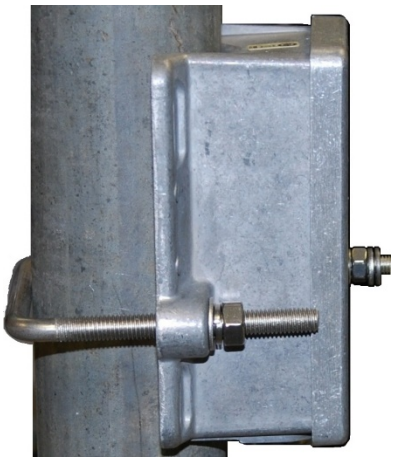
1	Use stainless steel hose clamps for the attachment.	
2	Attach the mounting bracket to the structure. Tighten the locking nut.	

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	

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 mm2 (10 AWG) stranded cable, max length 600 mm (24”). • Waterproof the cable lug with heat shrink sleeving. • 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 76: *Gigabit Ethernet Surge Suppressor*

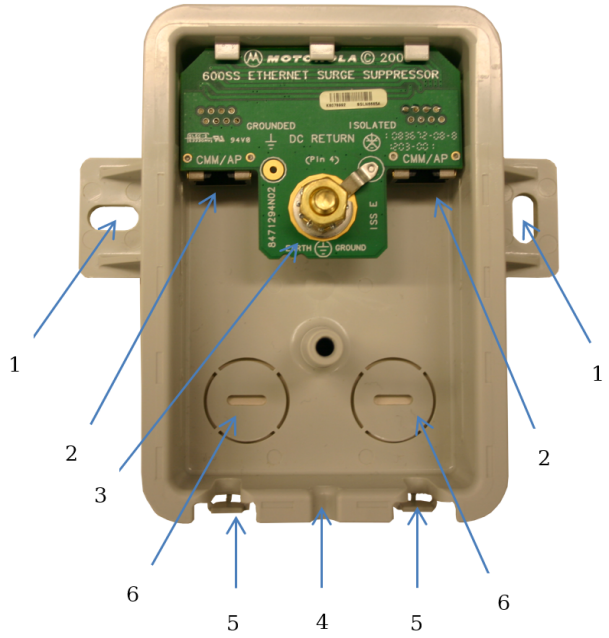
PMP/PTP 450 Series

The PMP/PTP 450 Series uses 600SSH Surge Suppressor. The inside of the surge suppressor is shown in Installation.

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 77: *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^2) copper wire for connection. Refer to local electrical codes for exact specifications.
4	Ground Cable Opening—route the 10 AWG (6 mm^2) 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^2) 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

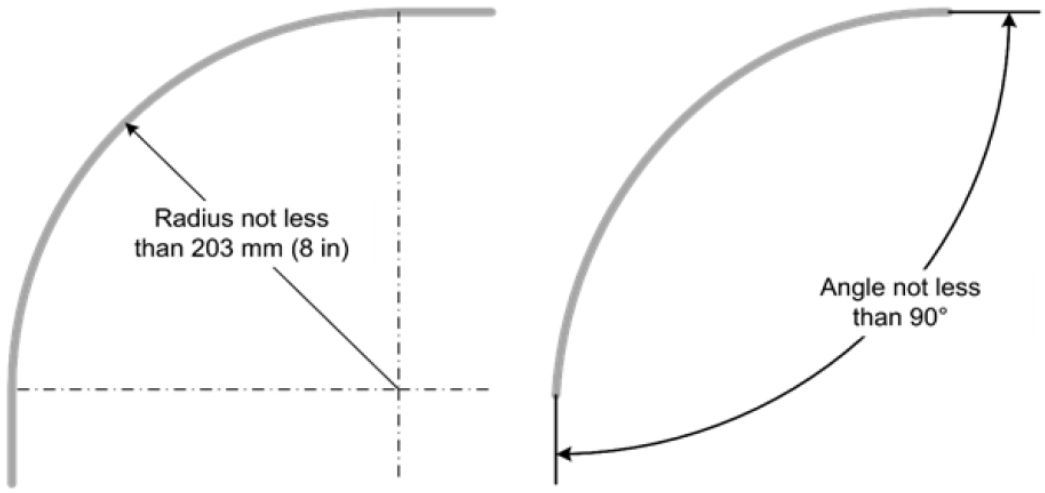
To adequately protect a 450 Platform Family installation, both ground bonding and transient voltage surge suppression are required.

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° (Installation). 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 78: *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).
- 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^2 csa (8AWG), preferably 16 mm^2 csa (6AWG), or 25 mm^2 csa (4AWG).

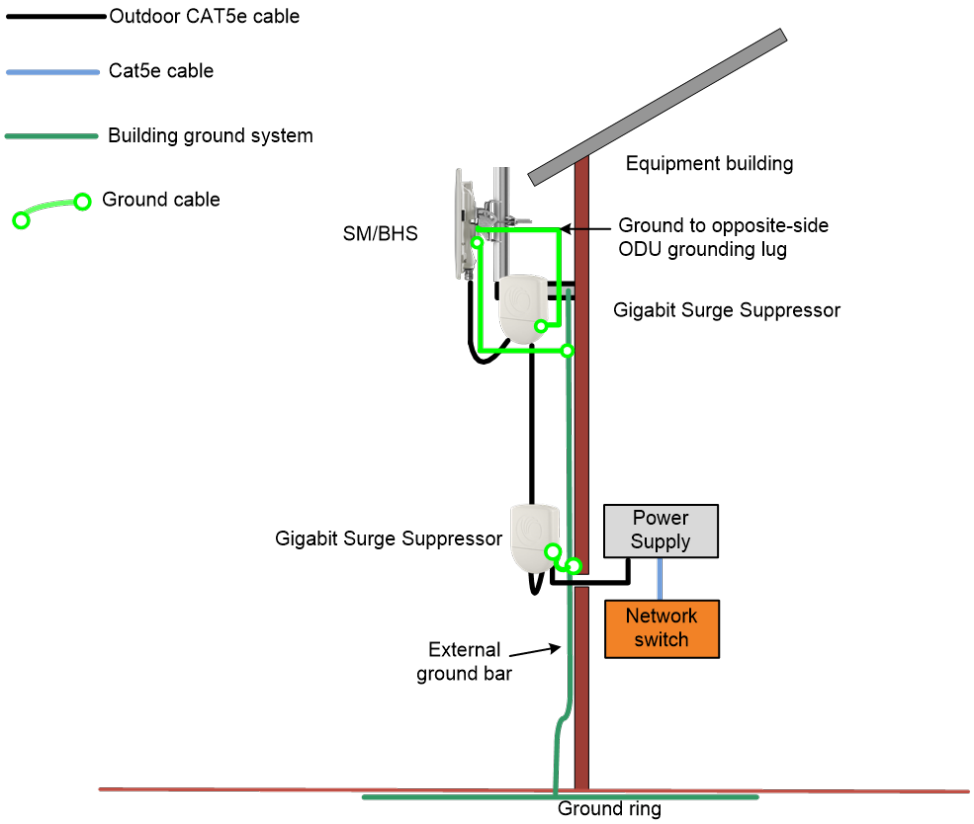
Protection requirements for a wall installation

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 Grounding and lightning protection on wall.

Figure 79: *Grounding and lightning protection on wall*



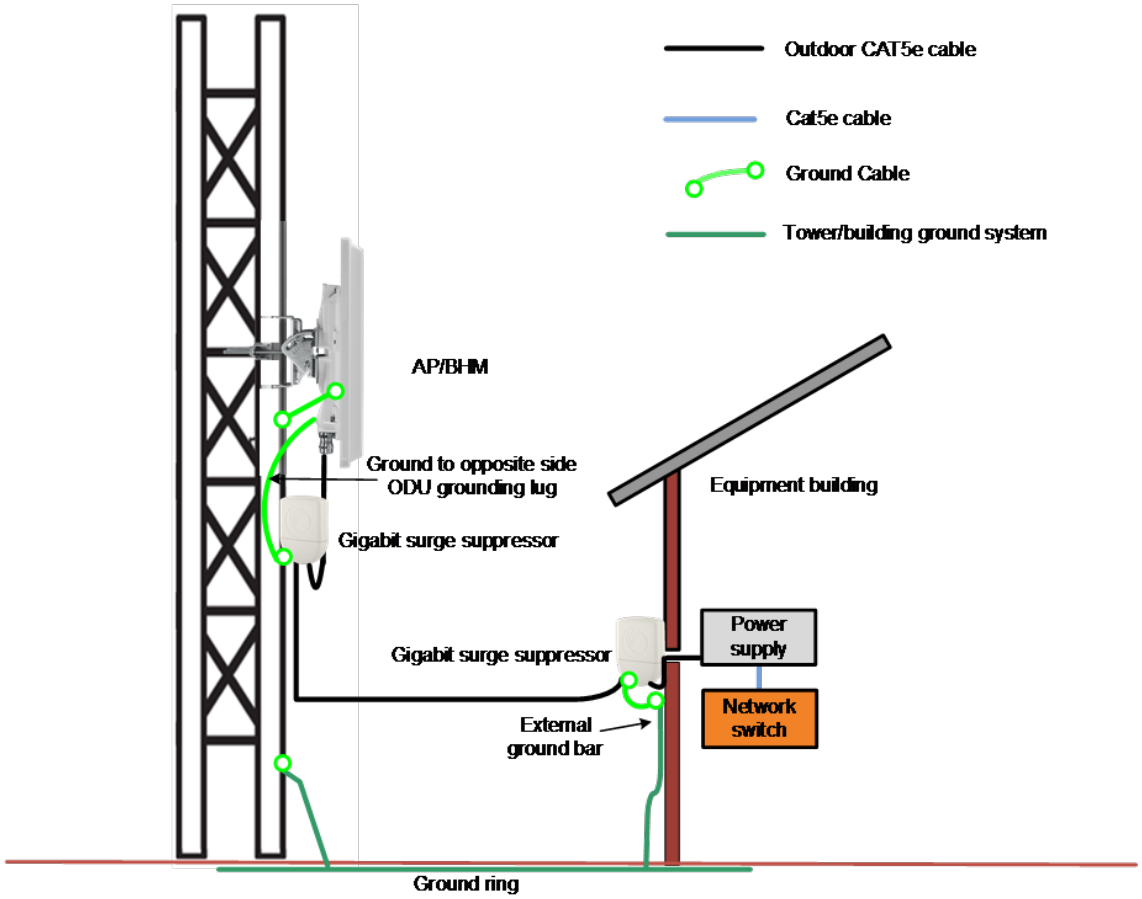
Protection requirements for a mast or tower installation

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 Grounding and lightning protection on mast or tower.

Figure 80: *Grounding and lightning protection on mast or tower*

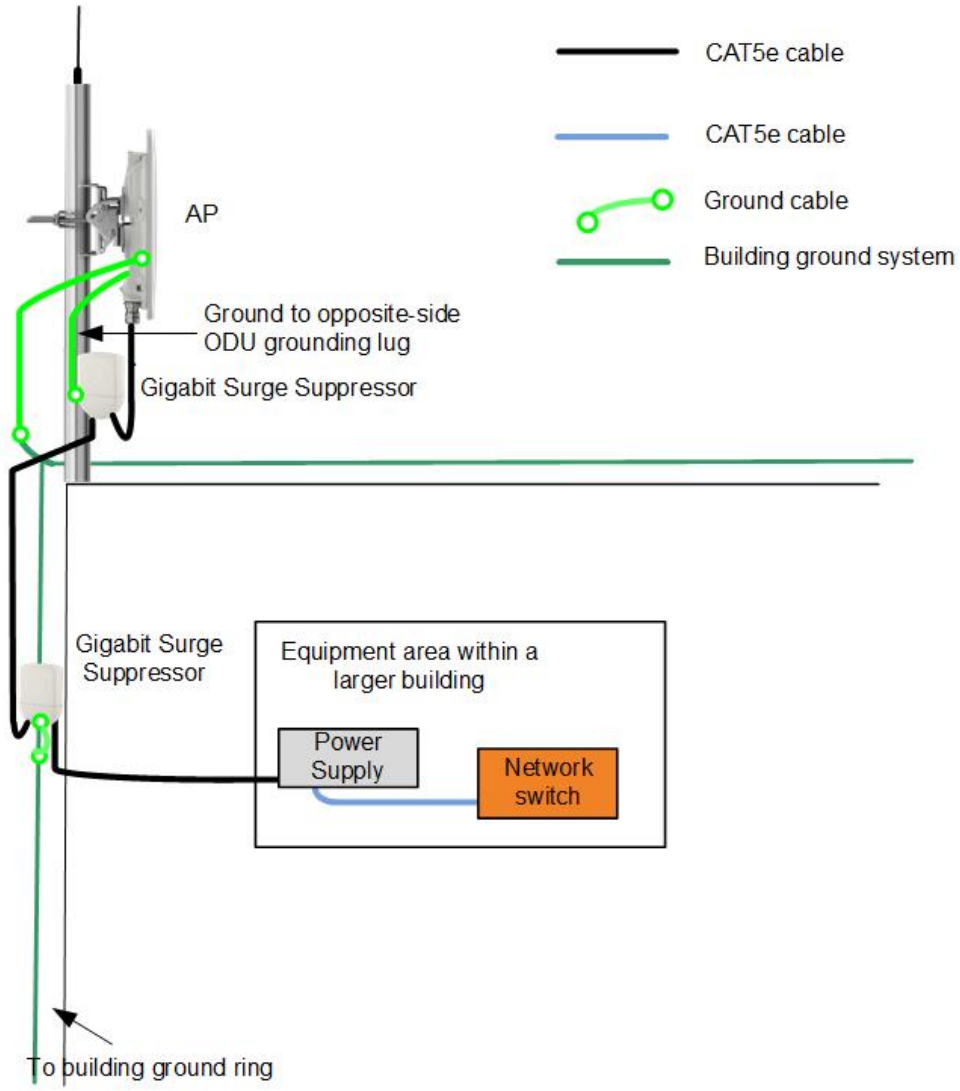


Protection requirements on a multi-floor building

If the ODU is to be mounted on a high-rise building, it is likely that cable entry is at roof level (Roof installation) 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 81: *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
- Install the bottom LPU to PSU drop cable
- Installing external antennas to a connectorized ODU

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.

Figure 82: *RJ45 connector and cable color code*

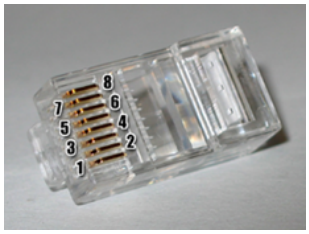
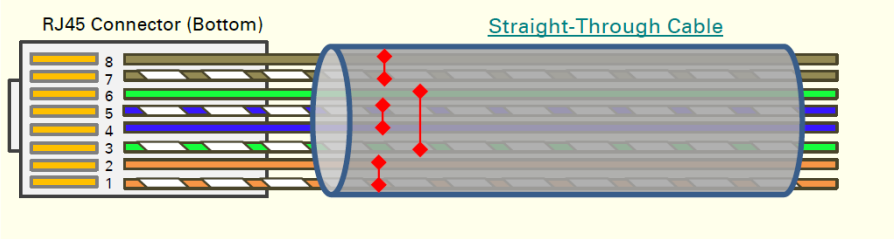
Pin	Color (Supplied cable)	Color (Conventional)	Pins on plug face
1	Light Orange	White/Orange	
2	Orange	Orange	
3	Light Green	White/Green	
4	Blue	Blue	
5	Light Blue	White/Blue	
6	Green	Green	
7	Light Brown	White/Brown	
8	Brown	Brown	

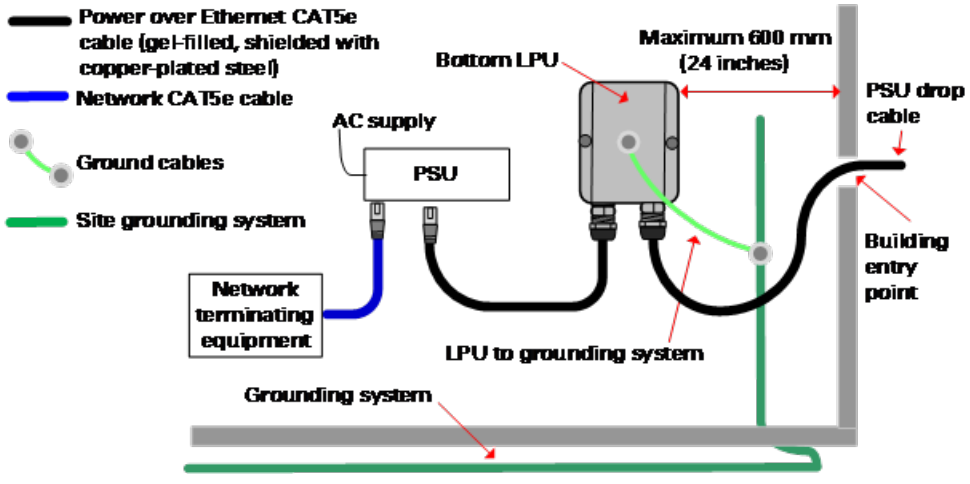
Figure 83: *RJ45 cable*

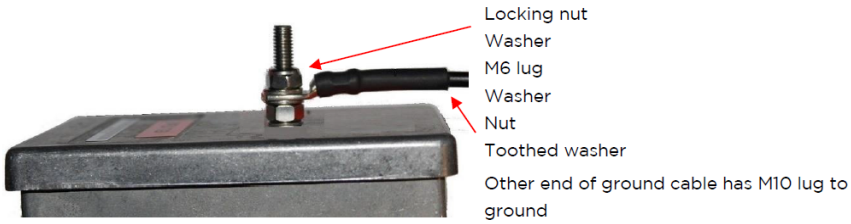


Install the bottom LPU to PSU drop cable

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.

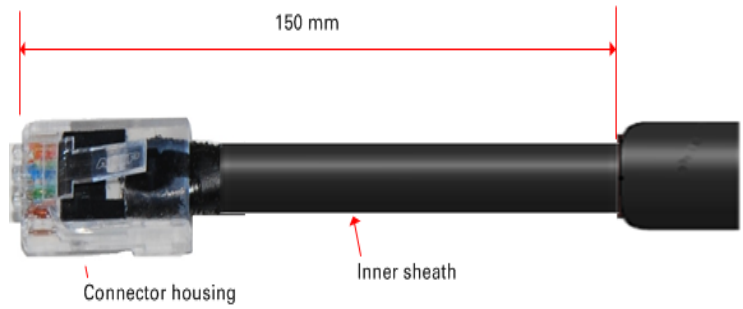
Warning

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.

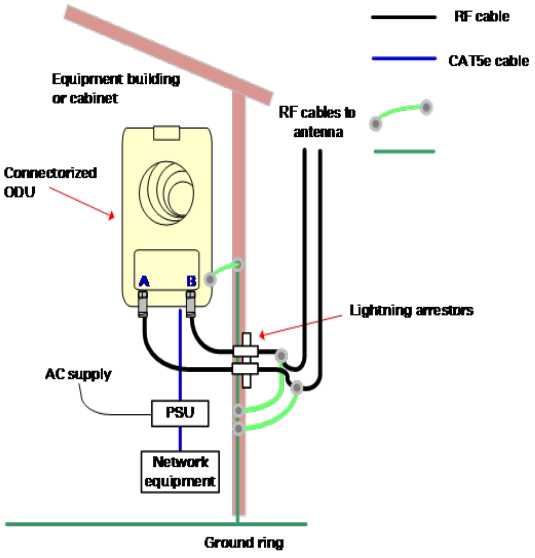
1	Cut the drop cable to the length required from bottom LPU to PSU.
2	At the LPU end only: • Fit one cable gland and one RJ45 connector by following the procedure Terminate with RJ45 connectors. • Connect this cable and gland to the bottom LPU.
3	At the PSU end only: Do not fit a cable gland. Strip the 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:

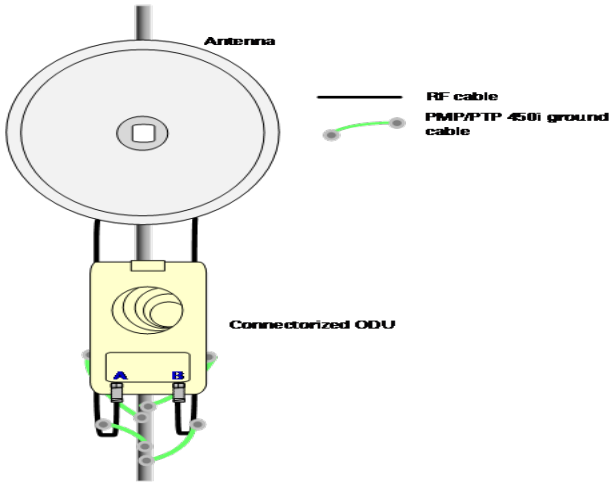


Installing external antennas to a connectorized ODU

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). 

7	Ground the antenna cables to the supporting structure within 0.3 meters (1 foot) of the ODU and antennas using the Cambium grounding kit (part number 01010419001): 
8	Fix the antenna cables to the supporting structure using site approved methods. Ensure that no undue strain is placed on the ODU or antenna connectors. Ensure that the cables do not flap in the wind, as flapping cables are prone to damage and induce unwanted vibrations in the supporting structure.

Note

A video on weatherproofing procedure can be found at:
https://www.youtube.com/watch?v=a-twPfCVq4A

Assembling the PMP 450i AP 5 GHz sector antenna and attaching to the radio

To assemble a PMP 450i Series AP antenna, perform the following steps.

Note

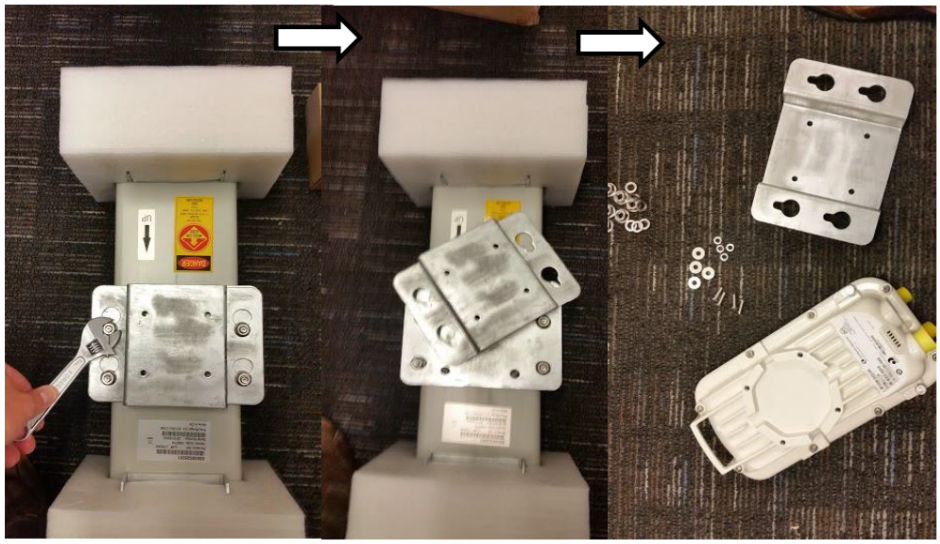
Cambium recommends assembling the antenna, attach the AP and cabling, and to seal the RF connections before installing the unit at the deployment site.

1. Inventory the parts to ensure that you have them all before you begin. The full set of parts is shown below.

Figure 84: *AP antenna parts*

2. Remove top plate from the antenna as shown in Antenna top plate.

Figure 85: *Antenna top plate*

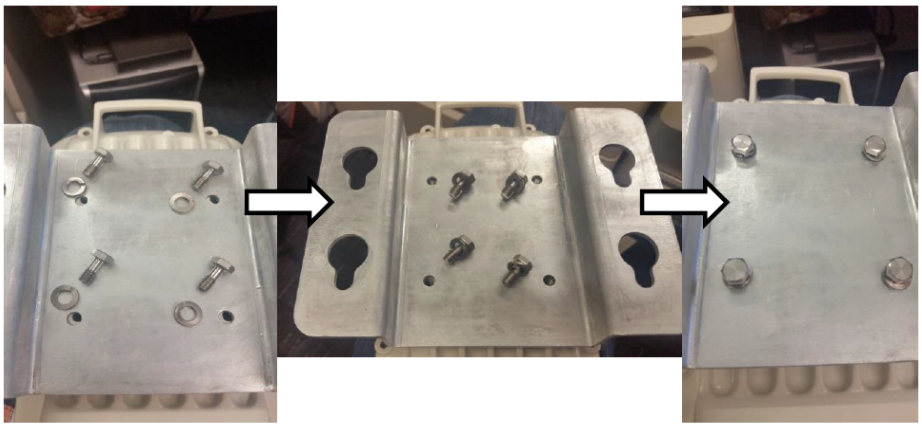


3. Attach the antenna plate to the AP as shown in Attaching antenna plate to the AP.

Note

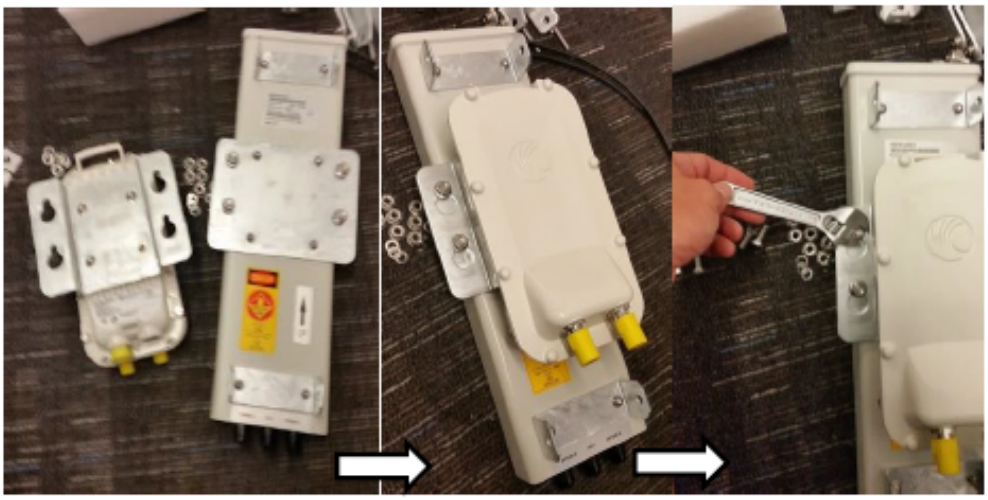
Please use the four “thin neck” M6 bolts and split washers provided with the connectorized units rather that the ones provided in the antenna kit.

Figure 86: *Attaching antenna plate to the AP*



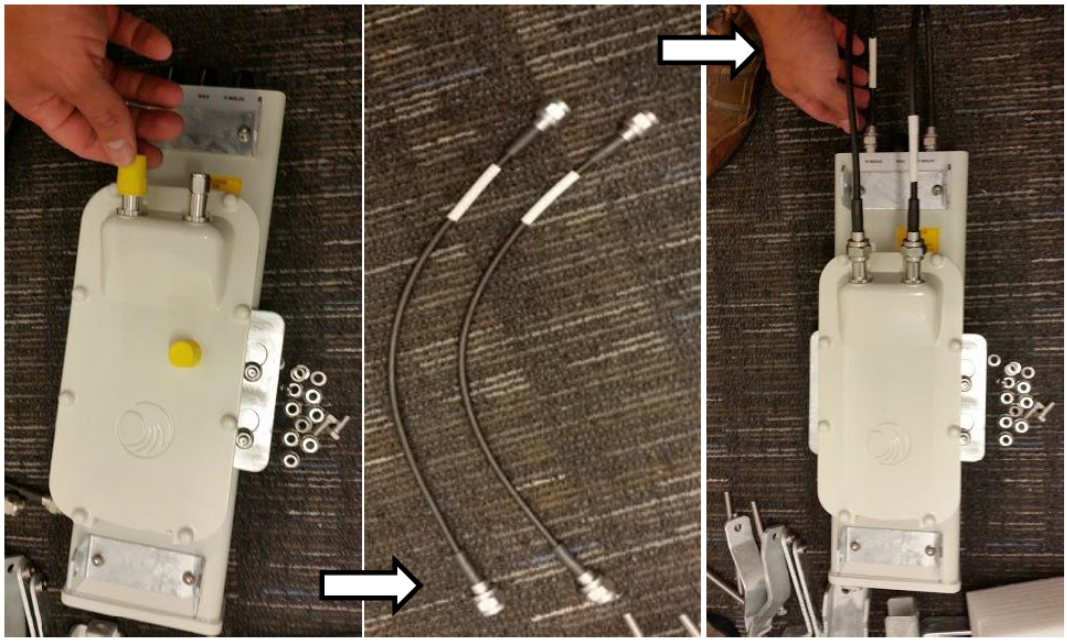
4. Attach the plate mounted AP to the antenna and tighten the (4) serrated flange nuts using a spanner wrench

Figure 87: *Attaching the plate*



5. Connect the port A of AP to vertical and port B of AP to horizontal polarization interfaces of the antenna with RF cable. Tighten the N type connectors to a torque setting of 1.7 Nm (1.3 lb ft).

Figure 88: *Connect the port A and B to the PMP 450i AP*

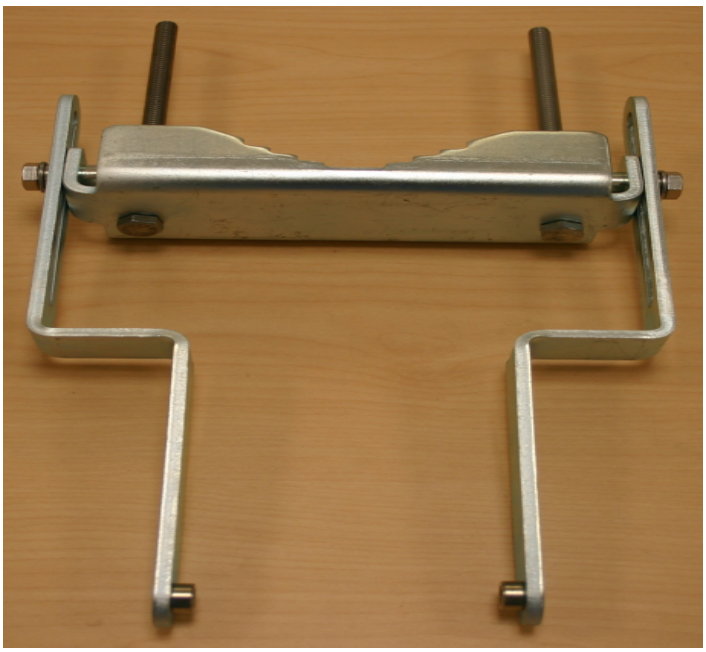


6. Assemble the upper bracket by attaching the (2) 7” hex bolts to the bracket using (2) serrated flange nuts

Figure 89: *AP antenna upper bracket assembly*

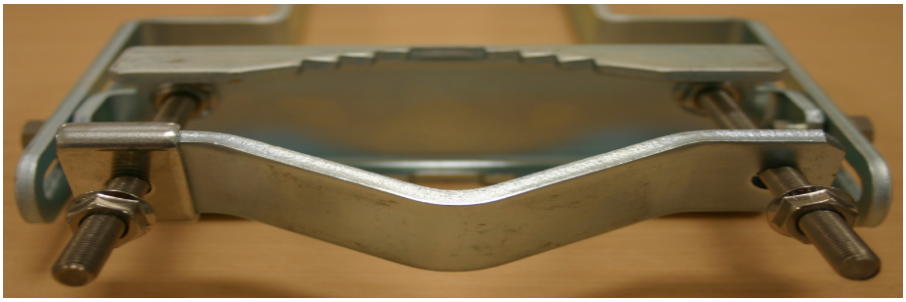
7. Attach the upper bracket to the adjustment arms using (2) hex bolts, (2) flat washers and (2) lock washers. Feed the bolt through the lock washer then flat washer, then thread the bolt into the upper bracket’s threaded receptacle.

Figure 90: *AP antenna upper bracket attached to upper adjustment arms*



8. Attach the rear strap to the upper bracket using (2) serrated flange nuts and (1) retaining bracket. Do not tighten the nuts now.

Figure 91: *Rear strap connected to upper AP antenna bracket*

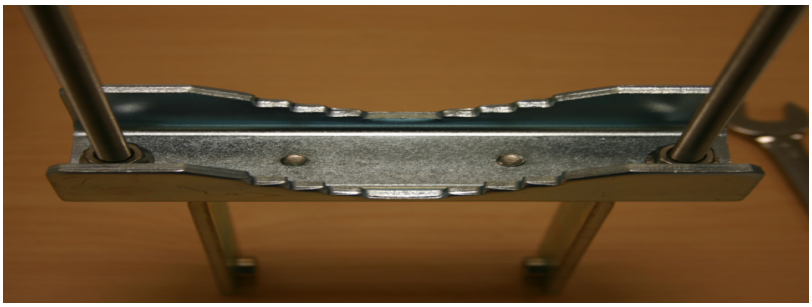


9. Attach the entire upper bracket to the antenna using (2) hex bolts, (2) flat washers and (2) lock washers. Feed the bolt through the lock washer then flat washer, then thread the bolt into the upper bracket's threaded receptacle.

Figure 92: *Assembled upper bracket connected to AP antenna*

10. Begin assembling the lower bracket by attaching the (2) 7” hex bolts to the bracket using (2) serrated flange nuts

Figure 93: *AP Antenna Lower Bracket Assembly*



11. Attach the rear strap to the bracket using (2) serrated flange nuts and (1) retaining bracket. Do not tighten the nuts now. Attach the entire lower bracket to the antenna using (2) hex bolts, (2) flat washers and (2) lock washers.

Figure 94: *Lower bracket attached to AP antenna*

Figure 95: *Completed AP and antenna assembly*

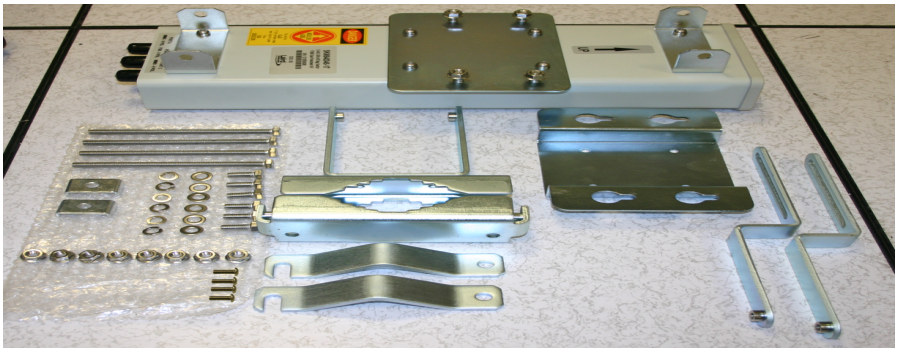
PMP 450 Series

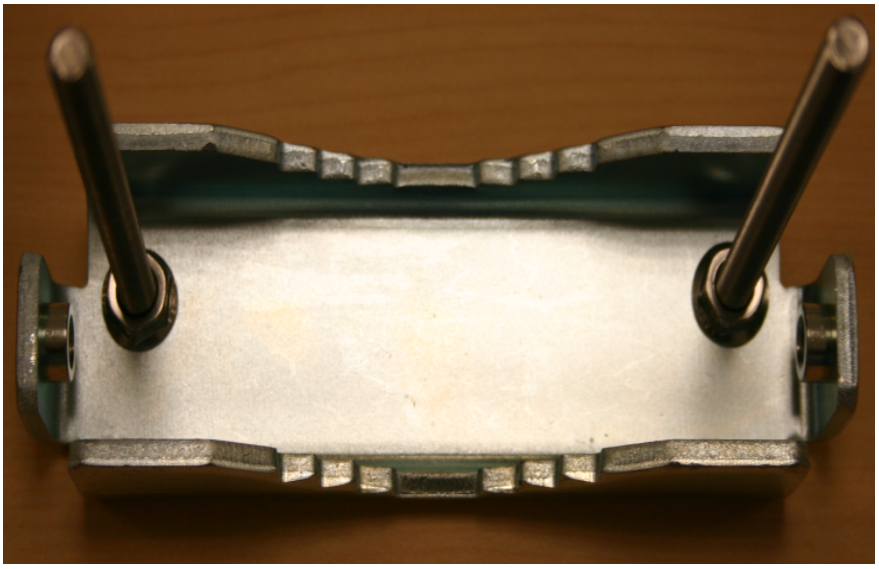
Assembling the PMP 450 AP antenna

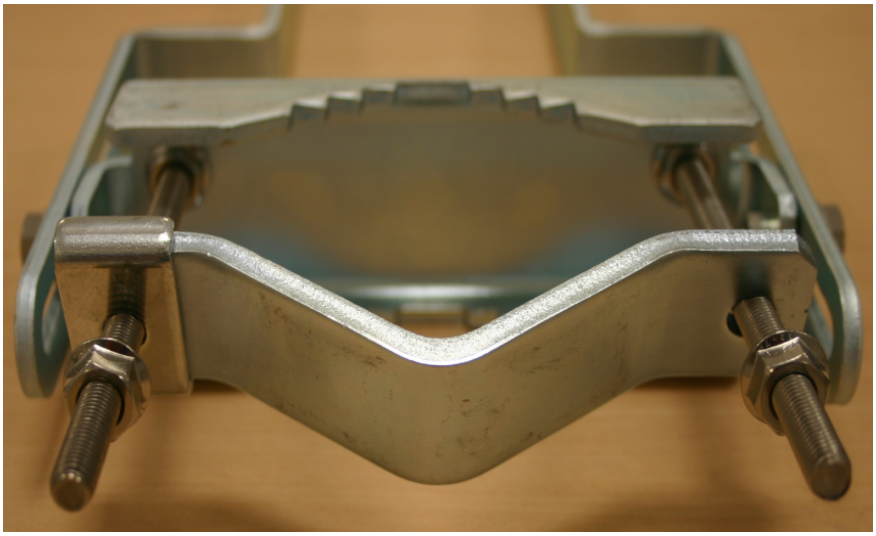
To assemble a PMP 450 Series AP antenna, perform the following steps.

Note

Cambium recommends assembling the antenna, attach the AP and cabling, and to seal the RF connections before installing the unit at the deployment site.

1	Inventory the parts to ensure that you have them all before you begin. The full set of parts is shown below. Figure 96: *PMP 450 AP antenna parts* 
2	Begin assembling the upper bracket by attaching the (2) 7” hex bolts to the bracket using (2) serrated flange nuts Figure 97: *AP antenna upper bracket assembly*

	
3	Attach the upper bracket to the adjustment arms using (2) hex bolts, (2) flat washers and (2) lock washers. Feed the bolt through the lock washer then flat washer, then thread the bolt into the upper bracket's threaded receptacle. Figure 98: *AP antenna upper bracket attached to upper adjustment arms* 
4	Attach the rear strap to the upper bracket using (2) serrated flange nuts and (1) retaining bracket. Do not tighten the nuts now. Figure 99: *Rear strap connected to upper AP antenna bracket*

	
5	Attach the entire upper bracket to the antenna using (2) hex bolts, (2) flat washers and (2) lock washers. Feed the bolt through the lock washer then flat washer, then thread the bolt into the upper bracket's threaded receptacle. Figure 100: *Assembled upper bracket connected to AP antenna*  **Note** Use shielded cable for all infrastructure connections associated with APs, SMs, and CMMs. The environment that these modules operate in often has significant unknown or varying RF energy. Operator experience consistently indicates that the additional cost of shielded cables is more than compensated by predictable operation and reduced costs for troubleshooting and support.
6	Begin assembling the lower bracket by attaching the (2) 7" hex bolts to the bracket using (2) serrated flange nuts Figure 101: *AP Antenna Lower Bracket Assembly*

	
7	Attach the rear strap to the bracket using (2) serrated flange nuts and (1) retaining bracket. Do not tighten the nuts now. Attach the entire lower bracket to the antenna using (2) hex bolts, (2) flat washers and (2) lock washers. Figure 102: *Lower bracket attached to AP antenna* 

Attaching the PMP 450 AP to the antenna

To attach a PMP 450 Series AP to the antenna, perform the following steps.

Note

Use shielded cable for all infrastructure connections associated with APs, SMs, and CMMs. The environment that these modules operate in often has significant unknown or varying RF energy. Operator experience consistently indicates that the additional cost of shielded cables is more than compensated by predictable operation and reduced costs for troubleshooting and support.

1	Attach the included bracket to the rear of the AP using the (4) M5 x 7mm bolts Figure 103: *Attaching bracket to the rear of the AP*

	
2	Attach the AP to the antenna by sliding the bracket onto the bolts and tighten the (4) serrated flange nuts using a 13-mm spanner wrench. Figure 104: *Lower bracket attached to AP antenna* 

Note

If using a non-standard antenna, do not cover the equilibrium membrane vent located on the back of the unit

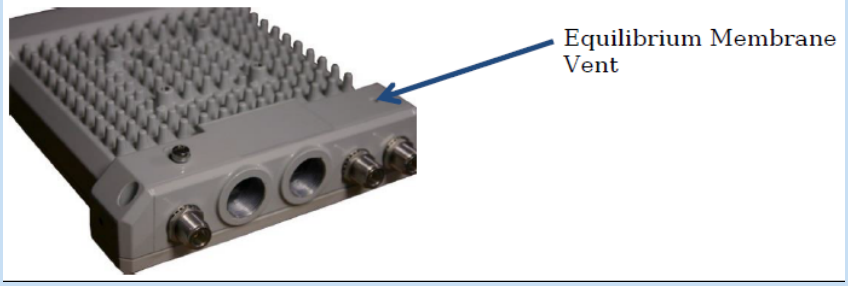
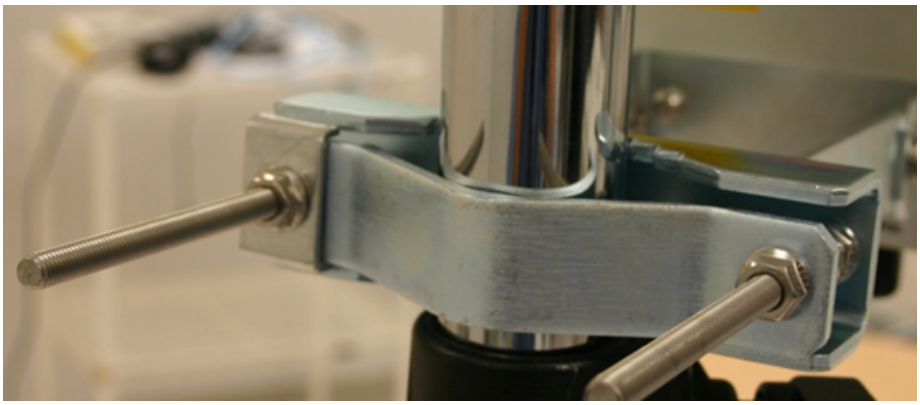
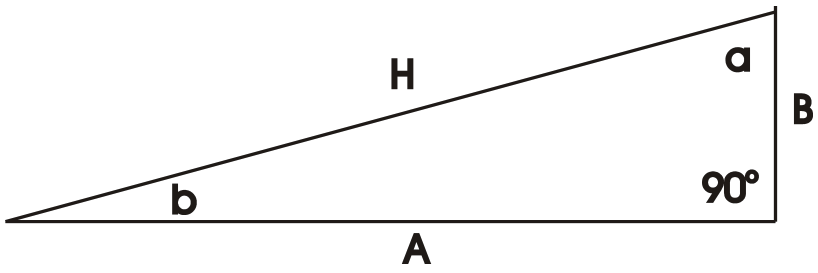


Figure 105: *Mounted PMP 450 AP and antenna assembly, viewed from back and back*

Attaching the PMP 450 Series AP and antenna to the mount point

1	Attach the upper bracket of the antenna to the mount point by closing the rear strap around the pole and tightening the (2) serrated flange nuts using a 13mm spanner wrench. These must be tightened evenly on the pol to avoid jumping/stripping threads. Figure 106: *Attaching the AP antenna upper bracket to the pole* 
2	Attach the lower bracket of the antenna to the mount point by closing the rear strap around the pole and tightening the (2) serrated flange nuts using a 13mm spanner wrench. These must be tightened evenly on the pole to avoid jumping/stripping threads.

	Figure 107: *Attaching the AP antenna lower bracket to the pole* 
3	Use a local map, compass, and/or GPS device as needed to determine the direction that one or more APs require to each cover the 90° sector.
4	Choose the best mounting location for your particular application. **Note** Use the embedded spectrum analyzer or a commercial analyzer to evaluate the frequencies present in various locations. OFDM APs need not be mounted next to each other. They can be distributed throughout a given site. However, the 90° offset must be maintained. If you want to collocate these APs with PMP 100 Series APs of the 5.4-GHz frequency band range, plan to allow at least 25 MHz of separation between their center channels.
5	Secure a ground strap to the ground lug on the back of the AP.
6	Secure the ground strap to the pole, tower, or other trusted ground.
7	The bracket of the standard antenna has provision for measured down tilt. The recommended practice is to use one of the many radio analysis and mapping tools or on-line tools to calculate down tilt based on antenna height above the service area. The proper angle of tilt can be calculated as a factor of both the difference in elevation and the distance that the link spans. Even in this case, a plumb line and a protractor can be helpful to ensure the proper tilt. This tilt is typically minimal. The number of degrees to offset (from vertical) the mounting hardware leg of the support tube is equal to the angle of elevation from the lower module to the higher module (<B in the example provided in Straight-through Ethernet Cable).
	Figure 108: *Variables for calculating angle of elevation (and depression)*



Where:		Is:	
	b		angle of elevation
	B		vertical difference in elevation
	A		horizontal distance between modules

To use metric units to find the angle of elevation, use the following formula:

$$\tan b = \frac{B}{1000A}$$

Where:		Is:	
	B		expressed in meters
	A		expressed in kilometers

To use English standard units to find the angle of elevation, use the following formula:

$$\tan b = \frac{B}{5280A}$$

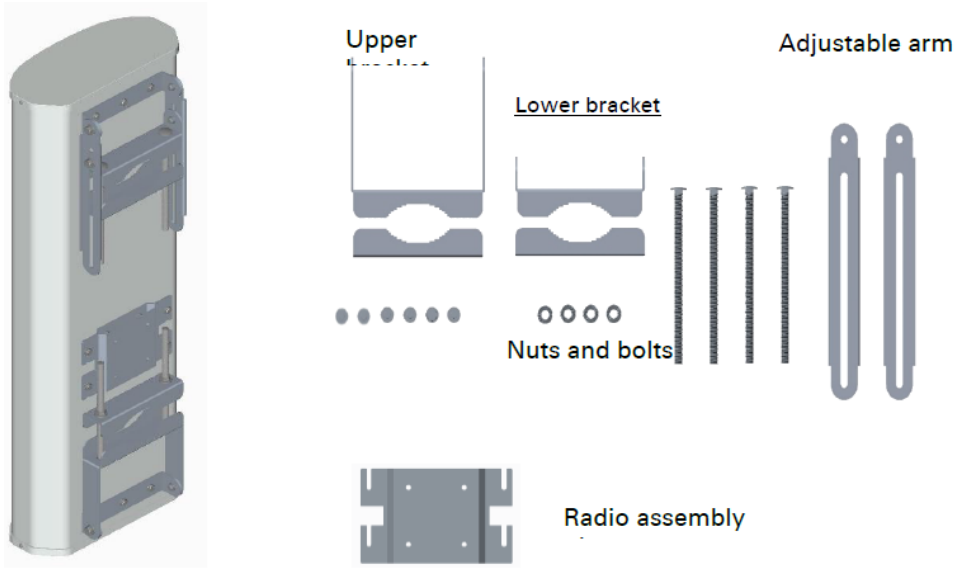
Where:		Is:	
	B		expressed in feet
	A		expressed in miles

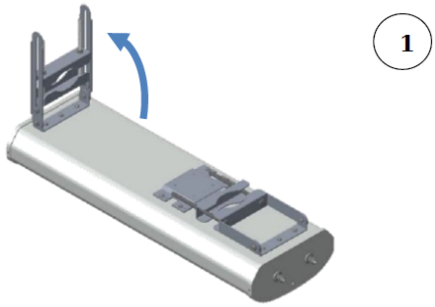
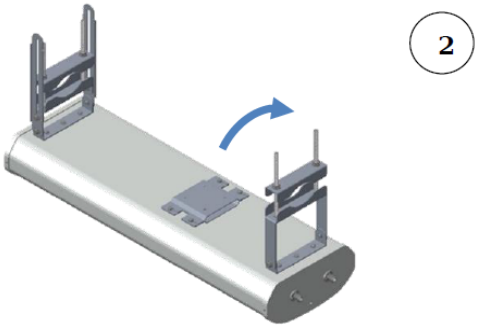
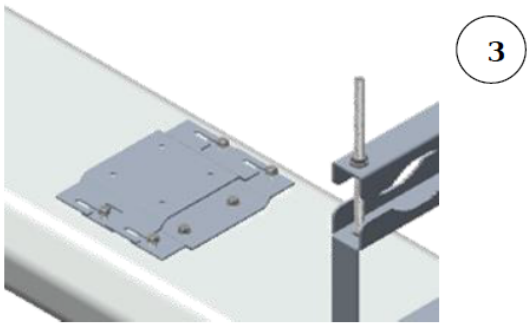
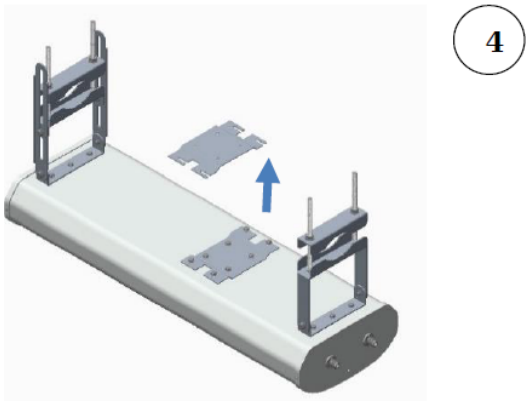
The angle of depression from the higher module is identical to the angle of elevation from the lower module.

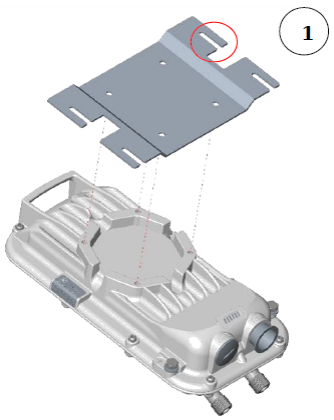
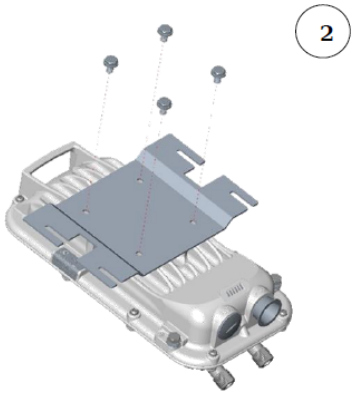
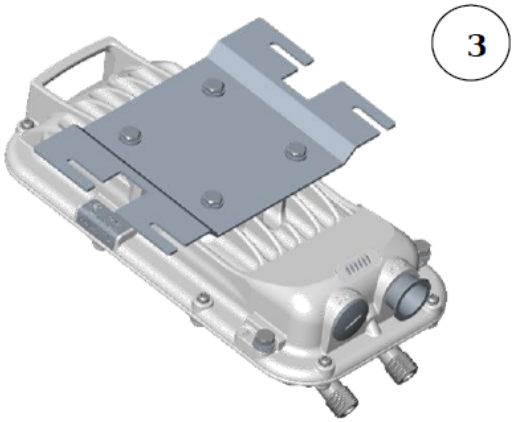
8	Connect the coax cables to the antenna and to the AP
9	Weatherproof the connector on the coax cables (see section Attaching and weatherproofing an N type connector).

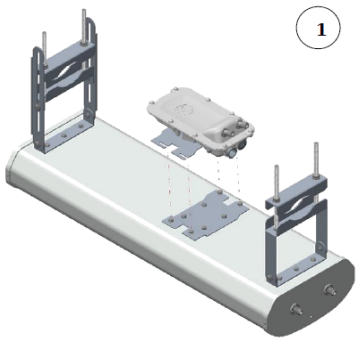
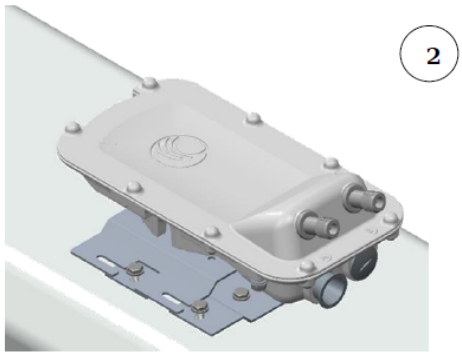
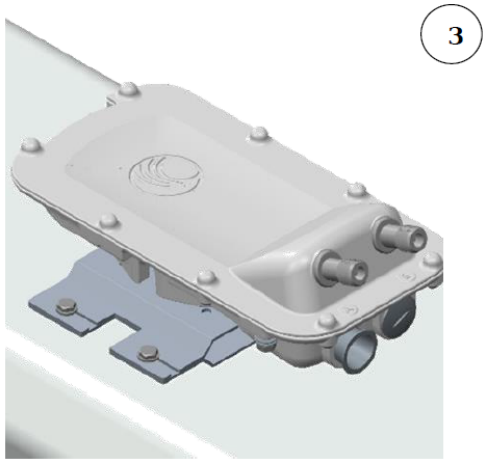
PMP 450i Series AP 900 MHz

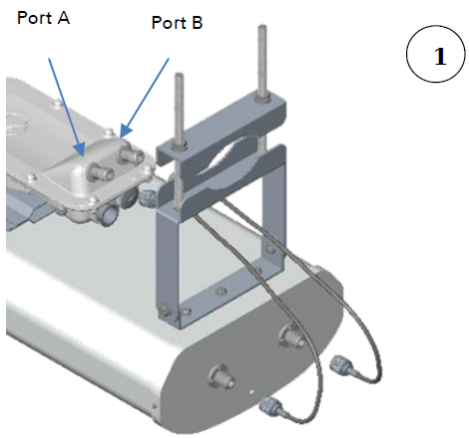
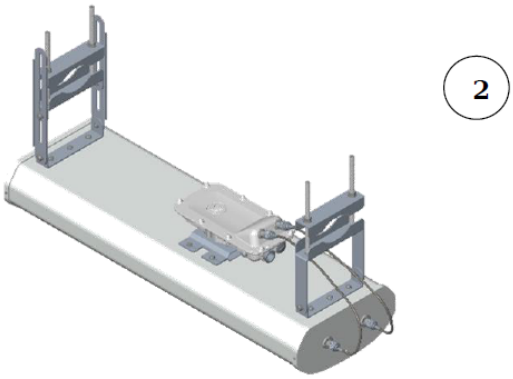
Mounting of PMP 450i AP 900 MHz

1	Inventory the parts to ensure that you have them all before you begin. The full set of parts is shown in Installation. Figure 109: *PMP 450i AP 900 MHz antenna unbox view*  Figure 110: *PMP 450i AP 900 MHz antenna inventory* 

2	(1) Unfold the upper bracket assembly of the antenna.	
	(2) Unfold the lower bracket assembly.	
	(3) Loose the radio assembly plate by untightening M8 four bolds.	
	(4) Remove the radio assembly top plate by sliding towards upper bracket assembly.	

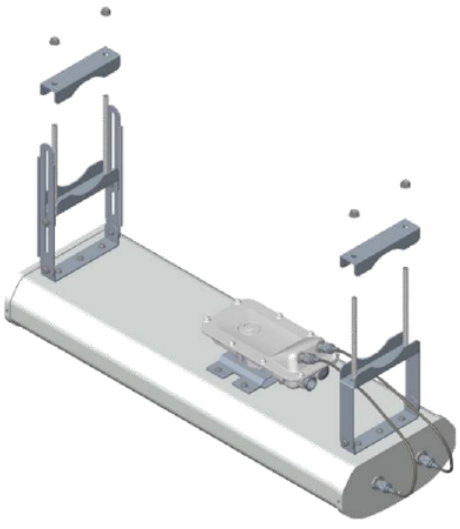
3	(1) Place the radio assembly plate on the radio and align holes with radio enclosure. **Note** Ensure that the radio plate notch opening and RF port of radio in same direction. It is also important to make sure you attach the radio assembly plate in the proper orientation as shown in figure.	
	(2) Insert M6 bolts through plate into radio enclosure	
	(3) Fix the plate by tightening four bolts with a torque setting on 2 ±0.5 Nm	

4	(1) Place the radio mounted plate on sector antenna as shown in the figure. Ensure that the orientation of RF port of antenna and radio are in same direction	
	(2) Line up the radio assembly to four bolts and slide towards lower bracket assembly to lock.	
	(3) Tighten the radio assembly plate using four M8 bolts to a torque setting of 2 ±0.5 Nm	

5	(1) Connect the port A of AP to vertical and port B of AP to horizontal polarization interfaces of the antenna with RF cable. Ensure that the RF cables are pass-through inside the lower bracket assembly	
	(2) Hand tighten the N type connectors and the torque should not exceed more than 1 Nm	

Mounting of PMP 450i AP 900 MHz antenna to the pole

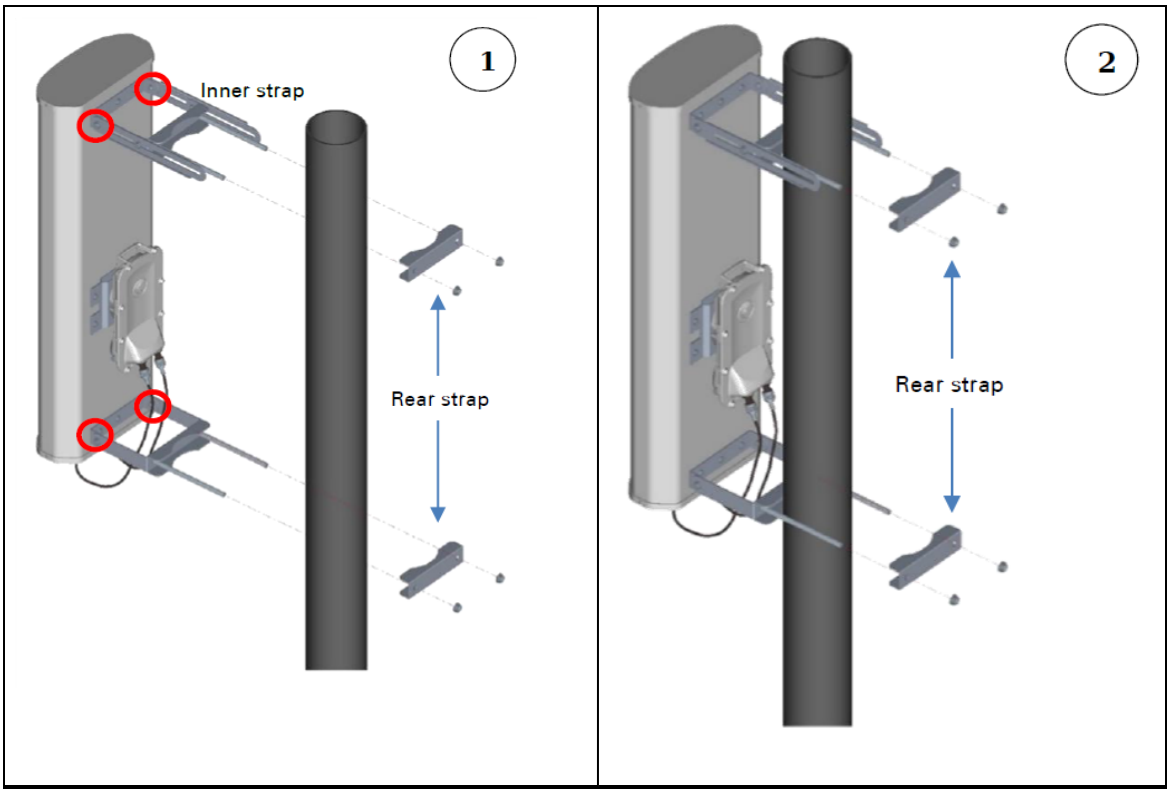
The mounting procedure of PMP 450i AP 900 MHz and antenna to the pole is given below:

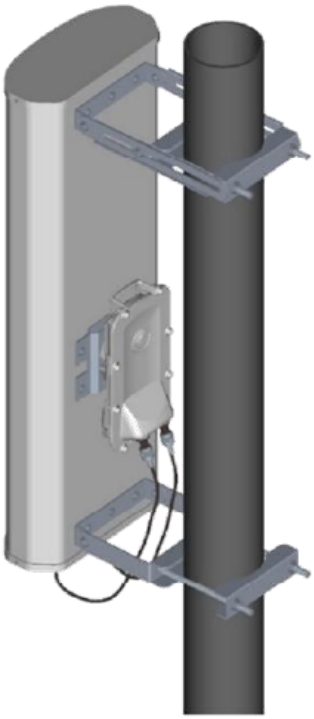
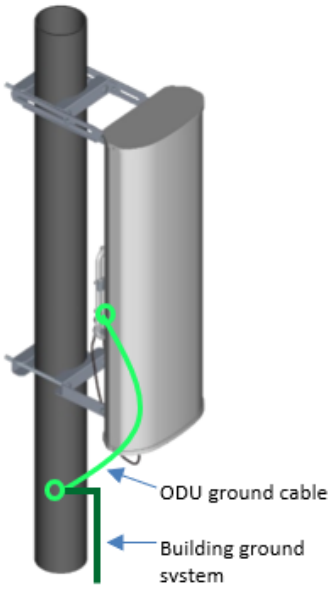
1	Remove the upper and lower rear bracket strap from the sector antenna.	
2	Attach the upper and lower bracket of the antenna to the mount point by closing the rear strap around the pole.	

Note

Before mounting the radio on the pole, secure the upper and lower bracket assemblies with a torque setting of 3 to 4 Nm as shown in Figure 1. Also, ensure that inner strap of upper bracket is set to zero-degree marking.

Figure 111: *Attaching radio mounting PMP 450i AP 900 MHz antenna to the pole*

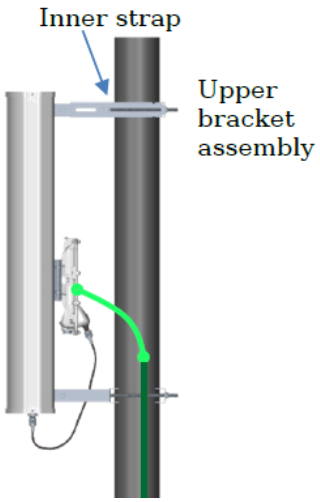
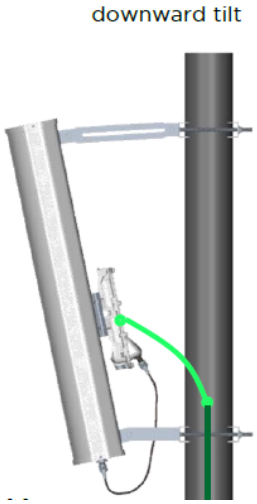
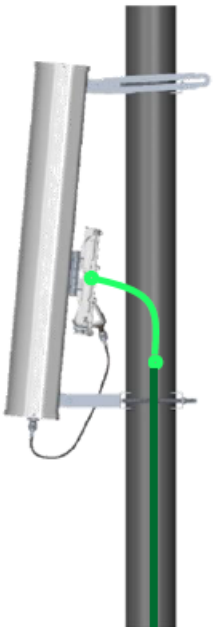


		
3	Tighten the four-serrated flange M10 nuts on the upper and lower rear straps using a 17 mm spanner wrench. These must be tightened evenly on the pole to avoid jumping/stripping threads	

Sector antenna alignment

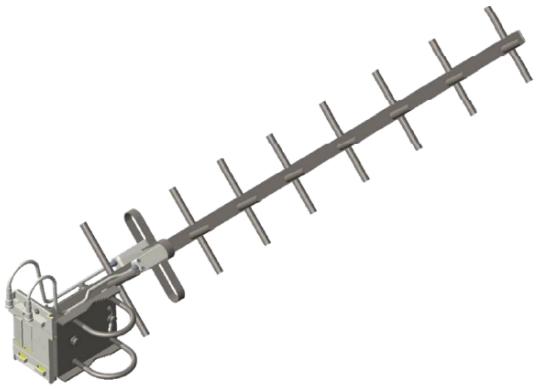
The 900 MHz sector antenna horizontal and vertical alignment procedure is shown in 900 MHz sector antenna alignment. The antenna can be aligned from +5 to -10 degree by adjusting the inner strap of the upper bracket assembly.

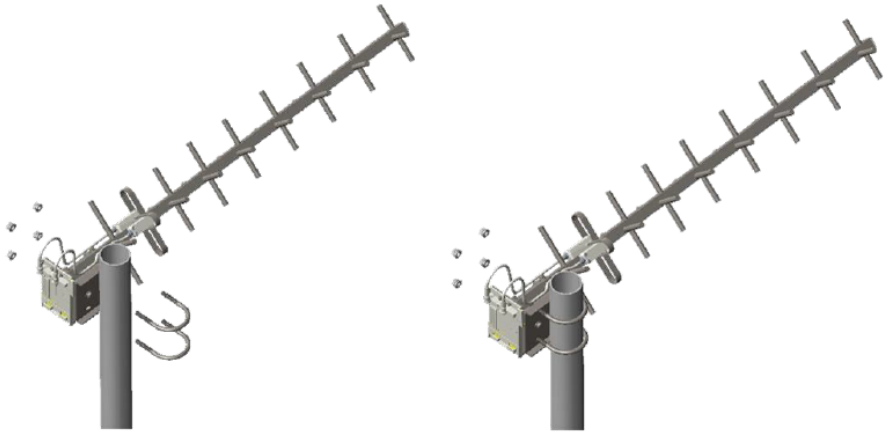
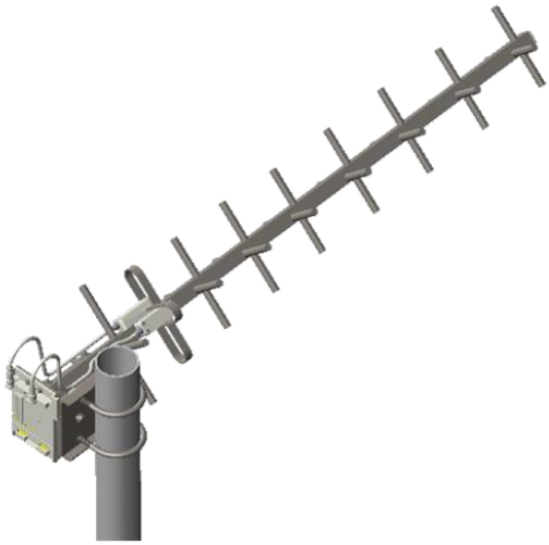
Figure 112: *900 MHz sector antenna alignment*

Horizontal alignment	Vertical alignment	Vertical alignment upward tilt
		

PMP 450 Series SM 900 MHz

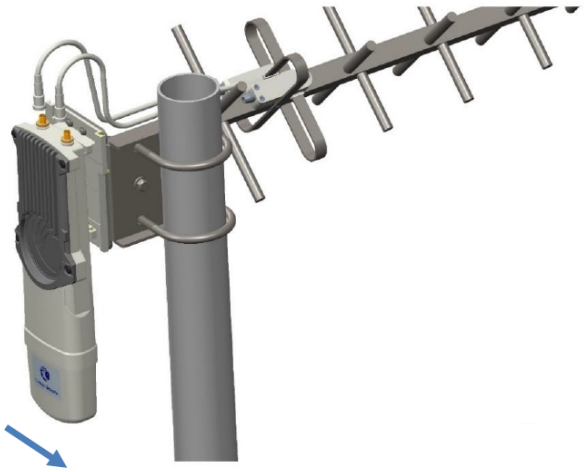
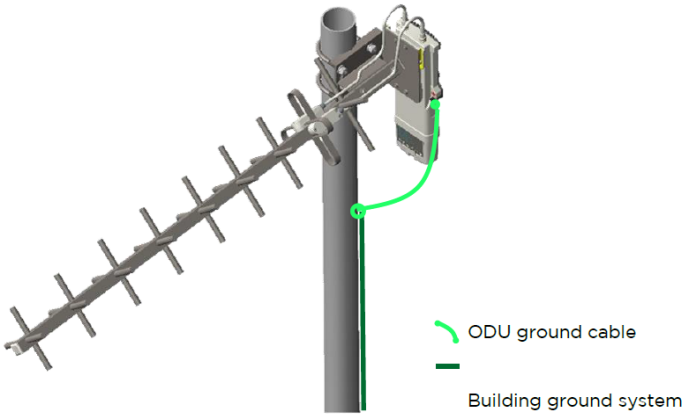
Attaching the SM 900 MHz directional antenna to the pole

1	Unbox the directional Yagi antenna. Figure 113: *PMP 450i SM 900 MHz external directional antenna* 
2	Attach the directional antenna to the pole and insert the two U clamps into the mounting bracket of the antenna Figure 114: *Attach the antenna to the pole*

	
3	Tighten all nuts to approximately 6 to 7 Nm or less to avoid deforming the pole. Figure 115: *Fixing the nuts* 

Radio mounting to the antenna

1	Align the radio to E bracket and slide towards right to lock on the antenna as shown in below figure. Figure 116: *Fixing the radio to the antenna*

	
2	Connect the port A of SM to vertical and port B of SM to horizontal polarization interfaces of the antenna with RF cable. Figure 117: *Connecting RF cable to the radio* 

Directional Yagi antenna alignment

The directional Yagi antenna horizontal and vertical alignment procedure is shown below. The Yagi antenna can be aligned for +15 to -15 degree.

Figure 118: *Yagi antenna alignment - horizontally*

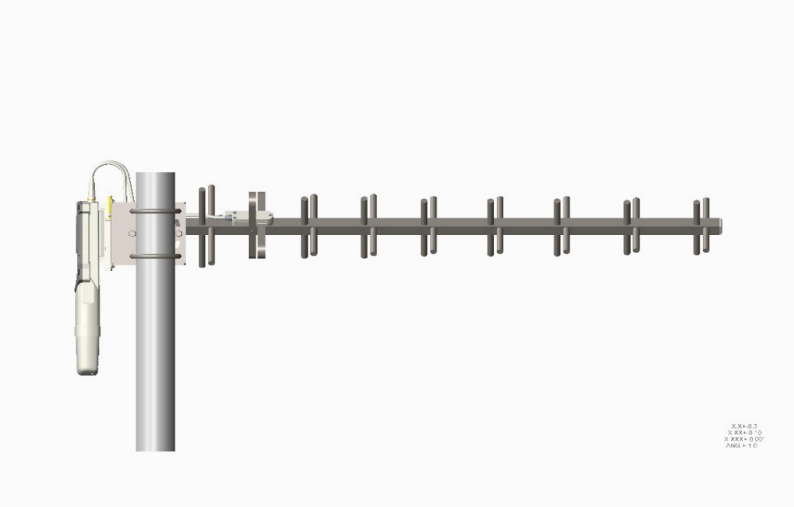
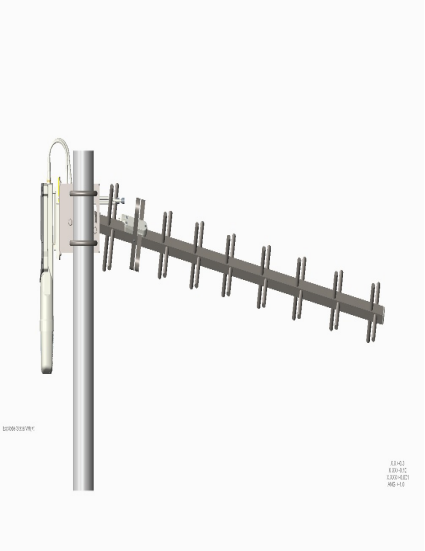


Figure 119: *Yagi antenna alignment - upward tilt*

Figure 120: *Yagi antenna alignment - downward tilt*



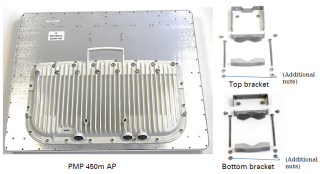
Installing an integrated ODU

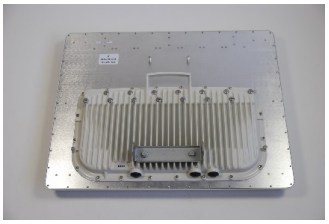
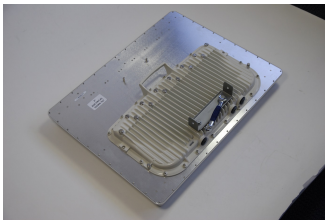
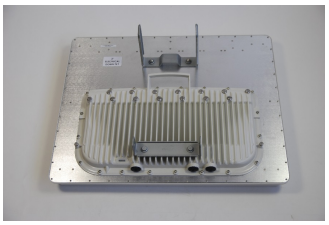
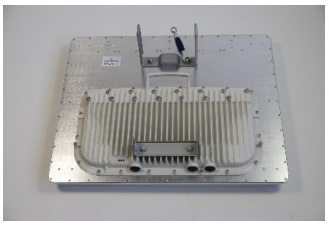
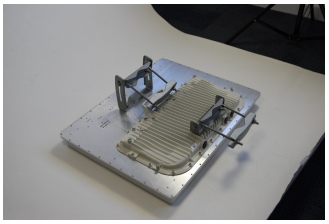
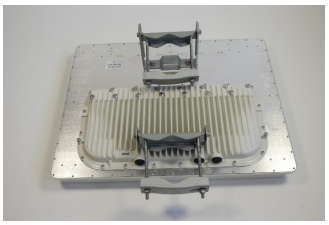
Caution

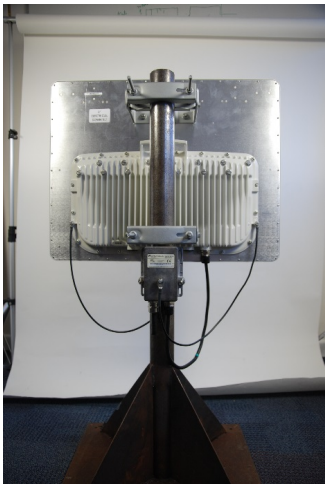
Do not reverse the bracket clamp, as this arrangement may lead to failure of the assembly. Do not over-tighten the bolts as this may lead to failure of the assembly.

PMP 450m Series – 5 GHz AP

To mount and connect an integrated ODU, proceed as follows:

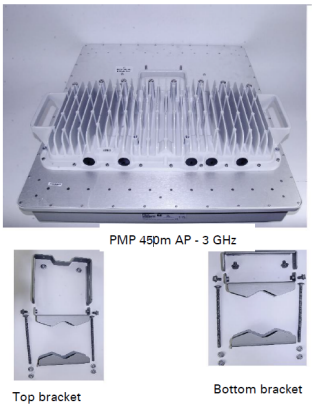
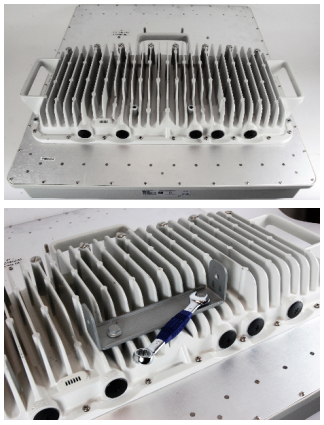
1	Inventory the parts to ensure that you have them all before you begin. The full set of parts is shown in PMP 450m Series - 5 GHz AP unbox view. **Note** The additional nuts provided for top and bottom brackets are used to hold the long bolts in position during installation.	PMP 450m Series - 5 GHz AP unbox view 

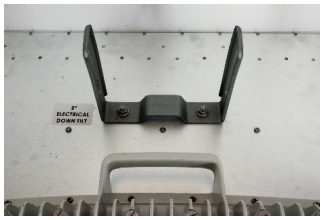
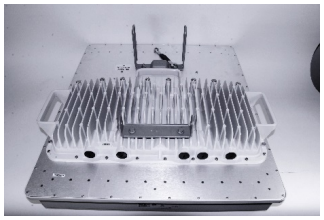
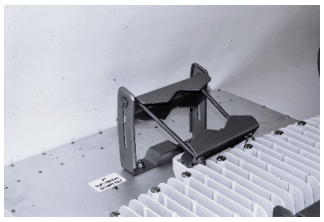
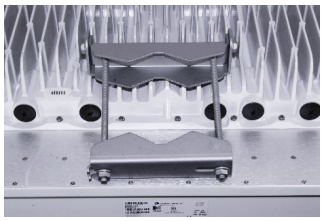
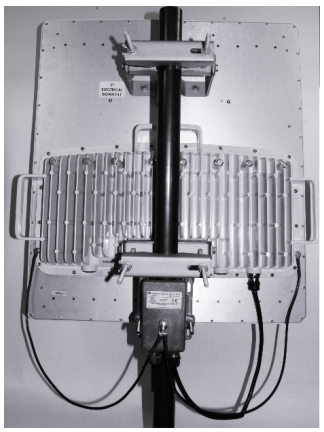
2	Attach the bottom bracket to the ODU using (2) hex bolts and secure the M8 bolts by applying 5 Nm torque.	 
3	Attach the top bracket to the projecting studs on the ODU and secure the top bracket using two M8 nuts by applying 5 Nm torque.	 
4	Fix the front and rear strap assembly to the upper bracket using two bolts. Do not tighten the nuts now. **Note** The PMP 450m antenna operates with 2 degrees of electrical down-tilt.	
5	Fix the front and rear strap assembly to the bottom bracket using two bolts. Do not tighten the nuts now.	

6	See PMP 450m Series – AP on page PMP 450m Series – AP for the grounding procedure. See PMP 450m Series – AP on page PMP 450m Series – AP for the mounting procedure.	

PMP 450m Series – 3 GHz AP

To mount and connect an integrated ODU, proceed as follows:

1	Inventory the parts to ensure that you have them all before you begin. The full set of parts is shown in PMP 450m Series - 5 GHz AP unbox view. **Note** The additional nuts provided for top and bottom brackets are used to hold the long bolts in position during installation.	PMP 450m Series - 3 GHz AP unbox view 
2	Attach the bottom bracket to the ODU using (2) hex bolts and secure the M8 bolts by applying 5 Nm torque.	

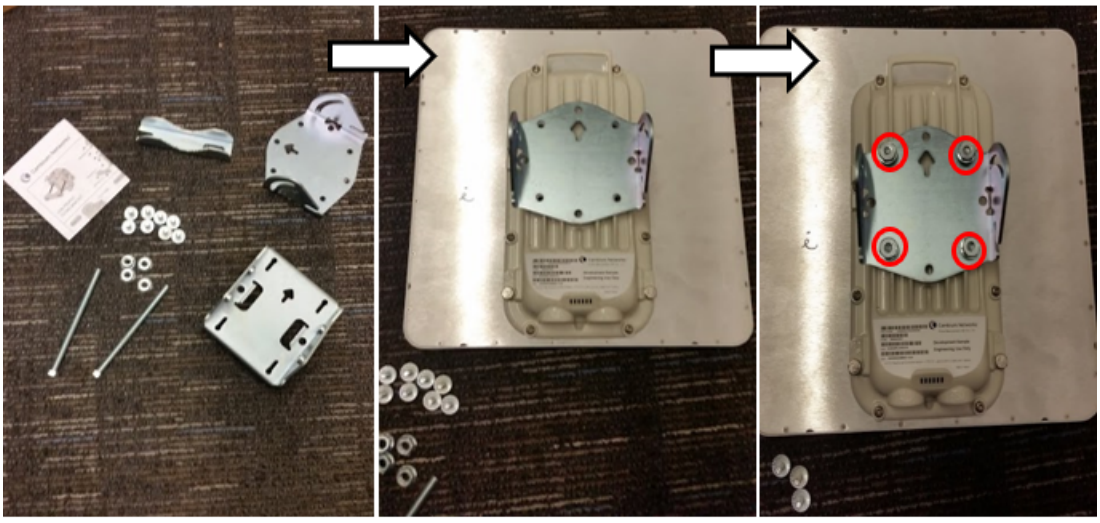
3	Attach the top bracket to the projecting studs on the ODU and secure the top bracket using two M8 nuts by applying 5 Nm torque.	 
4	Fix the front and rear strap assembly to the upper bracket using two bolts. Do not tighten the nuts now. **Note** The PMP 450m antenna operates with 2 degrees of electrical down-tilt.	
5	Fix the front and rear strap assembly to the bottom bracket using two bolts. Do not tighten the nuts now.	
6	See PMP 450m Series – AP for the grounding procedure. See PMP 450m Series – AP for the mounting procedure.	

PMP/PTP 450i Series – AP/SM/BH

To mount and connect an integrated ODU, proceed as follows:

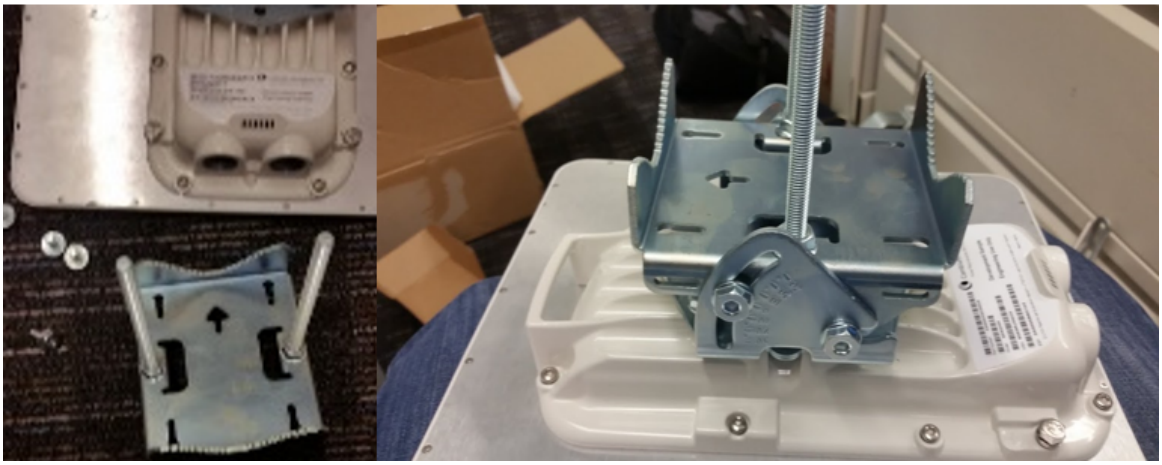
1. Fix the mounting plate to the back of the ODU using the four M6 bolts, and spring and plain washers provided. Tighten the bolts to a torque setting of 5.0 Nm (3.7 lb ft).

Figure 121: *Fixing the mounting plate to the back of the ODU*



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. If the ODU is mounted outdoors, weatherproof the N type connectors (when antenna alignment is complete) using PVC tape and self-amalgamating rubber tape.

Figure 122: *Attaching the bracket body*



Connecting Cat5e Ethernet cable

Connecting an RJ45 and gland to a unit

Perform this task to connect the Ethernet cable to an AP.

To connect the Ethernet cable with a gland to an AP unit, proceed as follows:

1	Insert the RJ45 cable through the gland components
2	Insert the RJ45 plug into the socket in the unit, making sure that the locking tab snaps home.
3	Support the drop cable and gently hand screw the gland body into the unit until the bushing seal is flush to the unit body. **Note** Do not fit the back shell prior to securing the gland body.
4	Once the gland is fully hand screwed into the unit, tighten it one full rotation only with a 1 1/8 inch spanner wrench.
5	When the gland body has been fitted, tighten the gland back shell

Caution

Do not over-tighten the gland back shell, as the internal seal and structure or RJ45 port may be damaged.

Figure 123: *Ethernet cable gland for PMP/PTP 450 Series*

Figure 124: *Ethernet cable gland for PMP/PTP 450i Series*

Disconnecting an RJ45 and gland from a unit

To disconnect the Ethernet cable and gland from a unit, proceed as follows:

1	Hold the Ethernet cable and remove the gland back shell.
2	Use a small flathead screwdriver (0.2”/5mm wide or greater) to gently release the black plastic watertight bushing from the compression fins, being careful not to damage the bushing.
3	Unscrew the gland body from the AP, making sure that the Ethernet cable is not rotating while disengaging the gland body from the AP housing.
4	Use a small screwdriver to depress the RJ45 locking clip.
5	Unplug the RJ45 cable.
6	Remove the gland from the cable, if necessary.

Installing ODU

Installing a 450 Platform Family AP

To install a 450 Platform Family AP, perform the following steps.

Procedure 5 Installing an AP

1	Begin with the AP in the powered-down state.

2	Choose the best mounting location for your particular application. Modules need not be mounted next to each other. They can be distributed throughout a given site. However, the 60° offset must be maintained. Mounting can be done with supplied clamps. See Installing external antennas to a connectorized ODU for connecting an external antenna to PMP 450i Series, PMP 450 Series, PMP 450m Series – 5 GHz AP, PMP 450m Series – 3 GHz AP, and PMP 450 Series SM 900 MHz See Installing an integrated ODU
3	Align the AP as follows: 1. Move the module to where the link will be unobstructed by the radio horizon and no objects penetrate the Fresnel zone. 2. Use a local map, compass, and/or GPS device as needed to determine the direction that one or more APs require to each cover the intended 60° sector. 3. Apply the appropriate degree of downward tilt. 4. Ensure that the nearest and furthest SMs that must register to this AP are within the beam coverage area.
4	Adjust the azimuth to achieve visual alignment, lock the AP in the proper direction and downward tilt.
5	Attach the cables to the AP (See Powering the AP/SM/BH for test configuration)
6	Waterproof the cables (See section Attaching and weatherproofing an N type connector).

Note

A video on PMP 450m drop cable installation procedure can be found at:

https://www.youtube.com/watch?v=CE--qYljWik.

Installing a 450 Platform Family SM

Installing a 450 Platform Family SM consists of two procedures:

- Physically installing the SM on a residence or other location and performing a coarse alignment using the alignment tool or alignment tone.
- Verifying the AP to SM link and finalizing alignment using review of power level, link tests, and review of registration and session counts.

Procedure 6 Installing an SM

1	Choose the best mounting location for the SM based on section ODU and external antenna location.
2	Use stainless steel hose clamps or equivalent fasteners to lock the SM into position. See Installing external antennas to a connectorized ODU for connecting external antenna See Installing an integrated ODU

<table>
<tr><td>3</td><td>Remove the base cover of the SM.</td></tr>
<tr><td>4</td><td>Terminate the UV outside grade Category 5 Ethernet cable with an RJ-45 connector, and connect the cable to the SM.</td></tr>
<tr><td>5</td><td>Wrap a drip loop in the cable.</td></tr>
<tr><td>6</td><td>For Connectorized Models, Install the external antenna according to the manufacturer’s instructions.</td></tr>
<tr><td>7</td><td>For Connectorized Models, connect the SM’s N-type antenna connectors to the external antenna, ensuring that the polarity matches between the SM cable labeling and the antenna port labels.
<table>
<tr><th>Connectorized SM Antenna Cable Label</th><th>Antenna Connection</th></tr>
<tr><td>A</td><td>Vertical</td></tr>
<tr><td>B</td><td>Horizontal</td></tr>
</table></td></tr>
<tr><td>8</td><td>For Connectorized Models, weatherproof the N-type antenna connectors following section Attaching and weatherproofing an N type connector.</td></tr>
<tr><td>9</td><td>Wrap an AWG 10 (or 6mm^2) copper wire around the Ground post of the SM</td></tr>
<tr><td>10</td><td>Securely connect the copper wire to the grounding system (Protective Earth) according to applicable regulations.</td></tr>
<tr><td>11</td><td>Install a surge suppressor as described in the section Mount the Surge Suppressor.</td></tr>
<tr><td>12</td><td>Connect the power supply to a power source.</td></tr>
<tr><td>13</td><td>Connect the Ethernet output from the Data port of the power supply to the Ethernet port of your laptop.</td></tr>
<tr><td>14</td><td>Connect the drop cable from ODU to the Data+power port of the power suppy.</td></tr>
<tr><td>15</td><td>Launch your web browser. In the URL address bar, enter 169.254.1.1. then press Enter.</td></tr>
<tr><td>16</td><td>If the browser in laptop fails to access the interface of the SM, follow the procedure Radio recovery mode.</td></tr>
<tr><td>17</td><td>Log in as admin on the ODU. Configure a password for the admin account and log off.</td></tr>
<tr><td>18</td><td>Log back into the SM as admin or root, using the password that you configured.</td></tr>
<tr><td>19</td><td>For coarse alignment of the SM, use the Alignment Tool located at Tools, Alignment Tool.

Optionally, connect a headset to the AUX/SYNC port on the SM and listen to the alignment tone, which indicates greater SM receive signal power by pitch. By adjusting the SM’s position until the highest frequency pitch is obtained operators and installers can be confident that the SM is properly positioned. For information on device GUI tools available for alignment, see sections Using the Alignment Tool, Using the Link Capacity Test tool, and Using AP Evaluation tool in Configuration Guide.</td></tr>
<tr><td>20</td><td>When the highest power is achieved, lock the SM mounting bracket in place.</td></tr>
<tr><td>21</td><td>Log off of the SM web interface.</td></tr>
</table>

22	Disconnect the Ethernet cable from your laptop.
23	Replace the base cover of the SM.
24	Connect the Ethernet cable to the computer that the subscriber will be using.

Installing a 450 Platform Family BHM

To install a 450 Platform Family BHM, perform the following steps.

Procedure 7 Installing a BHM

1	Choose the best mounting location for your particular application.
2	Align the BHM as follows: • Move the module to where the link will be unobstructed by the radio horizon and no objects penetrate the Fresnel zone. • Use a local map, compass, and/or GPS device as needed to determine the direction to the BHS. • Apply the appropriate degree of downward or upward tilt. • Ensure that the BHS is within the beam coverage area.
3	Using stainless steel hose clamps or equivalent fasteners, lock the BHM into position. See Installing external antennas to a connectorized ODU for connecting external antenna
4	If this BHM will not be connected to a CMM, optionally connect a cable to a GPS timing source and then to the SYNC port of the BHM.
5	Either connect the BHM's Aux to the CMM or connect the DC power converter to the BHM and then to an AC power source. RESULT: When power is applied to a module or the unit is reset on the web-based interface, the module requires approximately 25 seconds to boot. During this interval, self-tests and other diagnostics are being performed.
6	Access Configuration > General page of the BHM for Synchronization configuration.
7	If a CMM4 is connected, set the Sync Input parameter to the AutoSync or Autosync + Free Run selection.

Installing a 450 Platform Family BHS

To install a PTP 450 platform Series BHS, perform the following steps.

Procedure 8 Installing a BHS

1	Choose the best mounting location for the BHS.
2	Terminate the UV outside grade Category 5 Ethernet cable with an RJ-45 connector and connect the cable to the BHS. (See Powering the AP/SM/BH for test configuration)
3	Use stainless steel hose clamps or equivalent fasteners to lock the BHS into position.

4	Install a surge suppressor as described in the section Mount the Surge Suppressor
5	For coarse alignment of the BHS, use the Audible Alignment Tone feature as follows: • At the BHS, connect the RJ-45 connector of the Alignment Tool Headset to the Aux port via an alignment tone adapter as shown in section Alignment Tone in Configuration Guide. • Listen to the alignment tone for pitch, which indicates greater signal power (RSSI/dBm) by higher pitch. Adjust the module slightly until you hear the highest pitch and highest volume
6	When you have achieved the best signal (highest pitch, loudest volume), lock the BHS in place with the mounting hardware

Configuring the Link

See Configuring remote access in Configuration Guide.

Monitoring the Link

See Monitoring the Link in Configuration Guide.

Installing the AC Power Injector

Caution

As the PSU is not waterproof, locate it away from sources of moisture, either in the equipment building or in a ventilated moisture-proof enclosure. Do not locate the PSU in a position where it may exceed its temperature rating.

Caution

Do not plug any device other than a PMP/PTP 450i Series ODU into the ODU port of the PSU. Other devices may be damaged due to the non-standard techniques employed to inject DC power into the Ethernet connection between the PSU and the ODU.

Do not plug any device other than a Cambium 450 Platform PSU into the PSU port of the ODU. Plugging any other device into the PSU port of the ODU may damage the ODU and device.

Follow this procedure to install the AC Power Injector:

1	Form a drip loop on the PSU end of the LPU to PSU drop cable. The drip loop ensures that any moisture that runs down the cable cannot enter the PSU.
2	(a) Place the AC Power Injector on a horizontal surface. Plug the LPU to PSU drop cable into the PSU port labeled ODU. (b) When the system is ready for network connection, connect the network Cat5e cable to the LAN port of the PSU:

	(a)  	(b) 

Note

For instructions on CMM3 (CMMmicro) or CMM4 installation, including the outdoor temperature range in which it is acceptable to install the unit, tools required, mounting and cabling instructions, and connectivity verification, please see the PMP Synchronization Solutions User Guide located on the Cambium website.

Installing CMM4

The Cluster Management Module 4 (CMM4) provides power, sync, and network connectivity for up to eight APs, backhauls, and Ethernet terrestrial feeds in a variety of configurations.

The CMM4 provides:

- Sync over Power over Ethernet and integrated surge suppression on the controller board for up to 8 APs or BHs. Both a custom 30 VDC power scheme and a custom 56 VDC power scheme are available. Neither is the same as the later IEEE Standard 802.3af, and neither is compatible with it.
- Managed switching using a hardened EtherWAN switch (1090CKHH models). The CMM4 ships with a 14-port EtherWAN switch and is also available without a switch. The CMM4 originally shipped with a 9-port EtherWAN switch.
- Surge suppression on the controller board for the incoming 30V DC and 56V DC power lines and GPS coax cable.
- Auto-negotiation on the Ethernet ports. Ports will auto-negotiate to match inputs that are either 100Base-T or 10Base-T, and either full duplex or half duplex, when the connected device is set to auto-negotiate. Alternatively, these parameters are settable.
- An always-on NTP (Network Time Protocol) server that can provide date and time to any radio that can reach the CMM's management IP address.
- CNUT can be used to upgrade the CMM-4 software.

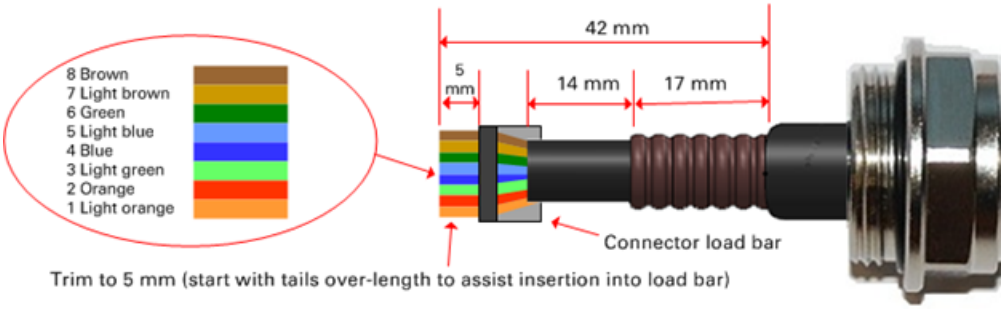
450 Series and 450i Series can use the CMM4's EtherWan switch for their network connectivity.

Supplemental installation information

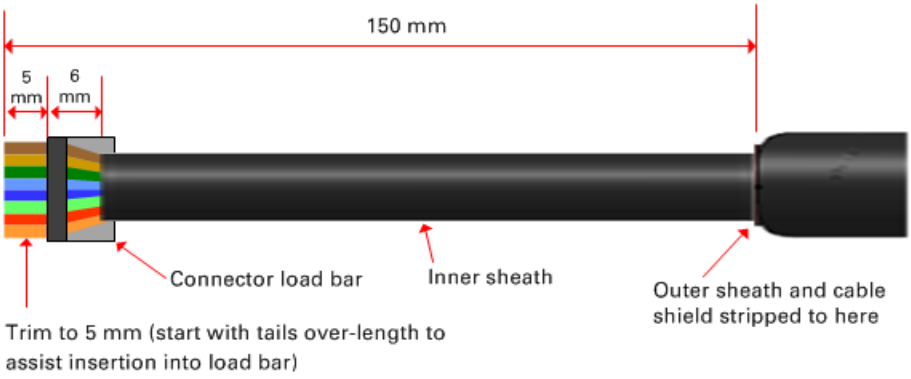
This section contains detailed installation procedures that are not included in the above topics, such as how to strip cables, create grounding points and weatherproof connectors.

Stripping drop cable

When preparing the drop cable for connection to the 450 Platform Family ODU or LPU, use the following measurements:



When preparing the drop cable for connection to the 450 Platform PSU (without a cable gland), use the following measurements:

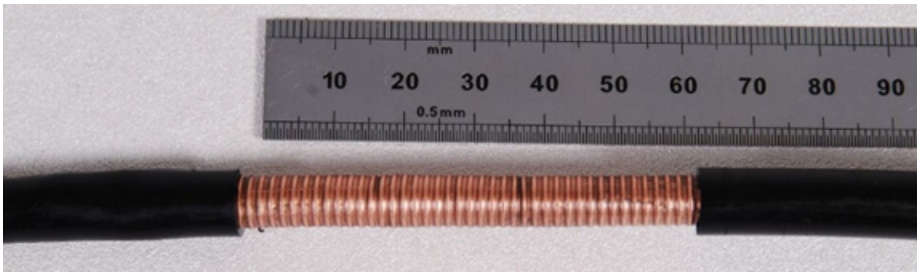
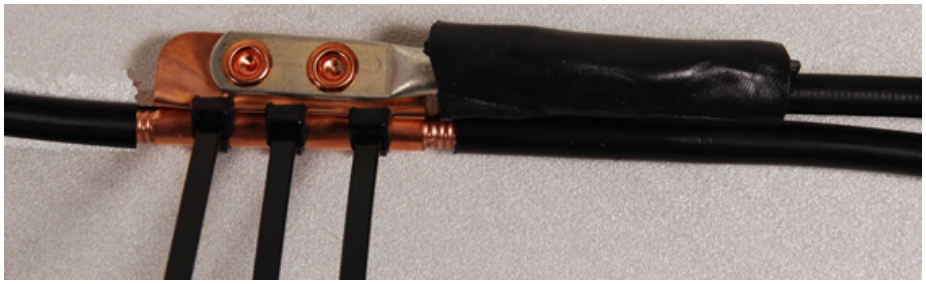


Creating a drop cable grounding point

Use this procedure to connect the screen of the main drop cable to the metal of the supporting structure using the cable grounding kit (Cambium part number 01010419001).

To identify suitable grounding points, refer to Hazardous locations.

1	Remove 60 mm (2.5 inches) of the drop cable outer sheath.

	
2	Cut 38mm (1.5 inches) of rubber tape (self-amalgamating) and fit to the ground cable lug. Wrap the tape completely around the lug and cable. 
3	Fold the ground wire strap around the drop cable screen and fit cable ties. 
4	Tighten the cable ties with pliers. Cut the surplus from the cable ties. 
5	Cut a 38mm (1.5 inches) section of self-amalgamating tape and wrap it completely around the joint between the drop and ground cables.

	
6	Use the remainder of the self-amalgamating tape to wrap the complete assembly. Press the tape edges together so that there are no gaps. 
7	Wrap a layer of PVC tape from bottom to top, starting from 25 mm (1 inch) below and finishing 25 mm (1 inch) above the edge of the self-amalgamating tape, overlapping at half width. 
8	Repeat with a further four layers of PVC tape, always overlapping at half width. Wrap the layers in alternate directions (top to bottom, then bottom to top). The edges of each layer should be 25mm (1 inch) above (A) and 25 mm (1 inch) below (B) the previous layer. 

9	Prepare the metal grounding point of the supporting structure to provide a good electrical contact with the grounding cable clamp. Remove paint, grease or dirt, if present. Apply anti-oxidant compound liberally between the two metals.
10	Clamp the bottom lug of the grounding cable to the supporting structure using site approved methods. Use a two-hole lug secured with fasteners in both holes. This provides better protection than a single-hole lug.

Attaching and weatherproofing an N type connector

The following procedure should be used to weatherproof the N type connectors fitted to the connectorized ODU (AP/sM/BH) and antenna. This procedure must be followed to ensure that there is no moisture ingress at the radio ports. Failure to properly seal N-type antenna connectors can result in poor link performance or complete loss of radio communication.

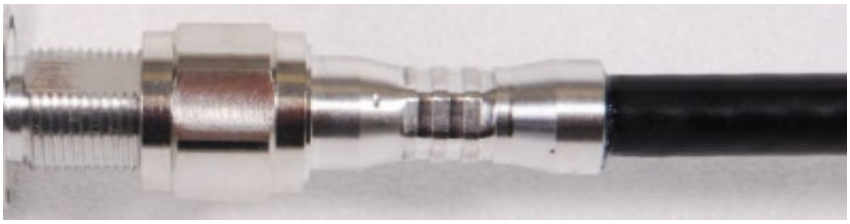
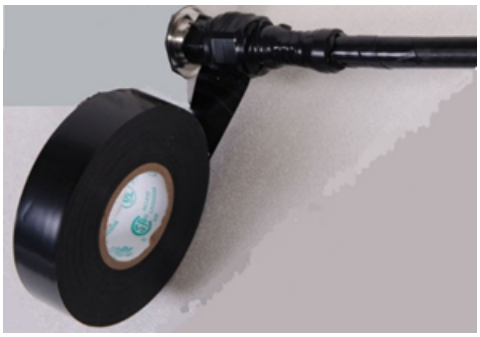
Note

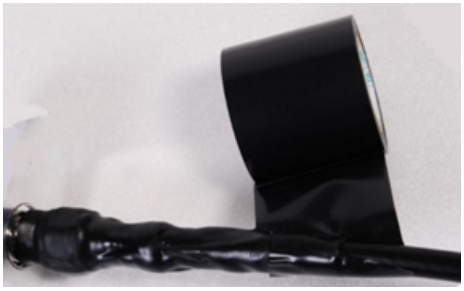
Cambium recommends assembling the antenna, attach the ODU and cabling, and to seal the RF connections before installing the unit at the deployment site.

Note

N type connectors should be tightened using a torque wrench, set to 15 lb in or 1.7 Nm. If a torque wrench is not available, N type connectors may be finger tightened.

Use this procedure to weatherproof the N type connectors fitted to the connectorized ODU and external antenna (if recommended by the antenna manufacturer).

1	Ensure the connection is tight. A torque wrench should be used if available: 
2	Wrap the connection with a layer of 19 mm (0.75 inch) PVC tape, starting 25 mm (1 inch) below the connector body. Overlap the tape to half-width and extend the wrapping to the body of the LPU. Avoid making creases or wrinkles: 
3	Smooth the tape edges:

	
4	Cut a 125mm (5 inches) length of rubber tape (self-amalgamating): 
5	Expand the width of the tape by stretching it so that it will wrap completely around the connector and cable: 
6	Press the tape edges together so that there are no gaps. The tape should extend 25 mm (1 inch) beyond the PVC tape: 
7	Wrap a layer of 50 mm (2 inch) PVC tape from bottom to top, starting from 25 mm (1 inch) below the edge of the self-amalgamating tape, overlapping at half width. 

8	Repeat with a further four layers of 19 mm (0.75 inch) PVC tape, always overlapping at half width. Wrap the layers in alternate directions: • Second layer: top to bottom. • Third layer: bottom to top. • Fourth layer: top to bottom. • Fifth layer: bottom to top. The bottom edge of each layer should be 25 mm (1 inch) below the previous layer. 
9	Check the completed weatherproof connection: 

Note

A video of this procedure can be found at:
https://www.youtube.com/watch?v=a-twPfCVq4A

Chapter 6: Compliance with safety standards

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 Safety compliance specifications.

Table 131: Safety compliance specifications

Region	Specification
USA	UL 60950-1 or UL 62368-1, UL 60950-22
Canada	CSA C22.2 No. 60950-1 or 62368-1, CSA C22.2 No 60950-22
International	CB certified & certificate to IEC 60950-1 or IEC 62368-1, IEC 60950-22

Electromagnetic compatibility (EMC) compliance

The EMC specification type approvals that have been granted for 450 Platform Family are listed under EMC emissions compliance.

Table 132: EMC emissions compliance

Region	Specification
USA	FCC Part 15 Class B
Canada	RSS Gen
International	EN 301 489-1 V2.1.1 EN 301 489-17 V3.1.1 EN 301 489-4 V3.1.1

Human exposure to radio frequency energy

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

- ANSI IEEE C95.1-2005, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
- 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 KDB 447498.

- Health Canada Safety Code 6 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 RSS-102.
    - 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 3, 4.9, 5.4 and 5.8 GHz frequency bands is 10 W/m^2 and in 900 MHz frequency band is 6 W/m^2. For more information, see Human exposure to radio frequency energy on page Human exposure to radio frequency energy.

The applicable ISEDC 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:

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

Where:		Is:	
	S		power density in W/m^2
	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:

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

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/m2)
- d – minimum safe separation distance from point source (meters)

Table 133: FCC minimum safe distances – PMP 450m 3 GHz and 5 GHz (5.1 GHz, 5.2 GHz, 5.4 GHz and 5.8 GHz)

Band (GHz)	Antenna	PG (W)	S (W/ m2)	d (m)
3.65	90° sector	33.9	10	0.52
4.9	90° sector	174	10	1.08
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 134: FCC minimum safe distances – PMP/PTP 450b 3.65 GHz, 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/ m2)	d (m)
3.65	Dish	0.199	20.0	10.0	0.40
4.9	Dish	0.501	24.0	10.0	1.00
	Patch Array	0.501	17.0	10.0	0.45
	On-board	0.501	0	10.0	0.06
5.1	Dish	0.501	24.0	10.0	1.00
	Patch Array	0.501	17.0	10.0.	0.45
	On-board	0.501	0	10.0	0.06

Band (GHz)	Antenna	P (W)	G (dBi)	S (W/ m2)	d (m)
5.2	Dish	0.004	24.0	10.0	0.09
	Patch Array	0.020	17.0	10.0	0.09
	On-board	0.251	0	10.0	0.04
5.4	Dish	0.004	24.0	10.0	0.09
	Patch Array	0.020	17.0	10.0	0.09
	On-board	0.501	0	10.0	0.06
5.8	Dish	0.501	24.0	10.0.	1.00
	Patch Array	0.501	17.0	10.0	0.45
	On-board	0.501	0	10.0	0.06

Table 135: FCC minimum safe distances – PMP 450 MicroPoP APs 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/ m2)	d (m)
4.9	Omni	0.501	9	10.0	0.18
	Sector	0.501	13	10.0	0.28
	Connectorized	0.501	(*)	10.0	(*)
5.1	Omni	0.501	9	10.0	0.18
	Sector	0.199	13	10.0.	0.18
	Connectorized	(*)	(*)	10.0	0.18
5.2	Omni	0.125	9	10.0	0.09
	Sector	0.050	13	10.0	0.09
	Connectorized	(*)	(*)	10.0	0.09
5.4	Omni	0.125	9	10.0	0.09
	Sector	0.050	13	10.0	0.09
	Connectorized	(*)	(*)	10.0	0.09
5.8	Omni	0.501	9	10.0.	0.18
	Sector	0.199	13	10.0	0.18
	Connectorized	(*)	(*)	10.0	0.18

(*) It depends on the external antenna gain

Table 136: FCC minimum safe distances – PMP/PTP 450b Retro APs 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/ m2)	d (m)
4.9	Integrated	0.501	8	10.0	0.16
5.1	Integrated	0.501	8	10.0	0.16
5.2	Integrated	0.501	8	10.0	0.16
5.4	Integrated	0.501	8	10.0	0.16
5.8	Integrated	0.501	8	10.0	0.16

Table 137: 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 (W)	P (W)	G (dBi)	S (W/m^2)	d (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

Band	Antenna	P burst (W)	P (W)	G (dBi)	S (W/m^2)	d (m)
5.1 GHz	Omni-directional	0.170	0.200	20.0 (13.0 dBi)	10.0	0.15
	90° sector	0.034	0.040	50.1 (17.0 dBi)	10.0	0.10
	2ft directional flat plate	0.002	0.002	707.9 (28.5 dBi)	10.0	0.09
	4ft directional parabolic	0.011	0.013	2818.4 (34.5 dBi)	10.0	0.44
5.2 GHz	Omni-directional	0.036	0.042	20.0 (13.0 dBi)	10.0	0.07
	90° sector	0.014	0.017	50.1 (17.0 dBi)	10.0	0.07
	2ft directional flat plate	0.001	0.001	707.9 (28.5 dBi)	10.0	0.07
	4ft directional parabolic	0.000	0.000	2818.4 (34.5 dBi)	10.0	0.06
5.4 GHz	Omni-directional	0.036	0.042	20.0 (13.0 dBi)	10.0	0.07
	90° sector	0.014	0.017	50.1 (17.0 dBi)	10.0	0.07
	2ft directional flat plate	0.001	0.001	707.9 (28.5 dBi)	10.0	0.07
	2ft directional parabolic	0.001	0.001	707.9 (28.5 dBi)	10.0	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 138: FCC minimum safe distances – PMP/PTP 450 900 MHz, 2.4 GHz, 3.65 GHz and 5 GHz

Band	Antenna	P burst (W)	G (dBi)	S (W/m^2)	d (m)
900 MHz	Yagi	0.032	13 (11 dBi)	6.0	0.07

Band	Antenna	P burst (W)	G (dBi)	S (W/ m^2)	d (m)
2.4 GHz	Sector Antenna	0.079	50 (17 dBi)	10.0	0.18
	Integrated	0.158	6 (8 dBi)	10.0	0.09
	Reflector	0.040	100 (20 dBi)	10.0	0.18
3.65 GHz	Sector Antenna	0.316	32 (15 dBi)	10.0	0.28
	Integrated	0.316	6 (8 dBi)	10.0	0.12
	Reflector	0.25	100 (20 dBi)	10.0	0.45
	High Gain Ruggedized	0.25	79 (19 dBi)	10.0	0.40
5.4 GHz	Sector	0.025	40 (16 dBi)	10.0	0.09
	Integrated	0.126	8 (9 dBi)	10.0	0.09
	Reflector	0.003	316 (25 dBi)	10.0	0.09
	CLIP	0.020	50 (17 dBi)	10.0	0.09
	LENS	0.032	28 (14.5 dBi)	10.0	0.08
	Integrated Dish (450d)	0.0032	316 (25 dBi)	10.0	0.09
5.8 GHz	Sector	0.079	40 (16 dBi)	10.0	0.16
	Integrated	0.158	8 (9 dBi)	10.0	0.10
	Reflector	0.158	316 (25 dBi)	10.0	0.63
	CLIP	0.158	50 (17 dBi)	10.0	0.25
	LENS	0.158	28 (14.5 dBi)	10.0	0.19
	Integrated Dish (450d)	0.158	316 (25 dBi)	10.0	0.63

Table 139: ISEDC minimum safe distances – PMP 450m 3GHz and 5 GHz (4.9 GHz, 5.4 GHz and 5.8 GHz)

Band (GHz)	Antenna	PG (W)	S (W/ m2)	d (m)
3.45	90° sector	851	6.85	3.14
3.65	90° sector	33.84	7.12	0.61
4.9	90° sector	174	8.75	1.16
5.4	90° sector	0.85	9.39	0.08
5.8	90° sector	3.38	9.83	0.17

Table 140: ISED minimum safe distances – PMP 450 MicroPoP APs 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/ m2)	d (m)	S @ 20 cm (W/ m2)
4.9	Omni	0.501	9	8.71	0.18	7.92
	Sector	0.501	13	8.71	0.28	19.89
	Connectorized	0.501	(*)	8.71	(*)	(*)
5.1	Omni	0.501	9	9.01	0.17	7.92
	Sector	0.199	13	9.01	0.17	7.92
	Connectorized	(*)	(*)	9.01	0.17	7.92
5.2	Omni	0.125	9	9.13	0.09	1.99
	Sector	0.050	13	9.13	0.09	1.99
	Connectorized	(*)	(*)	9.13	0.09	1.99
5.4	Omni	0.125	9	9.39	0.08	1.99
	Sector	0.050	13	9.39	0.08	1.99
	Connectorized	(*)	(*)	9.39	0.08	1.99
5.8	Omni	0.501	9	9.69	0.17	7.92
	Sector	0.199	13	9.69	0.17	7.92
	Connectorized	(*)	(*)	9.69	0.17	7.92

(*) It depends on the external antenna gain

Table 141: ISED minimum safe distances – PMP/PTP 450b Retro APs 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/ m2)	d (m)	S @ 20 cm (W/ m2)
4.9	Integrated	0.501	8	8.71	0.16	6.29
5.1	Integrated	0.501	8	9.01	0.15	6.29
5.2	Integrated	0.501	8	9.13	0.15	6.29
5.4	Integrated	0.501	8	9.39	0.15	6.29
5.8	Integrated	0.501	8	9.69	0.15	6.29

Table 142: ISEDC minimum safe distances – PMP/PTP 450b 3.65 GHz, 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/ m2)	d (m)	S @ 20 cm (W/ m2)
3.5	Dish	0.794	20	6.99	0.88	158.0
3.65 GHz (Lower Canada)	Dish	0.199	20	7.13	0.44	39.7
3.65 GHz (Upper Canada)	Dish	0.199	20	7.13	0.44	39.7
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 143: 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 (W)	P (W)	G (dBi)	S (W/ m2)	d (m)
900 MHz	Sector	-	.02	20.0 (13 dBi)	2.74	0.11
3.5 GHz	90° sector antenna, integrated	-	0.316	50.0 (17 dBi)	6.99	0.39
	90° sector antenna, connectorized	-	0.316	40.0 (16 dBi)	6.99	0.35
	Panel, integrated	-	0.316	79.0 (19 dBi)	6.99	0.49

Band	Antenna	P burst (W)	P (W)	G (dBi)	S (W/ m2)	d (m)
3.65 GHz (Lower 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
3.65 GHz (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
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

Band	Antenna	P burst (W)	P (W)	G (dBi)	S (W/ m2)	d (m)
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 144: ISEDC minimum safe distance – PMP/PTP 450 900 MHz, 2.4 GHz, 3.5/3.65 GHz and 5 GHz

Band	Antenna	P burst (W)	G (dBi)	S (W/ m2)	d (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 GHz (lower 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 GHz (upper 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

Band	Antenna	P burst (W)	G (dBi)	S (W/ m2)	d (m)
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)

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.

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 (W/m^2)

Densité de puissance (W/m^2)

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

Distance minimale de source ponctuelle (en mètres)

Tx power limits for PMP 450 MicroPoP

The PMP 450 MicroPoP uses the same FCC grant as the PMP 450b mid-gain. The Tx power limits are captured as shown below. Omni antenna gain = 8 dBi; Sector antenna gain = 13 dBi

	5/10 MHz				20/40 MHz			
	Rounded EIRP	MicroPoP Omni Tx power	MicroPoP Sector Tx power	MicroPoP Connectorized	Rounded EIRP	MicroPoP Omni Tx power	MicroPoP Sector Tx powe	MicroPoP Connectorized
4.9 GHz		26 dBm	26 dBm	26 dBm		24 dBm	24 dBm	24 dBm
5.1 GHz	26 dBm	17 dBm	13 dBm	EIRP – Antenna Gain	32 dBm	23 dBm	19 dBm	EIRP – Antenna Gain
5.2 GHz	25 dBm	16 dBm	12 dBm	EIRP – Antenna Gain	25 dBm	16 dBm	12 dBm	EIRP – Antenna Gain
5.4 GHz	25 dBm	16 dBm	12 dBm	EIRP – Antenna Gain	25 dBm	16 dBm	12 dBm	EIRP – Antenna Gain
5.8 GHz	32 dBm	23 dBm	19 dBm	EIRP – Antenna Gain	31 dBm	22 dBm	18 dBm	EIRP – Antenna Gain

Hazardous location compliance

The PMP/PTP 450i series IECEx/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 EN60079-11:2012.

The approval is given by certificate number EMT126ATEX0003X, issued by Element Materials Technology, 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)

IECEx approvals - Certificate No, IECEx EMT 16.0001X

Marking - Ex ic IIC T4 Gc Tamb -40C to + 60C

Chapter 7: 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.

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 Radio certifications.

Table 145: Radio certifications

Region/Country	Band	Specification
Brazil	4.9 GHz	ANATEL, RESOLUÇÃO Nº 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, FCC Part 15 Class B
	2.4 GHz	FCC Part 15.247, FCC Part 15 Class B
	3.6 GHz	FCC Part 96, FCC Part 15 Class B
	4.9 GHz	FCC 47 CFR Part 90, FCC Part 15 Class B
	5.1 GHz	FCC 47 CFR Part 15 E, FCC Part 15 Class B
	5.2 GHz	FCC 47 CFR Part 15 E, FCC Part 15 Class B
	5.4 GHz	FCC 47 CFR Part 15 E, FCC Part 15 Class B
	5.8 GHz	FCC 47 CFR Part 15 E
Canada	900 MHz	RSS Gen and RSS 210
	2.4 GHz	RSS Gen and RSS 210
	3.5 /3.6 GHz	RSS Gen, RSS-197 and RSS 192
	4.9 GHz	IC RSS-111, Issue 5
	5.8 GHz	IC RSS-247, Issue 2
Europe	3.5 GHz	ETSI EN 302 326-2 V1.2.2
	5.4 GHz	ETSI EN 301 893 V2.1.1
	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)

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 (TCP) and Dynamic Frequency Selection (DFS).

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 for further information.

Cambium Radio equipment operating in the 5470 to 5725 MHz band are categorized as “Class 1” devices within the EU in accordance with ECC DEC(04)08 and are “CE” marked to show compliance with the European Radio Equipment Directive (RED) 2014/53/EU. The relevant Declaration of Conformity can be found at http://www.cambiumnetworks.com/ec_dofc/ .

Canadian Installation Procedures (900 MHz 450i)

1. << En effet, il est conçu pour être approvisionné par un bloc d'alimentation PoE listé UL et portant la mention <<LPS>> ou <<PS2 complied>>.
2. Encapsulé dans un boîtier de type 450i, il comporte 450 circuits qui sont obligatoirement alimentés par 30V dc.
3. La prise de type RJ-11 est utilisée par une personne qualifiée uniquement pour la connexion GPS et aucun raccordement au système de télécommunication n'est nécessaire.