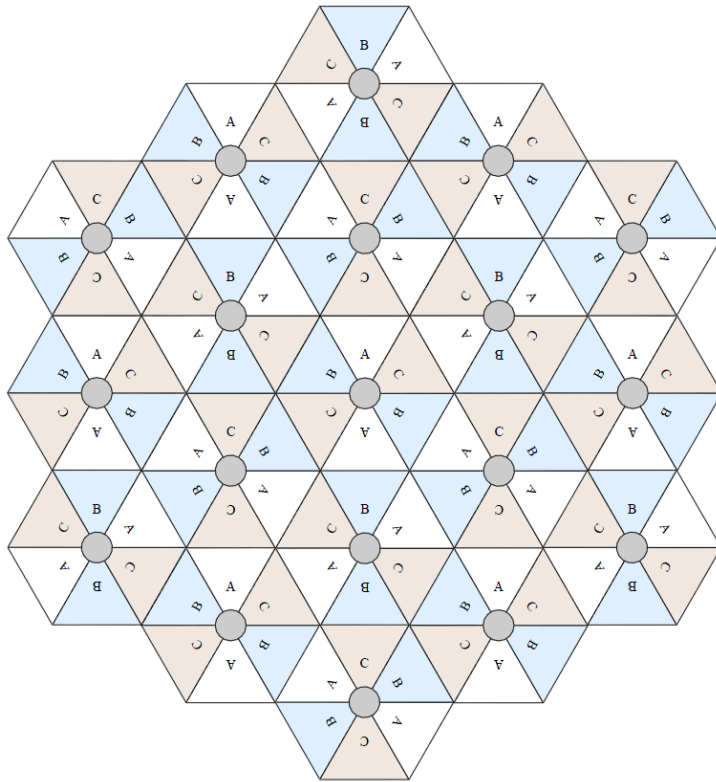


Figure 49 Example layout of 6 Access Point sectors (ABC), 60-degree sectors

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

Table 77 Example 5.8 GHz 3-channel assignment by access site

Symbol	Frequency
A	5.740 GHz
B	5.760 GHz
C	5.780 GHz

Considerations on back-to-back frequency reuse

Cambium Networks recommends using back-to-back (ABAB) frequency reuse, as shown in [Figure 48](#). This means that a base site of four sectors can be created using two frequencies, which works very well and helps define networks in situations where high capacity is required in a limited amount of spectrum.

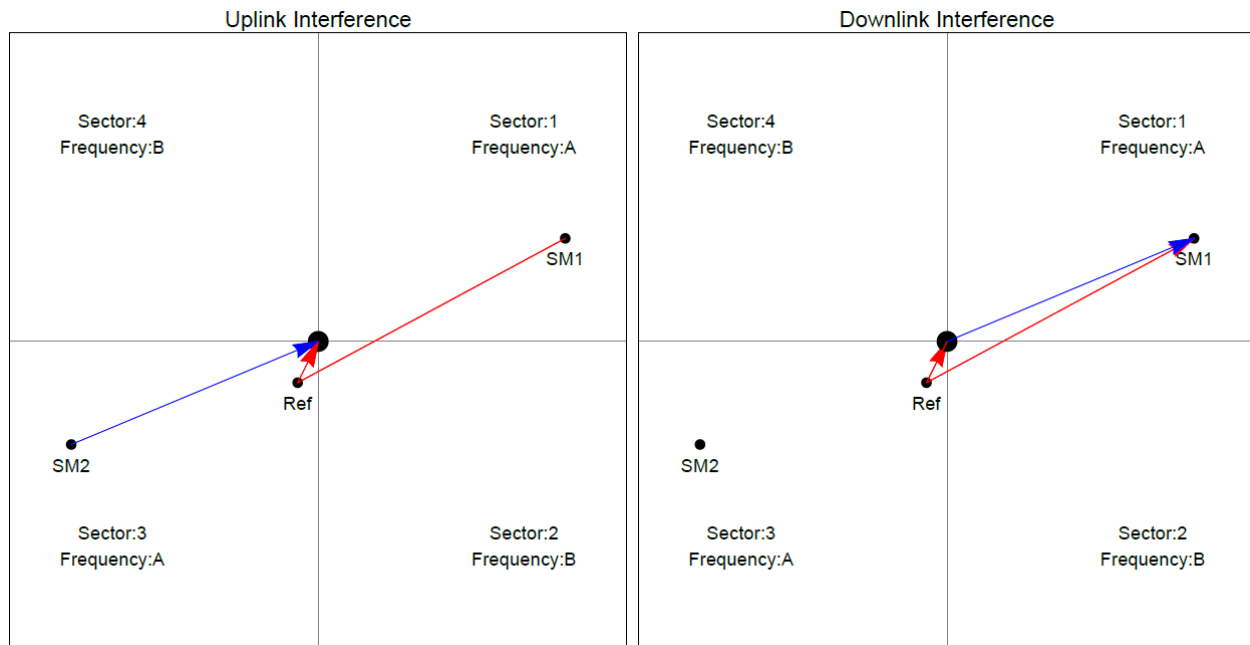
The conditions necessary to implement this plan are:

- GPS synchronization: all the access points transmit at the same time
- Uplink and Downlink timings across APs do not overlap: they can be adjusted using the frame calculators and co-location tools provided by Cambium
- Uplink power control to ensure that all signals are received on the uplink at the same level: this is automatically enabled on all sectors
- There are no reflecting objects which are too large in the exclusion zones defined in this section.
- The SMs do not normally have line-of-sight (LoS) to an interfering base station. The worst-case range ratio in [Figure 48](#) is 5:1 which in LoS only gives 14 dB protection. Greater than 30 dB is required for 256QAM capability. Down tilt can be used to advantage when the elevation beamwidth is low. Also, the range ratio applies to the longest distance SM, shorter distance SMs have a better range ratio. This frequency reuse plan may not always give 256QAM for the longest distance SMs. It is usually a good compromise between using more spectrum and guaranteed modulation rate.

Reflecting objects

[Figure 50](#) 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 50 Reflection

Reflection likelihood guidance

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

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

Figure 51 and Figure 52 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.

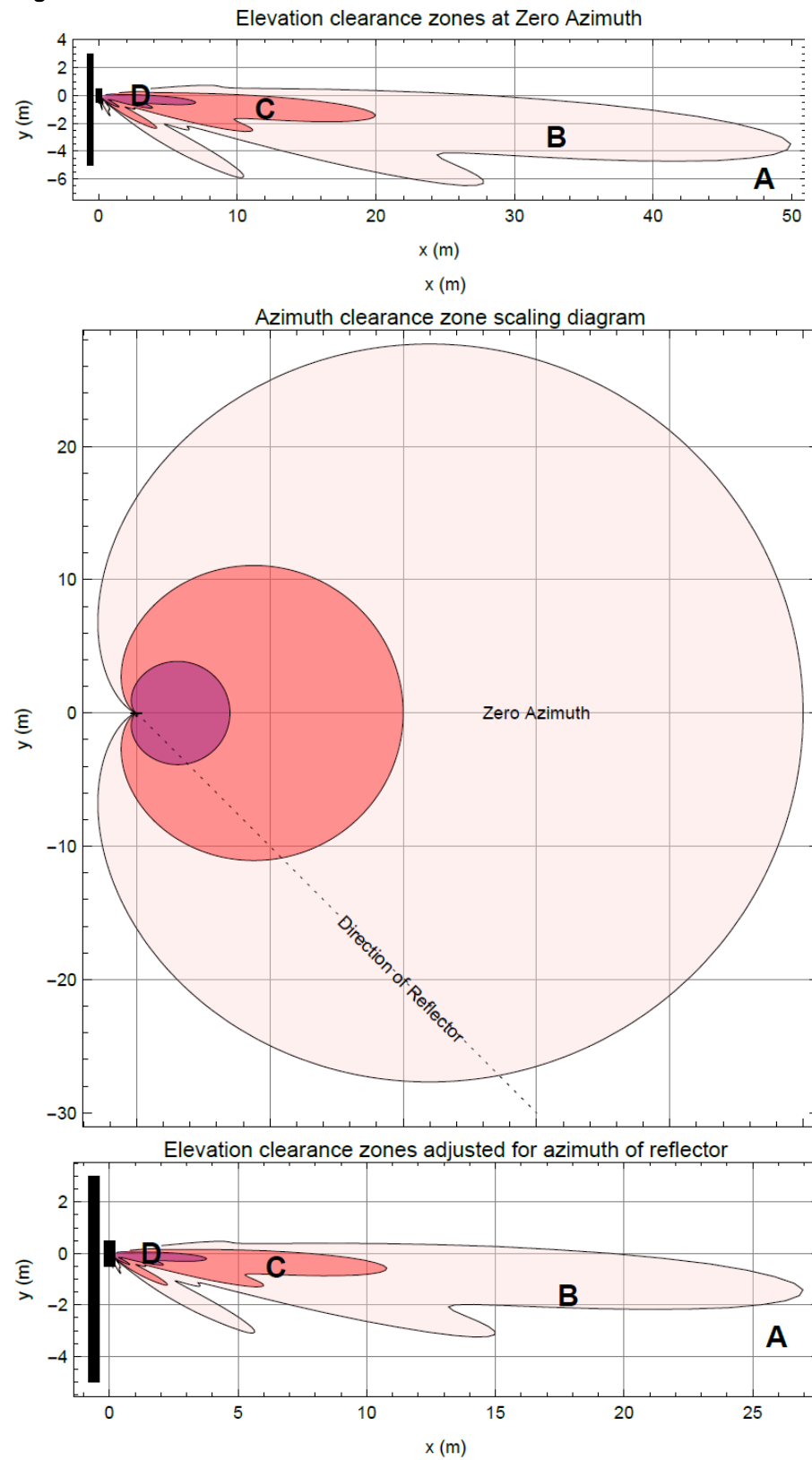
Figure 51 Sector Antenna

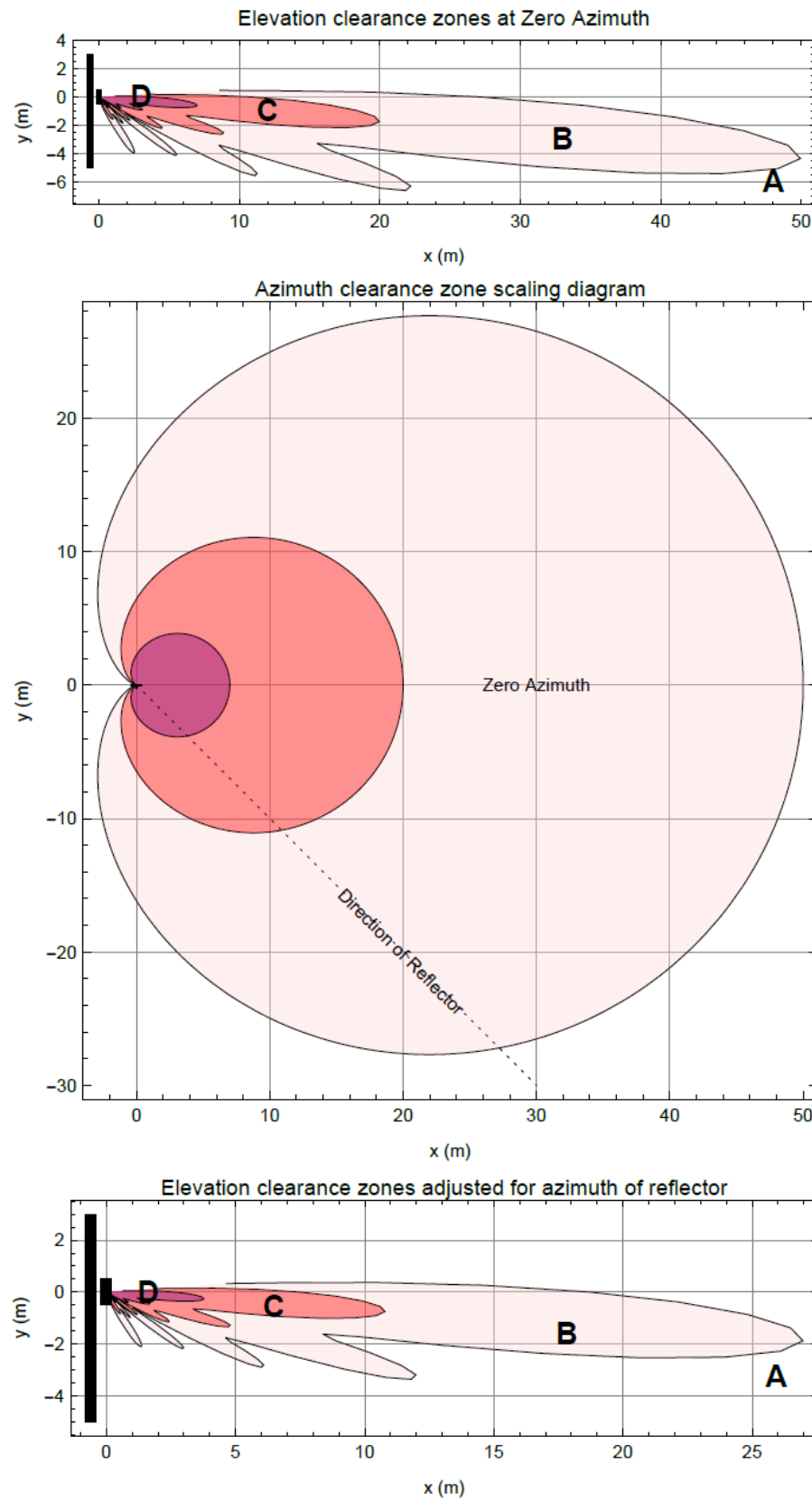
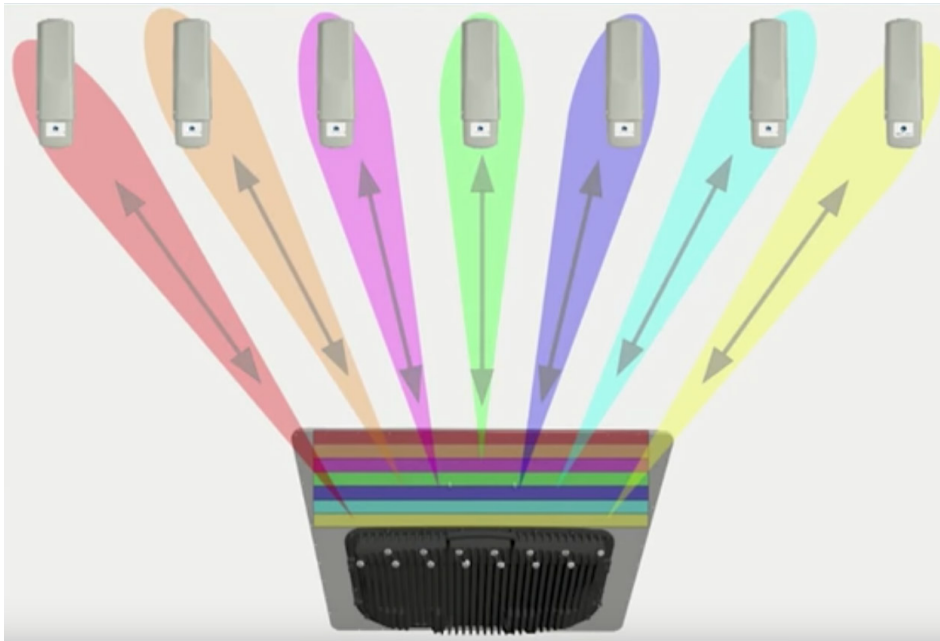
Figure 52 cnMedusa Antenna

Figure 51 and Figure 52 each have three diagrams scaled in meters where Figure 51 is for the sector antenna and Figure 52 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. It is a 14x14 MIMO system which allows simultaneous communication to up to seven SMs.

Figure 53 PMP 450m Series AP antenna beam



PMP 450m installation recommendations

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

Link planning

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

Range and obstacles

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

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

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

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

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

Path loss

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

$$L_{free_space} + L_{excess} + L_{fade} + L_{seasonal} < L_{capability}$$

Where:

Is:

L_{free_space}

Free Space Path Loss (dB)

L_{excess}

Excess Path Loss (dB)

L_{fade}

Fade Margin Required (dB)

$L_{seasonal}$	Seasonal Fading (dB)
$L_{capability}$	Equipment Capability (dB)

Calculating Link Loss

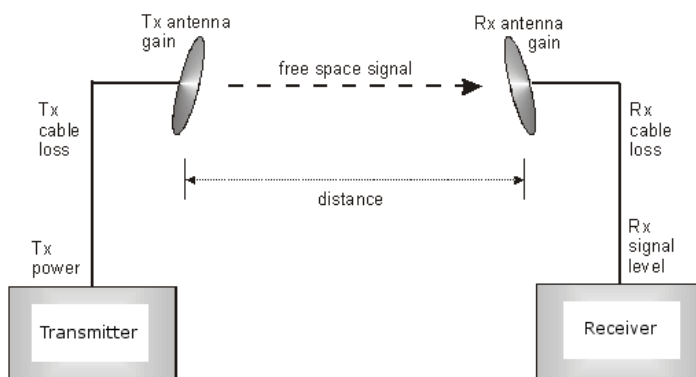
The link loss is the total attenuation of the wireless signal between two point-to-multipoint units. The link loss calculation is presented below:

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

Calculating Rx Signal Level

The determinants in Rx signal level are illustrated in [Figure 54](#).

Figure 54 Determinants in Rx signal level



Rx signal level is calculated as follows:

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



Note

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

Calculating Fade Margin

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

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

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

Adaptive modulation

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

For details of the system throughput, link loss and maximum distance for each frequency band in all modulation modes, see [Link](#) on page 10-45.

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 [Table 78](#) (source: Times Microwave). This data excludes connector losses.

Table 78 RF cable lengths required to achieve 1.2 dB loss at 5.8 GHz

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

Data network planning

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

Understanding addresses

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

IP address

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

Dynamic or static addressing

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

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



Note

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

When a DHCP server is not found

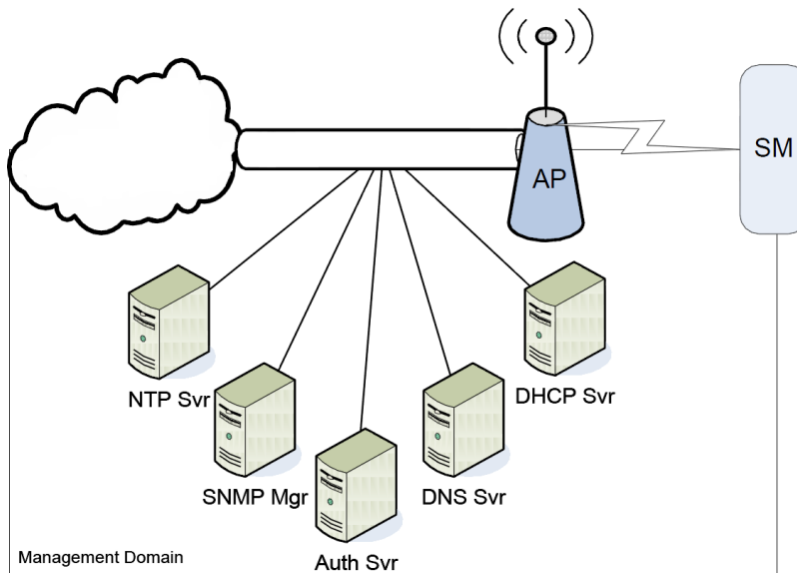
To operate on a network, a computer requires an IP address, a subnet mask, and possibly a gateway address. Either a DHCP server automatically assigns this configuration information to a computer on a network or an operator must input these items.

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

DNS Client

The DNS Client is used to resolve names of management servers within the operator's management domain (see [Figure 55](#)). 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 55 Cambium networks management domain



Network Address Translation (NAT)

NAT, DHCP Server, DHCP Client and DMZ in SM

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

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

NAT

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

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

DHCP

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

In conjunction with the NAT features, each SM provides:

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

DMZ

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

Developing an IP addressing scheme

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

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

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

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

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

Address Resolution Protocol

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

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

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

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

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

Allocating subnets

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

Example IP address and subnet mask

In [Figure 56](#), the first 16 bits of the 32-bit IP address identify the network:

Figure 56 Example of IP address in Class B subnet

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

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

Selecting non-routable IP addresses

The factory default assignments for network elements are:

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

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

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

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

Translation bridging

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

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

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

Engineering VLANs

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

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

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

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

Special case VLAN numbers

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

Table 79 Special case VLAN IDs

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

SM membership in VLANs

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

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

PMP 450 Platform Family modules provide the VLAN frame filters that are described in [Table 80](#).

Table 80 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...	
any combination of VLAN parameter settings	with a VID not in the membership table		Ingress
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.

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 81](#).

Table 81 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](#) on page 1).

Enabling SNMP

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

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

Security planning

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

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

Isolating AP/BHM from the Internet

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

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

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

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

Encrypting radio transmissions

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

- **DES (Data Encryption Standard):** An over-the-air link encryption option that uses secret 56-bit keys and 8 parity bits. DES performs a series of bit permutations, substitutions, and recombination operations on blocks of data. DES encryption does not affect the performance or throughput of the system.
- **AES (Advanced Encryption Standard):** An over-the-air link encryption option that uses the Rijndael algorithm and 128-bit keys to establish a higher level of security than DES. AES products are certified as compliant with the Federal Information Processing Standards (FIPS 197) in the U.S.A.

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

Planning for HTTPS operation

Before starting to configure HTTPS operation, ensure that the cryptographic material listed in [Table 82](#) is available.

Table 82 HTTPS security material

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

Planning for SNMPv3 operation

SNMP security mode

Decide how SNMPv3 security will be configured.

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

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

Web-based management of SNMPv3 security

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

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

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

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

- Read Only
- System Administrator

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

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

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

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

Managing module access by passwords

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

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



Caution

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

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

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

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

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

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

Planning for RADIUS operation

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

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

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

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

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

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

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

Filtering protocols and ports

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

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

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

Port Filtering with NAT Enabled

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

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



Note

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

Protocol and Port Filtering with NAT Disabled

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

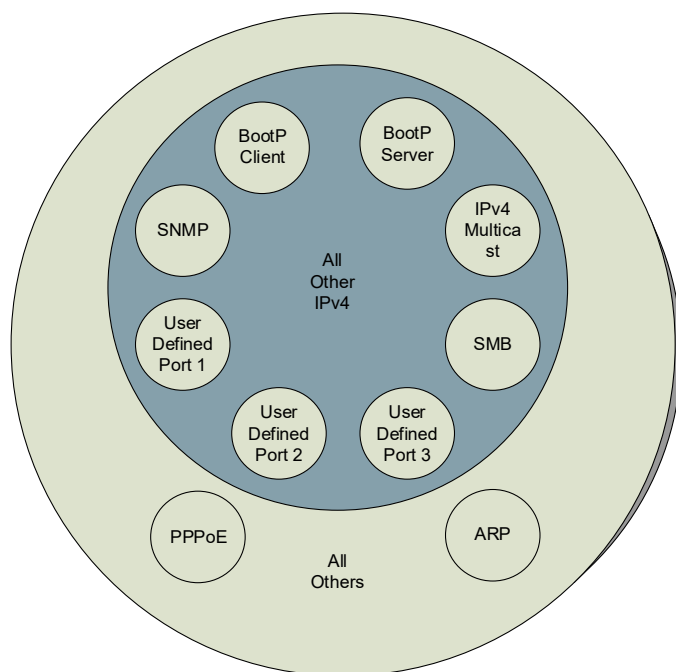
- Allow all protocols except those that user wish to block.
- Block all protocols except those that user wish to allow.

Allow or block any of the following protocols:

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

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

Figure 57 Categorical protocol filtering



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

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

The ports filtered because of protocol selections in the **Protocol Filtering** tab of the SM/BHS are listed in [Table 83](#).

Table 83 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
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 84 Device default port numbers

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

Encrypting downlink broadcasts

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

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

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

Isolating SMs in PMP

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

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

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

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

Filtering management through Ethernet

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

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

Allowing management from only specified IP addresses

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

If the selection is:

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

Configuring management IP by DHCP

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

In the SM/BHS, this parameter is settable

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

DHCP option 81

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

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

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

Controlling PPPoE PADI Downlink Forwarding

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

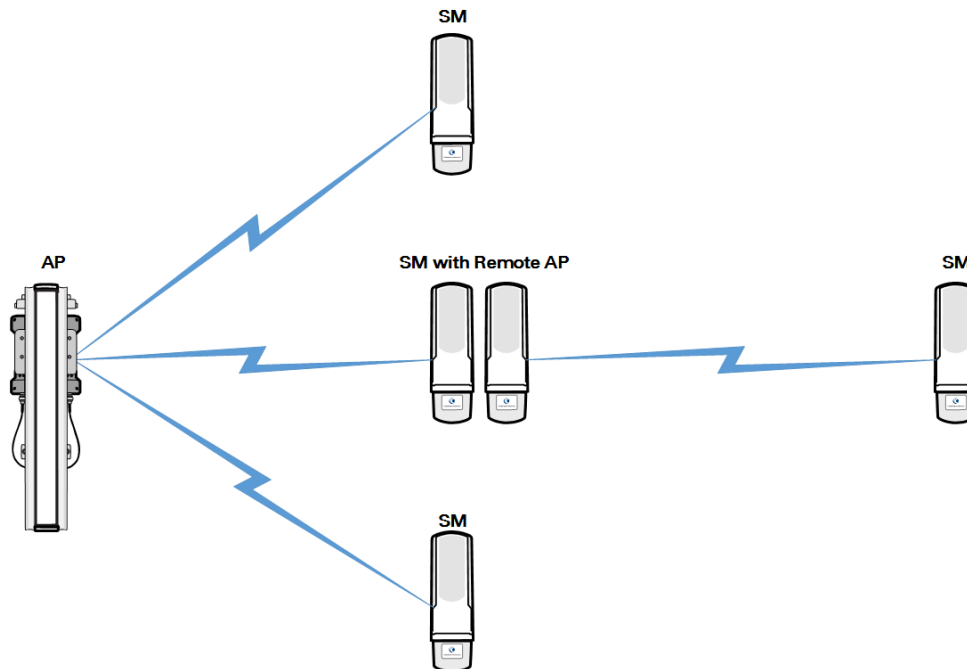
Remote AP Deployment

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

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

In the remote AP configuration, a remote AP is co-located with an SM. The remote AP distributes the signal to SMs that are logically behind the co-located SM. A remote AP deployment is illustrated in [Figure 58](#).

Figure 58 Remote AP deployment



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

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



Note

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

Remote AP (RAP) Performance

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

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

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

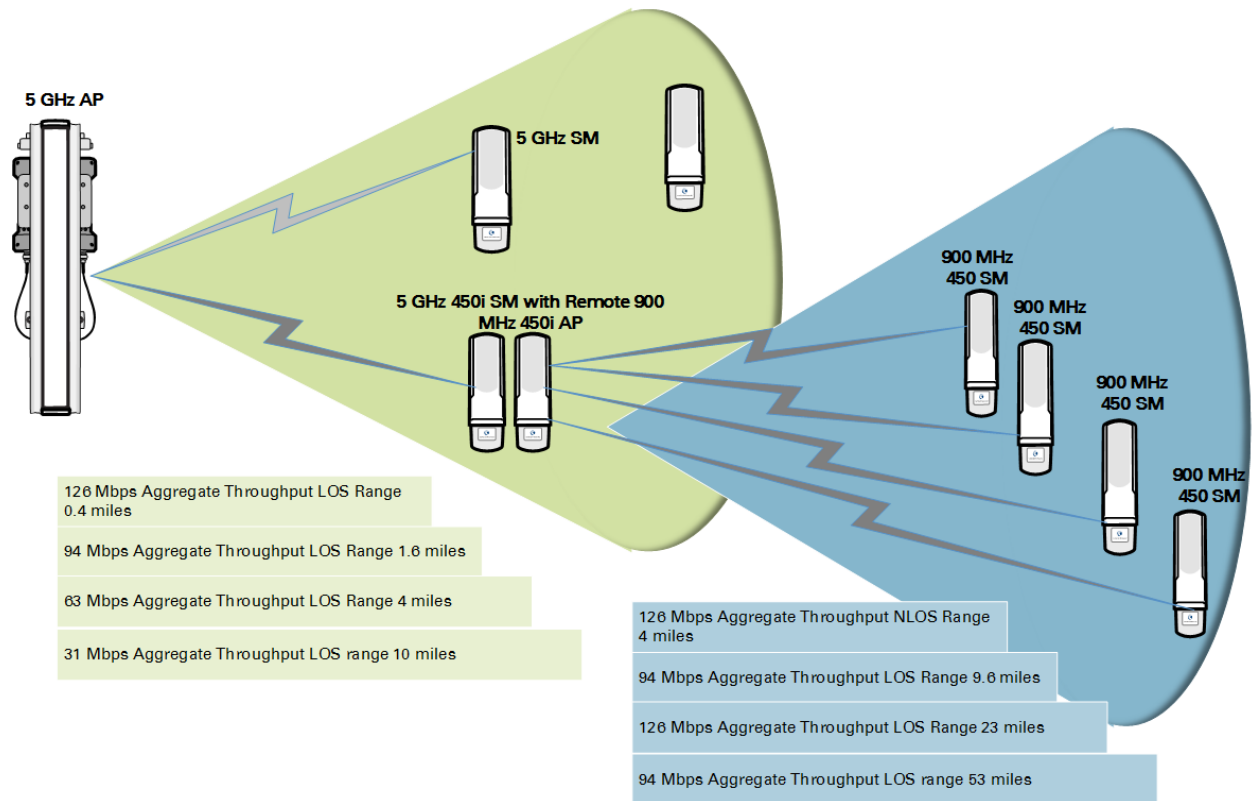
Example Use Case for RF Obstructions

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

An example of this use case is shown in [Figure 59](#).

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 59 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 throughput² 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

² NLoS ranges depend on environmental conditions. Your results may vary from these.

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

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

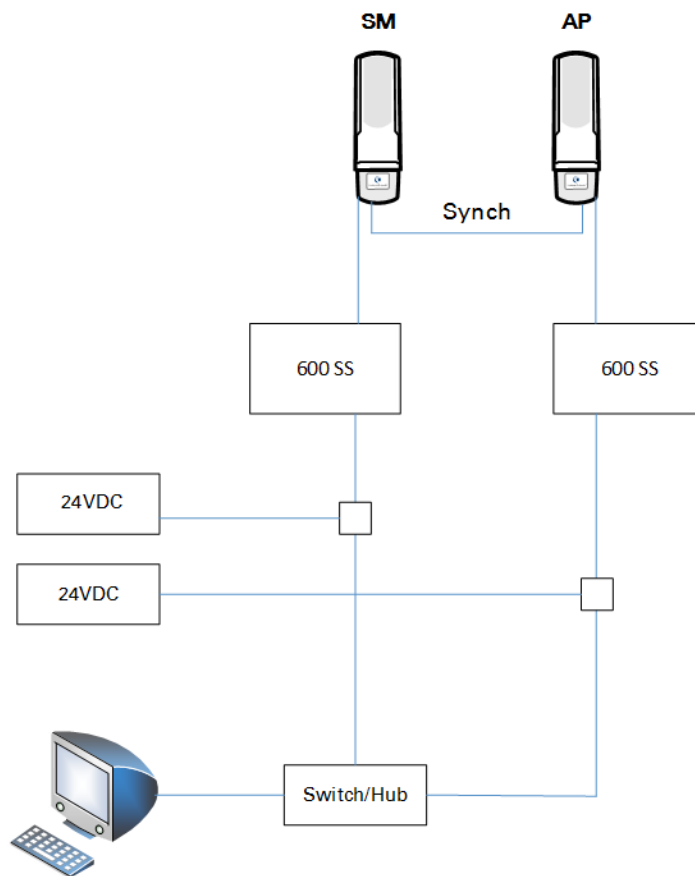
For PMP 450i/450m the sync is passed in a cable that connects Pins 7 and 8 of the RJ-45 timing ports of the two modules.

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

Physical Connections Involving the Remote AP

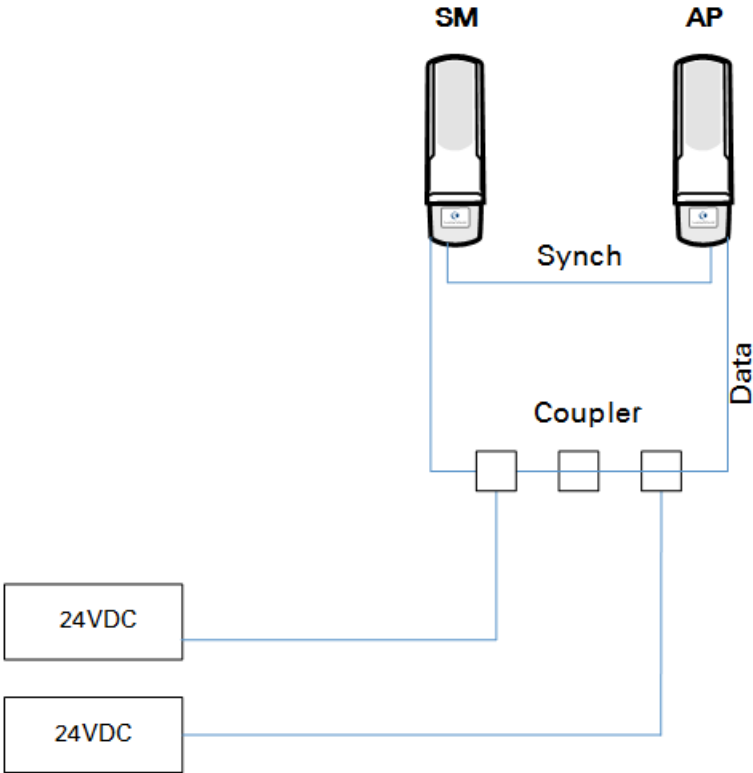
The SM to which a remote AP is connected to can be either an SM that serves a customer or an SM that simply serves as a relay. If the SM serves a customer, wire the remote AP to the SM as shown in [Figure 60](#).

Figure 60 Remote AP wired to SM that also serves a customer



If the SM simply serves as a relay, you must use a straight-through RJ-45 female-to-female coupler and wire the SM to the remote AP as shown in [Figure 61](#).

Figure 61 Remote AP wired to SM that serves as a relay



Passing Sync signal

Passing Sync in a Single Hop

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

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

Passing Sync in an Additional Hop

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



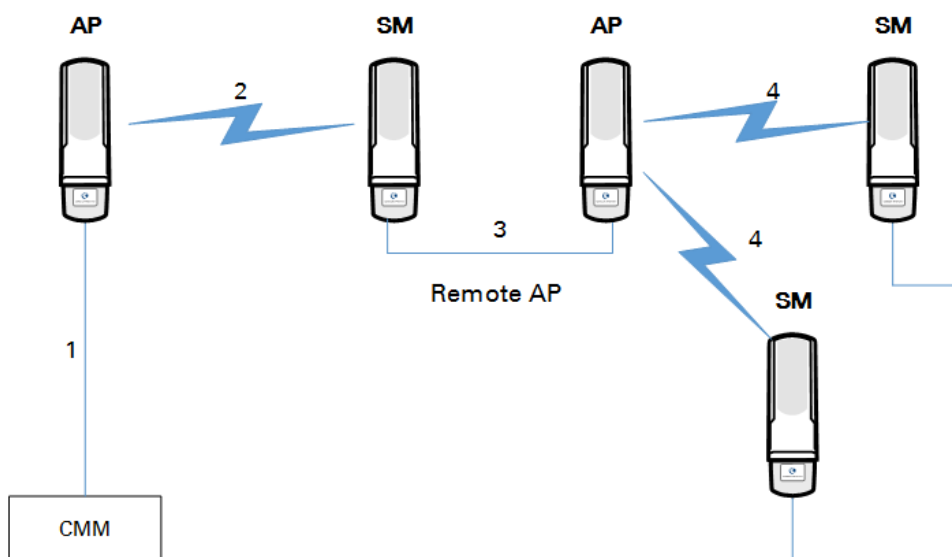
Note

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

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

This design is illustrated in [Figure 62](#).

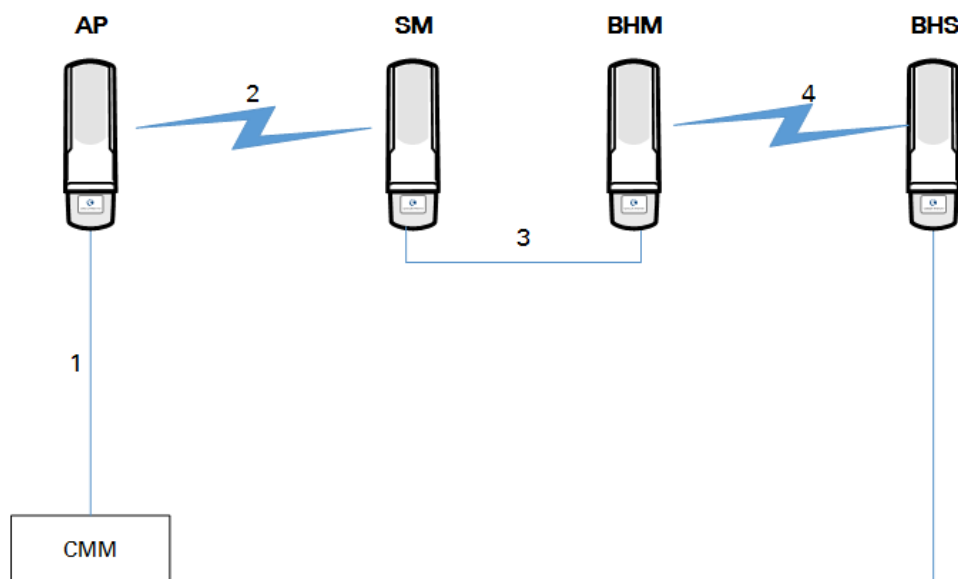
Figure 62 Additional link to extend network sync, Design 3



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

This design is illustrated in [Figure 63](#).

Figure 63 Additional link to extend network sync, Design 4

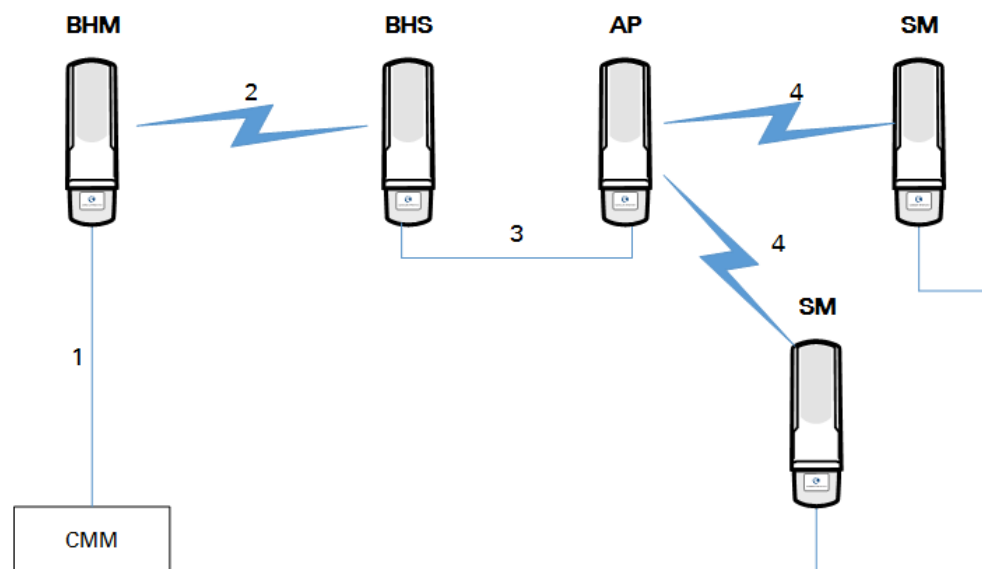


- Design 5
 - A CMM provides sync to a co-located BHM or the BHM generates timing.
 - This BHM sends the sync over the air to a BHS.
 - This BHS delivers the sync to a co-located AP.

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

This design is illustrated in [Figure 64](#).

Figure 64 Additional link to extend network sync, Design 5



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

Wiring to Extend Network Sync

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

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



Note

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

Figure 65 Co-located AP or BH timing master Sync Setting configuration

Sync Setting	
Sync Input :	AutoSync ▼
Free Run Before GPS Sync :	☐ Enabled ☒ Disabled
Device Type :	☐ Standard ☒ Remote
Verify GPS Message Checksum :	☒ Enabled ☐ Disabled
Sync Output to Aux Port :	☐ Enabled ☒ Disabled
UGPS Power :	☐ Enabled ☒ Disabled

Chapter 4: Legal and regulatory information

This chapter provides end user license agreements and regulatory notifications.



Caution

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



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The following topics are described in this chapter:

- [Cambium Networks end user license agreement](#) on page [4-2](#) contains the Cambium and third-party license agreements for the 450 Platform Family ODUs.
- [Compliance with safety standards](#) on page [4-22](#) lists the safety specifications against which the 450 Platform Family has been tested and certified. It also describes how to keep RF exposure within safe limits.
- [Compliance with radio regulations](#) on page [4-33](#) describes how the 450 Platform Family complies with the radio regulations that are in force in various countries, and contains notifications made to regulatory bodies for the 450 Platform Family.

Cambium Networks end user license agreement

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USB library functions

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D3 JS library

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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 [Table 85](#).

Table 85 Safety compliance specifications

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

Electromagnetic compatibility (EMC) compliance

The EMC specification type approvals that have been granted for 450 Platform Family are listed under [Table 86](#).

Table 86 EMC emissions compliance

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

Human exposure to radio frequency energy

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

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

- *Directive 2004/40/EC of the European Parliament and of the Council of 29 April 2004* on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (18th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC).
- US FCC limits for the general population. See the FCC web site at <http://www.fcc.gov>, and the policies, guidelines, and requirements in Part 1 of Title 47 of the Code of Federal Regulations, as well as the guidelines and suggestions for evaluating compliance in FCC OET Bulletin 65.
- Health Canada limits for the general population. See the Health Canada web site at http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/99ehd-dhm237/limits-limités_e.html and Safety Code 6.
- EN 50383:2002 to 2010 Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz - 40 GHz).
- BS EN 50385:2002 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 <http://www.icnirp.de/> and Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields.

Power density exposure limit

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

The applicable FCC power density exposure limit for RF energy in the 4.9, 5.4 and 5.8 GHz frequency bands is **10 W/m²** and in 900 MHz frequency band is **6 W/m²**. For more information, see [Human exposure to radio frequency energy](#) on page 4-22.

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

Calculation of power density

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

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

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

Where:

Is:

S	power density in W/m 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:

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

Calculated distances and power compliance margins

[Table 88](#) and [Table 89](#) shows 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 [Table 88](#) and [Table 89](#):

- 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 87 FCC minimum safe distances – PMP 450m 5.1 GHz, 5.2 GHz, 5.4 GHz and 5.8 GHz

Band (GHz)	Antenna	PG (W)	S (W/ m ²)	d (m)
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 88 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
5.1 GHz	Omni-directional	0.170	0.200	20.0 (13.0 dBi)	10	0.15
	90° sector	0.034	0.040	50.1 (17.0 dBi)	10	0.10
	2ft directional flat plate	0.002	0.002	707.9 (28.5 dBi)	10	0.09
	4ft directional parabolic	0.011	0.013	2818.4 (34.5 dBi)	10	0.44
5.2 GHz	Omni-directional	0.036	0.042	20.0 (13.0 dBi)	10	0.07
	90° sector	0.014	0.017	50.1 (17.0 dBi)	10	0.07
	2ft directional flat plate	0.001	0.001	707.9 (28.5 dBi)	10	0.07
	4ft directional parabolic	0.000	0.000	2818.4 (34.5 dBi)	10	0.06
5.4 GHz	Omni-directional	0.036	0.042	20.0 (13.0 dBi)	10	0.07
	90° sector	0.014	0.017	50.1 (17.0 dBi)	10	0.07
	2ft directional flat plate	0.001	0.001	707.9 (28.5 dBi)	10	0.07
	2ft directional parabolic	0.001	0.001	707.9 (28.5 dBi)	10	0.08
5.8 GHz	90°/120° sector	0.10	0.12	50.0 (17 dBi)	10.0	0.18

Table 89 ISED 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/ m ²)	d (m)
900 MHz	Sector	-	.02	20.0 (13 dBi)	2.74	0.11
	90° sector antenna, integrated	-	0.794	50.0 (17 dBi)	37.10	0.29
3.5 GHz	90° sector antenna, connectorized	-	0.794	40.0 (16 dBi)	37.10	0.23
	Panel, integrated	-	0.794	79.0 (19 dBi)	37.10	0.37
3.65 GHz (Lower Canada)	90° sector antenna, integrated	-	0.794	50.0 (17 dBi)	7.13	0.67
	90° sector antenna, connectorized	-	0.794	40.0 (16 dBi)	7.13	0.59
	Panel, integrated	-	0.794	79.0 (19 dBi)	7.13	0.84
3.65 GHz (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
	Omni-directional	0.214	0.251	20.0 (13 dBi)	8.71	0.20
4.9 GHz	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
	Omni-directional	0.009	0.011	20.0 (13.0 dBi)	9.13	0.04
5.2 GHz	90° sector	0.012	0.014	50.1 (17.0 dBi)	9.13	0.06
	2ft directional flat plate	0.001	0.001	707.9 (28.5 dBi)	9.13	0.07
	2ft directional parabolic	0.001	0.001	707.9 (28.5 dBi)	9.13	0.06

Band	Antenna	P burst (W)	P (W)	G (dBi)	S (W/ m ²)	d (m)
5.4 GHz	Omni-directional	0.036	0.042	20.0 (13.0 dBi)	9.39	0.07
	90° sector	0.014	0.017	50.1 (17.0 dBi)	9.39	0.07
	2ft directional flat plate	0.001	0.001	707.9 (28.5 dBi)	9.39	0.07
	2ft directional parabolic	0.001	0.001	707.9 (28.5 dBi)	9.39	0.06
5.8 GHz	90°/120° sector	0.10	0.12	50.1 (17 dBi)	9.69	0.20

Table 90 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	0.07
2.4 GHz	Sector Antenna	0.079	50 (17 dBi)	10	0.18
	Integrated	0.158	6 (8 dBi)	10	0.09
	Reflector	0.040	100 (20 dBi)	10	0.18
3.65 GHz	Sector Antenna	0.316	32 (15 dBi)	10	0.28
	Integrated	0.316	6 (8 dBi)	10	0.12
	Reflector	0.25	100 (20 dBi)	10	0.45
	High-gain Ruggedized	0.25	79 (19 dBi)	10	0.40
5.4 GHz	Sector	0.025	40 (16 dBi)	10	0.09
	Integrated	0.126	8 (9 dBi)	10	0.09
	Reflector	0.003	316 (25 dBi)	10	0.09
	CLIP	0.020	50 (17 dBi)	10	0.09
	LENS	0.032	28 (14.5 dBi)	10	0.08
	Integrated Dish (450d)	0.0032	316 (25 dBi)	10	0.09
5.8 GHz	Sector	0.079	40 (16 dBi)	10	0.16
	Integrated	0.158	8 (9 dBi)	10	0.10
	Reflector	0.158	316 (25 dBi)	10	0.63
	CLIP	0.158	50 (17 dBi)	10	0.25
	LENS	0.158	28 (14.5 dBi)	10	0.19
	Integrated Dish (450d)	0.158	316 (25 dBi)	10	0.63

Table 91 ISED minimum safe distances – 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/ m ₂)	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
5.4 GHz	Sector	0.025	40 (16 dBi)	9.39	0.09
	Integrated	0.126	8 (9 dBi)	9.39	0.09
	Reflector	0.003	316 (25 dBi)	9.39	0.09
	CLIP	0.020	50 (17 dBi)	9.39	0.09
	LENS	0.032	28 (14.5 dBi)	9.39	0.09
	Integrated Dish (450d)	0.0032	316 (25 dBi)	9.39	0.09
5.8 GHz	Sector	.079	40 (16 dBi)	9.69	0.16
	Integrated	0.158	8 (9 dBi)	9.69	0.10
	Reflector	0.158	316 (25 dBi)	9.69	0.064
	CLIP	0.158	50 (17 dBi)	9.69	0.25
	LENS	0.158	28 (14.5 dBi)	9.69	0.19
	Integrated Dish (450d)	0.158	316 (25 dBi)	9.69	0.64

- (*1) P: maximum average transmit power capability of the radio including cable loss (Watt)
Capacité de puissance d'émission moyenne maximale de la radio comprenant la perte dans les câble de connexion (W)
- (*2) G: total transmit gain as a factor, converted from dB
Gain total d'émission, converti à partir de la valeur en dB
- (*3) S: power density (W/m^2)
Densité de puissance (W/m^2)
- (*4) d: minimum distance from point source (meters)
Distance minimale de source ponctuelle (en mètres)

**Note**

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

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

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

**Remarque**

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

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

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

**Note**

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

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

**Remarque**

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

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

Hazardous location compliance

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

ATEX

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

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

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

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

Compliance with radio regulations

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

**Caution**

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

**Caution**

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

**Caution**

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

**Attention**

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

**Attention**

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

**Attention**

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

Type approvals

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

The radio specification type approvals that have been granted for 450 Platform Family frequency variants are listed under [Table 92](#).

Table 92 Radio certifications

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

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

Brazil specific information

Brazil notification

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

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

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

Brazil certification numbers

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

Australia Notification

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

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

Regulatory Requirements for CEPT Member States (www.cept.org)

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

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

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

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

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

For EU member states, RLAN equipment in the 5.4GHz bands is exempt from individual licensing under Commission Recommendation 2003/203/EC. Contact the appropriate national administrations for details on the conditions of use for the bands in question and any exceptions that might apply. Also see www.ero.dk 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 & Telecommunications Terminal Equipment (R&TTE) directive 1999/5/EC. The relevant Declaration of Conformity can be found at

http://www.cambiumnetworks.com/support/ec_doc/.

A European Commission decision, implemented by Member States on 31 October 2005, makes the frequency band 5470-5725 MHz available in all EU Member States for wireless access systems. Under this decision, the designation of Canopy 5.4GHz products become “Class 1 devices” and these do not require notification under article 6, section 4 of the R&TTE Directive. Consequently,

these 5.4GHz products are only marked with the **CE 0977** symbol and may be used in any member state.



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

Safety

**Warning**

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

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.

Power lines

Exercise extreme care when working near power lines.

Working at heights

Exercise extreme care when working at heights.

Power supply

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

Grounding and protective earth

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

Powering down before servicing

Always power down and unplug the equipment before servicing.

Primary disconnect device

The ODU power supply is the primary disconnect device.

External cables

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

RF exposure near the antenna

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

Minimum separation distances

Ensure that personnel are not exposed to unsafe levels of RF energy. The units start to radiate RF energy as soon as they are powered up. Never work in front of the antenna when the ODU is powered. Install the ODUs so as to provide and maintain the minimum separation distances from all persons. For minimum separation distances, see [Calculated distances and power compliance margins](#) on page 4-24.

Grounding and lightning protection requirements

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

Grounding cable installation methods

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

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

Siting ODUs and antennas

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

Thermal Safety

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



Warning

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

**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:

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

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

Preparing personnel

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

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

Ensure that all safety precautions are observed.

Preparing inventory

Perform the following inventory checks:

- Check that the correct components are available, as described in [Ordering the components](#) on page 2-60.
- Check the contents of all packages against their packing lists.

Preparing tools

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

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

Testing system components

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

Unpacking Components

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

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

Preparing the ODU

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

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

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

After changing configuration parameters on a GUI web page:

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

Configuring the Computing Device for Test

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

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

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

Factory default Configuration

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

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

ODU interfaces

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

ODU diagnostic LEDs

See section [AP/BHM LEDs](#) on page 2-15.

See section [SM/BHS LEDs](#) on page 2-17.

Recommended Tools for Installation

The following tools may be needed for installation:

Table 93 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 Used for tightening cable glands • Self-amalgamating and PVC Tape Used for weatherproofing N-type connections

Equipment to Be Installed	Tools Required
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:

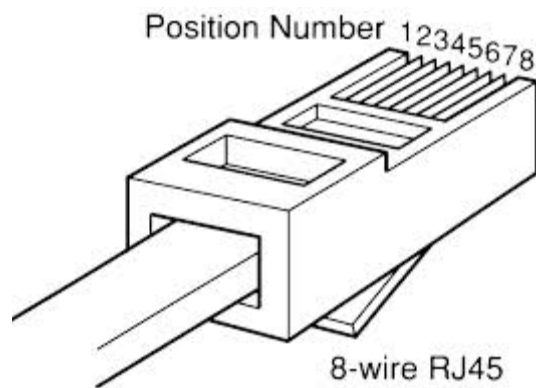
- Use only shielded cables to resist interference.
- For vertical runs, provide cable support and strain relief.
- Include a 2-ft (0.6-m) service loop on each end of the cable to allow for thermal expansion and contraction and to facilitate terminating the cable again when needed.
- Include a drip loop 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 66 Pin 1 location



Main port pinout

Table 94 Main port pinout

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

Aux port pinout

Table 95 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 67 Straight-through Ethernet Cable

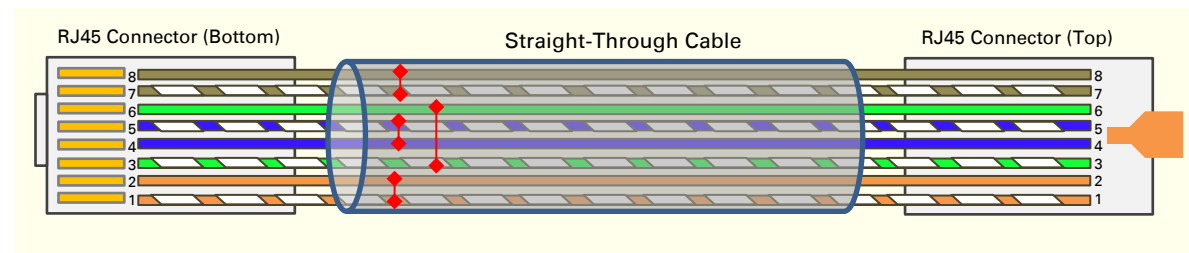


Table 96 RJ-45 pinout for straight-through Ethernet cable

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 68 Crossover Ethernet Cable

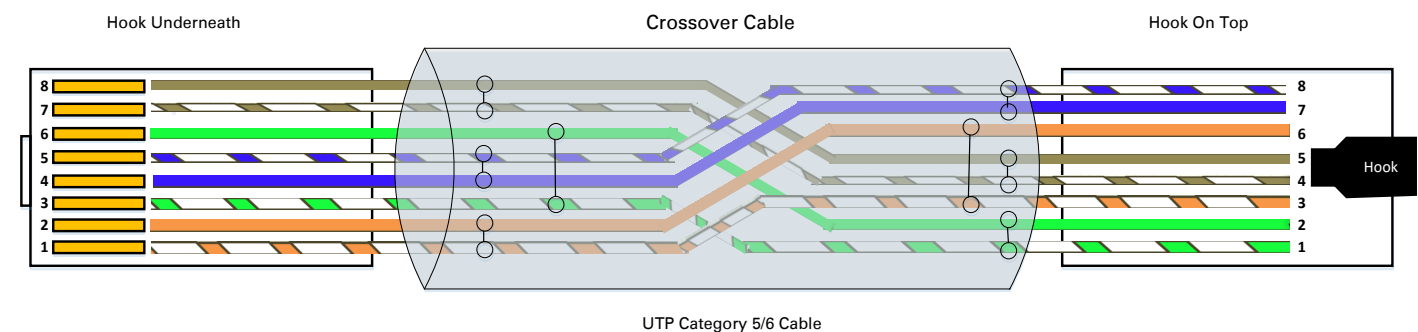


Table 97 RJ-45 pinout for crossover Ethernet cable

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

AP/BHM to UGPS cable

The AP/BHM to UGPS cable can be constructed from RJ12 to RJ 45 cable using the pin configuration described in [Table 98](#).



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 69 AP/BHM to UGPS cable

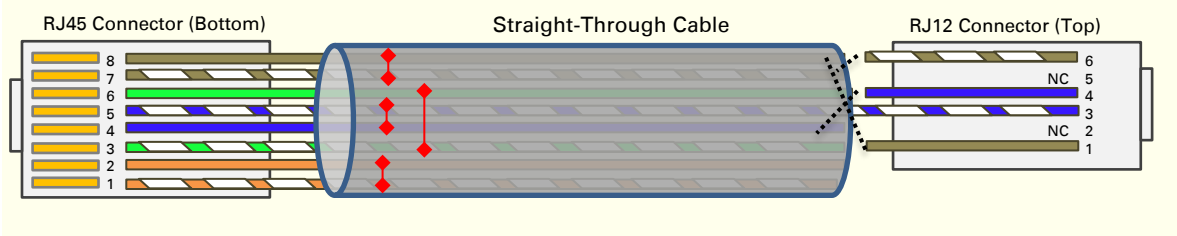


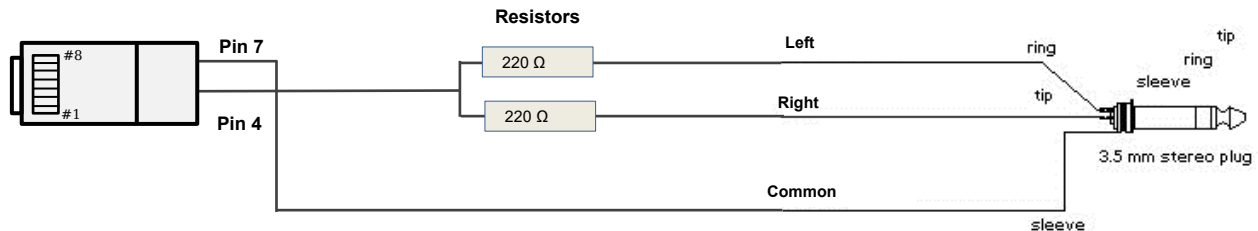
Table 98 AP/BHM to UGPS cable pinout

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

Alignment tone cable (for PMP/PTP 450i)

The alignment tone cable is constructed using RJ45 plug and Stereo plug. The pin configuration is shown in Figure 70

Figure 70 Alignment tone cable pin configuration



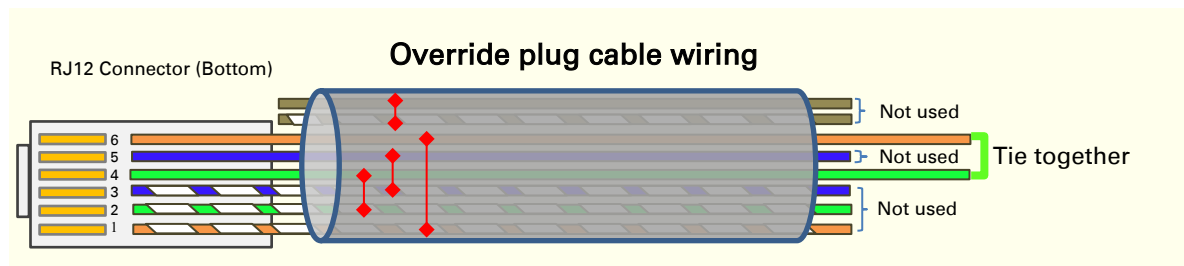
For more information, refer [Aux port to alignment tone headset wiring](#).

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 71 RJ-12 pinout for the default plug



Configuring Link for Test

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

Configuring the management PC

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

Powering the AP/SM/BH for test configuration

Perform the following steps to power on the ODU.

Procedure 2 Powering the ODU

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



Warning

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

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

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

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

Procedure 3 Bypassing browser proxy settings to access module web pages

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

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

Logging into the web interface – AP/SM/BH

Procedure 4 Logging into the web interface

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

Warning



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

Using the Quick Start Configuration Wizard of the AP/BHM

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

Chapter 6: Installation

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

- [ODU variants and mounting bracket options](#) on page 6-2 provides details of six different bracket options, including the type of ODU and range of pole diameters supported by each option.
- [Mount the ODU, LPU and surge suppressor](#) on page 6-3 describes how to mount and ground an integrated or connectorized ODU, how to mount and ground the top LPU.
- [Installing the copper Cat5e Ethernet interface](#) on page 6-19 describes how to install the copper Cat5e power over Ethernet interface from the ODU to the PSU.
- [Installing external antennas to a connectorized ODU](#) on page 6-23 describes how to install external antennas for a connectorized ODU.
- [Installing ODU](#) on page 6-58 describes how to install PTP and PMP ODU radios.
- [Installing the AC Power Injector](#) on page 6-63 describes how to install a power supply unit for the PMP/PTP 450 platform, either the AC Power Injector.
- [Supplemental installation information](#) on page 6-65 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 99 PMP/PTP 450i Series - ODU mounting bracket part numbers

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

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

Mounting bracket– PMP 450 Series – SM 900 MHz

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

Mount the ODU, LPU and surge suppressor

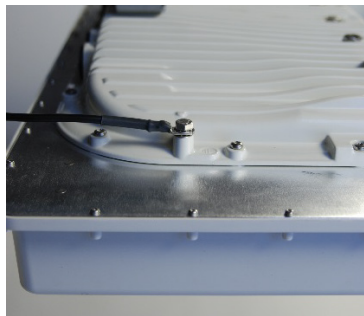
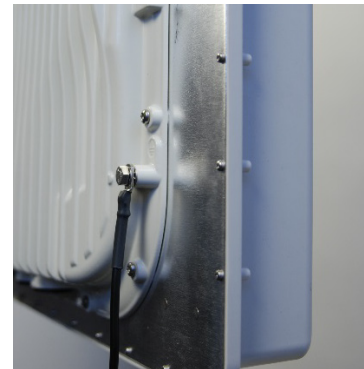
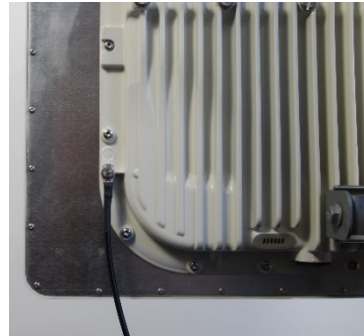
To install the ODU and top LPU, use the following procedures:

- [Attach ground cables to the ODU](#) on page 6-3
- [Mount the ODU on the mast](#) on page 6-6
- [Mount the top LPU](#) on page 6-10
- [Mount the Surge Suppressor](#) on page 6-10

Attach ground cables to the ODU

PMP 450m Series – AP

- 1 Fasten an AWG 10 (or 6mm²) copper ground cable to each ODU grounding point using the M6 (small) lugs.
- 2 Secure the M6 grounding bolts by applying 3 Nm torque..
- 3 Securely connect the copper wires to the grounding system (Protective Earth) and the LPU or Gigabit Ethernet Surge Suppressor according to applicable regulations.



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

- 1 Fasten an AWG 10 (or 6mm²) copper ground cable to each ODU grounding point using the M6 (small) lugs.



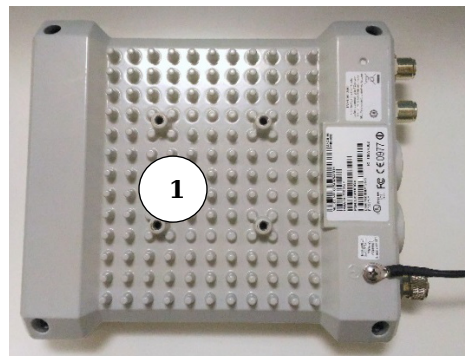
- 2 Tighten the Ground post screws.



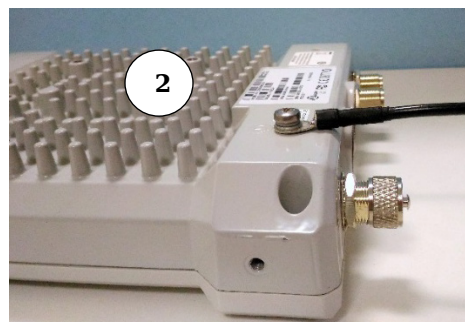
- 3 Securely connect the copper wires to the grounding system (Protective Earth) and the LPU or Gigabit Ethernet Surge Suppressor according to applicable regulations.

PMP 450 AP

- 1 Fasten an AWG 10 (or 6mm²) 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 6mm²) copper ground cable to each ODU grounding point using the M6 (small) lugs



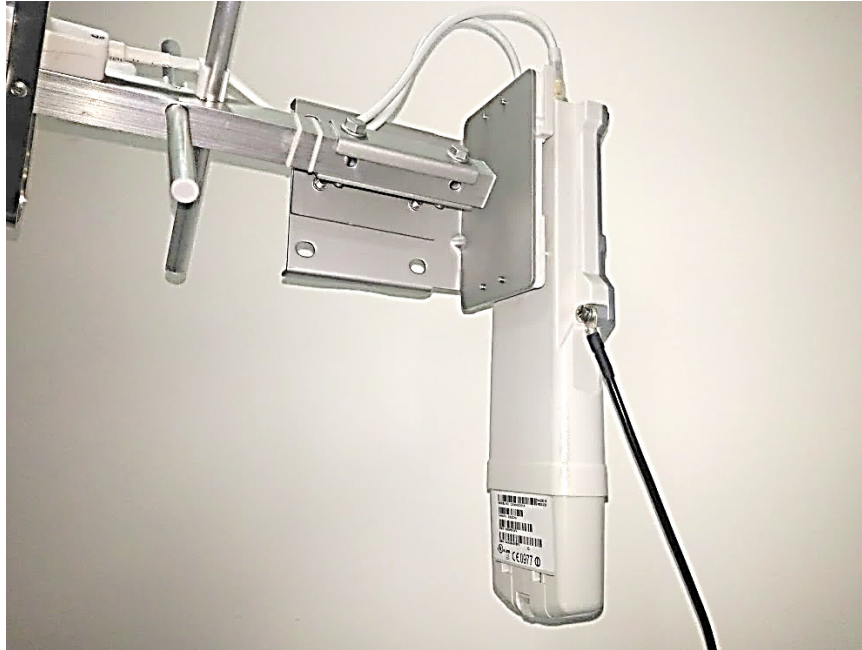
- 2 Tighten the Ground post locking nut in the copper wire



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

The grounding point on PMP 450 Series SM 900 MHz is different from 2.4, 3.5/3.65 and 5 GHz PMP 450 SMs as shown in [Figure 72](#).

Figure 72 PMP 450 900 MHz SM grounding

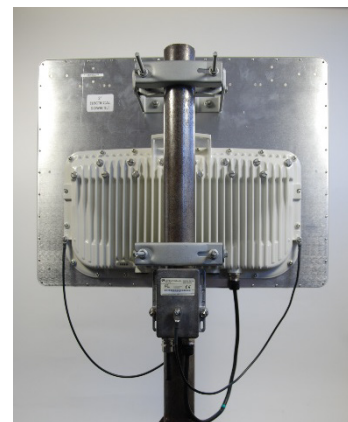


Mount the ODU on the mast

PMP 450m Series – AP

- 1 See - [PMP 450m Series – AP](#) on page 6-51 for Installation for an integrated ODU
- 2 Remove the rear bracket strap from upper and lower brackets of ODU
- 3 Attach the upper and lower bracket of ODU to the mount point by closing the rear strap around the pole
- 4 Secure the four serrated flange M8 nuts by applying 10 Nm torque on upper and lower rear strap using a 13 mm spanner wrench. These must be tightened evenly on the pole to avoid jumping/stripping threads

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



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



Caution

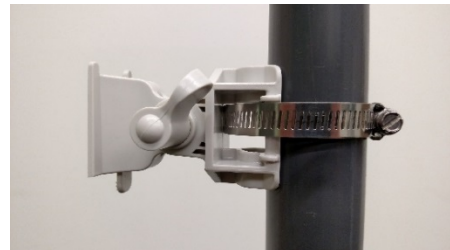
Do not reverse the bracket clamp, as this arrangement may lead to failure of the assembly. Do not over-tighten the bolts as this may lead to failure of the assembly.

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



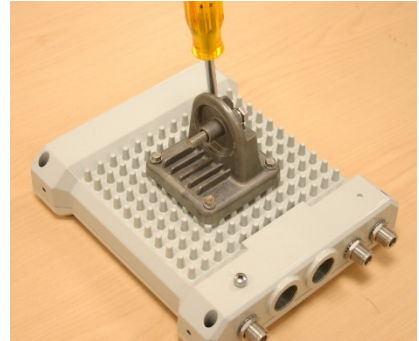
PMP 450b SM

- 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 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)

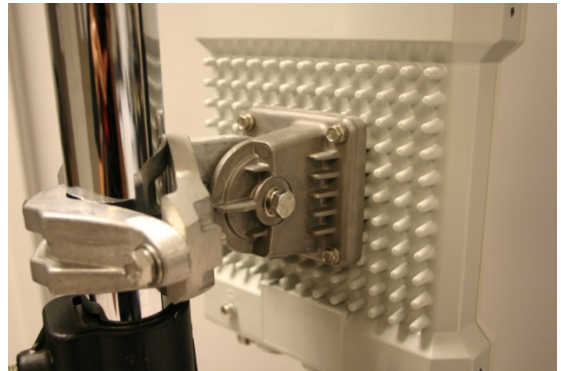
Attach the mounting bracket to the pole/mast. The mounting bracket is designed to attach to poles with diameters in the range of 2 in. (50mm) to 3in. (75mm).



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

- 8mm hex cap bolt (one quantity)

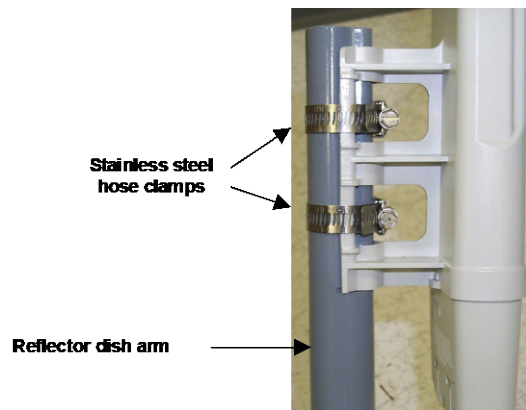
Through the AP's attached mounting bracket and pole mount. At this time the AP may be adjusted to the desired position and tightened with a 1/2 inch spanner wrench to 11 lb/ft (14Nm).



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

- 1 Use stainless steel hose clamps for the attachment.

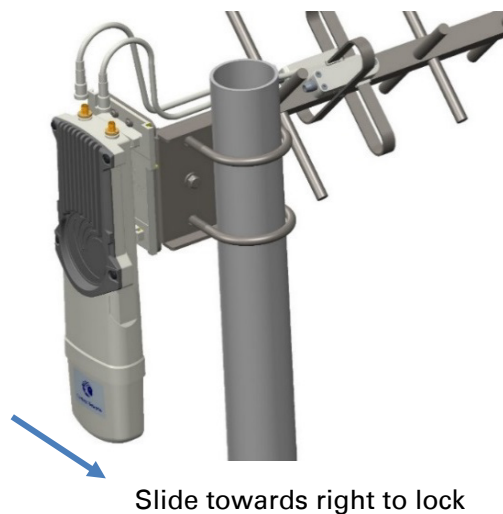
- 2 Attach the mounting bracket to the structure.
Tighten the locking nut.



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.

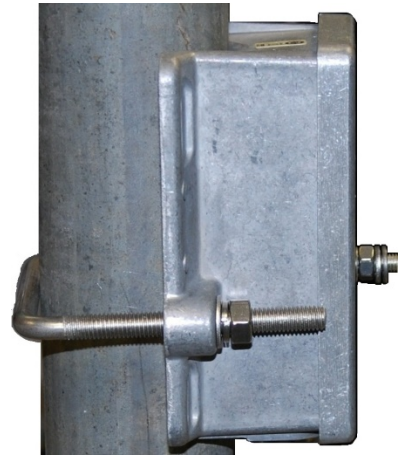
- 1 Align the 900 MHz SM to E bracket of Yagi antenna
- 2 Slide the radio towards right to lock on the antenna



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.

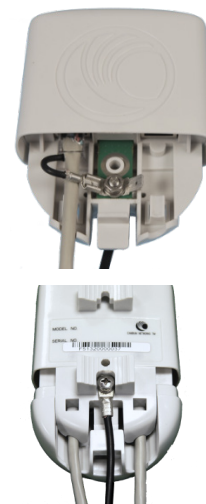
Quick procedure:

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").
 - I. Waterproof the cable lug with heat shrink sleeving.
 - II. Secure the Cable assembly to the unit using the supplied screw and washer.
- 2 Mount the Gigabit Ethernet Surge Suppressor on the wall or pole



- 3 Connect the two CAT5e cables to the Gigabit Ethernet Surge Suppressor
- 4 Slide the end cap over the bottom of the Gigabit Ethernet Surge Suppressor, ensuring it clicks firmly in place



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

Figure 73 Gigabit Ethernet Surge Suppressor



PMP/PTP 450 Series

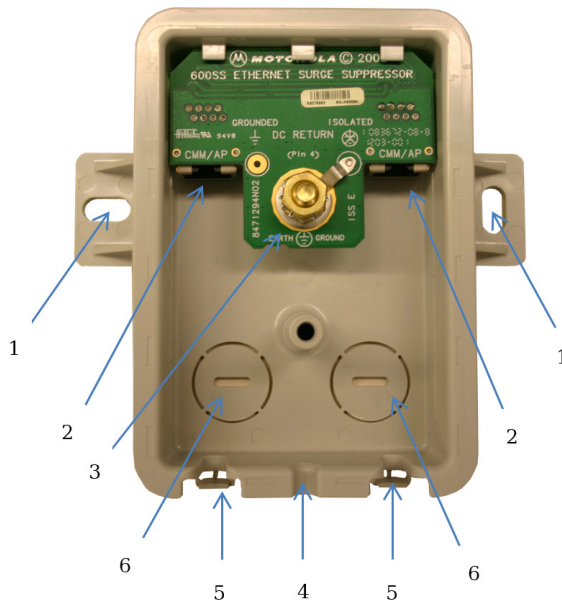
The PMP/PTP 450 Series uses 600SSH Surge Suppressor. The inside of the surge suppressor is shown in [Figure 74](#).



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 74 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 mm²) copper wire for connection. Refer to local electrical codes for exact specifications.
- 4 Ground Cable Opening—route the 10 AWG (6 mm²) 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 6mm²) 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 of the surge suppressor Ethernet jacks with dielectric grease.
- 8 Wrap a splice loop in the loose end of the Ethernet cable from the SM.
- 9 Connect that cable to one of the Ethernet jacks.
- 10 Connect an Ethernet cable to the other Ethernet jack of the 600SSH and to the power adapter.
- 11 Replace the cover of the 600SSH.

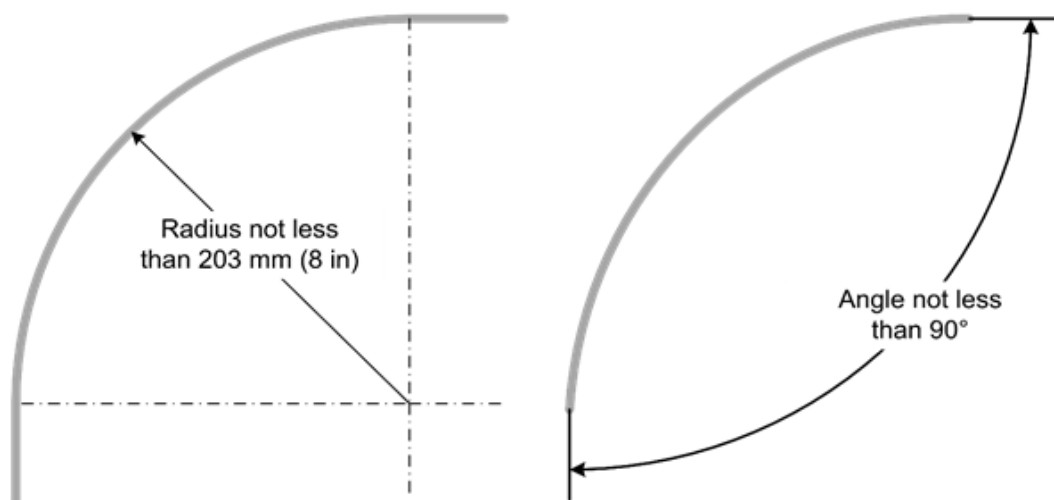
General protection installation

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

Grounding cable requirements

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

- Grounding conductors must be run as short, straight, and smoothly as possible, with the fewest possible number of bends and curves.
- Grounding cables must not be installed with drip loops.
- All bends must have a minimum radius of 203 mm (8 in) and a minimum angle of 90° ([Figure 75](#)). 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 75 Grounding cable minimum bend radius and angle**Caution**

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

Basic requirements

The following basic protection requirements must be implemented:

- ODU must be in 'Zone B' (see [Lightning protection zones](#) on page 3-9).
- ODU must be grounded to the supporting structure.
- A surge suppression unit must be installed on the outside of the building.
- The distance between the ODU and Gigabit Surge Suppressor should be kept to a minimum.
- The drop cable must not be laid alongside a lightning air terminal.
- All grounding cables must be a minimum size of 10 mm² csa (8AWG), preferably 16 mm² csa (6AWG), or 25 mm² csa (4AWG).

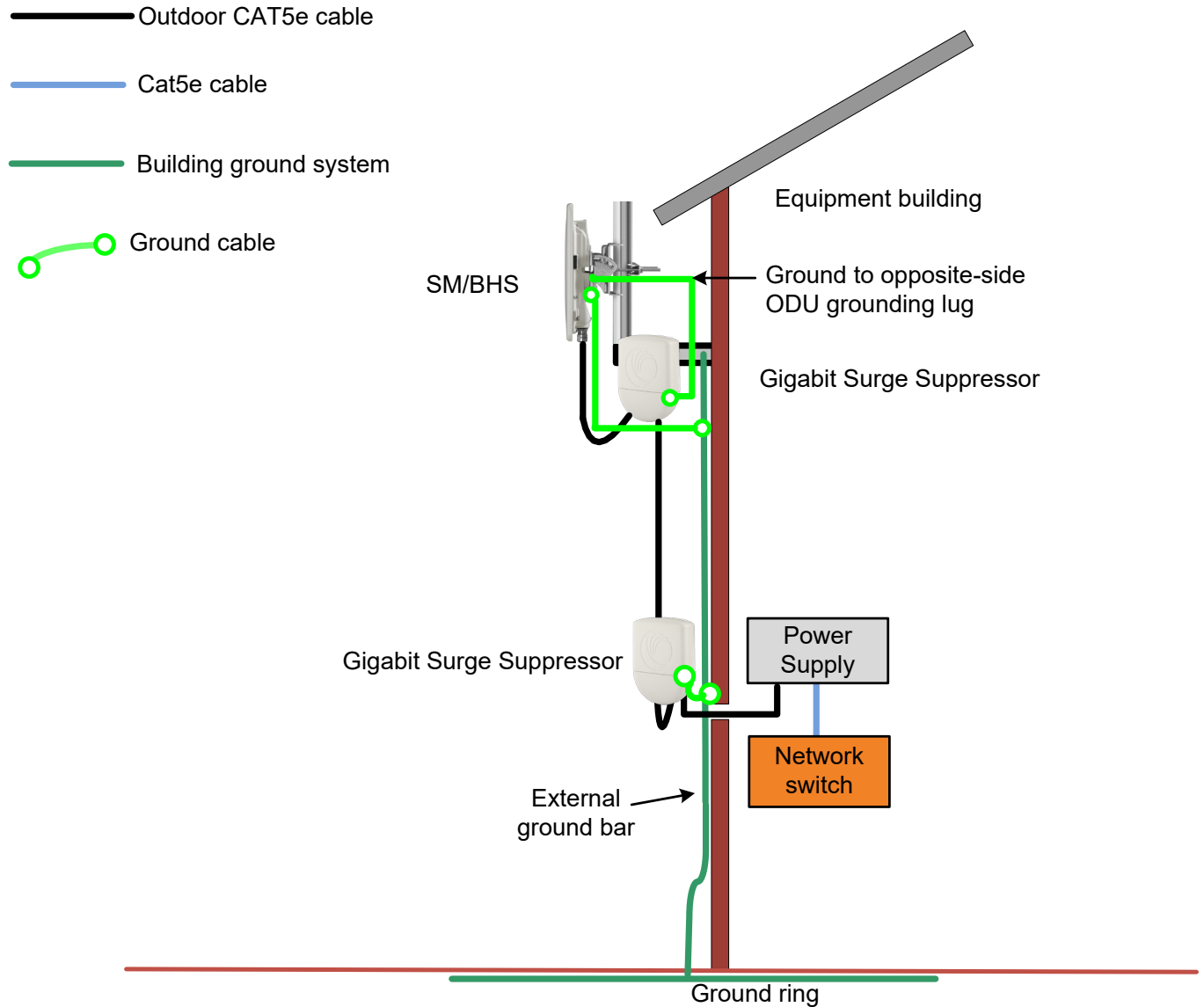
Protection requirements for a wall installation

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

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

Schematic examples of wall installations are shown in [Figure 76](#).

Figure 76 Grounding and lightning protection on wall

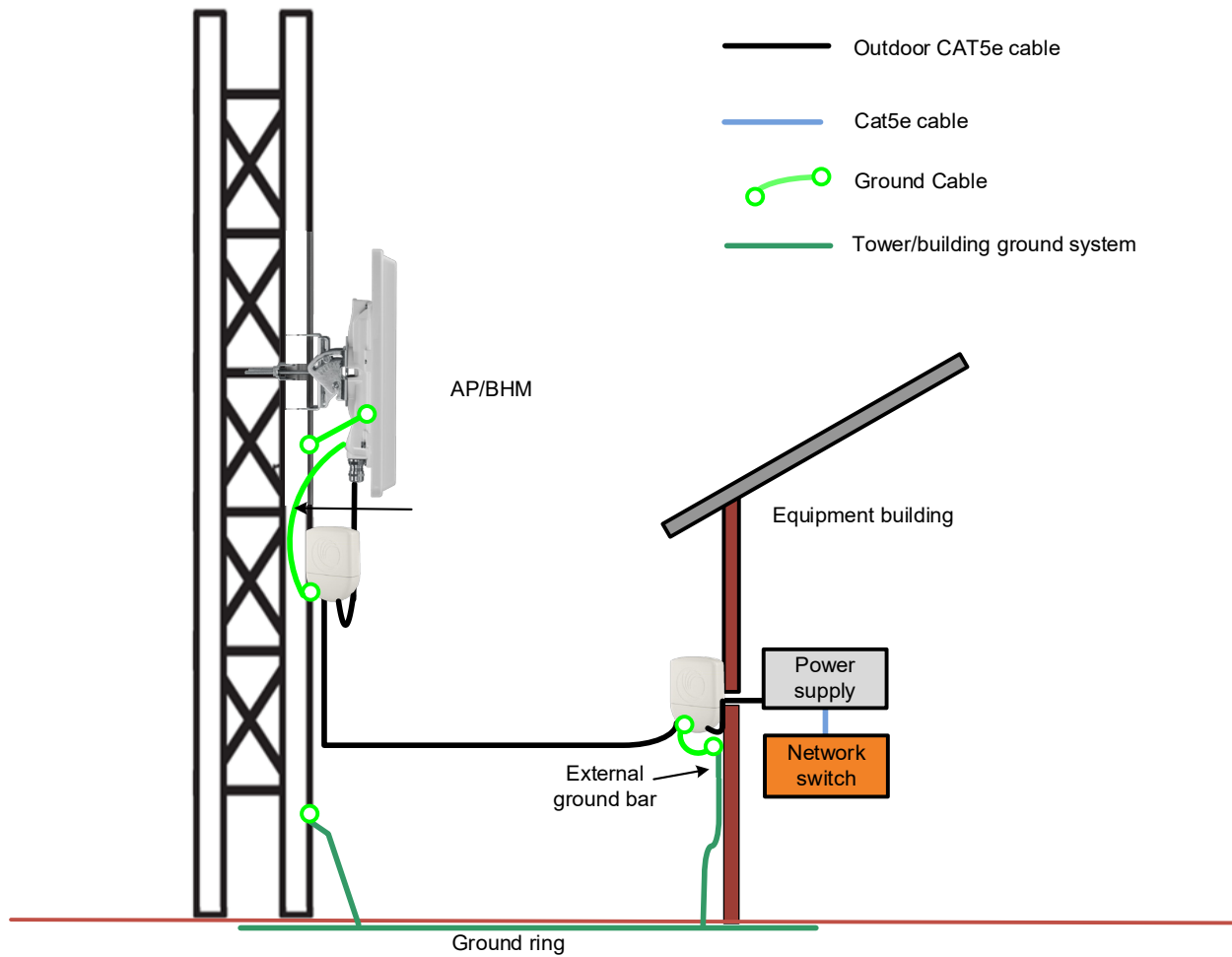


Protection requirements for a mast or tower installation

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

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

Schematic examples of mast or tower installations are shown in [Figure 77](#).

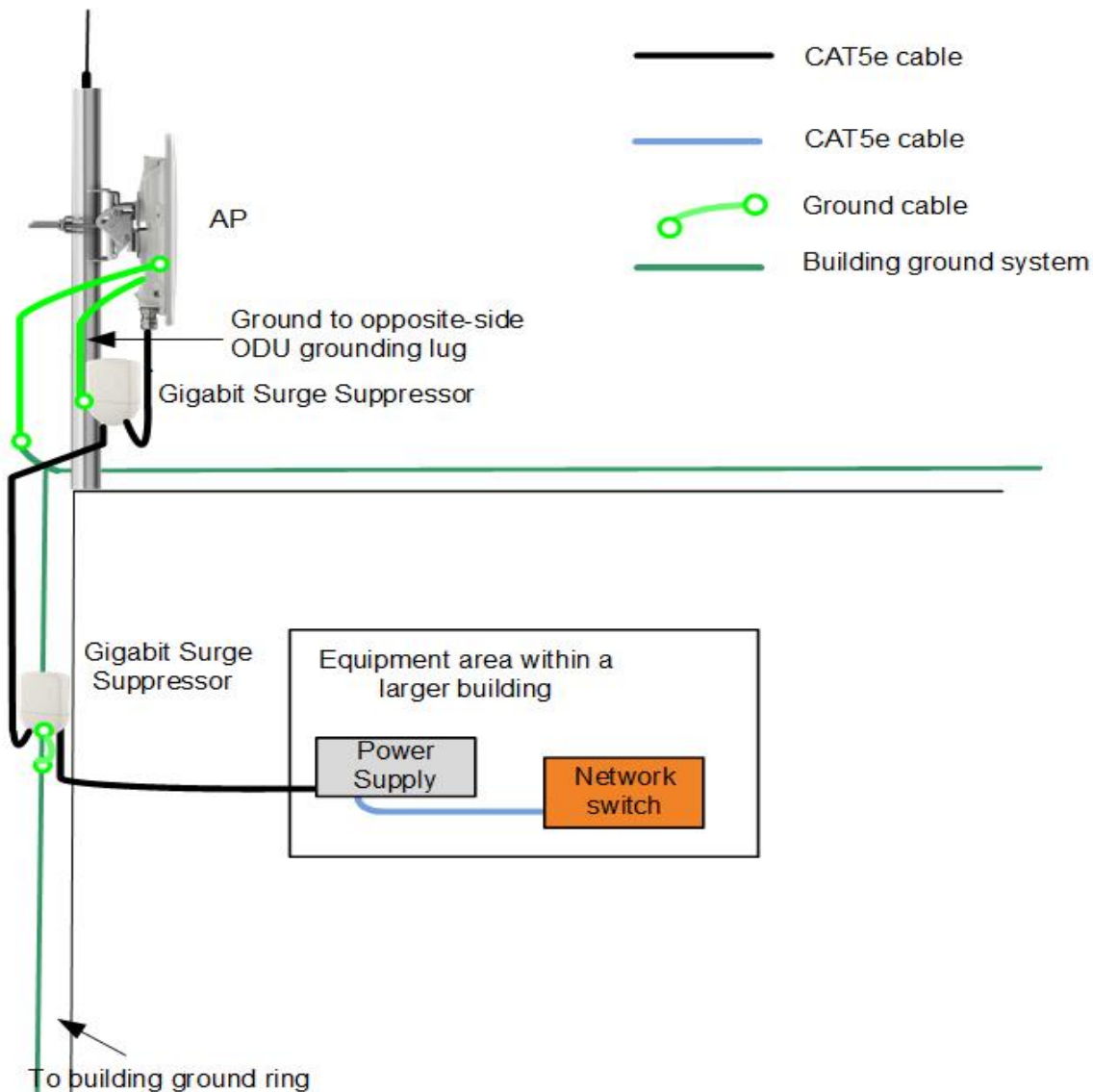
Figure 77 Grounding and lightning protection on mast or tower

Protection requirements on a multifloor building

If the ODU is to be mounted on a high rise building, it is likely that cable entry is at roof level (Figure 44) 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 78 Grounding and lightning protection on building



Installing the copper Cat5e Ethernet interface

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

- [Install the main drop cable](#) on page 6-19
 - [Install the bottom LPU to PSU drop cable](#) on page 6-21
 - [Installing external antennas to a connectorized ODU](#) on page 6-23
-

**Caution**

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

**Caution**

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

Install the main drop cable

**Warning**

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

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

**Warning**

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

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

Cut to length and fit hoisting grips

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

Terminate with RJ45 connectors



Caution

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

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

Table 100 RJ45 connector and cable color code

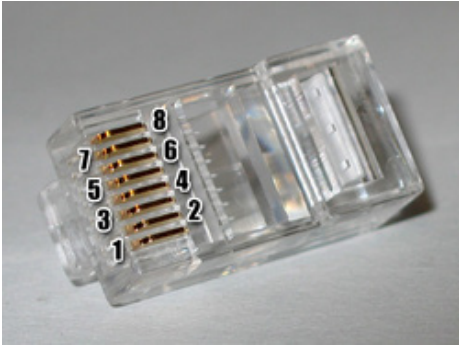
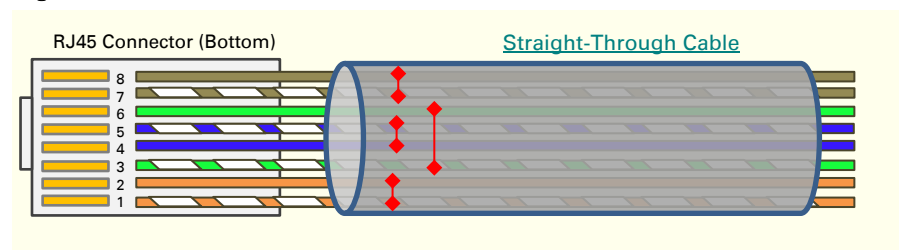
Pin	Color (Supplied cable)	Color (Conventional)	Pins on plug face
1	Light Orange	White/Orange	
2	Orange	Orange	
3	Light Green	White/Green	
4	Blue	Blue	
5	Light Blue	White/Blue	
6	Green	Green	
7	Light Brown	White/Brown	
8	Brown	Brown	

Figure 79 RJ45 cable

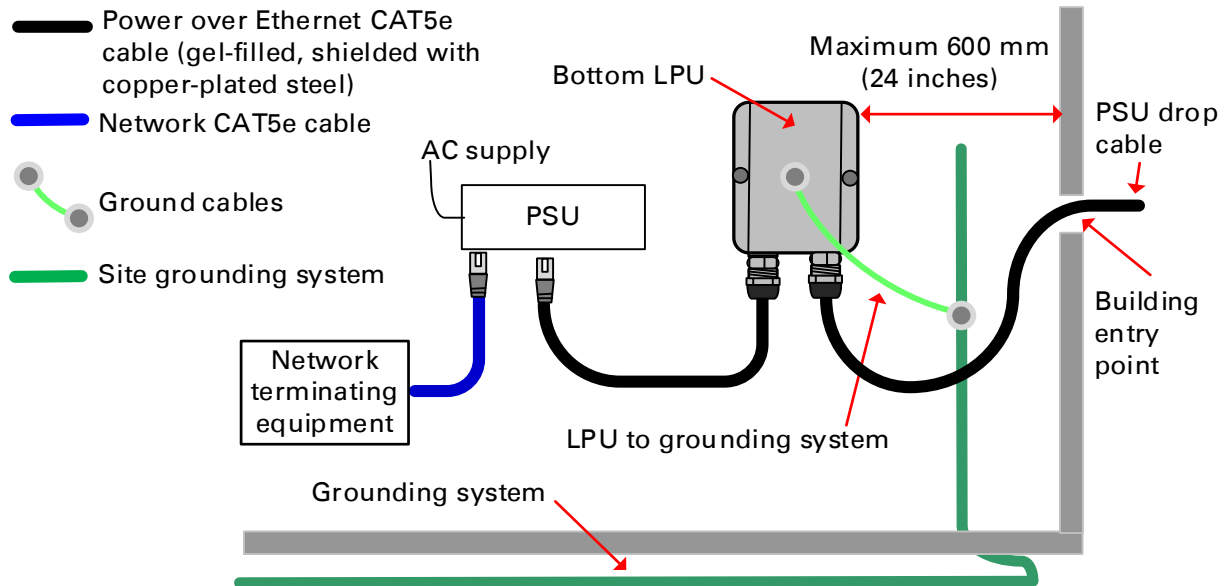


Install the bottom LPU to PSU drop cable

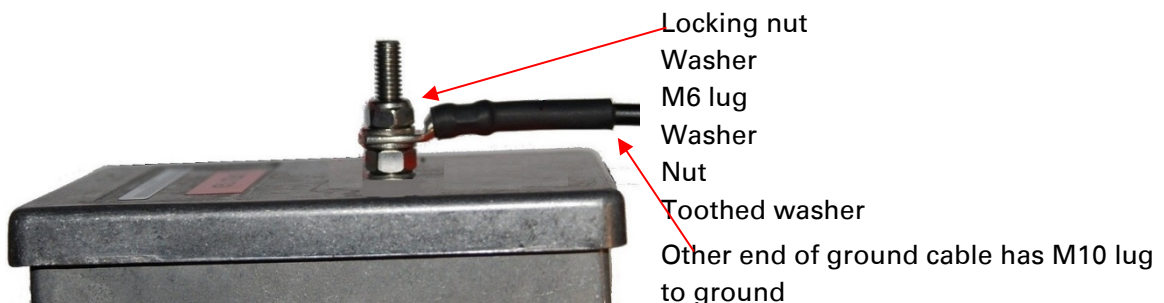
Install the bottom LPU

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

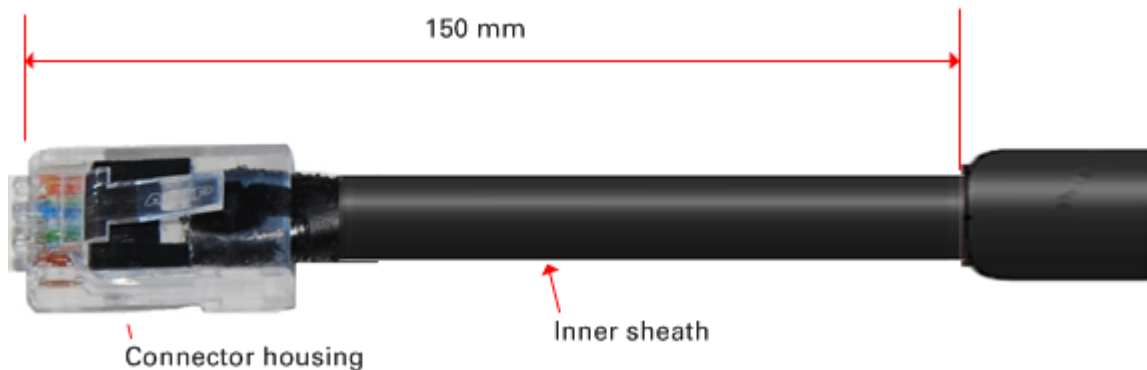
The metal screen of the drop cable is very sharp and may cause personal injury. ALWAYS wear cut-resistant gloves (check the label to ensure they are cut resistant). ALWAYS wear protective eyewear. ALWAYS use a rotary blade tool to strip the cable, not a bladed knife.



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](#) on page 6-20.
 - 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:

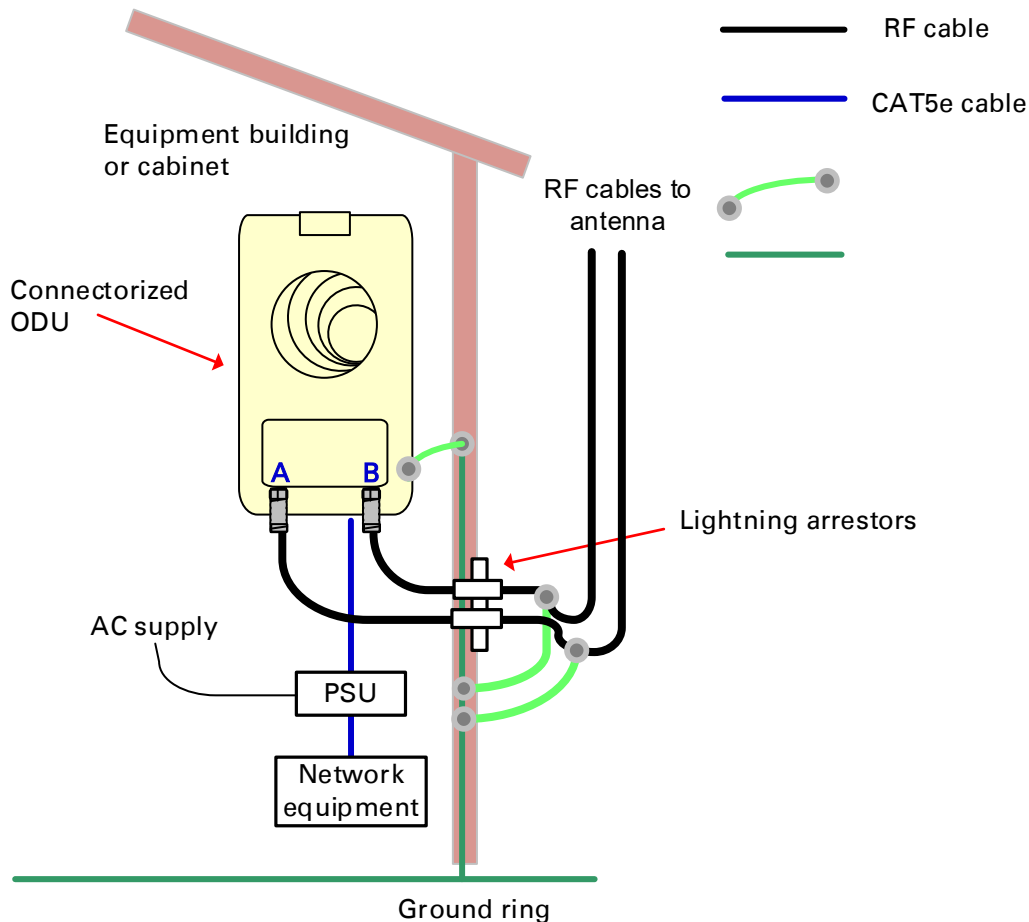


Installing external antennas to a connectorized ODU

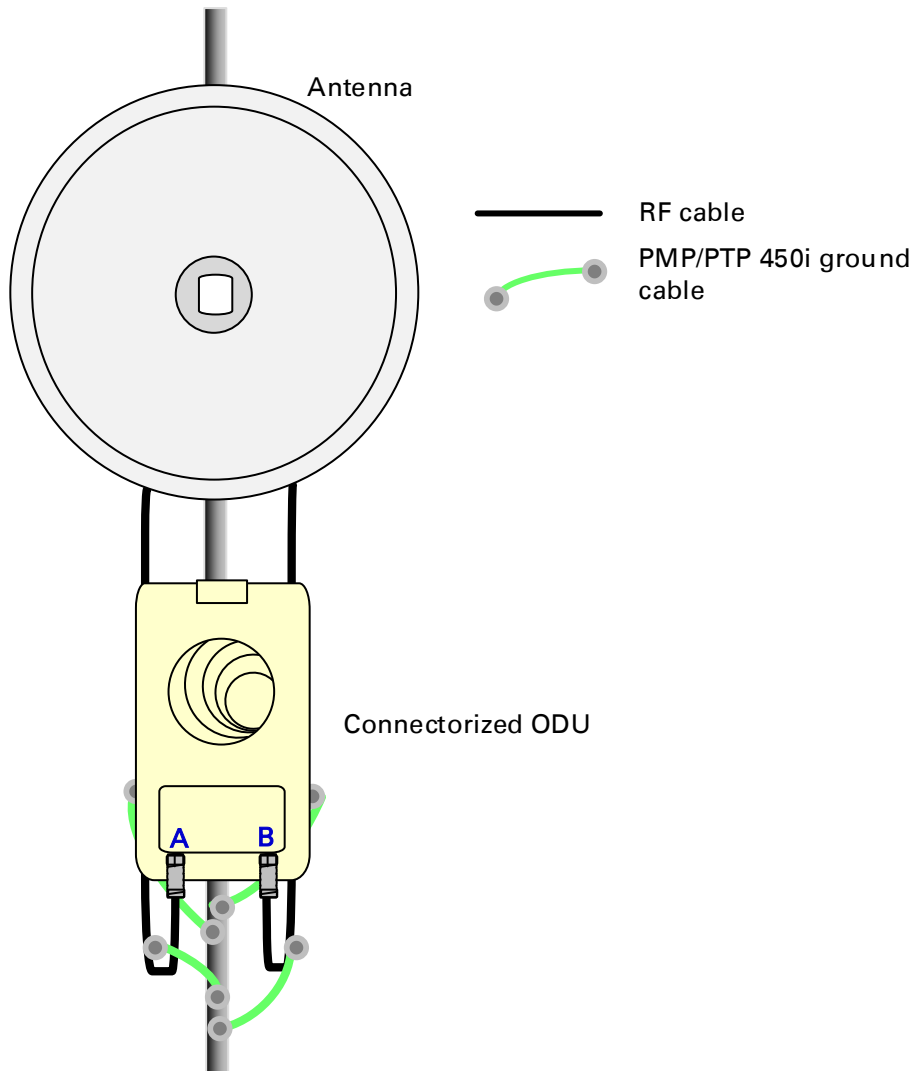
PMP 450i Series

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

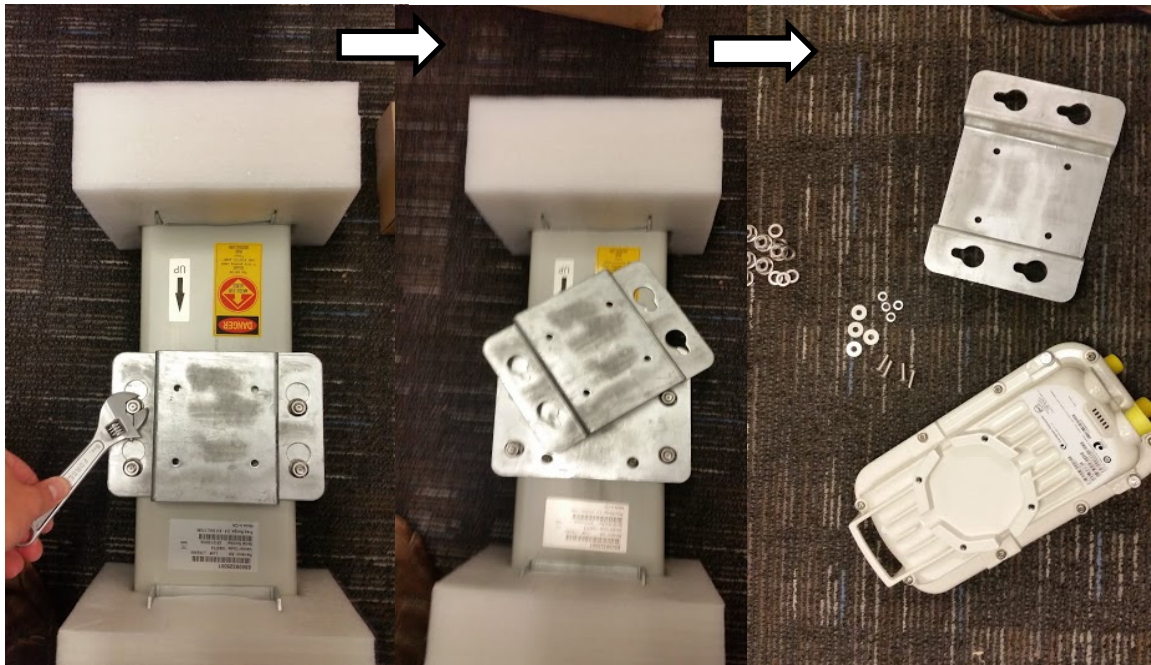
- 1 Inventory the parts to ensure that you have them all before you begin. The full set of parts is shown below.

Figure 80 AP antenna parts



- 2 Remove top plate from the antenna as shown in [Figure 81](#).

Figure 81 Antenna top plate



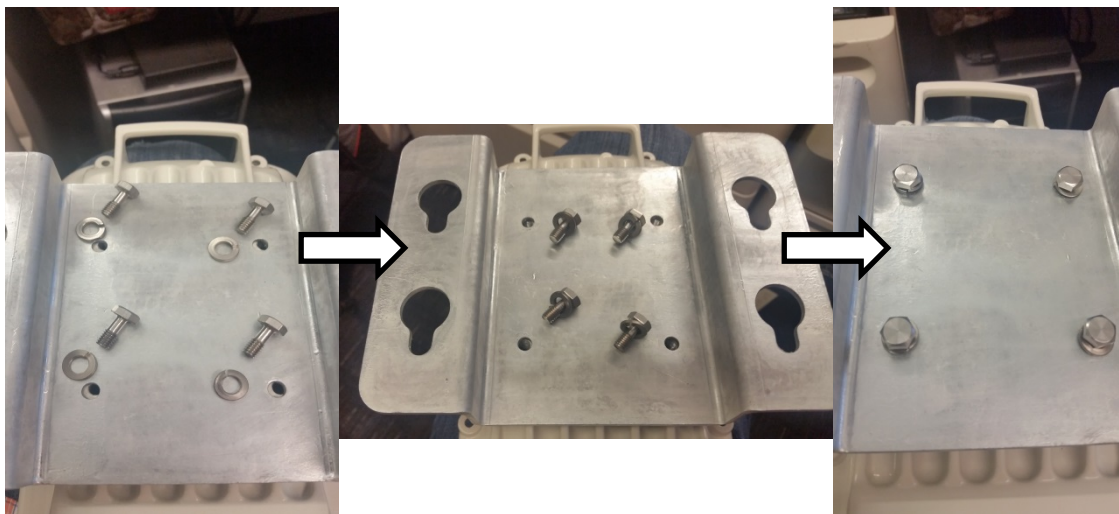
- 3 Attach the antenna plate to the AP as shown in [Figure 82](#).



Note

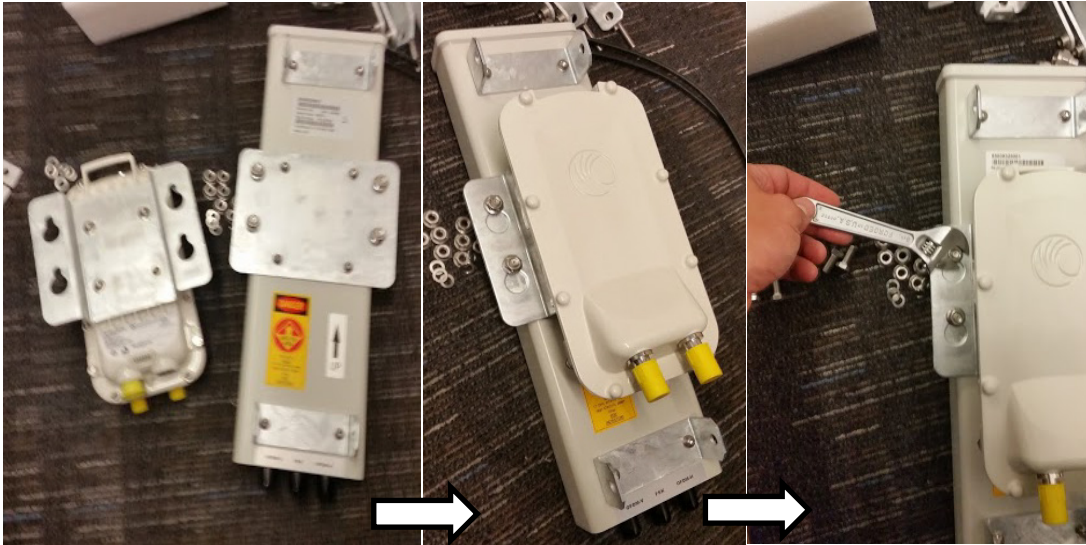
Please use the four “thin neck” M6 bolts and split washers provided with the connectorized units rather than the ones provided in the antenna kit.

Figure 82 Attaching antenna plate to the AP



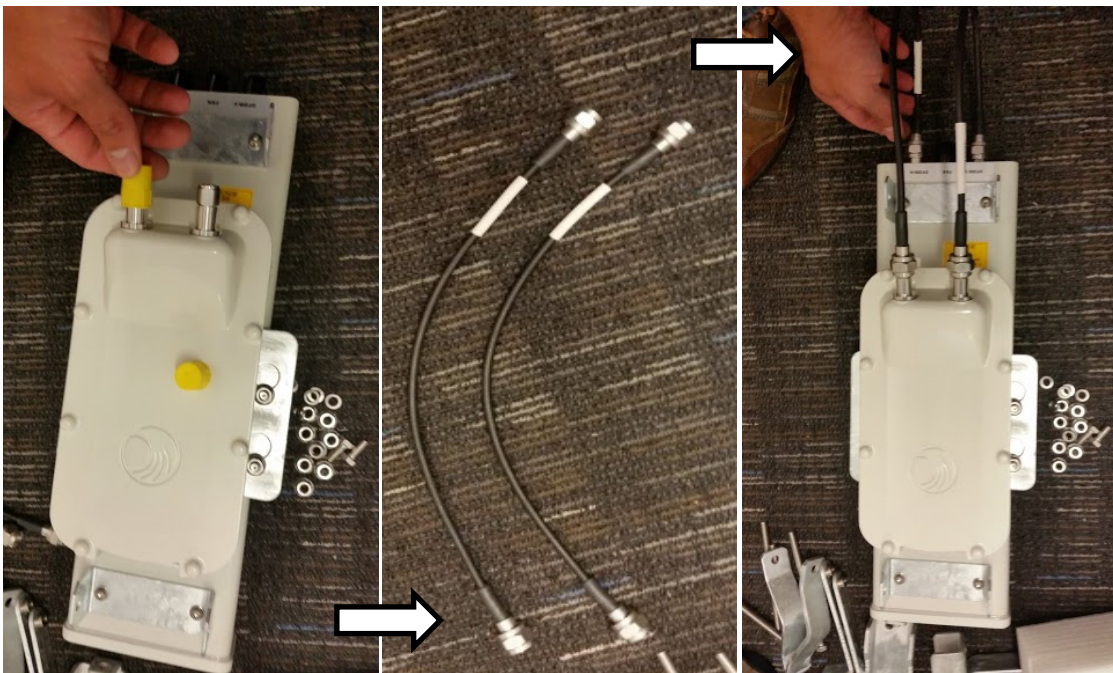
- 4 Attach the plate mounted AP to the antenna and tighten the (4) serrated flange nuts using a spanner wrench

Figure 83 Attaching the plate



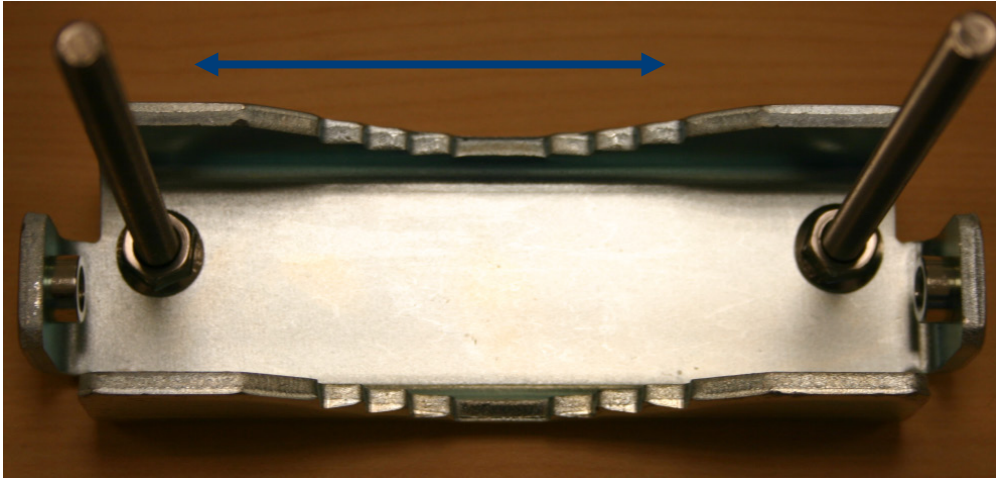
- 5 Connect the port A of AP to vertical and port B of AP to horizontal polarization interfaces of the antenna with RF cable. Tighten the N type connectors to a torque setting of 1.7 Nm (1.3 lb ft).

Figure 84 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 85 AP antenna upper bracket assembly



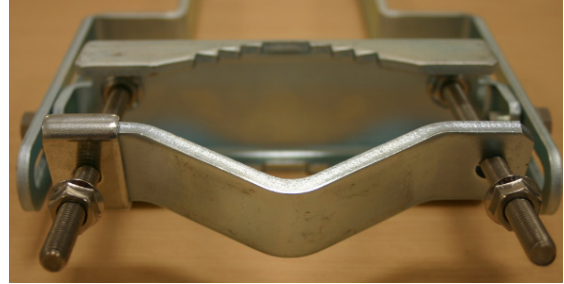
- 7 Attach the upper bracket to the adjustment arms using (2) hex bolts, (2) flat washers and (2) lock washers. Feed the bolt through the lock washer then flat washer, then thread the bolt into the upper bracket's threaded receptacle.

Figure 86 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 87 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 88 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 89 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 90 Lower bracket attached to AP antenna



Figure 91 Completed AP and antenna assembly

