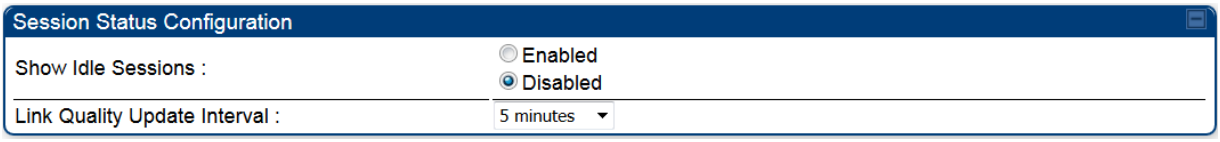
Link Quality tab

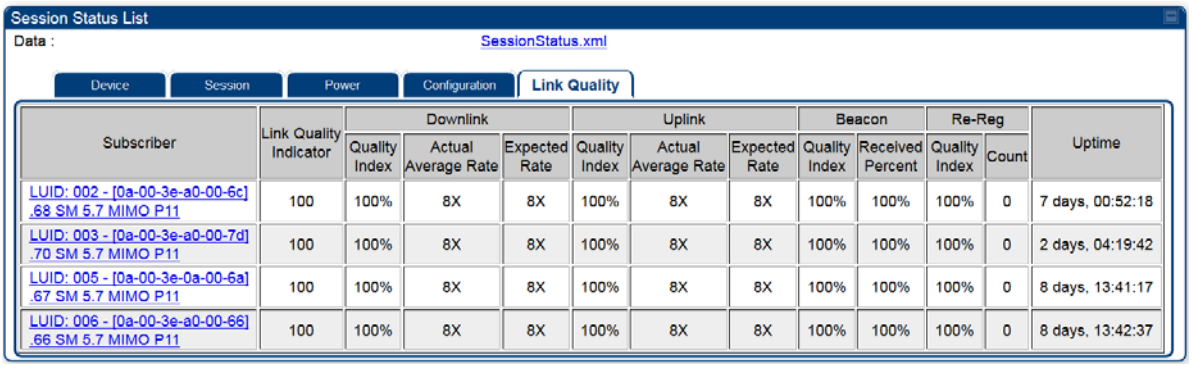
The **Link Quality** tab provides information on the Subscriber's UID, Link quality, Downlink, Uplink, Beacon, ReReg, and the Uptime.

This data is refreshed based on the **Link Quality Update Interval** parameter configuration under the **Sessions Status** page.



The **Link Quality** tab displays the calculated Link Quality Indicator (LQI) for the configured interval (**Link Quality Update Interval** parameter).

Table 217 Link Quality tab attributes



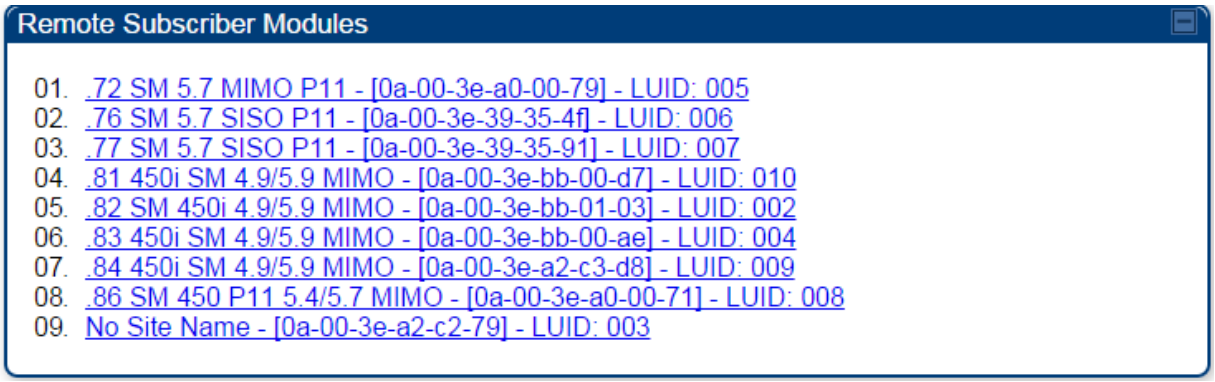
Attribute	Meaning
Subscriber	See Table 212 on page 9-20.
Link Quality Indicator	This field displays quality of the link. It is calculated based on receive power, modulation rate, re-registrations and beacon percentage.
Downlink - Quality Index	This field displays the downlink quality in percentage. It is calculated based on Downlink receiver power, modulation rate, and beacon percentage.
Downlink -Actual Average Rate	This field displays the average Downlink modulation rate. For 450m, this field specifies the SU-MIMO Modulation Rate.
Downlink - Expected Rate	This field displays the expected modulation rate based on receive power in Downlink.
Uplink - Quality Index	This field displays the uplink quality in percentage. It is calculated based on Uplink receiver power and modulation rate.
Uplink -Actual Average Rate	This field displays the average Uplink modulation rate.
Uplink - Expected Rate	This field displays the expected modulation rate based on receive power in Uplink.

Beacon - Quality Index	This field displays the beacon quality index. It is calculated based on beacon percentage.
Beacon - Received Percent	This field displays the received beacon percentage.
Re-Reg - Quality Index	This field displays the re-registration quality. It is calculated based on the re-registration count.
Re-Reg Count	This field displays the number of re-registrations.
Uptime	This field displays the uptime of the device.

Viewing Remote Subscribers

This page allows to view the web pages of registered SMs or BHS over the RF link. To view the pages for a selected SM/BHS, click its link. The **General Status** page of the SM opens.

Figure 193 Remote Subscribers page of AP



Interpreting messages in the Event Log

Each line in the Event Log of a module Home page begins with a time and date stamp. However, some of these lines wrap as a combined result of window width, browser preferences and line length. You may find this tab easiest to use if you expand the window till all lines are shown beginning with time and date stamp.

Time and Date Stamp

The time and date stamp reflect one of the following:

- GPS time and date directly or indirectly received from the CMM4.
- NTP time and date from a NTP server (CMM4 may serve as an NTP server)
- The running time and date that you have set in the Time & Date web page.

Note

In the Time & Date web page, if you have left any time field or date field unset and clicked the **Set Time and Date** button, then the time and date default to **`00:00:00 UT : 01/01/00`**.

A reboot causes the preset time to pause or, in some cases, to run in reverse. Additionally, a power cycle resets the running time and date to the default **`00:00:00 UT : 01/01/00`**. Thus, whenever either a reboot or a power cycle has occurred, must reset the time and date in the Time & Date web page of any module that is not set to receive sync.

Event Log Data Collection

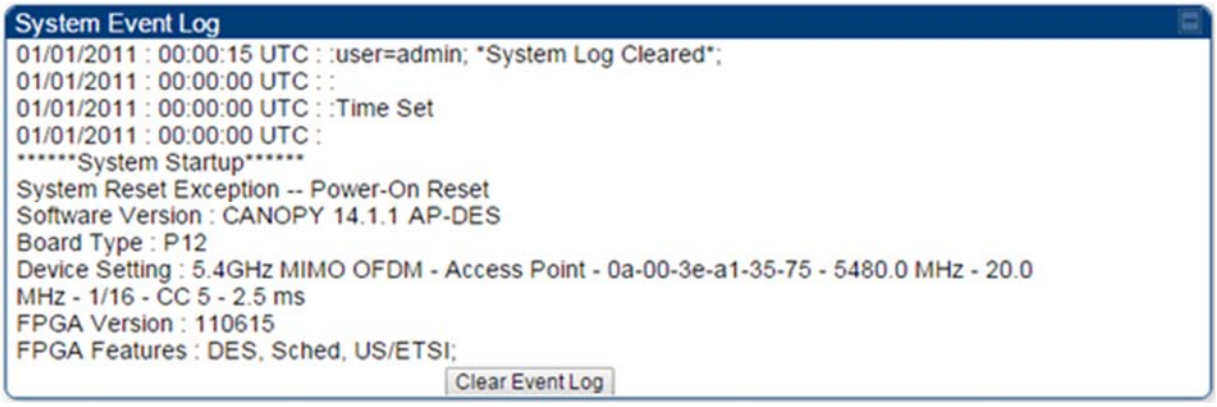
The collection of event data continues through reboots and power cycles. When the buffer allowance for event log data is reached, the system adds new data into the log and discards an identical amount of the oldest data.

Each line that contains the expression WatchDog flags an event that was both:

- considered by the system software to have been an exception
- recorded in the preceding line.

Conversely, a Fatal Error () message flags an event that is recorded in the next line. Some exceptions and fatal errors may be significant and require either operator action or technical support.

Figure 194 Event log data



Messages that Flag Abnormal Events

The messages listed below flag abnormal events and, case by case, may signal the need for corrective action or technical support.

Table 218 Event Log messages for abnormal events

Event Message	Meaning

Expected LUID = *6* Actual LUID = *7*	Something is interfering with the control messaging of the module. Also ensure that you are using shielded cables to minimize interference. Consider trying different frequency options to eliminate or reduce interference.
FatalError()	The event recorded on the line immediately beneath this message triggered the Fatal Error ().
Loss of GPS Sync Pulse	Module has lost GPS sync signal.
Machine Check Exception	This is a symptom of a possible hardware failure. If this is a recurring message, begin the RMA process for the module.
RcvFrmNum = *0x00066d* ExpFrmNum = *0x000799*	Something is interfering with the control messaging of the module. Also ensure that you are using shielded cables to minimize interference. Consider trying different frequency options to eliminate or reduce interference.
System Reset Exception -- External Hard Reset	The unit lost power or was power cycled.
System Reset Exception -- External Hard Reset WatchDog	The event recorded on the preceding line triggered this WatchDog message.

Messages that Flag Normal Events

The messages listed below record normal events and typically *do not* signal a need for any corrective action or technical support.

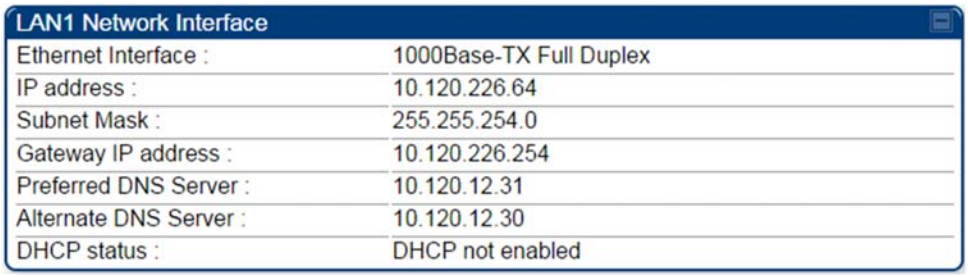
Table 219 Event Log messages for normal events

Event Message	Meaning
Acquired GPS Sync Pulse.	Module has acquired GPS sync signal.
FPGA Features	Type of encryption.
FPGA Version	FPGA (JBC) version in the module.
GPS Date/Time Set	Module is now on GPS time.
Reboot from Webpage	Module was rebooted from management interface.
Software Boot Version	Boot version in the module.
Software Version	The software release and authentication method for the unit.
System Log Cleared	Event log was manually cleared.

Viewing the Network Interface

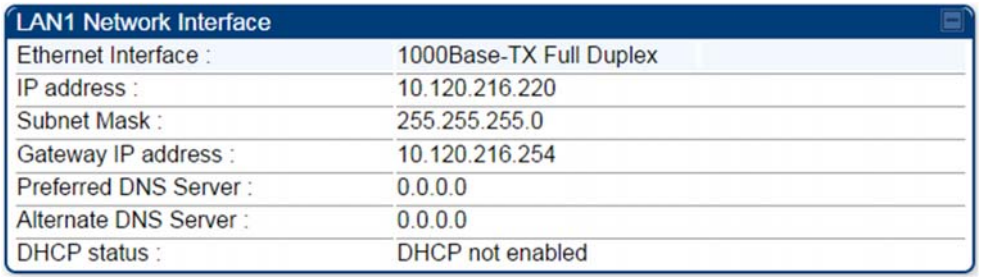
In any module, the LAN1 Network Interface section of this tab displays the defined Internet Protocol scheme for the Ethernet interface to the module. In SM/BHS devices, this page also provides an RF Public Network Interface section, which displays the Internet Protocol scheme defined for network access through the master device (AP/BHM).

Figure 195 Network Interface tab of the AP



LAN1 Network Interface	
Ethernet Interface :	1000Base-TX Full Duplex
IP address :	10.120.226.64
Subnet Mask :	255.255.254.0
Gateway IP address :	10.120.226.254
Preferred DNS Server :	10.120.12.31
Alternate DNS Server :	10.120.12.30
DHCP status :	DHCP not enabled

Figure 196 Network Interface tab of the SM



LAN1 Network Interface	
Ethernet Interface :	1000Base-TX Full Duplex
IP address :	10.120.216.220
Subnet Mask :	255.255.255.0
Gateway IP address :	10.120.216.254
Preferred DNS Server :	0.0.0.0
Alternate DNS Server :	0.0.0.0
DHCP status :	DHCP not enabled

Viewing the Layer 2 Neighbors

In the Layer 2 Neighbors tab, a module reports any device from which it has received a message in Link Layer Discovery Protocol within the previous two minutes. Given the frequency of LLDP messaging, this means that the connected device will appear in this tab 30 seconds after it is booted and remain until two minutes after its shutdown.

Figure 197 Layer 2 Neighbors page

System statistics

This section describes how to use the system statistics pages to manage the performance of the PMP/PTP 450 Platform Family link.

Viewing the Scheduler statistics

The **Statistics > Scheduler** page is applicable for all modules (AP/SM/BHM/BHS) and the parameters are displayed as shown below:

Table 220 Scheduler tab attributes

Radio Statistics	
Transmit Unicast Data Count :	0
Transmit Broadcast Data Count :	393
Transmit Multicast Data Count :	0
Receive Unicast Data Count :	0
Receive Broadcast Data Count :	0
Receive Multicast Data Count :	0
Transmit Control Count :	0
Receive Control Count :	0
In Sync Count :	0
Out of Sync Count :	0
Overrun Count :	0
Underrun Count :	0
Receive Corrupt Data Count :	0
Receive Corrupt Control Data Count :	0
Receive Bad Broadcast Control Count :	0
Rcv LT Start :	0
Rcv LT Start HS :	0
Rcv LT Result :	0
Xmt LT Result :	0
Frame Too Big :	0
Bad Acknowledgment :	0
Bad Fragment :	0
VC Clear Error Count :	0
Rx No Buffer Count :	0
Scheduler Error :	0

Clear Statistics

Attribute	Meaning
Transmit Unicast Data Count	Total amount of unicast packets transmitted from the radio
Transmit Broadcast Data Count	Total amount of broadcast packets transmitted from the radio
Transmit Multicast Data Count	Total amount of multicast packets transmitted by the radio
Receive Unicast Data Count	Total amount of unicast packets received by the radio
Receive Broadcast Data Count	Total amount of broadcast packets received by the radio
Receive Multicast Data Count	Total amount of multicast packets received by the radio
Transmit Control Count	Amount of radio control type messages transmitted (registration requests and grants, etc.)
Receive Control Count	Amount of radio control type messages received (registration requests and grants, etc.)
In Sync Count	Number of times the radio has acquired sync. When GPS synchronization is used it is number of times GPS sync acquired. For the SM, it is the number of times the SM successfully obtained sync with an AP.
Out of Sync Count	Number of times the radio lost same sync lock
Overrun Count	Number of times FPGA frame has overrun its TX Frame
Underrun Count	Number of times FPGAs TX Frame aborted prematurely
Receive Corrupt Data Count	Number of times a corrupt packet has been received at the FPGA.
Receive Corrupt Control Data Count	Number of times a corrupt control data packet has been received at the FPGA.
Receive Bad Broadcast Control Count	Number of times the radio has received an invalid control message via broadcast (SM only).
Rcv LT Start	Number of Link Test Start messages received. A remote radio has requested that this radio start a link test to it.
Rcv LT Start HS	Number of Link Test Start Handshake messages received. This radio requested that a remote radio start a link test and the remote radio has sent a handshake back acknowledging the start.

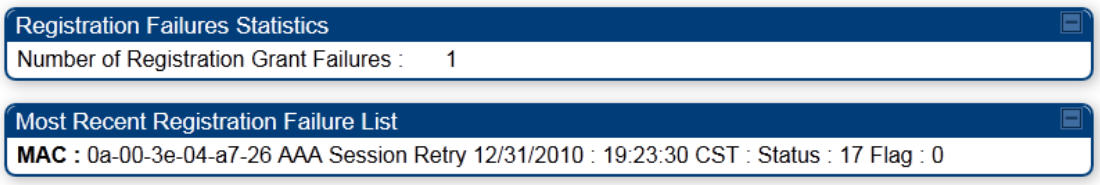
Rcv LT Result	This radio received Link Test results from the remote radio under test. When this radio initiates a link test, the remote radio will send its results to this radio for display.
Xmt LT Result	This radio transmitted its link test results to the remote radio under test. When the remote radio initiates a link test, this radio must send its results to the remote radio for display there.
Frame Too Big	This statistics indicates the number of packets received and processed by the radios which were greater than max packet size 1700 bytes.
Bad Acknowledgment	This statistics indicates the number of packets received as bad acknowledgment. It is for engineering use only.
Bad Fragment	This statistic indicates number of fragments tagged internally as bad. It is for engineering use only.
VC Clear Error Count	This statistic indicates number of times VC clear failed.
Rx No Buffer Count	Currently unused
Scheduler Error	This error is incremented when the scheduler cannot send or get scheduled to send a packet. t is also general called a “VC Error”.

Viewing list of Registration Failures statistics

SM Registration Failures page of AP

The SM Registration Failures tab identifies SMs that have recently attempted and failed to register to this AP. With its time stamps, these instances may suggest that a new or transient source of interference exists.

Table 221 SM Registration Failures page attributes - AP



Attribute	Meaning
Status 17 Flag 0	No response was received from the AAA server and hence SM is trying to send a session request again.

BHS Registration Failures page of BHM

Table 222 BHS Registration Failures page attributes - BHM

Attribute	Meaning
Status 17 Flag 0	No response was received from the AAA server and hence SM is trying to send a session request again.

There is a list of flags from 0 to 20 as shown in Table 223 and the “Flags” can be ignored.

Table 223 Flags status

Flag	Meaning	Flag	Meaning
0	Normal	11	AP Lite Limit Reached
1	Out of Range	12	Only Ver 9.5+ Allowed
2	No Luids	13	Temporary Data VC for AAA
3	BH ReRange	14	AAA Authentication Failure
4	Auth Fail	15	Registration Grant Reject
5	Encrypt Fail	16	Blank
6	Power Adjust	17	AAA Session Retry
7	No VCs	18	AAA Reauth Failure
8	Reserve VC Fail	19	RegReq at zero power
9	Activate VC Fail	20	RegReq no time ref
10	Hi VC Setup Fail	-	-

Interpreting Bridging Table statistics

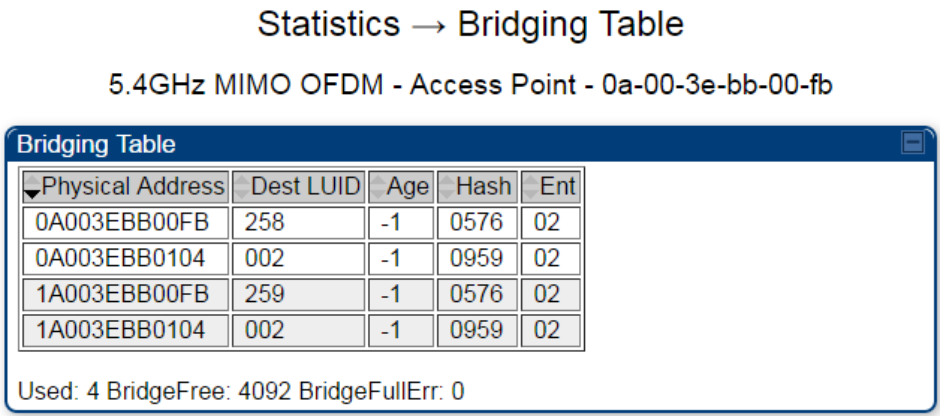
If NAT (network address translation) is not active on the SM/BHS, then the Bridging Table page provides the MAC address of all devices that are attached to registered SMs/BHS (identified by LUIDs).

The SM/BHS management MAC addresses are also added in bridge table upon SMs/BHS registration. These entries will be remove automically from the table once SMs/BHS is de-registered. This alleviates the arp cache > bridge cache timeout problems.

The bridging table allows data to be sent to the correct module as follows:

- For the AP/BHM, the uplink is from RF to Ethernet. Thus, when a packet arrives in the *RF* interface to the AP/BHM, the AP/BHM reads the MAC address from the inbound packet and creates a bridging table entry of the source MAC address on the other end of the *RF* interface.
- For the SM/BHS, the uplink is from Ethernet to RF. Thus, when a packet arrives in the Ethernet interface to one of these modules, the module reads the MAC address from the inbound packet and creates a bridging table entry of the source MAC address on the other end of the Ethernet interface.

Figure 198 Bridging Table page



The Bridging Table supports up to 4096 entries.

Interpreting Translation Table statistics

When Translation Bridging is enabled in the AP, each SM keeps a table mapping MAC addresses of devices attached to the AP to IP addresses, as otherwise the mapping of end-user MAC addresses to IP addresses is lost. (When Translation Bridging is enabled, an AP modifies all uplink traffic originating from registered SMs such that the source MAC address of every packet is changed to that of the SM which bridged the packet in the uplink direction.)

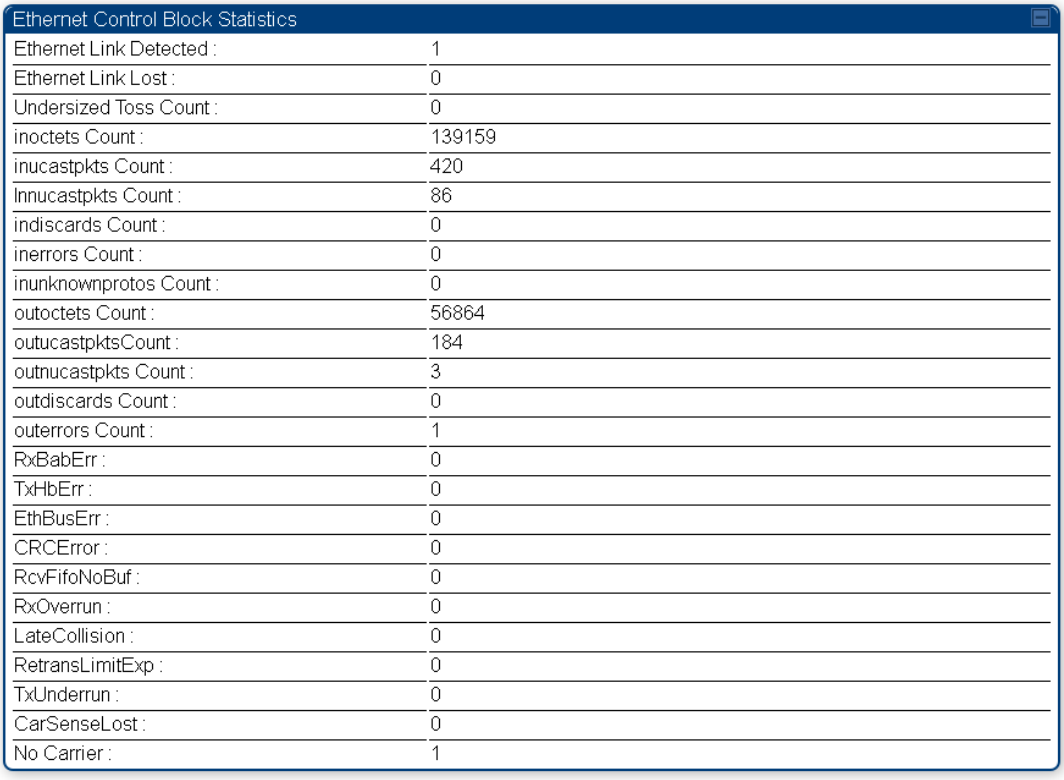
Figure 199 Translation Table page of SM

Interpreting Ethernet statistics

The **Statistics > Ethernet** page reports TCP throughput and error information for the Ethernet connection of the module. This page is applicable for all modules (AP/SM/BHM/BHS).

The **Ethernet** page displays the following fields.

Table 224 Ethernet tab attributes



Attribute	Meaning
Ethernet Link Detected	1 indicates that an Ethernet link is established to the radio, 0 indicates that no Ethernet link is established

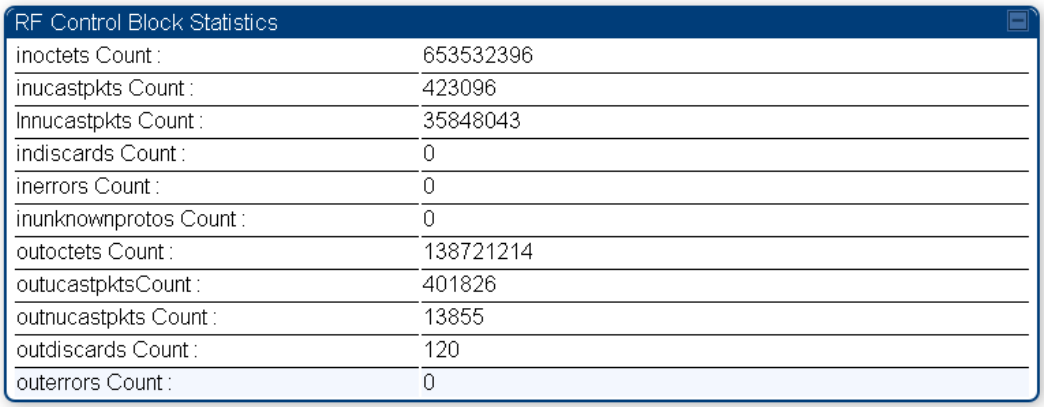
Ethernet Link Lost	This field indicates a count of how many times the Ethernet link was lost.
Undersized Toss Count	This field indicates the number of packets that were too small to process and hence discarded.
inoctets Count	This field displays how many octets were received on the interface, including those that deliver framing information.
inucastpkts Count	This field displays how many inbound subnetwork-unicast packets were delivered to a higher-layer protocol.
Innucastpkts Count	This field displays how many inbound non-unicast (subnetwork-broadcast or subnetwork-multicast) packets were delivered to a higher-layer protocol.
indiscards Count	This field displays how many inbound packets were discarded without errors that would have prevented their delivery to a higher-layer protocol. (Some of these packets may have been discarded to increase buffer space.)
inerrors Count	This field displays how many inbound packets contained errors that prevented their delivery to a higher-layer protocol.
inunknownprotos Count	This field displays how many inbound packets were discarded because of an unknown or unsupported protocol.
outoctets Count	This field displays how many octets were transmitted out of the interface, including those that deliver framing information.
outucastpkts Count	This field displays how many packets for which the higher-level protocols requested transmission to a subnetwork-unicast address. The number includes those that were discarded or not sent.
outnucastpkts Count	This field displays how many packets for which the higher-level protocols requested transmission to a non-unicast (subnetwork-broadcast or subnetwork-multicast) address. The number includes those that were discarded or not sent.
outdiscards Count	This field displays how many outbound packets were discarded without errors that would have prevented their transmission. (Some of these packets may have been discarded to increase buffer space.)
outerrrors Count	This field displays how many outbound packets contained errors that prevented their transmission.
RxBabErr	This field displays how many receiver babble errors occurred.
TxHbErr	This field displays how many transmit heartbeat errors have occurred.
EthBusErr	This field displays how many Ethernet bus errors occurred on the Ethernet controller.
CRCError	This field displays how many CRC errors occurred on the Ethernet controller.
RcvFifoNoBuf	This field displays the number of times no FIFO buffer space was able to be allocated.

	Note: PMP 450 AP running in Gigabit Ethernet Mode displays error “RcfFifoNoBuf” which indicates packet loss. For 450 AP platforms, if ethernet auto-negotation is set to Gigabit, then it is a known limitation that “RcfFifoNoBuf” error will be seen. This issue is not seen if autonegotation is set to 100Mbps or lower, and the issue is not seen on 450i or 450m AP's.
RxOverrun	This field displays how many receiver overrun errors occurred on the Ethernet controller.
Late Collision	This field displays how many late collisions occurred on the Ethernet controller. A normal collision occurs during the first 512 bits of the frame transmission. A collision that occurs after the first 512 bits is considered a late collision. **Caution** A late collision is a serious network problem because the frame being transmitted is discarded. A late collision is most commonly caused by a mismatch between duplex configurations at the ends of a link segment.
RetransLimitExp	This field displays how many times the retransmit limit has expired.
TxUnderrun	This field displays how many transmission-underrun errors occurred on the Ethernet controller.
CarSenseLost	This field displays how many carrier sense lost errors occurred on the Ethernet controller.
No Carrier	This field displays how many no carrier errors occurred on the Ethernet controller.

Interpreting RF Control Block statistics

The **Statistics > Radio** page is applicable for all module (AP/SM/BHM/BHS). The Radio page of the Statistics page displays the following fields.

Table 225 Radio (Statistics) page attributes – RF Control Block



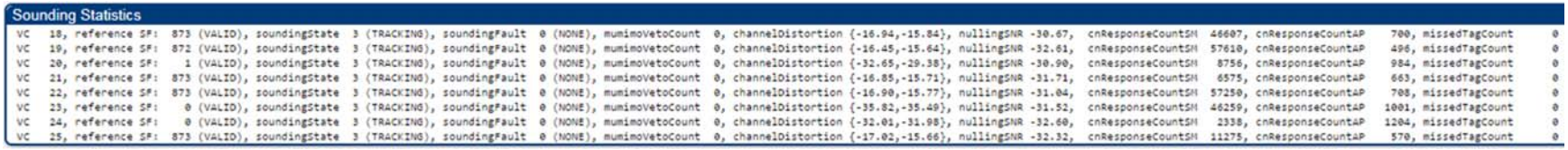
Attribute	Meaning
inoctets Count	This field displays how many octets were received on the interface, including those that deliver framing information.
inucastpkts Count	This field displays how many inbound subnetwork-unicast packets were delivered to a higher-layer protocol.
Innucastpkts Count	This field displays how many inbound non-unicast (subnetwork-broadcast or subnetwork-multicast) packets were delivered to a higher-layer protocol.
indiscards Count	This field displays how many inbound packets were discarded without errors that would have prevented their delivery to a higher-layer protocol. This stat is pegged whenever corrupt data is received by software or whenever the RF Software Bridge queue is full. Corrupt data is a very unusual event because all packets are CRC checked by hardware before being passed into software. The likely case for indiscards is if the RF bridge queue is full. If this is the case the radio is most likely PPS limited due to excessive small packet traffic or a problem at the Ethernet interface. If there is a problem at the Ethernet interface there is likely to be discards at the Ethernet as well.
inerrors Count	This field displays how many inbound packets contained errors that prevented their delivery to a higher-layer protocol.
inunknownprotos Count	This field displays how many inbound packets were discarded because of an unknown or unsupported protocol.

outoctets Count	This field displays how many octets were transmitted out of the interface, including those that deliver framing information.
outucastpkts Count	This field displays how many packets for which the higher-level protocols requested transmission to a subnetwork-unicast address. The number includes those that were discarded or not sent.
outnucastpkts Count	This field displays how many packets for which the higher-level protocols requested transmission to a non-unicast (subnetwork-broadcast or subnetwork-multicast) address. The number includes those that were discarded or not sent.
outdiscards Count	This field displays how many outbound packets were discarded without errors that would have prevented their transmission. (Some of these packets may have been discarded to increase buffer space.)
outerrrors Count	This field displays how many outbound packets contained errors that prevented their transmission.

Interpreting Sounding statistics for AP

In the AP GUI, sounding statistics can be found under **Statistics > Radio**.

Table 226 Radio (Statistics - AP) page attributes - Sounding



Attribute	Meaning
reference SF	Spatial Frequency of VC. Values 0 to 1023 are valid and value 2048 is considered as invalid.
soundingState	Different types of Sounding states are: • UNKNOWN: VC has recently registered to the AP but not registered with the channel manager yet. • NEW: VC has been registered with the channel manager and will soon transition to ASSESSING. • ASSESSING: AP will instruct SM to take the channel measurements. Channel estimates and spatial frequencies will be calculated. • TRACKING: Valid measurements resulted in good channel estimates and spatial frequency. This VC can now be used for MU-MIMO. • INVALID: Inconsistent measurements resulting in no channel estimate or spatial frequency. This VC cannot be used for MU-MIMO and it will ultimately be re-assessed.

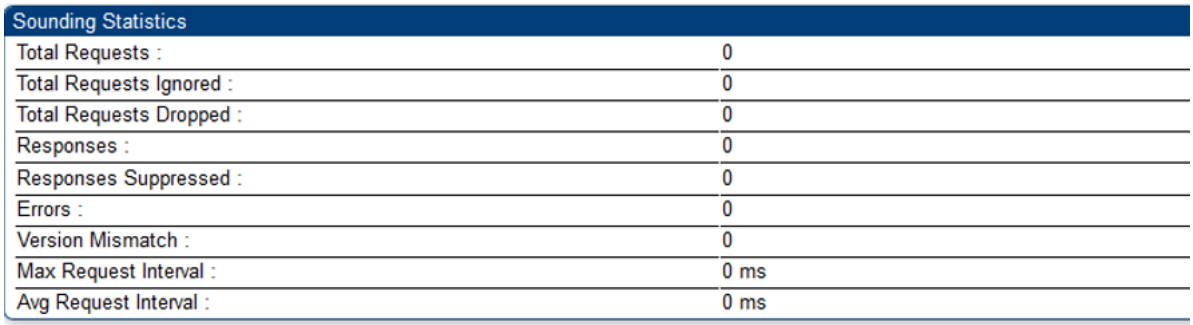
soundingFault	Generally if VC is UNTRUSTED, this means something went wrong. The fault codes can help to describe what is wrong with this channel (If VC is TRACKING this will generally indicate 0 (SOUNDING_FAULT_NONE)). Error codes are: • SOUNDING_FAULT_VC_CEST: Channel Estimate Error, could be due to issues with the channel.. • SOUNDING_FAULT_NULLING_SNR: Channel Estimate Error, could be due to issues with the channel. • SOUNDING_FAULT_SM_ERROR: SM returned Error code when taking channel measurements. • SOUNDING_FAULT_CHANNEL_DISTORTION: Channel Distortion is beyond tolerance, could be due to issues with the channel. • SOUNDING_FAULT_UNSTABLE_SF: Inconsistent Spatial Frequency, could be due to issues with the channel. • SOUNDING_FAULT_SF_DEVIATION: Inconsistent Spatial Frequency, could be due to issues with the channel. • SOUNDING_FAULT_INTERNAL_ERROR: Could be due to incompatible software (AP – SM), or other catastrophic software issue.
mumimoVetoCount	If excessive channel distortion is observed during condensed nulling (tracking state) this count will increment and VC will transition back to assessing state.
channelDistortion	Channel distortion readings.
nullingSNR	Signal to noise ratio of condensed nulling error response.
cnResponseCountSM	The SM adds a counter to the CN (Condensed Nulling) response. This indicates how many responses were sent by that SM.
cnResponseCountAP	The AP increments a count for each CN response received.
missedTagCount	This is the number of CN responses transmitted by SM but not received at AP.

Interpreting Sounding statistics for SM

In the SM GUI, sounding statistics can be found under **Statistics > Radio**.

The top section, RF Control Block Statistics, is applicable to the SM communicating to any AP (450, 450i, or 450m), and it is always visible. The bottom section, Sounding Statistics, is visible only if the SM is communicating with a 450m AP.

Table 227 Radio (Statistics - SM) page attributes - Sounding



Sounding Statistics	
Total Requests :	0
Total Requests Ignored :	0
Total Requests Dropped :	0
Responses :	0
Responses Suppressed :	0
Errors :	0
Version Mismatch :	0
Max Request Interval :	0 ms
Avg Request Interval :	0 ms

Attribute	Meaning
Responses	Number of sounding responses (full VC assessments or condensed nulling) sent from the SM to the AP
Responses Suppressed	Number of sounding requests suppressed by the SM. The reason why a sounding response is suppressed is because the error calculated during the sounding process is lower than the threshold set by the AP. In this case, the SM does not need to transmit a sounding response to the AP
Errors	Number of errors in the sounding process at the SM Examples of events that count as errors: • Sounding type is not supported • IQ capture not enabled: for example, if sounding requested too soon after SM boot • IQ capture did not complete • Sounding processing took too long
Version Mismatch	Number of sounding requests with mismatched version numbers The Sounding Acquisition Command contains a version number. The SM checks its own version number and flags any mismatch. Currently, AP and SMs use V1.
Max Request Interval	Largest time between two sounding requests received from the 450m AP
Avg Request Interval	Average time between two sounding requests received from the 450m AP

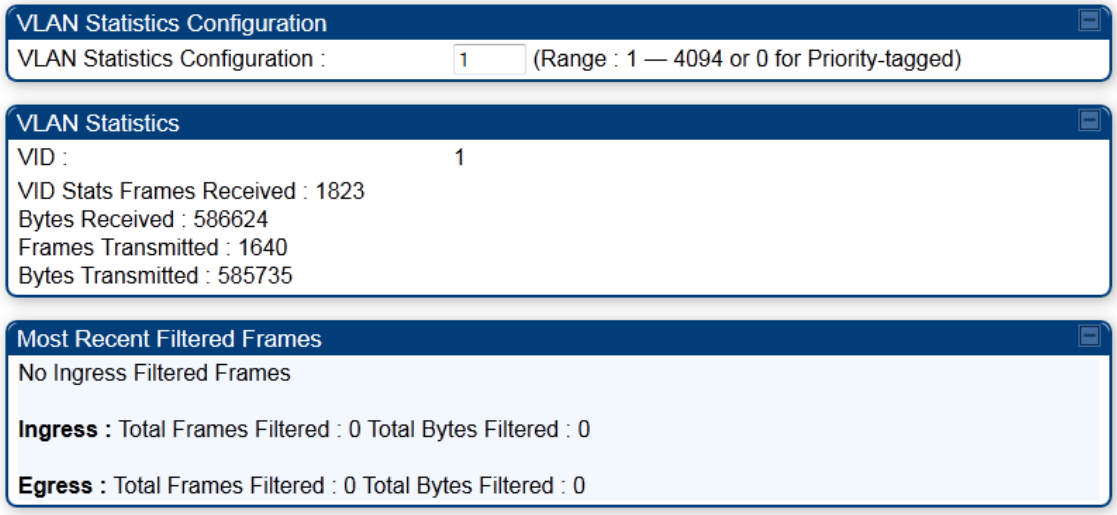
The following attributes are applicable only for 450m:

Attribute	Meaning
mumimoVetoCount	If excessive channel distortion is observed during condensed nulling (tracking state) this count will increment and VC will transition back to assessing state.
channelDistortion	Channel distortion readings.
nullingSNR	Signal to noise ratio of condensed nulling error response.
cnResponseCountSM	The SM adds a counter to the CN (Condensed Nulling) response. This indicates how many responses were sent by that SM.
cnResponseCountAP	The AP increments a count for each CN response received.
missedTagCount	This is the number of CN responses transmitted by SM but not received at AP.

Interpreting VLAN statistics

The **Statistics > VLAN** page provides a list of the most recent packets that were filtered because of VLAN membership violations. It is applicable for all modules (AP/SM/BHM/BHS).

Table 228 VLAN page attributes



Attribute	Meaning
Unknown	This must not occur. Contact Technical Support.
Only Tagged	The packet was filtered because the configuration is set to accept only packets that have an 802.1Q header and this packet did not.
Ingress	When the packet entered through the wired Ethernet interface, the packet was filtered because it indicated an incorrect VLAN membership.

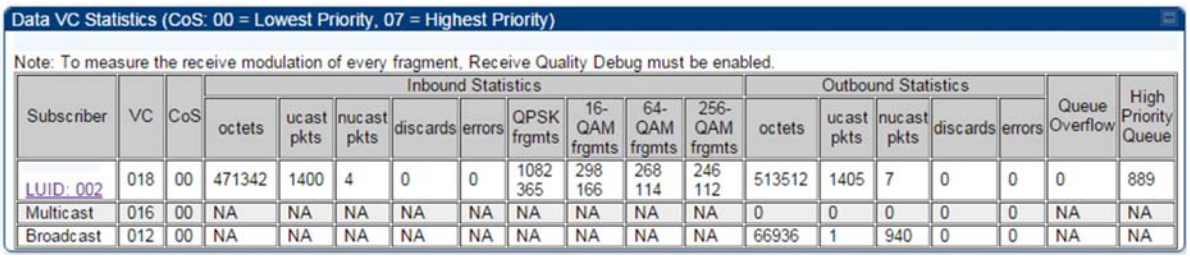
Local Ingress	When the packet was received from the local TCP/IP stack, the packet was filtered because it indicated an incorrect VLAN membership. This must not occur. Contact Technical Support.
Egress	When the packet attempted to leave through the wired Ethernet interface, the packet was filtered because it indicated an incorrect VLAN membership.
Local Egress	When the packet attempted to reach the local TCP/IP stack, the packet was filtered because it indicated an incorrect VLAN membership.

Interpreting Data VC statistics

The **Statistics** > **Data VC** page displays information about Virtual Channel (VC) used in data communications. This page is applicable for all modules (AP/SM/BHM/BHS).

The **Data VC** tab displays the fields as explained in Table 229.

Table 229 Data VC page attributes



Data VC Statistics (CoS: 00 = Lowest Priority, 07 = Highest Priority)

Note: To measure the receive modulation of every fragment, Receive Quality Debug must be enabled.

Subscriber	VC	CoS	Inbound Statistics									Outbound Statistics					Queue Overflow	High Priority Queue
			octets	ucast pkts	nucast pkts	discards	errors	QPSK frgmts	16-QAM frgmts	64-QAM frgmts	256-QAM frgmts	octets	ucast pkts	nucast pkts	discards	errors		
LUID: 002	018	00	471342	1400	4	0	0	1082 365	298 166	268 114	246 112	513512	1405	7	0	0	0	889
Multicast	016	00	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA
Broadcast	012	00	NA	NA	NA	NA	NA	NA	NA	NA	NA	66936	1	940	0	0	NA	NA

Attribute	Meaning
Subscriber	This field displays the LUID (logical unit ID), MAC address and Site Name of the SM/BHS. As each SM or BHS registers to the AP/BHM, the system assigns an LUID of 2 or a higher unique number to the SM/BHS. If a SM/BHS loses registration with the AP/BHM and then regains registration, the SM/BHS retains the same LUID.
VC	This field displays the virtual channel number. Low priority channels start at VC18 and count up. High priority channels start at VC255 and count down. If one VC is displayed, the high-priority channel is disabled. If two are displayed, the high-priority channel is enabled.
CoS	This field displays the Class of Service for the virtual channel. The low priority channel is a CoS of 00 and the high priority channel is a CoS of 01. CoS of 02 through 07 are not currently used.
Inbound Statistics, octets	This field displays how many octets were received on the interface, including those that deliver framing information.
Inbound Statistics, ucastpkts	This field displays how many inbound subnetwork-unicast packets were delivered to a higher-layer protocol.
Inbound Statistics, nucastpkts	This field displays how many inbound non-unicast (subnetwork-broadcast or subnetwork-multicast) packets were delivered to a higher-layer protocol.
Inbound Statistics, discards	This field displays how many inbound packets were discarded without errors that would have prevented their delivery to a higher-layer protocol. Inbound discard statistics are incremented similar to the indiscards stat on the RF control block stats page. The sum of all data VC indiscards must be close to the RF control block in discards. If indiscards are evenly distributed across SMs, then the radio is PPS limited due to either excessive small packet transmissions, or a problem at the Ethernet link. If indiscards are contained to one or a few SMs, then there is likely a problem at or underneath the SM which is incrementing the count.

Inbound Statistics, errors	This field displays how many inbound packets contained errors that prevented their delivery to a higher-layer protocol.
Inbound Statistics, QPSK frgmts	This field displays how many inbound fragments were received via the QPSK modulation scheme.
Inbound Statistics, 16-QAM frgmts	This field displays how many inbound fragments were received via the 16-QAM modulation scheme.
Inbound Statistics, 64-QAM frgmts	This field displays how many inbound fragments were received via the 64-QAM modulation scheme.
Inbound Statistics, 256-QAM frgmts	This field displays how many inbound fragments were received via the 256-QAM modulation scheme.
Outbound Statistics, octets	This field displays how many octets were transmitted out of the interface, including those that deliver framing information.
Outbound Statistics, ucastpkts	This field displays how many packets for which the higher-level protocols requested transmission to a subnetwork-unicast address. The number includes those that were discarded or not sent.
Outbound Statistics, nucastpkts	This field displays how many packets for which the higher-level protocols requested transmission to a non-unicast (subnetwork-broadcast or subnetwork-multicast) address. The number includes those that were discarded or not sent.
Outbound Statistics, discards	This field displays how many outbound packets were discarded without errors that would have prevented their transmission. Outbound discard statistics are incremented if a VC is not active when a packet is ready to send. This is a rare condition.
Outbound Statistics, errors	This field displays how many outbound packets contained errors that prevented their transmission.
Queue Overflow	This is a count of packets that were discarded because the queue for the VC was already full. If Queue Overflows are being seen across most or all SMs, then there is either an interferer local to the AP or the APs RF link is at capacity. If Queue Overflows are being seen at one or only a few SMs, then it is likely that there is a problem with those specific links whether it is insufficient signal strength, interferer, or a problem with the actual SM hardware.
High Priority Queue	This is a count of packets that were received on high priority queue.

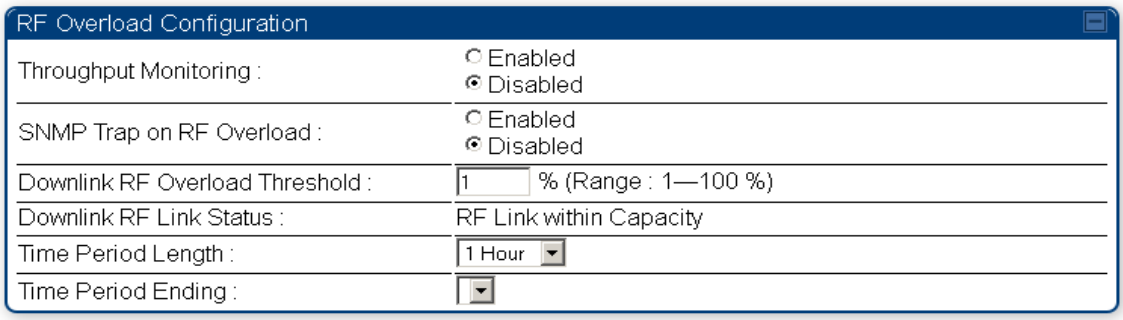
Interpreting Throughput statistics

The 450 Platform Family has a **Statistics** > **Throughput** page which shows historical information about sector or backhaul throughput and packet discards. This page is applicable for AP and BHM modules. This information can be useful to identify an overloaded sector or heavy bandwidth users. This page also shows the user throughput in terms of data rate (kbps) and packet rate (packets per second, or PPS), as well as the average packet size during the sample period.

Operators may set the AP/BHM to send an SNMP trap when it detects an RF overload condition based on a configurable threshold.

The following configuration parameters are available on the Throughput tab GUI pane and a radio reboot is not required when configuring these parameters:

Table 230 RF overload Configuration attributes – AP/BHM



Attribute	Meaning
Throughput Monitoring	This enables or disables the monitoring of sector throughput and packet discards. This parameter is disabled by default.
SNMP Trap on RF Overload	This enables or disables the sending of an SNMP trap when an AP/BHM overload condition is reached (based on Downlink RF Overload Threshold).
Downlink RF Overload Threshold	This parameter determines the overload threshold in percent of packets discarded that triggers the generation of an SNMP trap.
Downlink RF Link Status	This field displays the status of the capacity of the RF link.
Time Period Length Time Period Ending	These two configuration parameters determine what set of collection samples to show on the GUI display. The Time Period Length can be set from one to three hours. Time Period Ending allows the operator to set the end time for the set of collection samples to display.

Below the configuration settings are three tables that display the statistics that are collected.

Board Performance statistics

This table contains a row that corresponds to each 1 minute statistics collection interval. Each row contains the following data aggregated for the entire AP/BHM:

- **Ethernet Throughput** - Statistics collected at the Ethernet port:
  - **kbps in** – average throughput over the collection interval in Kbps into the AP/BHM on the Ethernet Interface
  - **kbps out** – average throughput over the collection interval in Kbps out of the AP/BHM on the Ethernet Interface
  - **PPS in** – average packets per second over the collection interval into the AP/BHM on the Ethernet Interface
  - **PPS out** – average packets per second over the collection interval out of the AP/BHM on the Ethernet Interface
- **RF Throughput -** Statistics collected at the RF Interface:
  - **kbps in** – average throughput over the collection interval in Kbps into the AP/BHM on the RF Interface
  - **kbps out** – average throughput over the collection interval in Kbps out of the AP/BHM on the RF Interface
  - **PPS in** – average packets per second over the collection interval into the AP/BHM on the RF Interface
  - **PPS out** – average packets per second over the collection interval out of the AP/BHM on the RF Interface
- **Aggregate Through Board** – Sum of bidirectional data transferred *through* (not originating or terminating at) the AP/BHM:
  - **kbps** – average bidirectional throughput over the collection interval in Kbps
  - **PPS** – average bidirectional packets per second over the collection interval
  - **Ave Pkt Size** – Average Packet size over the collection interval of bidirectional data transferred

Board Throughput statistics

This table contains a row that corresponds to each one minute statistics collection interval. This table may be used to determine if there are problems with any of the interfaces. For example, if the Ethernet in packets is much higher than the RF out packets it could indicate a denial of service (DoS) attack on the AP/BHM. Each row contains the following data aggregated for the entire AP/BHM:

- **Ethernet Statistics** - Statistics collected at the Ethernet port:
  - **inOctets** – Number of octets (bytes) received by the AP/BHM at the Ethernet Interface over the collection interval
  - **outOctets** – Number of octets (bytes) sent by the AP/BHM at the Ethernet Interface over the collection interval
  - **inPkts** – Number of packets received by the AP/BHM at the Ethernet Interface over the collection interval
  - **outPkts** – Number of packets sent by the AP/BHM at the Ethernet Interface over the collection interval
  - **Discards (in/out)** – Number of packets that had to be discarded by the AP/BHM at the respective Ethernet Interface Queue
- **RF Statistics** - Statistics collected at the RF Interface:
  - **inOctets** – Number of octets (bytes) received by the AP/BHM at the RF Interface over the collection interval
  - **outOctets** – Number of octets (bytes) sent by the AP/BHM at the RF Interface over the collection interval
  - **inPkts** – Number of packets received by the AP/BHM at the RF Interface over the collection interval

- **outPkts** – Number of packets sent by the AP/BHM at the RF Interface over the collection interval
- **Discards (in/out)** – Number of packets that had to be discarded by the AP/BHM at the respective RF Interface Queue during the collection interval
- **Discards % (in/out)** – Percent of the total packets received / transmitted that had to be discarded during the collection interval

LUID RF Throughput statistics

This table contains a row that corresponds to each active LUID served by the AP/BHM. Note that an LUID may be assigned 1 or 2 VCs. If the LUID is assigned 2 VCs, then the data in the table is the sum of the activity for both VCs. This table may be used to determine which LUIDs are experiencing overload so that corrective action can be taken (i.e. fixing a poor RF link or moving a heavily loaded link to a less congested AP/BHM). Each row contains counters and statistics related to the RF Interface that are updated once per minute:

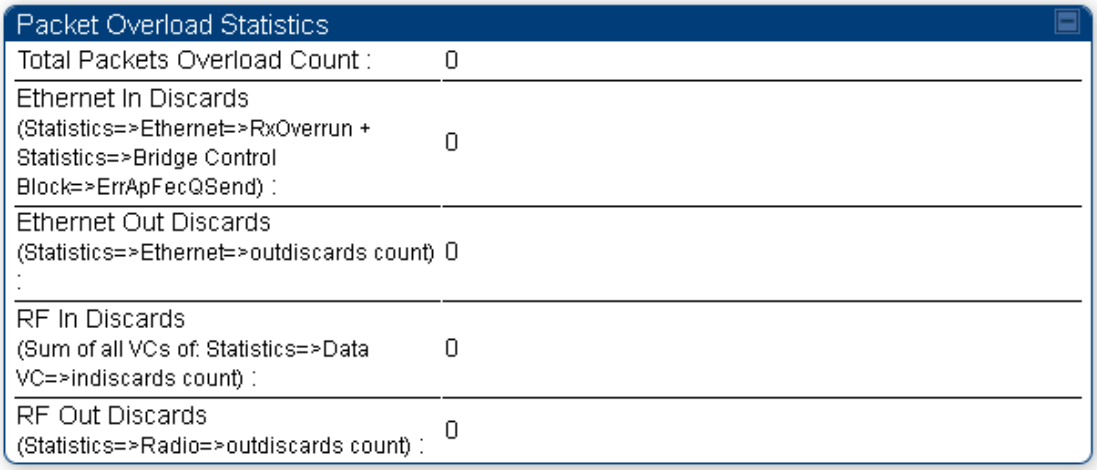
- **Inbound Statistics** - Statistics collected at the RF Interface for the Uplink:
  - **octets** – Number of octets (bytes) received by the AP/BHM at the RF Interface for this LUID over the collection interval
  - **pkts** – Number of packets received by the AP/BHM at the RF Interface for this LUID over the collection interval
  - **Ave Pkt Size** – Average size of the packets received by the AP/BHM at the RF Interface for this LUID over the collection interval
  - **discards** – Number of packets received by the AP/BHM at the RF Interface for this LUID over the collection interval that had to be discarded because the RF In Queue was full
  - **discards %** – Percent of the total packets received by the AP/BHM at the RF Interface for this LUID over the collection interval that had to be discarded because the RF In Queue was full
- **Outbound Statistics** - Statistics collected at the RF Interface for the Downlink:
  - **octets** – Number of octets (bytes) transmitted by the AP/BHM at the RF Interface for this LUID over the collection interval
  - **pkts** – Number of packets transmitted by the AP/BHM at the RF Interface for this LUID over the collection interval
  - **Ave Pkt Size** – Average size of the packets transmitted by the AP/BHM at the RF Interface for this LUID over the collection interval
  - **discards** – Number of packets to be transmitted by the AP/BHM at the RF Interface for this LUID over the collection interval that had to be discarded because the RF Out Queue was full
  - **discards %** – Percent of the total packets to be transmitted by the AP/BHM at the RF Interface for this LUID over the collection interval that had to be discarded because the RF Out Queue was full.

Interpreting Overload statistics

The Statistics > Overload page displays statistics on packet overload and resultant packet discards. Unlike the other fields, the Total Packets Overload Count is expressed in only this page. It is not a count of how many packets have been lost, but rather of how many discard events (packet loss bursts) have been detected due to overload condition.

This statistics page is applicable for all modules (AP/SM/BHM/BHS) and explained in Table 231.

Table 231 Overload page attributes – AP/SM/BHM/BHS



Attribute	Meaning
Total Packets Overload Count	This field represents the sum of all RF and Ethernet in/out discards.
Ethernet In Discards	This field represents the number of packets tossed due to the Ethernet queue being full. If a climb in this stat accompanies a climb in RF Out Discards stat, then most likely the board is at RF capacity either due to traffic exceeding the RF pipe, or interference temporarily limiting the RF throughput. If this stat climbs without the RF Out Discards stat climbing, then the radio is most likely PPS limited.
Ethernet Out Discards	This field represents the number of packets tossed due to an Ethernet out overload. This stat must not climb in normal operation because the Ethernet link is much higher capacity than the RF link. If this stat is incrementing, then either the Ethernet link is established at a low speed (i.e. 10Mbps – half duplex), or there is a problem with cabling/Ethernet hardware.
RF In Discards	This field indicates the number of packets tossed due to no resources available within the radio to process them. This stat also must not be increasing because the system is designed to shed packets on the RF Out interface. If this stat is incrementing the board, it is most likely congested due to high PPS rate in combination with an Ethernet Out problem, which limits packet flow off the device.

RF Out Discards	This field indicates the number of packets tossed due to RF link at capacity. This stat will increase whenever the RF link is at capacity. When the internal FPGA RF input queue overflows, this stat is incremented. If this stat is seen to be incrementing at the AP, then the sector is congested. If seen at the SM, the number of Contention Slots must be looked at to ensure that enough Contention Slots are allocated to allow for bandwidth requests to be seen at the AP.

Note

450m Overload:

The 450m Series AP is designed to handle high load in terms of high throughput and high PPS. In terms of throughput, 450m is designed to achieve 3x or more throughput improvement over 450 and 450i Series products. In terms of packets per second (PPS), 450m is designed to handle up to 100k PPS.

Overload occurs when the offered load exceeds the above limits. When overload occurs, 450m will start discarding packets and TCP throughput will degrade due to packet loss.

It's worth noting that Frame Utilization statistics (Statistics > Frame Utilization tab: Frame Utilization: Downlink and Uplink) are not necessarily indicative of overload condition. They show how much the TDD frame is utilized. High frame utilization depends on:

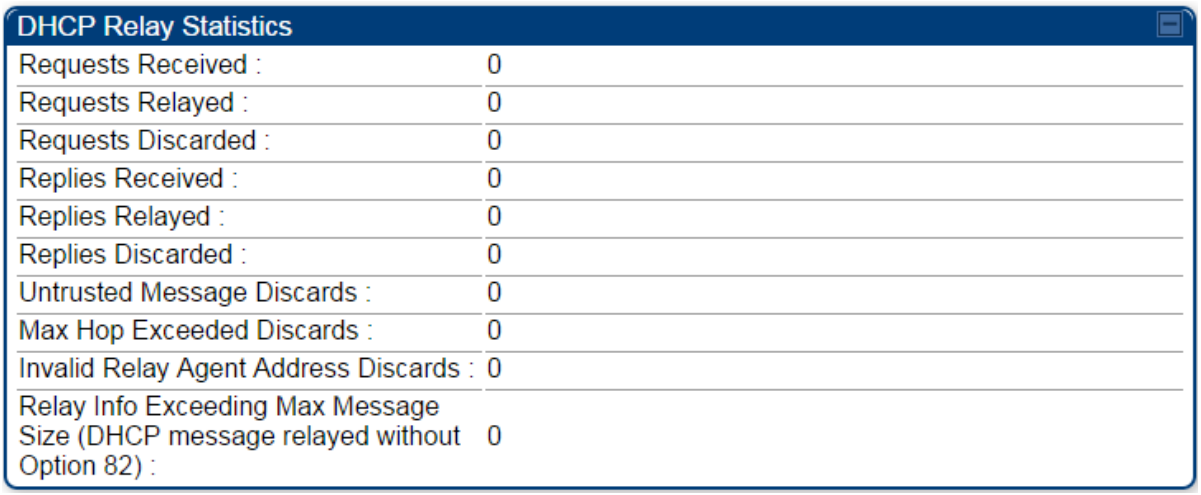
- High traffic during busy periods: those statistics will be close to 100% and almost all slots will be utilized. In this case if the Overload statistics show that packets are discarded then this is an indication of overload condition.
- High percentage of VCs with low modulation with moderate traffic. Those VCs will require more slots to service them (due to low modulation) and the frame utilization will be high. In this case the TDD frame is fully utilized but the system is at low capacity and is not in an overload condition.

450m has higher PPS than 450 and 450i and supports higher throughput through spatial multiplexing, therefore when a 450m replaces an overloaded 450 or 450i AP the 450m will not be overloaded under the same conditions but the frame utilization may still show close to 100%; this should not alarm the customer. The overload statistics shall be monitored on 450m to see if it is overloaded or not.

Interpreting DHCP Relay statistics

The **Statistics > DHCP Relay** page displays requests and replies received, relayed and discarded when the AP is configured as a DHCP relay. Typically, in a working DHCP relay configuration a one-to-one ratio is established between requests and replies that are received and relayed. This statistics page is only applicable for PMP (AP and SM modules) and it is explained in Table 232.

Table 232 DHCP Relay page attributes – AP/SM

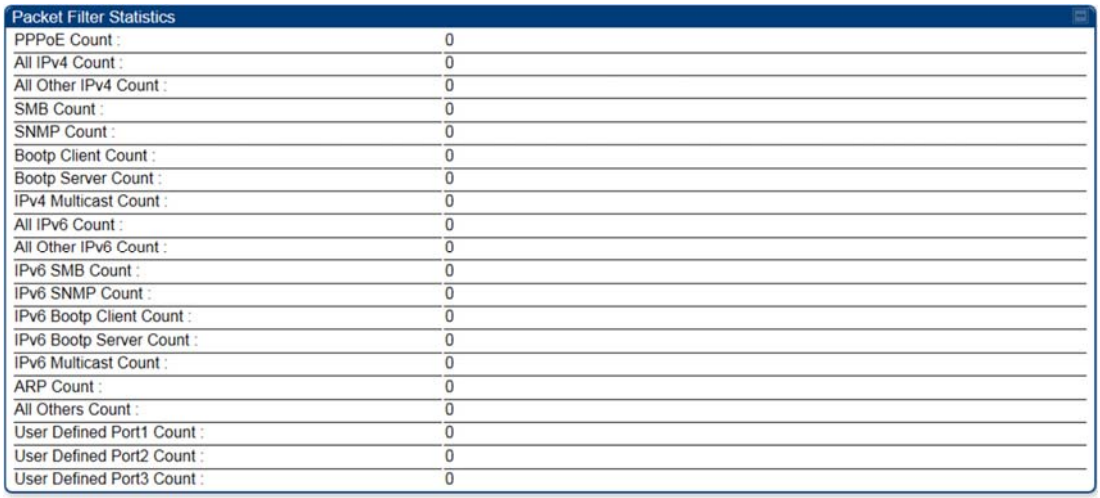


Attribute	Meaning
Requests Received	This field represents the number of DHCP relay requests received by the AP.
Requests Relayed	This field represents the number of DHCP relay requests relayed by the AP.
Requests Discarded	This field represents the number of DHCP relay requests discarded by the AP due to errors in the request.
Replies Received	This field represents the number of DHCP relay replies received by the AP.
Replies Relayed	This field represents the number of DHCP relay replies relayed by the AP.
Replies Discarded	This field represents the number of DHCP relay replies discarded by the AP due to errors in the reply.
Untrusted Message Discards	This field indicates messages that were discarded because the message already contained Option 82 information with no Relay Agent specified.
Max Hop Exceeded Discards	This field indicates messages that have been relayed too many times, exceeding the max hop count (16).
Invalid Relay Agent Address Discards	This field indicates messages that have been discarded because the message relay agent address is already in place (relay agent address does not equal address of the AP).
Relay Info Exceeding Max Message Size (DHCP message relayed without Option 82)	This field indicates DHCP messages too large to fit Option 82 data. These messages are sent on without Option 82 information.

Interpreting Filter statistics

The **Statistics > Filter** page displays statistics on packets that have been filtered (dropped) due to the filters set on the **Protocol Filtering** page. The filter page of SM is explained in Table 233.

Table 233 Filter page attributes - SM



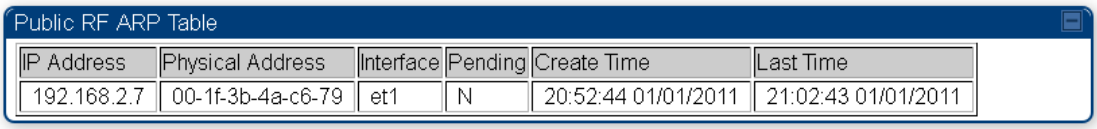
Attribute	Meaning
PPPoE Count	Number of PPPoE packets filtered.
All IPv4 Count	Number of IPv4 packets filtered.
All Other IPv4 Count	Any IPv4 message that was not SMB, SNMP, Bootp, Multicast or one of the user defined filters, that was filtered out.
SMB Count	Number of IPv4 Server Message Block (file sharing) packets filtered.
SNMP Count	Number of IPv4 SNMP packets filtered.
Bootp Client Count	Total number of IPv4 DHCP requests filtered.
Bootp Server Count	Total number of IPv4 DHCP replies filtered.
IPv4 Multicast Count	Number of IPv4 Multicast messages filtered.
All IPv6 Count	Number of IPv6 messages filtered.
All Other IPv6 Count	Any IPv6 message that was not SMB, SNMP, Bootp, Multicast or one of the user defined filters, that was filtered out.
IPv6 SMB Count	Number of IPv6 Server Message Block (file sharing) packets filtered
IPv6 SNMP Count	Number of IPv6 SNMP messages filtered
IPv6 Bootp Client Count	Total number of IPv6 DHCP replies filtered
IPv6 Bootp Server Count	Total number of IPv6 DHCP replies filtered
IPv6 Multicast Count	Number of IPv6 Multicast messages filtered

ARP Count	Total number of ARP packets filtered.
All other Count	The count of any messages that did not fit above that were filtered out
User Defined Port1 Count	Number of packets defined by the user port1 that were filtered.
User Defined Port2 Count	Number of packets defined by the user port2 that were filtered.
User Defined Port3 Count	Number of packets defined by the user port3 that were filtered.

Viewing ARP statistics

The **Statistics > ARP** page in a SM module correlated the IP address of the Ethernet-connected device to its MAC address and provides data about the connection.

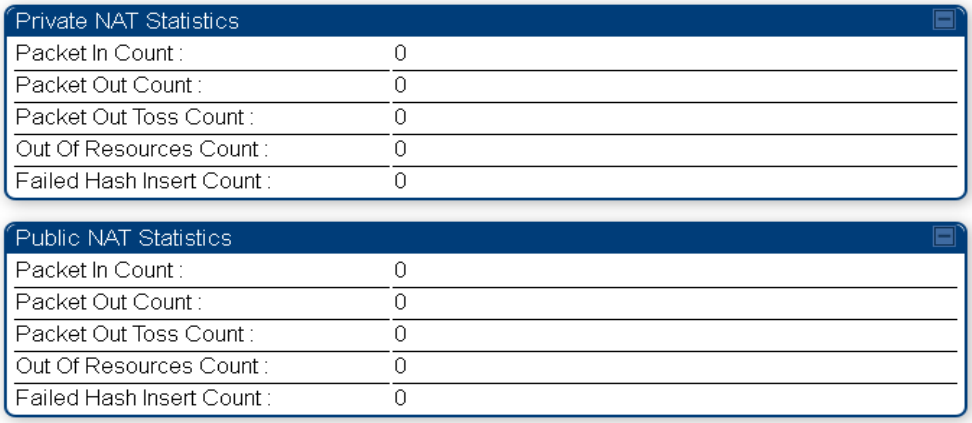
Figure 200 ARP page of the SM



Viewing NAT statistics

When NAT is enabled on a SM, statistics are kept on the Public and Private (WAN and LAN) sides of the NAT and displayed on the **Statistics > NAT Stats** page. The NAT page of SM is explained in Table 234.

Table 234 NAT page attributes - SM



Private NAT Statistics	
Packet In Count :	0
Packet Out Count :	0
Packet Out Toss Count :	0
Out Of Resources Count :	0
Failed Hash Insert Count :	0

Public NAT Statistics	
Packet In Count :	0
Packet Out Count :	0
Packet Out Toss Count :	0
Out Of Resources Count :	0
Failed Hash Insert Count :	0

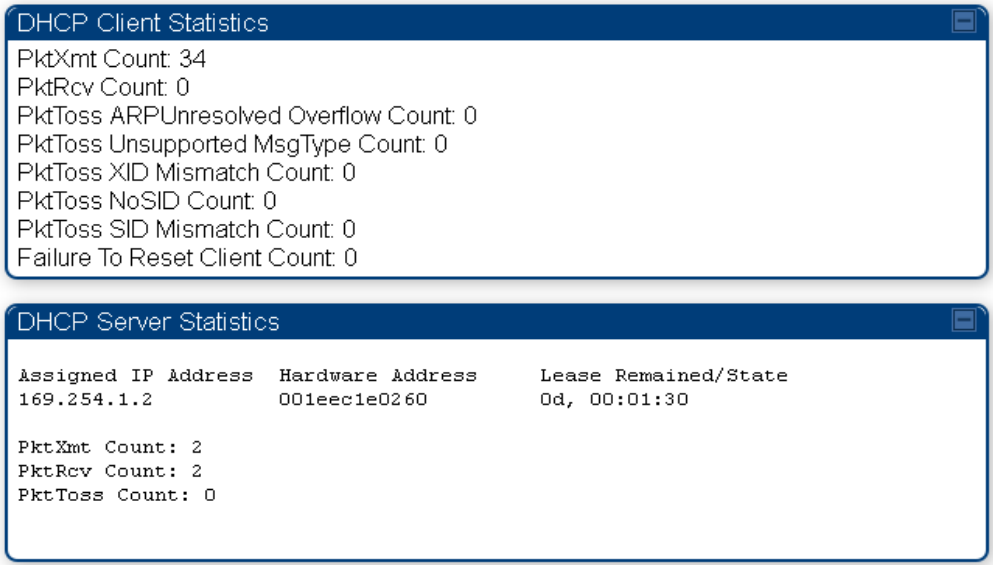
Attribute	Meaning
Private NAT Statistics, Packet In Count	This field represents the number of packets received on the SM's LAN/Ethernet interface
Private NAT Statistics, Packet Out Count	This field represents the number of packets sent from the SM's LAN/Ethernet interface
Private NAT Statistics, Packet Out Toss Count	This field represents the number of packets that we not sent from the SM's LAN/Ethernet interface due to addressing issues.
Private NAT Statistics, Out of Resources Count	This field represents the number of times the NAT table for the SM's LAN/Ethernet interfaces has been filled.
Private NAT Statistics, Failed Hash Insert Count	This field represents the number of times that the device failed to insert an address binding into the NAT hash table.
Public NAT Statistics, Packet In Count	This field represents the number of packets received on the SM's WAN/wireless interface
Public NAT Statistics, Packet Out Count	This field represents the number of packets sent from the SM's WAN/wireless interface
Public NAT Statistics, Out of Resources Count	This field represents the number of packets that we not sent from the SM's WAN/wireless interface due to addressing issues.
Public NAT Statistics, Failed Hash Insert Count	This field represents the number of times the NAT table for the SM's WAN/wireless interfaces has been filled.

Viewing NAT DHCP Statistics

The Statistics > NAT DHCP page displays NAT enabled DHCP client statistics. This is statistics page is applicable for SM only.

When NAT is enabled on a SM with DHCP client (**DHCP** selected as the **Connection Type** of the WAN interface) and/or DHCP Server, statistics are kept for packets transmitted, received and tossed, as well as a table of lease information for the DHCP server (Assigned IP Address, Hardware Address and Lease Remained/State).

Table 235 NAT DHCP Statistics page attributes - SM



Attribute	Meaning
PktXmt Count	Represents the number of DHCP packets transmitted from the client
PktRcv Count	This field represents the number of DHCP packets received by the client
PktToss ARPUnresolved Overflow Count	This field represents the number of packets tossed due to failed attempts to resolve an IP address into a physical MAC address
PktToss Unsupported MsgType Count	This field represents the number of packets tossed due to the receipt of an unsupported message type (cannot be interpreted by DHCP client)
PktToss XID Mismatch Count	The field represents the number of packets that were tossed due to a transaction ID mismatch
PktToss NoSID Count	This field represents the number of packets that were tossed due to lack of a DHCP session ID
PktToss SID Mismatch Count	Represents the number of packets tossed due to a session ID mismatch

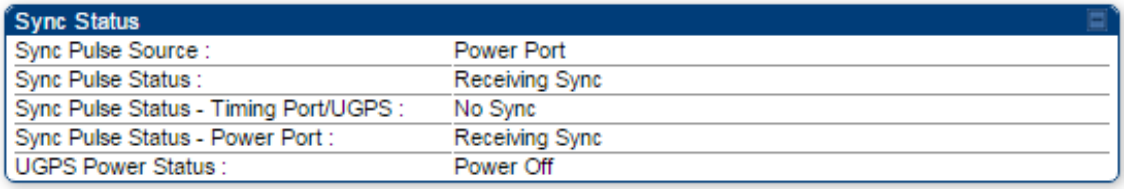
Failure to Reset Client Count	This field represents the number of times the DHCP client was unable to be reset (resulting in no IP address being served).

Interpreting Sync Status statistics

The **Statistics > Sync Status** page of AP is only displayed when the Sync Input is set to AutoSync or AutoSync+Free Run.

The Sync Status page is explained in Table 236.

Table 236 Sync Status page attributes - AP



Attribute	Meaning
Sync Pulse Source	This field indicates the status of the synchronization source: • **Searching** indicates that the unit is searching for a GPS fix • **Timing Port/UGPS** indicates that the module is receiving sync via the timing AUX/SYNC timing port • **Power Port** indicates that the module is receiving sync via the power port (Ethernet port).
Sync Pulse Status	This field indicates synchronization source pulse status.
Sync Pulse Status – Timing Port/UGPS	This field indicates synchronization pulse status over Timing Port/UGPS port.
Sync Pulse Status - Power Port	This field indicates synchronization pulse status over power port.
UGPS Power Status	This field indicates UGPS power up status (on or off).

This information may be helpful in a decision of whether to climb a tower to diagnose a perceived antenna problem.

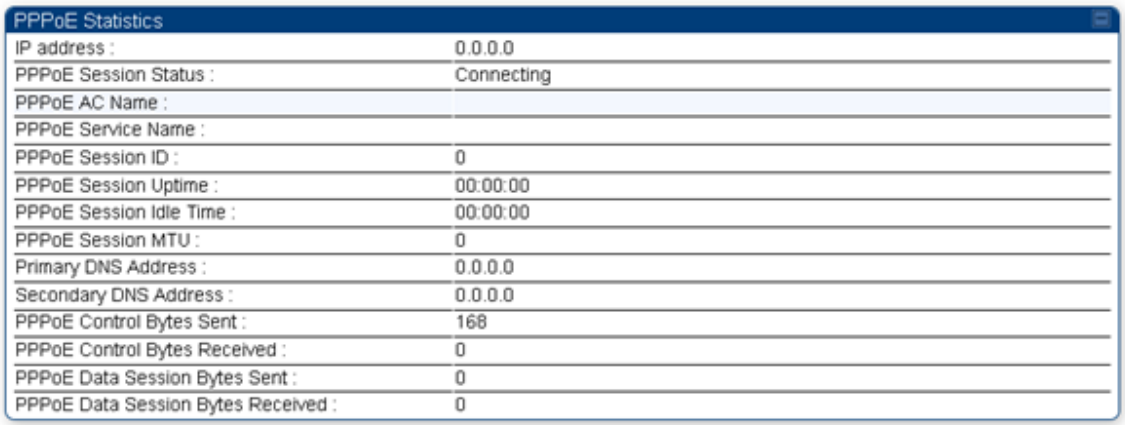
Interpreting PPPoE Statistics for Customer Activities

The page can be access under **Statistics > PPPoE** of SM GUI.

When the PPPoE feature is enabled on the SM, PPPoE statistics provide data about activities of the customer.

The PPPoE Statistics of SM is explained in Table 237.

Table 237 PPPoE Statistics page attributes - SM



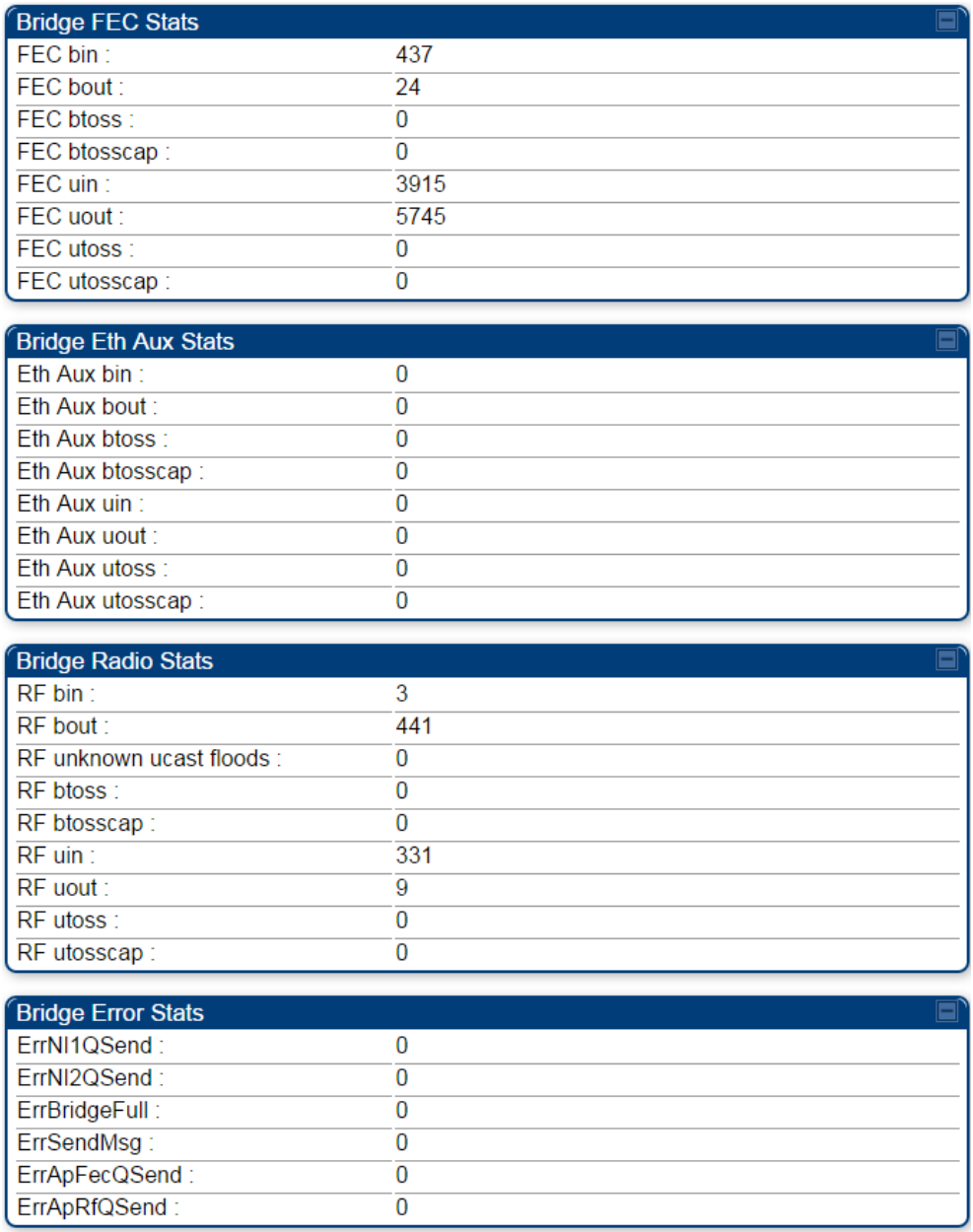
Attribute	Meaning
IP address	This field displays the IP address of the PPPoE session initiator (situated below the SM)
PPPoE Session Status	This field displays the operational status of the PPPoE Session
PPPoE AC Name	This field displays access concentrator name used in the PPPoE session
PPPoE Service Name	This field displays the PPPoE service name associated with the PPPoE server in use
PPPoE Session ID	This field displays the current PPPoE session ID
PPPoE Session Uptime	This field displays the total session uptime for the PPPoE session
PPPoE Session Idle Time	This field displays the total idle time for the PPPoE session
PPPoE Session MTU	This field displays Maximum Transmission Unit configured for the PPPoE session
Primary DNS Address	This field displays the primary DNS server used by the PPPoE session
Secondary DNS Address	This field displays the secondary DNS server used by the PPPoE session

PPPoE Control Bytes Sent	Displays the total number of PPPoE session control bytes sent from SM
PPPoE Control Bytes Received	This field displays the total number of PPPoE session control bytes received by the SM
PPPoE Data Session Bytes Sent	This field displays the total number of PPPoE data session (non-control/non-session management user data) sent by the SM
PPPoE Data Session Bytes Received	This field displays the total number of PPPoE data session (non-control/non-session management user data)

Interpreting Bridge Control Block statistics

The **Statistics > Bridge Control Block** page displays statistics of Bridge FEC, Bridge ratio and Bridge error. The page is applicable for all modules (AP/SM/BHM/BHS). The Bridge Control Block Statistics page is explained in Table 238.

Table 238 Bridge Control Block page attributes – AP/SM/BHM/BHS



Bridge FEC Stats	
FEC bin :	437
FEC bout :	24
FEC btoss :	0
FEC btosscap :	0
FEC uin :	3915
FEC uout :	5745
FEC utoss :	0
FEC utosscap :	0

Bridge Eth Aux Stats	
Eth Aux bin :	0
Eth Aux bout :	0
Eth Aux btoss :	0
Eth Aux btosscap :	0
Eth Aux uin :	0
Eth Aux uout :	0
Eth Aux utoss :	0
Eth Aux utosscap :	0

Bridge Radio Stats	
RF bin :	3
RF bout :	441
RF unknown ucast floods :	0
RF btoss :	0
RF btosscap :	0
RF uin :	331
RF uout :	9
RF utoss :	0
RF utosscap :	0

Bridge Error Stats	
ErrNI1QSend :	0
ErrNI2QSend :	0
ErrBridgeFull :	0
ErrSendMsg :	0
ErrApFecQSend :	0
ErrApRfQSend :	0

Attribute	Meaning
Bridge FEC Stats	

FEC bin	This field indicates the number of broadcast packets received by the bridge control block on the Main Ethernet interface
FEC bout	This field indicates the number of broadcast packets sent by the bridge control block on the Main Ethernet interface
FEC btoss	This field indicates the number of broadcast packets tossed out by the bridge control block on the Main Ethernet interface
FEC btosscap	This field indicates the number of broadcast packets tossed out at the Main Ethernet interface due to MIR cap being exceeded.
FEC uin	This field indicates the number of unicast packets received by the bridge control block on the Main Ethernet interface
FEC uout	This field indicates the number of unicast packets sent by the bridge control block on the Main Ethernet interface
FEC utoss	This field indicates the number of unicast packets tossed by the bridge control block on the Main Ethernet interface
FEC utosscap	This field indicates the number of unicast packets tossed out at the Main Ethernet interface due to MIR cap being exceeded.
Bridge Eth Aux Stats	
FEC bin	This field indicates the number of broadcast packets received by the bridge control block on the Aux Ethernet interface
FEC bout	This field indicates the number of broadcast packets sent by the bridge control block on the Aux Ethernet interface
FEC btoss	This field indicates the number of broadcast packets tossed out by the bridge control block on the Aux Ethernet interface
FEC btosscap	This field indicates the number of broadcast packets tossed out at the Aux Ethernet interface due to MIR cap being exceeded.
FEC uin	This field indicates the number of unicast packets received by the bridge control block on the Aux Ethernet interface
FEC uout	This field indicates the number of unicast packets sent by the bridge control block on the Aux Ethernet interface
FEC utoss	This field indicates the number of unicast packets tossed by the bridge control block on the Aux Ethernet interface
FEC utosscap	This field indicates the number of unicast packets tossed out at the Aux Ethernet interface due to MIR cap being exceeded.
Bridge Radio Stats	
RF bin	This field indicates the number of broadcast packets received by the bridge control block on the radio interface

RF bout	This field indicates the number of broadcast packets sent by the bridge control block on the radio interface
RF btoss	This field indicates the number of broadcast packets tossed by the bridge control block on the radio interface
RF btosscap	This field indicates the number of broadcast packets tossed out at the radio interface due to MIR cap being exceeded.
RF uin	This field indicates the number of unicast packets received by the bridge control block on the radio interface
RF uout	This field indicates the number of unicast packets sent by the bridge control block on the radio interface
RF utoss	This field indicates the number of unicast packets tossed by the bridge control block on the radio interface
RF utosscap	This field indicates the number of unicast packets tossed out at the radio interface due to MIR cap being exceeded.
Bridge Error Stats	
ErrNI1QSend	This field indicates that a packet which was sourced from the radio network stack interface 1 (Ethernet interface) could not be sent because the radio bridge queue was full. The packet was tossed out.
ErrNI2QSend	This field indicates that a packet which was sourced from the radio network stack interface 2 (RF interface) could not be sent because the radio bridge queue was full. The packet was tossed out.
ErrBridgeFull	This field indicates the total number of times the bridging table was full and could not accept new entries.
ErrSendMsg	This field displays the error message from bridge core call back routine.
ErrApFecQSend	This field indicates that a packet which was received on the Ethernet interface could not be processed because the radio bridge queue was full and packet was tossed out.
ErrApRfQSend	This field indicates that a packet which was received on the RF interface could not be processed because the radio bridge queue was full. The packet was tossed out.

Note:
PMP 450m Series AP does not support Aux port in current release of 15.0/15.0.0.1.

Interpreting Pass Through Statistics

The **Statistics > Pass Through Statistics** page displays radius related statistics. The page is applicable for PMP 450 Platform Family - AP only. The Pass Through Statistics page is explained in Table 239.

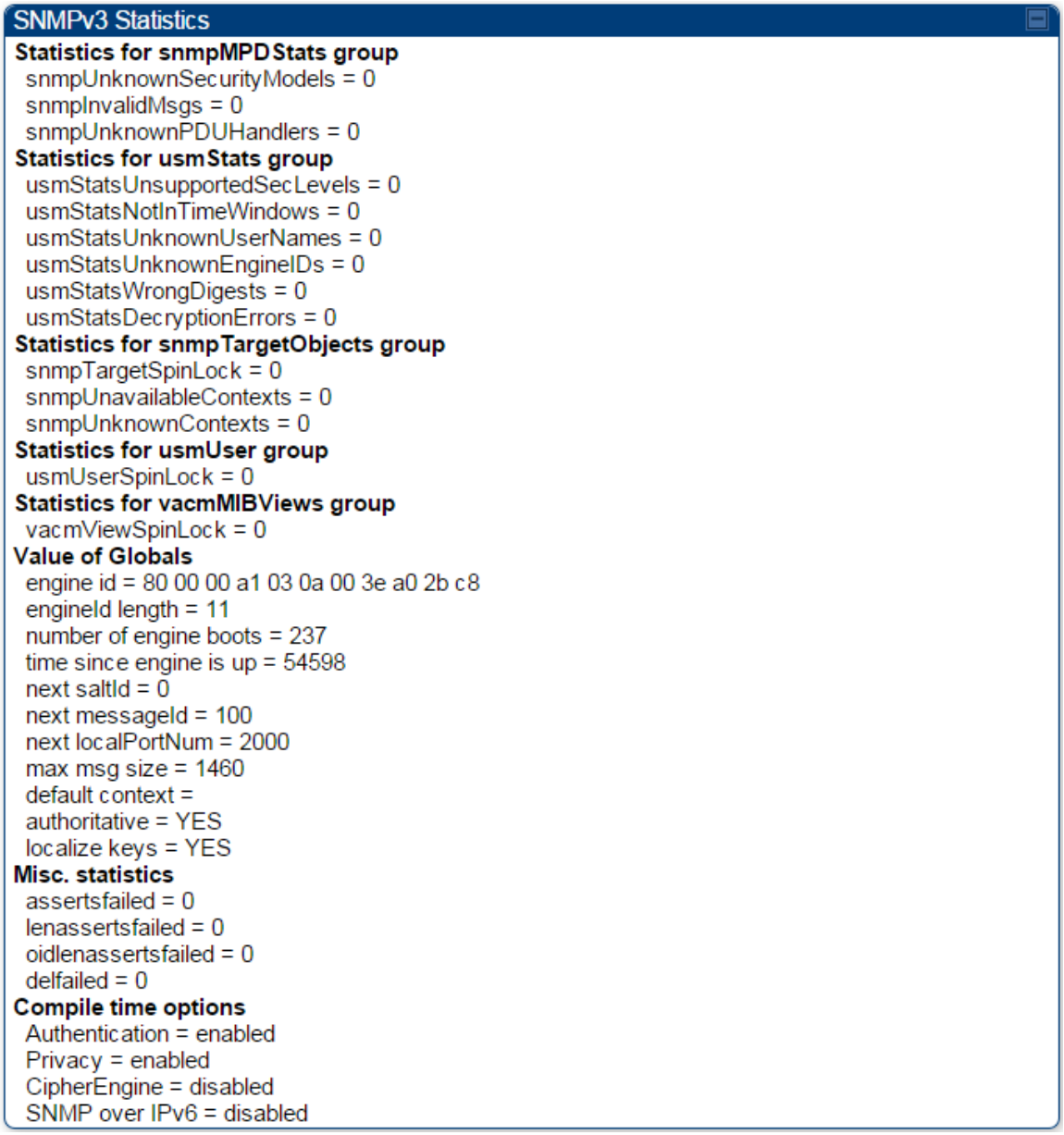
Table 239 Pass Through Statistics page attributes – AP

Attribute	Meaning
IdentityReqSent	This field indicates the number of EAP Identity requests sent through the AP with respect to an SM.
PktsEncapsulated	This field indicates no of packets received from the SM which are encapsulated by the AP.
PktsDecasulated	This field indicates no of packets received from the radius server and are decapsulated by the AP with respect to an SM
AccessAcceptRcvd	This field indicates no of RADIUS Access Accept message received by the AP with respect to an SM.

Interpreting SNMPv3 Statistics

The **Statistics > SNMPv3 Statistics** page displays all SNMPv3 related statistics. The page is applicable for all type of ODUs of PMP 450 Platform. The SNMPv3 Statistics page is explained in Table 240.

Table 240 SNMPv3 Statistics page attributes – AP



Attribute	Meaning
Statistics for snmpMPDStats group	SNMP Message Processing and Dispatching RFC 3412

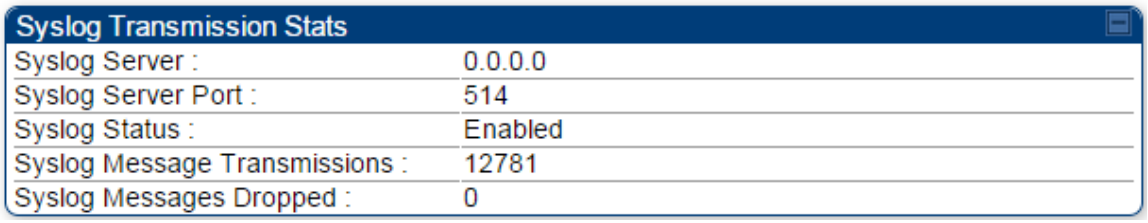
snmpUnknownSecurityModels	The total number of packets received by the SNMP engine which were dropped because they referenced a securityModel that was not known to or supported by the SNMP engine.
snmpInvalidMsgs	The total number of packets received by the SNMP engine which were dropped because there were invalid or inconsistent components in the SNMP message.
snmpUnknownPDUHandlers	The total number of packets received by the SNMP engine which were dropped because the PDU contained in the packet could not be passed to an application responsible for handling the pduType, e.g. no SNMP application had registered for the proper combination of the contextEngineID and the pduType.
usmStatsUnsupportedSecLevels	The total number of packets received by the SNMP engine which were dropped because they requested a securityLevel that was unknown to the SNMP engine or otherwise unavailable.
usmStatsNotInTimeWindows	The total number of packets received by the SNMP engine which were dropped because they appeared outside of the authoritative SNMP engine's window.
usmStatsUnknownUserNames	The total number of packets received by the SNMP engine which were dropped because they referenced a user that was not known to the SNMP engine.
usmStatsUnknownEngineIDs	The total number of packets received by the SNMP engine which were dropped because they referenced a snmpEngineID that was not known to the SNMP engine.
usmStatsWrongDigests	The total number of packets received by the SNMP engine which were dropped because they didn't contain the expected digest value.
usmStatsDecryptionErrors	The total number of packets received by the SNMP engine which were dropped because they could not be decrypted.
snmpTargetSpinLock	This object is used to facilitate modification of table entries in the SNMP-TARGET-MIB module by multiple managers.
snmpUnavailableContexts	The total number of packets received by the SNMP engine which were dropped because the context contained in the message was unavailable.
snmpUnknownContexts	The total number of packets received by the SNMP engine which were dropped because the context contained in the message was unknown.
usmUserSpinLock	The use of usmUserSpinlock is to avoid conflicts with another SNMP command generator application which may also be acting on the usmUserTable.

vacmViewSpinLock	An advisory lock used to allow cooperating SNMP Command Generator applications to coordinate their use of the Set operation in creating or modifying views.
snmpEngineBoots	It is a count of the number of times the SNMP engine has re-booted/re-initialized since snmpEngineID was last configured
snmpEngineTime time since engine is up	which is the number of seconds since the snmpEngineBoots counter was last incremented

Interpreting syslog statistics

The **Statistics > Syslog Statistics** page displays statistics of syslog messages. The page is applicable for all modules (AP/SM/BHM/BHS). The Syslog Statistics page is explained in Table 241.

Table 241 Syslog statistics page attributes – AP/SM/BH



Attribute	Meaning
Syslog Server	This displays dotted decimal or DNS name (if the DNS is enabled) of the syslog server address.
Syslog Server Port	The syslog server port (default 514) to which syslog messaging is sent.
Syslog Status	This indicates status of syslog messaging. It can be Enable or Disabled based on configuration
Syslog Message Transmissions	This field indicates the count of syslog messages sent to UDP layer.
Syslog Message Dropped	This field indicates the count of dropped syslog messages.

Interpreting Frame Utilization statistics

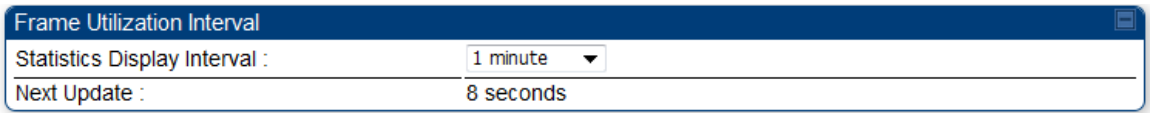
The Frame Utilization Statistics is a feature helps user to understand how effectively the RF channel is being utilized. This feature allows to check Time Division Duplex (TDD) frame utilization pattern and diagnose for any excessive usage in uplink or downlink direction.

This forms the first step of identifying the TDD frame utilization information. If the user finds excessive utilization based on this stats, the second step would be to take several actions like sectorization, tuning the uplink/downlink ratio etc. to improve RF channel utilization. Efficient use of the TDD frame will help to achieve optimum performance of link.

Note

The backhauls (BHM and BHS) will have only the downlink scheduler based statistics

Table 242 Frame utilization statistics for PMP 450m AP



MU-MIMO Downlink Utilization

Spatial Utilization

Spatial Frequency	Azimuth (degrees)	Instantaneous (%)	Total (%)	Max (%)	Min (%)	VCs in Range
0 - 31	(0.0 - 1.4)	65	74	97	50	21, 51, 81, 106
32 - 63	(1.4 - 2.9)	65	74	97	50	49, 61, 76, 98
64 - 95	(2.9 - 4.3)	60	55	81	22	30, 65, 79, 97
96 - 127	(4.3 - 5.7)	60	48	77	21	78
128 - 159	(-44.5 - -42.5) , (5.7 - 7.2)	54	30	63	8	59, 64, 83
160 - 191	(-42.5 - -40.6) , (7.2 - 8.6)	59	31	63	8	41, 50, 117, 122, 151
192 - 223	(-40.6 - -38.7) , (8.6 - 10.1)	59	30	63	8	52, 53, 56, 72, 103
224 - 255	(-38.7 - -36.9) , (10.1 - 11.5)	59	29	61	8	47
256 - 287	(-36.9 - -35.1) , (11.5 - 13.0)	60	32	64	9	48
288 - 319	(-35.1 - -33.4) , (13.0 - 14.5)	60	32	64	9	71
320 - 351	(-33.4 - -31.7) , (14.5 - 16.0)	60	32	64	9	28, 115
352 - 383	(-31.7 - -30.0) , (16.0 - 17.5)	60	32	64	9	19, 29, 73, 74, 138
384 - 415	(-30.0 - -28.4) , (17.5 - 19.0)	71	51	76	26	60, 124, 126
416 - 447	(-28.4 - -26.8) , (19.0 - 20.5)	71	51	76	26	37, 42, 80, 95, 113, 147
448 - 479	(-26.8 - -25.2) , (20.5 - 22.0)	71	60	89	37	32, 62, 82, 93, 105, 129
480 - 511	(-25.2 - -23.6) , (22.0 - 23.6)	71	73	92	48	45, 77, 107, 137
512 - 543	(-23.6 - -22.0) , (23.6 - 25.2)	71	74	92	48	31, 44, 57, 75, 88, 91, 94, 96, 121, 127, 128, 145
544 - 575	(-22.0 - -20.5) , (25.2 - 26.8)	71	73	92	46	18, 35, 38, 89, 90, 123, 141
576 - 607	(-20.5 - -19.0) , (26.8 - 28.4)	71	73	92	46	20, 25, 27, 43, 54, 55, 58, 84, 85, 86, 134, 136, 152
608 - 639	(-19.0 - -17.5) , (28.4 - 30.0)	71	73	92	46	24, 67, 92, 139
640 - 671	(-17.5 - -16.0) , (30.0 - 31.7)	71	73	92	46	135
672 - 703	(-16.0 - -14.5) , (31.7 - 33.4)	60	56	83	26	119
704 - 735	(-14.5 - -13.0) , (33.4 - 35.1)	59	54	82	26	
736 - 767	(-13.0 - -11.5) , (35.1 - 36.9)	55	45	73	21	22, 108, 133
768 - 799	(-11.5 - -10.1) , (36.9 - 38.7)	55	35	66	14	111, 118
800 - 831	(-10.1 - -8.6) , (38.7 - 40.6)	59	53	73	25	33, 46, 116
832 - 863	(-8.6 - -7.2) , (40.6 - 42.5)	59	57	74	34	
864 - 895	(-7.2 - -5.7) , (42.5 - 44.5)	65	74	97	50	26, 63, 66, 104, 132
896 - 927	(-5.7 - -4.3)	65	74	97	50	39, 68, 87
928 - 959	(-4.3 - -2.9)	65	74	97	50	23, 69, 130
960 - 991	(-2.9 - -1.4)	65	74	97	50	34, 70, 102, 109, 120
992 - 1023	(-1.4 - 0.0)	65	74	97	50	36, 110, 112, 114, 125, 131

Frame Utilization	
Downlink :	77 %
Uplink :	99 %
Bandwidth Requests :	100 %

Downlink Counts	
Total :	166525
Per Frame Average :	6
Low Priority :	142198
High Priority :	54
Broadcast/Multicast :	39
Canopy MAC Acknowledgments :	24234
Registration Messages :	0

Grouping

Group Size	% Distribution
0 (unused)	5.9
1 (ungrouped)	22.4
2	34.1
3	30.5
4	6.9
5	0.2
6	0.0
7	0.0

Instantaneous Distribution

Group	Median Slot Count	VCs in Group (Larger groups include all VCs from smaller groups)
Top VC	2453	91
Top 2 VCs	1871	110
Top 4 VCs	1074	152, 71
Top 8 VCs	806	124, 23, 33, 47
Top 16 VCs	667	131, 135, 69, 123, 126, 22, 60, 136
Top 32 VCs	14	58, 63, 125, 133, 42, 44, 88, 37, 21, 26, 30, 35, 46, 50, 77, 117
Top 64 VCs	2	119, 151, 24, 29, 31, 38, 41, 43, 48, 51, 55, 62, 65, 70, 87
Top 128 VCs	0	
Top 256 VCs	0	

Average MU-MIMO Group Size: 2.6
Sector Utilization: 55%
MU-MIMO Utilization: 29%
SU-MIMO Utilization: 20%
Canopy MAC Acknowledgement Utilization: 6%
Broadcast/Multicast Utilization: 0%

Multiplexing Gain: 1.43

Attribute	Meaning
Frame Utilization Interval	
Statistics Display interval	This allows to configure timer interval to monitor and display the frame utilization statistics. It can be configured for 1 minute (low interval), 5 minutes (medium interval) or 15 minutes (high interval) based on requirement.
MU-MIMO Utilization	
Spatial Utilization	This is a table (32 rows) that lists frame utilization for each spatial frequency (SF) range with following information: • **Spatial frequency:** Range of spatial frequency for each bin. Each bin includes 32 consecutive spatial frequency values. • **Azimuth (degrees):** Azimuth range in degrees corresponding to the spatial frequencies of the bin. The zero degree azimuth is boresight.  **Note:** Some SF ranges correspond to multiple azimuth ranges. This is due to the fact that for some spatial frequencies the AP generates beams in multiple azimuth directions. The SM can be physically located in any of the azimuth ranges.
Spatial Utilization	• **Instantaneous (%):** Frame utilization for the SF bin, updated every 500 ms. The frame utilization percentage accounts for all traffic, both sector mode and MU-MIMO transmissions. • **Total (%):** Average utilization in the SF bin for the past 1/5/15 minutes, as selected in the Statistics Display Interval. • **Max (%):** Maximum Instantaneous utilization in the 1/5/15 minute interval • **Min (%):** Minimum Instantaneous utilization in the 1/5/15 minute interval • **VCs in Range:** List of VCs with spatial frequency falling in the bin.  **Note:** The size of each SF bin is smaller than the beam generated by the AP during a MU-MIMO transmission. This means that when a VC in a bin is scheduled for a MU-MIMO transmission, the adjacent bins also receive the signal, and the transmission is counted towards their utilization as well. Bins with consistent low utilization indicate the areas of the sector where more SMs could be installed, or the customers that could be offered higher data plans.

Grouping	This specifies the distribution of group size for the past 1/5/15 minutes. For each group size, from 0 to 7, the table shows the percentage of slots using that group size. • A group size of 0 corresponds to unused slots. • A group size of 1 corresponds to sector mode transmissions (ungrouped). • A group size of 2 to 7 corresponds to MU-MIMO transmissions.
Instantaneous Distribution	This table is updated every 500 ms and displays the following: • Group: Each row corresponds to the top (most active) 1, 2, 4, 8, 16, 32, 64, 128, and 256 VCs. • Median Slot Count: Median value of the average number of slots scheduled for the VCs in each group in the past 500 ms. • VCs in Group: List of VCs belonging to each bin where each bin includes all VCs listed in preceding rows along with the VCs listed in the corresponding row. For example, the row labeled “Top 32 VCs” considers up to 32 VCs, which are: one VC listed in “Top VC” row, plus one VC listed in “Top 2 VCs” row, plus 2 VCs listed in “Top 4 VCs” row, plus four VCs listed in “Top 8 VCs” row, plus 8 VCs listed in “Top 16 VCs” rows, plus up to 16 VCs listed in “Top 32 VCs” row. If the number of VCs in the sector is less than 32, this row will include less than 16 VCs; if the number of VCs in the sector is equal to or greater than 32, this row will include 16 VCs.  **Note:** For best MU-MIMO operation, the distribution of the median values in this table should be as close to flat as possible. If many VCs are equally active, there is a higher probability of being able to group their transmissions. If only a few VCs are active, the probability of grouping transmissions is lower, and both the Average MU-MIMO Group size and the Multiplexing Gain are expected to be lower.
Average MU-MIMO Group Size	This specifes the average number of users in the MU-MIMO groups formed in the last 1/5/15 minutes.
Sector Utilization	This specifes the average of the 32 values of the Spatial Utilization table.
MU-MIMO Utilization	This specifies the portion of the Sector Utilization used for MU-MIMO transmissions.
SU-MIMO Utilization	This specifies the portion of the Sector Utilization used for SU-MIMO transmissions.

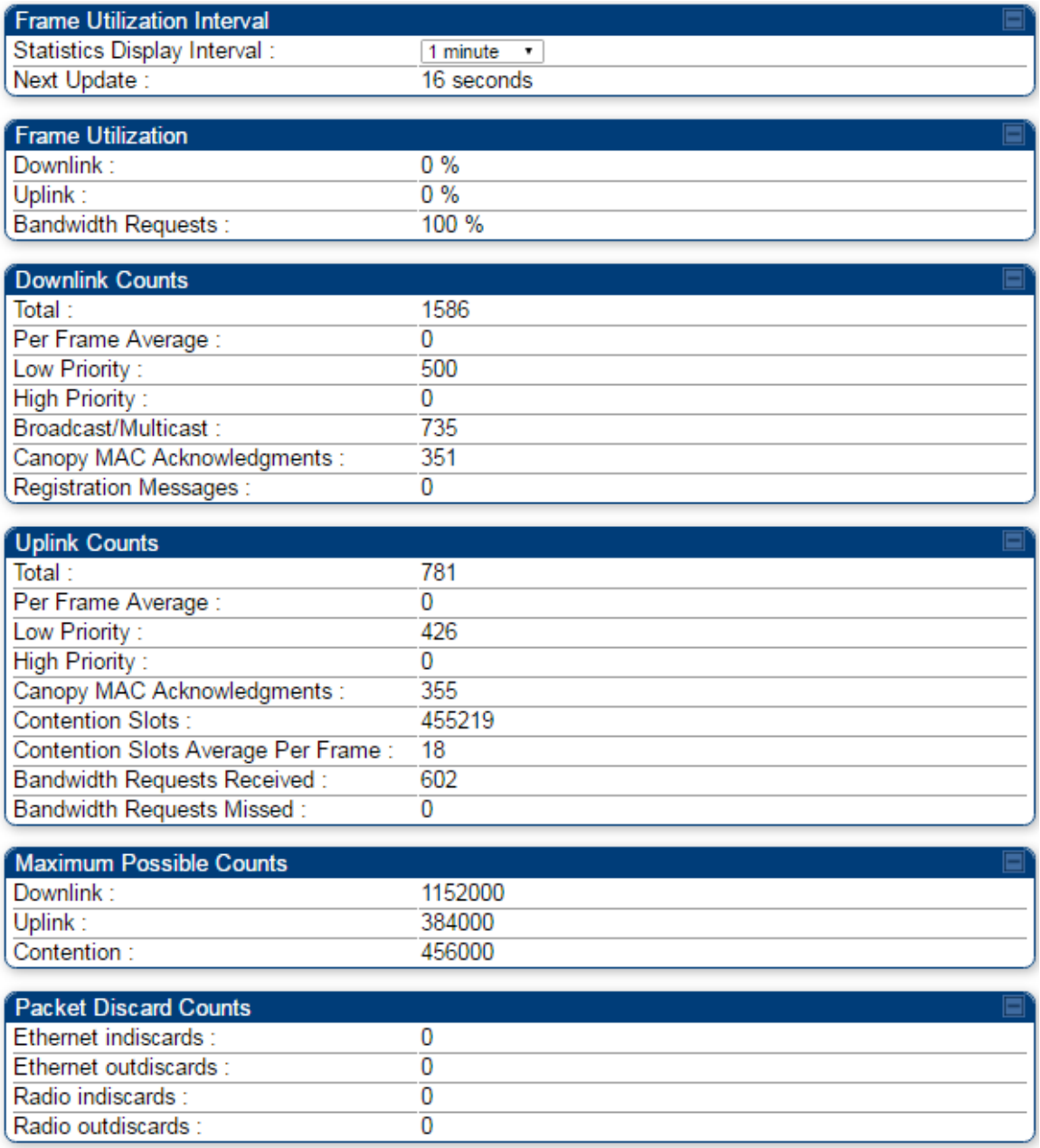
Canopy MAC Acknowledgment Utilization	This specifies the portion of the Sector Utilization used for acknowledgments transmission.
Broadcast/Multicast Utilization	This specifies the portion of the Sector Utilization used for broadcast and multicast transmissions.
Multiplexing Gain	This specifies the ratio between the number of logical slots and the number of physical slots used. A physical slot is an OFDM symbol. In non MU-MIMO mode, each logical slot is sent during one physical slot. In MU-MIMO mode a number of logical slots are sent during a physical slot, equal to the number of VCs in the group. A logical slot carries new information; if data is repeated in a group, because some VCs have more data to send then others, then the repeated transmissions are not counted as a logical slots. Without MU-MIMO operation, the multiplexing gain would always be equal to 1. With MU-MIMO operation, this number accounts for parallel transmissions to multiple users in the MU-MIMO group. The difference between the Average MU-MIMO Group Size and the Multiplexing Gain is that the Average MU-MIMO Group Size only considers the MU-MIMO groups, and it averages the number of VCs in the Group. The Multiplexing Gain also considers non MU-MIMO transmissions, which are counted as groups of size 1.
Frame Utilization	
Downlink	This indicates the percentage of downlink data slots used against the maximum number of slots possible in the configured interval.
Uplink	This indicates the percentage of uplink data slots used against the maximum number of uplink slots possible in the configured interval.
Bandwidth Requests	The "Bandwidth Request" is a message sent from the SM to the AP asking to be scheduled for bandwidth to send in the uplink. This gets transmitted in the unscheduled portion of the uplink. Unscheduled uplink is defined as Contention Slots + unscheduled uplink slots. Since this is sent in the unscheduled portion of the uplink, it will result in collisions when SMs randomly pick the same slot. The "Bandwidth Request Missed" metrics are to add data to know how many of requests are colliding. If it is near 100%, then near all of the SM’s bandwidth requests are getting through to the AP, so this a is near perfect scenario. If it is significantly less than that, you may be experiencing uplink latency as your SMs are attempting to request bandwidth and are unable to do so. Also note that if it is consistently at 100% the AP may be able to reduce its contention slots to a lower value and gain more data slots.

Downlink Counts	
Total	This indicates the sum of all downlink data slots used in the configured interval.
Per Frame Average	This indicates the average data per frame in the downlink traffic.
Low Priority	The number of downlink data slots used for low priority downlink traffic.
High Priority	The number of downlink data slots used for high priority downlink traffic.
Broadcast/Multicast	The number of downlink data slots used for broadcast and multicast traffic.
Canopy MAC Acknowledgements	The number of downlink data slots used as ACKs.
Registration Messages	The number of downlink data slots used for registration messages.
Uplink Counts	
Total	This indicates the sum of all uplink data slots used in configured interval.
Per Frame Average	This indicates the average data per frame in the uplink traffic.
Low Priority	The number of uplink data slots used for low priority uplink traffic.
High Priority	The number of uplink data slots used for high priority uplink traffic.
Canopy MAC Acknowledgements	The number of uplink data slots used as ACKs.
Contention Slots	The number of (reserved contention slots + unscheduled symbols that can be used as contention slots) Contention slots configured by the operator.
Contention Slots Average Per Frame	It is the average number of contention slots in a frame for the last duration. Duration is 1/5/15 mins.
Bandwidth Requests Received	This indicates the number of Bandwidth Requests received from SMs.
Bandwidth Requests Missed	This indicates how many of Bandwidth Requests are colliding.
Maximum possible counts	
Downlink	This indicates the maximum possible downlink data slots in the configured interval. This is based on the configuration of Channel Bandwidth, Frame period, uplink/downlink allocation, contention slots and configured Statistics Display interval.

Uplink	This indicates the maximum possible uplink data slots in the configured interval. This is based on the configuration of Channel Bandwidth, Frame period, uplink/downlink allocation, contention slots and configured Statistics Display interval.
Contention	This indicates the maximum possible contention slots.

Packet Discard counts	
Ethernet indiscards	This indicates the number of Ethernet packets discarded in the IN queue.
Ethernet outdiscards	This indicates the number of Ethernet packets discarded in the OUT queue.
Radio indiscards	This indicates the number of packets discarded over radio in the IN queue.
Radio outdiscards	This indicates the number of packets discarded over radio in the OUT queue.

Table 243 Frame utilization statistics for 450/450i/450m



Attribute	Meaning
Frame Utilization Interval	
Statistics Display interval	This allows to configure timer interval to monitor and display the frame utilization statistics. It can be configured for 1 minute (low interval), 5 minutes (medium interval) or 15 minutes (high interval) based on requirement.
Frame Utilization	

Downlink	This indicates the percentage of downlink data slots used against the maximum number of slots possible in the configured interval.
Uplink	This indicates the percentage of uplink data slots used against the maximum number of uplink slots possible in the configured interval.
Bandwidth Requests	The "Bandwidth Request" is a message sent from the SM to the AP asking to be scheduled for bandwidth to send in the uplink. This gets transmitted in the unscheduled portion of the uplink. Unscheduled uplink is defined as Contention Slots + unscheduled uplink slots. Since this is sent in the unscheduled portion of the uplink, it will result in collisions when SMs randomly pick the same slot. The "Bandwidth Request Missed" metrics are to add data to know how many of requests are colliding. If it is near 100%, then near all of the SM's bandwidth requests are getting through to the AP, so this a is near perfect scenario. If it is significantly less than that, you may be experiencing uplink latency as your SMs are attempting to request bandwidth and are unable to do so. Also note that if it is consistently at 100% the AP may be able to reduce its contention slots to a lower value and gain more data slots.
Downlink Counts	
Total	This indicates the sum of all downlink data slots used in the configured interval.
Per Frame Average	This indicates the average data per frame in the downlink traffic.
Low Priority	The number of downlink data slots used for low priority downlink traffic.
High Priority	The number of downlink data slots used for high priority downlink traffic.
Broadcast/Multicast	The number of downlink data slots used for broadcast and multicast traffic.
Canopy MAC Acknowledgements	The number of downlink data slots used as ACKs.
Registration Messages	The number of downlink data slots used for registration messages.
Uplink Counts	
Total	This indicates the sum of all uplink data slots used in configured interval.
Per Frame Average	This indicates the average data per frame in the uplink traffic.
Low Priority	The number of uplink data slots used for low priority uplink traffic.
High Priority	The number of uplink data slots used for high priority uplink traffic.

Canopy MAC Acknowledgements	The number of uplink data slots used as ACKs.
Contention Slots	The number of (reserved contention slots + unscheduled symbols that can be used as contention slots) Contention slots configured by the operator.
Contention Slots Average Per Frame	It is the average number of contention slots in a frame for the last duration. Duration is 1/5/15 mins.
Bandwidth Requests Received	This indicates the number of Bandwidth Requests received from SMs.
Bandwidth Requests Missed	This indicates how many of Bandwidth Requests are colliding.
Maximum possible counts	
Downlink	This indicates the maximum possible downlink data slots in the configured interval. This is based on the configuration of Channel Bandwidth, Frame period, uplink/downlink allocation, contention slots and configured Statistics Display interval.
Uplink	This indicates the maximum possible uplink data slots in the configured interval. This is based on the configuration of Channel Bandwidth, Frame period, uplink/downlink allocation, contention slots and configured Statistics Display interval.
Contention	This indicates the maximum possible contention slots.
Packet Discard counts	
Ethernet indiscards	This indicates the number of Ethernet packets discarded in the IN queue.
Ethernet outdiscards	This indicates the number of Ethernet packets discarded in the OUT queue.
Radio indiscards	This indicates the number of packets discarded over radio in the IN queue.
Radio outdiscards	This indicates the number of packets discarded over radio in the OUT queue.

Radio Recovery

This section describes:

- How to recover a PMP/PTP 450i and PMP 450m Series ODUs from configuration errors or software image corruption
- How to override a PMP/PTP 450 Series ODUs from forgotten IP address and password to factory default

Radio Recovery Console– PMP/PTP 450i/450b and PMP 450m

Recovery mode allows to restore IP address and password. Also, it allows new main application software to be loaded even when the integrity of the existing main application software image has been compromised. The most likely cause of an integrity problem with the installed main application software is where the power supply has been interrupted during a software upgrade.

Note

When Recovery has been entered through a power on/off/on cycle, the ODU will revert to normal operation if no web access has been made to the unit within 30 seconds. This prevents the unit remaining inadvertently in recovery following a power outage.

Options in recovery mode are:

- Boot with normal operation
- Boot with default Canopy system software settings
- Load a previous SW image

The last most recent software images loaded to the board are retained. However the factory image is not retained.

Boot with default Canopy system software settings (similar to the hardware Default Plug based on 450 Platforms Family).

Note

The unit may enter recovery console automatically, in response to some failures.

Note

Once the unit has entered recovery, it will switch back to normal operation if no access has been made to the recovery web page within 30 seconds.

Use below procedure to enter in recovery console manually.

Procedure 35 Radio Recovery Console

1. Apply power to PSU for at least 10 seconds.
2. Remove power from the PSU, and then re-apply it as soon as the power indicator light goes out (about 1 - 2 seconds).
3. When the unit is in recovery mode, access the web interface by entering the default IP address **169.254.1.1**. The Recovery Image Warning page is displayed.
4. Review the Boot Selection (Table 244).
5. Select a recovery option

Figure 201 Recovery Options page

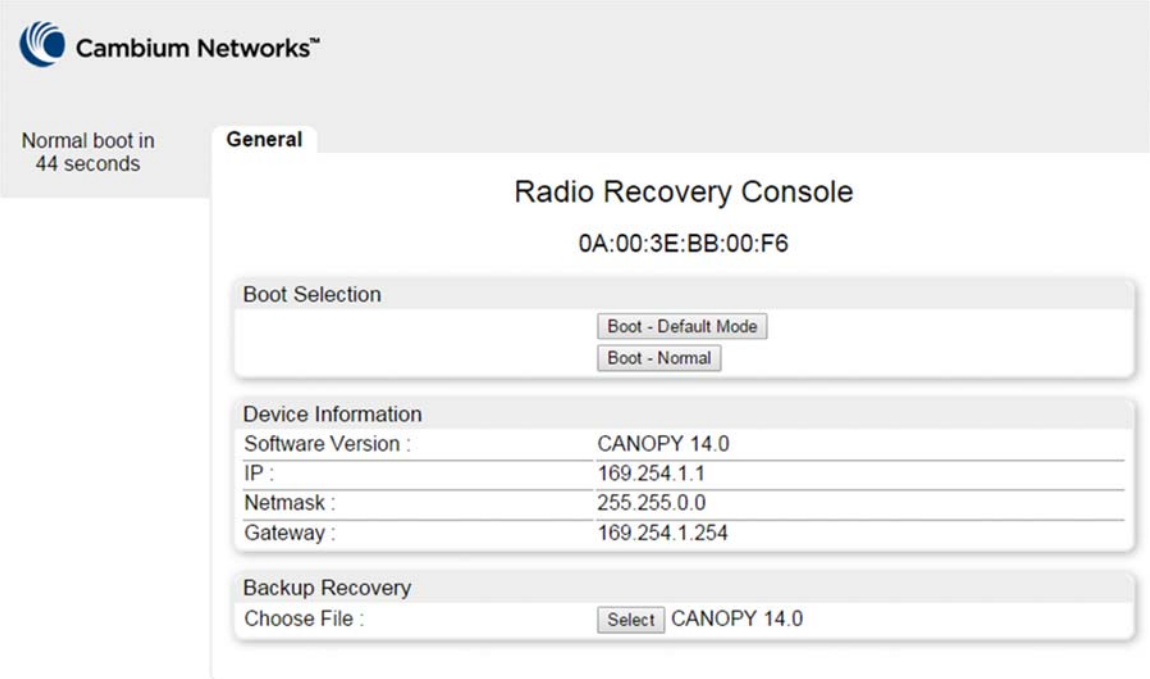


Table 244 Recovery Options attributes

Attribute	Meaning
Boot Selection	**Boot – Default Mode**: Use this option to temporarily set the IP and Ethernet attributes to factory defaults until the next reboot. **Boot – Normal**: Use this option to reboot the unit.
IP address, Netmask, Gateway	These fields display IP address, Netmask and Gateway of the radio while it is in recovery or default mode.

Note

The radio enters recovery mode when a short power cycle is used. The radio will boot normally if power has been removed for a longer period (typically 5 - 10 seconds).

Default Mode (or Default/Override Plug) - PMP/PTP 450 Series

The default modeallows to temporarily override some PMP/PTP 450 Series ODU settings and thereby regain control of the module by powering the module on with the Default Plug inserted into the unit's synchronization (RJ11) port.

This override plug is needed for access to the module in any of the following cases:

- You have forgotten either
  - the IP address assigned to the ODU.
  - the password that provides access to the ODU.
- The ODU has been locked by the No Remote Access feature.
- You want local access to a module that has had the 802.3 link disabled in the Configuration page.

You can configure the module such that, when it senses the override plug, it responds by either

- resetting the LAN1 IP address to 169.254.1.1, allowing access through the default configuration without *changing* the configuration, whereupon you will be able to view and reset any non-default values as you wish.
- resetting all configurable parameters to their factory default values.

Note

The Default Plug is available from Best-Tronics Manufacturing, Inc.
See http://www.best-tronics.com/cambium.htm as Part BT-0583 (RJ-11 Default Plug).
Alternatively, you can fabricate an override plug. See Override plug cable on page 5-15 for pinout.

Using the Default/Override Plug

The following section details usage of the override plug to regain access to PMP/PTP 450 Series ODU.

Note

While the override plug is connected to a PMP/PTP 450 Series ODU, the ODU can neither register nor allow registration of another ODU.

Note

Since the 900 MHz SM is based on the 450 Series, it only supports the "Default Plug" mode of overriding.

Use below procedure to enter in default mode manually.

Procedure 36 Default mode

1. Insert the override plug into the RJ-11 GPS utility port of the module.
2. Power cycle by removing, then re-inserting, the Ethernet cable.
   RESULT: The module boots with the default IP address of 169.254.1.1, password fields blank, and all other configuration values as previously set.
3. Wait approximately 30 seconds for the boot to complete.
4. Remove the override plug.
5. Set passwords and IP address as desired.
6. Change configuration values if desired.
7. Click the Save Changes button.
8. Click the Reboot button.

Chapter 10: Reference information

This chapter contains reference information and regulatory notices that apply to the 450 Platform Family ODUs.

The following topics are described in this chapter:

- Equipment specifications on page 10-2 contains specifications of the 450 Platform Family, ODU specifications including RF bands, channel width and link loss.
- Data network specifications on page 10-43 shows the 450 Platform Family Ethernet interface specifications.
- Compliance with safety standards on page 4-22 lists the safety specifications against which 450 Platform Family ODU has been tested and certified. It also describes how to keep RF exposure within safe limits.
- Country specific radio regulations on page 10-46 describes how the 450 Platform Family complies with the radio regulations that are enforced in various countries.
- Equipment Disposal on page 10-49 describes the Equipment Disposal system for Electronic and Electric Equipment.

Equipment specifications

This section contains specifications of the AP, SM, BHM and BHS associated supplies required for 450 Platform Family installations.

Specifications for PMP 450m Series - AP

The PMP 450m AP conforms to the specifications listed in Table 245.

Table 245 PMP 450m Series - AP specifications

Category		Specification
Model Number		PMP 450m AP
Spectrum		
Channel Spacing		Configurable on 2.5 MHz increments
Frequency Range		5150 to 5925 MHz
Channel Bandwidth		5, 10, 15, 20, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		14x14 Multi-User MIMO OFDM
Ethernet Interface		100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	5.1 GHz	1x=-101.6 dBm, 2x=-96.2 dBm, 4x=-90.2 dBm, 6x=-84 dBm, 8x=-76.6 dBm
	5.2 GHz	1x=-101.3 dBm, 2x=-96.3 dBm, 4x=-89.7 dBm, 6x=-83.3 dBm, 8x=-75.7 dBm
	5.4 GHz	1x=-101.1 dBm, 2x=-96.8 dBm, 4x=-90 dBm, 6x=-83.9 dBm, 8x=-76.2 dBm

	5.8 GHz	1x=-101.6 dBm, 2x=-96.6 dBm, 4x=-89.9 dBm, 6x=-83.7 dBm, 8x=-76.3 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	5.1 GHz	1x=-99 dBm, 2x=-94.6 dBm, 4x=-87.8 dBm, 6x=-81.6 dBm, 8x=-74.6 dBm
	5.2 GHz	1x=-98.8 dBm, 2x=-93.8 dBm, 4x=-87.6 dBm, 6x=-81.4 dBm, 8x=-73.6 dBm
	5.4 GHz	1x=-98.1 dBm, 2x=-94.1 dBm, 4x=-87.5 dBm, 6x=-81.5 dBm, 8x=-73.8 dBm
	5.8 GHz	1x=-98.5 dBm, 2x=-93.6 dBm, 4x=-87.5 dBm, 6x=-81.2 dBm, 8x=-73.7 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	5.1 GHz	1x=-97.3 dBm, 2x=-92.5 dBm, 4x=-86.3 dBm, 6x=-79.9 dBm, 8x=-72.9 dBm
	5.2 GHz	1x=-96.7 dBm, 2x=-91.9 dBm, 4x=-85.7 dBm, 6x=-79.5 dBm, 8x=-72.5 dBm
	5.4 GHz	1x=-96.2 dBm, 2x=-92.1 dBm, 4x=-85.5 dBm, 6x=-79.4 dBm, 8x=-72.4 dBm
	5.8 GHz	1x=-97.2 dBm, 2x=-92.4 dBm, 4x=-85.5 dBm, 6x=-79.4 dBm, 8x=-72.5 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	5.1 GHz	1x=-96.3 dBm, 2x=-91.9 dBm, 4x=-85.3 dBm, 6x=-79.3 dBm, 8x=-71.3 dBm
	5.2 GHz	1x=-95.8 dBm, 2x=-91.8 dBm, 4x=-84.8 dBm, 6x=-78.8 dBm, 8x=-71.8 dBm
	5.4 GHz	1x=-95.1 dBm, 2x=-91.4 dBm, 4x=-84.8 dBm, 6x=-78.3 dBm, 8x=-71.1 dBm
	5.8 GHz	1x=-95.8 dBm, 2x=-91.3 dBm, 4x=-84.7 dBm, 6x=-78.3 dBm, 8x=-70.8 dBm
Performance		
Subscriber Per Sector		Up to 238
ARQ		Yes
Cyclic Prefix		1/16
Frame Period		2.5 ms

Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		4x	16QAM	17
		6x	64QAM	24
		8x	256QAM	32
Latency		10 ms, typical (MU-MIMO introduces additional latency only for the low priority traffic)		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes, via Autosync (UGPS)		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width	5 GHz	90° integrated sector (Dual polarity, H+V)		
Antenna Gain		+14 dBi		
Maximum Transmit Power		+24 dBm combined		
Physical				
Data, Sync/AUX and SFP port	RJ45	• 1000BASE-T Ethernet Data • AUX port for UGPS or PoE out to 802.3at		
Antenna Connection		Integrated Sector Array		
Surge Suppression (with LPU)		EN61000-4-5: 1.2 us/50 us, 500 V voltage waveform Recommended external surge suppressor: Cambium Networks Model # C000065L007A		
Mean Time Between Failure		> 40 Years		
Environmental		IP66, IP67		
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F) 0-95% non-condensing		
Weight	Integrated	Approx. 14.2 kg (31 bs)		
		@90 mph / 144 kph	460 N	

Wind Loading – Front Facing		@110 mph /177 kph 700 N
Dimension (HxWxD)	Integrated	52 x 65 x 11 cm (20.3” x 25.7” x 4.4”)
Power Consumption		70 W typical, 80 W peak (up to 110 W max with AUX port PoE enabled)
Input Voltage		58 V, 1.7 A
Mounting		Pole mount with included brackets
Security		
Encryption		56-bit DES, FIPS-197 128-bit AES

Specifications for PMP 450i Series - AP

The PMP 450i AP conforms to the specifications listed in Table 246.

Table 246 PMP 450i Series - AP specifications

Category		Specification
Model Number		PMP 450i AP
Spectrum		
Channel Spacing		5, 7, 10, 15, 20, 30, and 40 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range		902 to 928 MHz
		3300 - 3900 MHz
		4900 - 5925 MHz
Channel Bandwidth	902 – 928 MHz	5, 7, 10, 15, and 20 MHz
	3300 - 3900 MHz	5, 7, 10, 15, 20, 30, and 40 MHz
	4900 – 5925 MHz	5, 10, 15, 20, 30, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	900 MHz	1x = -91.9 dBm, 2x = -86.7 dBm, 4x = -80.9 dBm, 6x = -75 dBm, 8x = -68.8 dBm
	3.5 GHz	1x = -92.7 dBm, 2x = -88.7 dBm, 4x = -82.7 dBm, 6x = -75.8 dBm, 8x = -69 dBm

	3.6 GHz	1x=-91 dBm, 2x=-86.1 dBm, 4x=-80.2 dBm, 6x=-73.1 dBm, 8x=-66 dBm
	4.9 GHz	1x = -91.6 dBm, 2x = -87.6 dBm, 4x = -80.4 dBm, 6x = -73.2 dBm, 8x = -66 dBm
	5.4 GHz	1x = -92 dBm, 2x = -87 dBm, 4x = -80.8 dBm, 6x = -73.7 dBm, 8x = -66.6 dBm
	5.8 GHz	1x = -91.5 dBm, 2x = -87 dBm, 4x = -80.2 dBm, 6x = -73.1 dBm, 8x = -66 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	900 MHz	1x = -90 dBm, 2x = -85.9 dBm, 4x = -79.8 dBm, 6x = -73.6 dBm, 8x = -67.9 dBm
	3.5 GHz	1x=-91.8 dBm, 2x=-87.7 dBm, 4x=-80.8 dBm, 6x=-74.7 dBm, 8x=-67.3 dBm
	3.6 GHz	1x=-90 dBm, 2x=-87 dBm, 4x=-79.8 dBm, 6x=-73.8 dBm, 8x=-67.2 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	900 MHz	1x = -90.6 dBm, 2x = -85.2 dBm, 4x = -79.1 dBm, 6x = -73.2 dBm, 8x = -66.2 dBm
	3.5 GHz	1x=-90.2 dBm, 2x=-86.2 dBm, 4x=-80 dBm, 6x=-73.1 dBm, 8x=-66.7 dBm
	3.6 GHz	1x=-89.5 dBm, 2x=-85.7 dBm, 4x=-79.8 dBm, 6x=-72.8 dBm, 8x=-66.3 dBm
	4.9 GHz	1x = -89.1 dBm, 2x = -85 dBm, 4x = -77.9 dBm, 6x = -71.8 dBm, 8x = -64.6 dBm
	5.4 GHz	1x = -89.5 dBm, 2x = -85.4 dBm, 4x = -78.2 dBm, 6x = -72.2 dBm, 8x = -64.8 dBm
	5.8 GHz	1x = -89.5 dBm, 2x = -84.7 dBm, 4x = -77.8 dBm, 6x = -71.6 dBm, 8x = -64 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	900 MHz	1x=-88.2 dBm, 2x=-83.2 dBm, 4x=-76.3 dBm, 6x=-70.2 dBm, 8x=-64.3 dBm
	3.5 GHz	1x=-89 dBm, 2x=-84 dBm, 4x=-77.9 dBm, 6x=-72 dBm, 8x=-64.8 dBm
	3.6 GHz	1x=-87.6 dBm, 2x=-83.7 dBm, 4x=-77.5 dBm, 6x=-71.6 dBm, 8x=-64.5 dBm

	4.9 GHz	1x = -87.2 dBm, 2x = -83 dBm, 4x = -75.8 dBm, 6x = -69.6 dBm, 8x = -62.6 dBm
	5.4 GHz	1x = -87.2 dBm, 2x = -83.3 dBm, 4x = -76.2 dBm, 6x = -70.1 dBm, 8x = -63 dBm
	5.8 GHz	1x = -87.7 dBm, 2x = -82.7 dBm, 4x = -75.5 dBm, 6x = -69.6 dBm, 8x = -62.4 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	900 MHz	1x = -86.99 dBm, 2x = -82 dBm, 4x = -75.9 dBm, 6x = -69.9 dBm, 8x = -62.9 dBm
	3.5 GHz	1x=-87.4 dBm, 2x=-83 dBm, 4x=-76.9 dBm, 6x=-69.9 dBm, 8x=-63 dBm
	3.6 GHz	1x=-86.4 dBm, 2x=-82.5 dBm, 4x=-76.4 dBm, 6x=-69.4 dBm, 8x=-62.9 dBm
	4.9 GHz	1x = -86.1 dBm, 2x = -82.1 dBm, 4x = -74.8 dBm, 6x = -68.8 dBm, 8x = -61.7 dBm
	5.4 GHz	1x = -86.6 dBm, 2x = -81.3 dBm, 4x = -75.5 dBm, 6x = -68.6 dBm, 8x = -62 dBm
	5.8 GHz	1x = -85.8 dBm, 2x = -80.7 dBm, 4x = -74.6 dBm, 6x = -68.7 dBm, 8x = -61 dBm
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	3.5 GHz	1x=-85.6 dBm, 2x=-81.7 dBm, 4x=-74.5 dBm, 6x=-68 dBm, 8x=-61.5 dBm
	3.6 GHz	1x=-85.5 dBm, 2x=-80.5 dBm, 4x=-74.4 dBm, 6x=-68.4 dBm, 8x=-61.5 dBm
	4.9 GHz	1x = -84.1 dBm, 2x = -80 dBm, 4x = -73 dBm, 6x = -66.4 dBm, 8x = -59.6 dBm
	5.4 GHz	1x = -84.5 dBm, 2x = -82 dBm, 4x = -75 3.5Bm, 6x = -67.4 dBm, 8x = -60.2 dBm
	5.8 GHz	1x = -84.1 dBm, 2x = -80 dBm, 4x = -73 dBm, 6x = -66.5 dBm, 8x = -59.4 dBm
	3.5 GHz	1x=-83.9 dBm, 2x=-79.5 dBm, 4x=-73 dBm, 6x=-66 dBm, 8x=-58.5 dBm

Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	3.6 GHz	1x=-82.8 dBm, 2x=-79 dBm, 4x=-73 dBm, 6x=-66 dBm, 8x=-59 dBm		
	4.9 GHz	1x=-83.9 dBm, 2x=-78.9 dBm, 4x=-72 dBm, 6x=-66 dBm, 8x=-56.6 dBm		
	5.4 GHz	1x=-83.7 dBm, 2x=-78.5 dBm, 4x=-72.4 dBm, 6x=-66 dBm, 8x=-58 dBm		
	5.8 GHz	1x=-83.8 dBm, 2x=-78.4 dBm, 4x=-72 dBm, 6x=-66 dBm, 8x=-57 dBm		
Performance				
ARQ		Yes		
Cyclic Prefix		1/16		
Frame Period		2.5 ms or 5.0 ms		
Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		4x	16QAM	17
		6x	64QAM	24
		8x	256QAM	32
Latency		3 - 5 ms		
Maximum Deployment Range		Up to 40 miles (64 km) Up to 120 miles (190 km) for 900 MHz		
GPS Synchronization		Yes, via Autosync (CMM4), via UGPS		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width	900 MHz	65° sector antenna (Dual Slant)		
	3 GHz	90° sector for integrated (Dual polarity, slant +45° and -45°)		
	5 GHz	90° (3 dB roll off) sector for integrated (Dual polarity, H+V)		

Antenna Gain (Does not include cable loss, ~1dB)	900 MHz	13 dBi
	3 GHz	17 dBi integrated 90° sector or external
	5 GHz	17 dBi integrated 90° sector or external
Transmit Power Range		40 dB dynamic range (to EIRP limit by region) (1 dB step)
Maximum Transmit Power		+27 dBm combined output (for 5 GHz) +25 dBm combined output (for 3 GHz) +25 dBm combined output (for 900MHz)
Physical		
Sync/AUX port	RJ45	• 10/100/100BASE-T Ethernet Data • PoE output (planned for future release) • Sync input or output (Connection and powering of UGPS Sync input)
Antenna Connection		50 ohm, N-type (Connectorized version only)
Surge Suppression EN61000-4-5		EN61000-4-5: 1.2 us/50 us, 500 V voltage waveform Recommended external surge suppressor: Cambium Networks Model # C000000L033A
Mean Time Between Failure		> 40 Years
Environmental		IP66, IP67
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing
Weight	Connectorized	Approx. 2.0 kg (4.5 lbs)
	Integrated	Approx. 2.5 kg (5.5 lbs)
Wind Survival	Connectorized	322 km/h (200 mi/h)
	Integrated	200 km/h (124 mi/h)
Dimension(HxWxD)	Connectorized	26.0 x 13.4 x 6.4 cm (10.3” x 5.3” x 3.3”)
	Integrated	37.0 x 37.0 x 6.3 cm (14.5” x 14.5” x 3.2”)
Power Consumption		15 W typical, 25 W max, 55 W max with Aux port PoE out enabled
Input Voltage		48-59 V DC, 802.3at compliant
Mounting		Wall or Pole mount with Cambium Networks Model # N000045L002A

Security	
Encryption	56-bit DES, FIPS-197 128-bit AES

Specifications for PMP 450i Series - SM

The PMP 450i SM conforms to the specifications listed in Table 247.

Table 247 PMP 450i Series - SM specifications

Category		Specification
Model Number		PMP 450i SM
Spectrum		
Channel Spacing		5, 7, 10, 15, 20, 30, and 40 Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range		3300 – 3900 MHz
		4900 - 5925 MHz
Channel Bandwidth	3300 – 3900 MHz	5, 7, 10, 15, 20, 30, and 40 MHz
	4900 – 5925 MHz	5, 10, 15, 20, 30, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v2c and v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	3.5 GHz	1x = -92.6 dBm, 2x =-89.22 dBm, 4x = -83.19 dBm, 6x = -76.5 dBm, 8x = -69.1 dBm
	3.6 GHz	1x = -92 dBm, 2x = -88.08 dBm, 4x = -82.3 dBm, 6x = -75.9 dBm, 8x = -68.6 dBm
	4.9 GHz	1x = -92.5 dBm, 2x = -88.5 dBm, 4x = -81 dBm, 6x = -74.2 dBm, 8x = -66 dBm

	5.4 GHz	1x = -93 dBm, 2x = -89.1 dBm, 4x = -81.5 dBm, 6x = -74.8 dBm, 8x = -67.4 dBm
	5.8 GHz	1x = -92 dBm, 2x = -88.3 dBm, 4x = -80.8 dBm, 6x = -74 dBm, 8x = -66.2 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	3.5 GHz	1x = -92 dBm, 2x = -88.4 dBm, 4x = -81.4 dBm, 6x = -75.37 dBm, 8x = -68.1 dBm
	3.6 GHz	1x = -91.02 dBm, 2x = -87.87 dBm, 4x = -80.82 dBm, 6x = -73.6 dBm, 8x = -67.32 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	3.5 GHz	1x = -90.787 dBm, 2x = -86.6 dBm, 4x = -80.2 dBm, 6x = -73.52 dBm, 8x = -66.34 dBm
	3.6 GHz	1x = -89.8 dBm, 2x = -86 dBm, 4x = -79.84 dBm, 6x = -72.92 dBm, 8x = -66 dBm
	4.9 GHz	1x = -90.2 dBm, 2x = -85.2 dBm, 4x = -78.8 dBm, 6x = -71.4 dBm, 8x = -64.5 dBm
	5.4 GHz	1x = -90 dBm, 2x = -85.8 dBm, 4x = -78.5 dBm, 6x = -72.2 dBm, 8x = -65.8 dBm
	5.8 GHz	1x = -89.9 dBm, 2x = -84.9 dBm, 4x = -78.5 dBm, 6x = -71.2 dBm, 8x = -63.8 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	3.5 GHz	1x = -88.57 dBm, 2x = -84.5 dBm, 4x = -78.4 dBm, 6x = -71.47 dBm, 8x = -65.22 dBm
	3.6 GHz	1x = -87.6 dBm, 2x = -84.1 dBm, 4x = -77.1 dBm, 6x = -71.03 dBm, 8x = -64.8 dBm
	4.9 GHz	1x = -88.2 dBm, 2x = -83.1 dBm, 4x = -76.9 dBm, 6x = -70.5 dBm, 8x = -62.3 dBm
	5.4 GHz	1x = -87.7 dBm, 2x = -83.9 dBm, 4x = -76.6 dBm, 6x = -70.4 dBm, 8x = -63 dBm
	5.8 GHz	1x = -88 dBm, 2x = -82.9 dBm, 4x = -76.7 dBm, 6x = -69.4 dBm, 8x = -62.3 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	3.5 GHz	1x = -87 dBm, 2x = -83.45 dBm, 4x = -76.25 dBm, 6x = -70.33 dBm, 8x = -63.23 dBm
	3.6 GHz	1x = -86.9 dBm, 2x = -82.9 dBm, 4x = -76.9 dBm, 6x = -69.8 dBm, 8x = -62.8 dBm

Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	4.9 GHz	1x = -87 dBm, 2x = -81.8 dBm, 4x = -75.8 dBm, 6x = -68.5 dBm, 8x = -61.4 dBm
	5.4 GHz	1x = -87 dBm, 2x = -82.8 dBm, 4x = -75.6 dBm, 6x = -69.3 dBm, 8x = -61.6 dBm
	5.8 GHz	1x = -85.9 dBm, 2x = -81.5 dBm, 4x = -74.8 dBm, 6x = -68.7 dBm, 8x = -61.2 dBm
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	3.5 GHz	1x = -86 dBm, 2x = -80.9 dBm, 4x = -75 dBm, 6x = -67.9 dBm, 8x = -61.1 dBm
	3.6 GHz	1x = -85.5 dBm, 2x = -80.6 dBm, 4x = -74.5 dBm, 6x = -67.5 dBm, 8x = -61 dBm
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	4.9 GHz	1x = -84.9 dBm, 2x = -80.9 dBm, 4x = -73.2 dBm, 6x = -67.4 dBm, 8x = -59.3 dBm
	5.4 GHz	1x = -85.2 dBm, 2x = -80.2 dBm, 4x = -74.1 dBm, 6x = -67.9 dBm, 8x = -59.8 dBm
	5.8 GHz	1x = -84.9 dBm, 2x = -80 dBm, 4x = -73.2 dBm, 6x = -67.4 dBm, 8x = -59.4 dBm
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	3.5 GHz	1x = -83.2 dBm, 2x = -79 dBm, 4x = -72.4 dBm, 6x = -66 dBm, 8x = -58.4 dBm
	3.6 GHz	1x = -82.5 dBm, 2x = -79 dBm, 4x = -71.3 dBm, 6x = -65.4 dBm, 8x = -58.3 dBm
	4.9 GHz	1x=-84.2 dBm, 2x=-79.3 dBm, 4x=-72.3 dBm, 6x=-66 dBm, 8x=-56.8 dBm
	5.4 GHz	1x=-84.2 dBm, 2x=-79.1 dBm, 4x=-73.1 dBm, 6x=-66 dBm, 8x=-56.9 dBm
	5.8 GHz	1x=-83.6 dBm, 2x=-78.7 dBm, 4x=-72.5 dBm, 6x=-66.4 dBm, 8x=-56.3 dBm

Performance	
ARQ	Yes
Cyclic Prefix	1/16

Frame Period		2.5 ms or 5.0 ms		
Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		4x	16QAM	17
		6x	64QAM	24
		8x	256QAM	32
Latency		3 - 5 ms		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes, via Autosync (CMM4)		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width		10° azimuth for 23 dBi integrated antenna		
Antenna Gain (Does not include cable loss, ~1dB)	5 GHz	+23 dBi H+V, integrated or external		
	3 GHz	+19 dBi dual slant, integrated or external		
Transmit Power Range		40 dB dynamic range (to EIRP limit by region) (1 dB step)		
Maximum Transmit Power		+27 dBm combined output (for 5 GHz)		
		+25 dBm combined output (for 3 GHz)		
Physical				
Sync/AUX port	RJ45	• 10/100/1000BASE-T Ethernet Data • PoE output (planned for future release) • Sync input or output (Connection and powering of UGPS Sync input)		
Antenna Connection		50 ohm, N-type (Connectorized version only)		
Surge Suppression EN61000-4-5		EN61000-4-5: 1.2us/50us, 500 V voltage waveform Recommended external surge suppressor: Cambium Networks Model # C000000L033A		
Mean Time Between Failure		> 40 Years		
Environmental		IP66, IP67		

Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing
Weight	Connectorized	Approx. 2.0 kg (4.5 lbs)
	Integrated	Approx. 2.5 kg (5.5 lbs)
Wind Survival	Connectorized	322 km/h (200 mi/h)
	Integrated	200 km/h (124 mi/h)
Dimension(HxWxD)	Connectorized	26.0 x 13.4 x 6.4 cm (10.3” x 5.3” x 3.3”)
	Integrated	31.0 x 31.0 x 6.4 cm (12” x 12” x 2.5”)
Power Consumption		15 W typical, 25 W max, 55 W max with Aux port PoE out enabled
Input Voltage		48-59 V DC, 802.3at compliant
Mounting		Wall or Pole mount with Cambium Networks Model # N000045L002A
Security		
Encryption		56-bit DES, FIPS-197 128-bit AES

Specifications for PTP 450i Series - BH

The PTP 450i BH conforms to the specifications listed in Table 248.

Table 248 PTP 450i Series - BH specifications

Category		Specification
Model Number		PTP 450i BH
Spectrum		
Channel Spacing		5, 10, 15, 20, 30, and 40 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range		4900 - 5925 MHz
Channel Bandwidth	4900 – 5925 MHz	5, 10, 15, 20, 30, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v2c and v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	900 MHz	1x = -92.2 dBm, 2x = -90.2 dBm, 4x = -83.2 dBm, 6x = -77.2 dBm, 8x = -71.2 dBm
	4.9 GHz	1x = -93 dBm, 2x = -88.3 dBm, 4x = -82 dBm, 6x = -74.4 dBm, 8x = -67.9 dBm
	5.4 GHz	1x = -93 dBm, 2x = -88.4 dBm, 4x = -81.3 dBm, 6x = -75.5 dBm, 8x = -67.8 dBm
	5.8 GHz	1x = -93.2 dBm, 2x = -88.3 dBm, 4x = -80.8 dBm, 6x = -74.3 dBm, 8x = -66.8 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	900 MHz	1x = -91 dBm, 2x = -86 dBm, 4x = -80 dBm, 6x = -74 dBm, 8x = -67 dBm

Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	900 MHz	1x = -90 dBm, 2x = -84 dBm, 4x = -79 dBm, 6x = -73 dBm, 8x = -66 dBm
	4.9 GHz	1x = -90 dBm, 2x = -85 dBm, 4x = -78.6 dBm, 6x = -72.5dBm, 8x = -65 dBm
	5.4 GHz	1x = -87.6 dBm, 2x = -82.5 dBm, 4x = -76.5 dBm, 6x = -70.5 dBm, 8x = -61.5dBm
	5.8 GHz	1x = -89.9 dBm, 2x = -84.8 dBm, 4x = -78.5 dBm, 6x = -71.4 dBm, 8x = -64 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	4.9 GHz	1x = -88 dBm, 2x = -83.9 dBm, 4x = -76.9 dBm, 6x = -70.7 dBm, 8x = -63.6 dBm
	5.4 GHz	1x = -88 dBm, 2x = -84.2 dBm, 4x = -76.9 dBm, 6x = -70.8 dBm, 8x = -62.7 dBm
	5.8 GHz	1x = -87.8 dBm, 2x = -82.8 dBm, 4x = -6.6 dBm, 6x = 69.3 dBm, 8x = -62.1 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	900 MHz	1x = -86 dBm, 2x = -82 dBm, 4x = -75 dBm, 6x = -69 dBm, 8x = -62 dBm
	4.9 GHz	1x = -86.9 dBm, 2x = -82.5 dBm, 4x = -75.7 dBm, 6x = -69.4 dBm, 8x = -62.3 dBm
	5.4 GHz	1x = -84.5 dBm, 2x = -80.5 dBm, 4x = -73.4 dBm, 6x = -66.4 dBm, 8x = -56.4 dBm
	5.8 GHz	1x = -85.8 dBm, 2x = -81.7 dBm, 4x = -75 dBm, 6x = -68.4 dBm, 8x = -61.2 dBm
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	4.9 GHz	1x = -85 dBm, 2x = -80.7 dBm, 4x = -73.7 dBm, 6x = -66.5 dBm, 8x = -60 dBm
	5.4 GHz	1x = -85.3 dBm, 2x = -80.5 dBm, 4x = -74.2 dBm, 6x = -67.2 dBm, 8x = -60 dBm
	5.8 GHz	1x = -84.6 dBm, 2x = -80 dBm, 4x = -73,3 dBm, 6x = -66.5 dBm, 8x = -59.1 dBm
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	4.9 GHz	1x=-84.1 dBm, 2x=-79.3 dBm, 4x=-73 dBm, 6x=-66 dBm, 8x=-58.8 dBm
	5.4 GHz	1x=-84.5 dBm, 2x=-79.4 dBm, 4x=-73.3 dBm, 6x=-66.5 dBm, 8x=-58 dBm
	5.8 GHz	1x=-84 dBm, 2x=-79 dBm, 4x=-72 dBm, 6x=-66 dBm, 8x=-58 dBm
Performance		
ARQ		Yes
Cyclic Prefix		1/16
Frame Period		2.5 ms or 5.0 ms

Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		4x	16QAM	17
		6x	64QAM	24
		8x	256QAM	32
Latency		3 - 5 ms		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes, via Autosync (CMM4)		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width	900 MHz	37° azimuth for 12 dBi Yagi antenna		
	5 GHz	10° azimuth for 23 dBi integrated antenna		
Antenna Gain (Does not include cable loss, ~1dB)	900 MHz	12 dBi Yagi antenna		
	5 GHz	+23 dBi H+V, integrated or external		
Transmit Power Range		40 dB dynamic range (to EIRP limit by region) (1 dB step)		
Maximum Transmit Power		+27 dBm combined output		
Physical				
Sync/AUX port	RJ45	• 10/100/1000BASE-T Ethernet Data • PoE output • Sync input or output (Connection and powering of UGPS Sync input)		
Antenna Connection		50 ohm, N-type (Connectorized version only)		
Surge Suppression EN61000-4-5		EN61000-4-5: 1.2us/50us, 500 V voltage waveform Recommended external surge suppressor: Cambium Networks Model # C000000L033A		
Mean Time Between Failure		> 40 Years		
Environmental		IP66, IP67		
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing		

Weight	Connectorized	Approx. 2.0 kg (4.5 lbs)
	Integrated	Approx. 2.5 kg (5.5 lbs)
Wind Survival	Connectorized	322 km/h (200 mi/h)
	Integrated	200 km/h (124 mi/h)
Dimension(HxWxD)	Connectorized	26.0 x 13.4 x 6.4 cm (10.25” x 5.25” x 3.25”)
	Integrated	31.0 x 31.0 x 6.4 cm (12” x 12” x 2.5”)
Power Consumption		15 W typical, 25 W max, 55 W max with Aux port PoE out enabled
Input Voltage		48-59 V DC, 802.3at compliant
Mounting		Wall or Pole mount with Cambium Networks Model # N000045L002A
Security		
Encryption		56-bit DES, FIPS-197 128-bit AES

Specifications for PMP 450b Series - SM

The PMP 450b SM conforms to the specifications listed in Table 247.

Table 249 PMP 450b Series - SM specifications

Category		Specification
Model Number		PMP 450b SM
Spectrum		
Channel Spacing		Configurable in 2.5 MHz increments
Frequency Range		4900 - 5925 MHz
Channel Bandwidth		5, 10, 15, 20, 30, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v2c and v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	4.9 GHz	1x = -92.5 dBm, 2x = -88.5 dBm, 4x = -81 dBm, 6x = -74.2 dBm, 8x = -66 dBm
	5.1 GHz	1x = -93 dBm, 2x = -89.1 dBm, 4x = -81.5 dBm, 6x = -74.8 dBm, 8x = -67.4 dBm
	5.2 GHz	1x = -92 dBm, 2x = -88.3 dBm, 4x = -80.8 dBm, 6x = -74 dBm, 8x = -66.2 dBm
	5.4 GHz	1x = -93 dBm, 2x = -89.1 dBm, 4x = -81.5 dBm, 6x = -74.8 dBm, 8x = -67.4 dBm
	5.8 GHz	1x = -92 dBm, 2x = -88.3 dBm, 4x = -80.8 dBm, 6x = -74 dBm, 8x = -66.2 dBm
	4.9 GHz	1x = -90.2 dBm, 2x = -85.2 dBm, 4x = -78.8 dBm, 6x = -71.4 dBm, 8x = -64.5 dBm

Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	5.1 GHz	1x = -90 dBm, 2x = -85.8 dBm, 4x = -78.5 dBm, 6x = -72.2 dBm, 8x = -65.8 dBm
	5.2 GHz	1x = -89.9 dBm, 2x = -84.9 dBm, 4x = -78.5 dBm, 6x = -71.2 dBm, 8x = -63.8 dBm
	5.4 GHz	1x = -90 dBm, 2x = -85.8 dBm, 4x = -78.5 dBm, 6x = -72.2 dBm, 8x = -65.8 dBm
	5.8 GHz	1x = -89.9 dBm, 2x = -84.9 dBm, 4x = -78.5 dBm, 6x = -71.2 dBm, 8x = -63.8 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	4.9 GHz	1x = -88.2 dBm, 2x = -83.1 dBm, 4x = -76.9 dBm, 6x = -70.5 dBm, 8x = -62.3 dBm
	5.1 GHz	1x = -87.7 dBm, 2x = -83.9 dBm, 4x = -76.6 dBm, 6x = -70.4 dBm, 8x = -63 dBm
	5.2 GHz	1x = -88 dBm, 2x = -82.9 dBm, 4x = -76.7 dBm, 6x = -69.4 dBm, 8x = -62.3 dBm
	5.4 GHz	1x = -87.7 dBm, 2x = -83.9 dBm, 4x = -76.6 dBm, 6x = -70.4 dBm, 8x = -63 dBm
	5.8 GHz	1x = -88 dBm, 2x = -82.9 dBm, 4x = -76.7 dBm, 6x = -69.4 dBm, 8x = -62.3 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	4.9 GHz	1x = -87 dBm, 2x = -81.8 dBm, 4x = -75.8 dBm, 6x = -68.5 dBm, 8x = -61.4 dBm
	5.1 GHz	1x = -87 dBm, 2x = -82.8 dBm, 4x = -75.6 dBm, 6x = -69.3 dBm, 8x = -61.6 dBm
	5.2 GHz	1x = -85.9 dBm, 2x = -81.5 dBm, 4x = -74.8 dBm, 6x = -68.7 dBm, 8x = -61.2 dBm
	5.4 GHz	1x = -87 dBm, 2x = -82.8 dBm, 4x = -75.6 dBm, 6x = -69.3 dBm, 8x = -61.6 dBm
	5.8 GHz	1x = -85.9 dBm, 2x = -81.5 dBm, 4x = -74.8 dBm, 6x = -68.7 dBm, 8x = -61.2 dBm
	4.9 GHz	1x = -84.9 dBm, 2x = -80.9 dBm, 4x = -73.2 dBm, 6x = -67.4 dBm, 8x = -59.3 dBm

Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	5.1 GHz	1x = -85.2 dBm, 2x = -80.2 dBm, 4x = -74.1 dBm, 6x = -67.9 dBm, 8x = -59.8 dBm
	5.2 GHz	1x = -84.9 dBm, 2x = -80 dBm, 4x = -73.2 dBm, 6x = -67.4 dBm, 8x = -59.4 dBm
	5.4 GHz	1x = -85.2 dBm, 2x = -80.2 dBm, 4x = -74.1 dBm, 6x = -67.9 dBm, 8x = -59.8 dBm
	5.8 GHz	1x = -84.9 dBm, 2x = -80 dBm, 4x = -73.2 dBm, 6x = -67.4 dBm, 8x = -59.4 dBm
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	4.9 GHz	1x=-84.2 dBm, 2x=-79.3 dBm, 4x=-72.3 dBm, 6x=-66 dBm, 8x=-56.8 dBm
	5.1 GHz	1x=-84.2 dBm, 2x=-79.1 dBm, 4x=-73.1 dBm, 6x=-66 dBm, 8x=-56.9 dBm
	5.2 GHz	1x=-83.6 dBm, 2x=-78.7 dBm, 4x=-72.5 dBm, 6x=-66.4 dBm, 8x=-56.3 dBm
	5.4 GHz	1x=-84.2 dBm, 2x=-79.1 dBm, 4x=-73.1 dBm, 6x=-66 dBm, 8x=-56.9 dBm
	5.8 GHz	1x=-83.6 dBm, 2x=-78.7 dBm, 4x=-72.5 dBm, 6x=-66.4 dBm, 8x=-56.3 dBm

Performance			
ARQ	Yes		
Cyclic Prefix	1/16		
Frame Period	2.5 ms or 5.0 ms		
Modulation Levels (Adaptive)	Modulation Levels	MCS	SNR (in dB)
	2x	QPSK	10
	4x	16QAM	17
	6x	64QAM	24
	8x	256QAM	32
Latency	3 - 5 ms		

Maximum Deployment Range		Up to 40 miles (64 km)
GPS Synchronization		Yes, via Autosync (CMM4)
Quality of Service		Diffserv QoS
Link Budget		
Antenna Beam Width		15° azimuth for 17 dBi integrated antenna 30° elevation for 17 dBi integrated antenna
Antenna Gain (Does not include cable loss, ~1dB)	5 GHz	+17 dBi H+V, integrated
Transmit Power Range		40 dB dynamic range (to EIRP limit by region) (1 dB step)
Maximum Transmit Power		+27 dBm combined output
Physical		
Sync/AUX port	RJ45	• 100/1000BASE-T Ethernet Data • PoE output (planned for future release) • Sync input or output (Connection and powering of UGPS Sync input)
Antenna Connection		50 ohm, N-type (Connectorized version only)
Surge Suppression EN61000-4-5		EN61000-4-5: 1.2us/50us, 500 V voltage waveform
Mean Time Between Failure		> 40 Years
Environmental		IP55
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing
Weight	Integrated	Approx. 0.5 kg (1.1 lb. including mounting bracket)
Wind Survival	Integrated	190 km/h (118 mi/h)
Dimension(HxWxD)	Integrated	12.4 x 25.1 x 11.9 cm (4.9” x 9.9” x 4.7”)
Power Consumption		9 W nominal, 12 W peak
Input Voltage		20 - 32 V DC,
Mounting		Wall or Pole mount
Security		

Encryption	56-bit DES, FIPS-197 128-bit AES

Specifications for PMP 450 Series - AP

The PMP 450 AP conforms to the specifications listed in Table 250.

Table 250 PMP 450 Series - AP specifications

Category		Specification
Model Number		PMP 450 AP
Spectrum		
Channel Spacing		5, 7, 10, 15, 20 and 30 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range	2.4 GHz	2400 – 2483.5 MHz
	3.5 GHz	3300 – 3600 MHz
	3.65 GHz	3500 – 3850 MHz
	5 GHz	5470 – 5875 MHz
Channel Bandwidth	3.5 and 3.65 GHz	5, 7, 10, 15, 20 and 30 MHz
	2.4 and 5 GHz	5, 10, 15, 20 and 30 MHz
OFDM Subcarriers		512 FFT
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP, TFTP, RADIUS
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v3, TFTP, Syslog
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	2.4 GHz	1x = -92 dBm, 2x = -87.8 dBm, 4x = -80.4 dBm, 6x = -74.4 dBm, 8x = -66.5 dBm
	3.5 GHz	1x = -92.4 dBm, 2x = -88.3 dBm, 4x = -81.3 dBm, 6x = -75.3 dBm, 8x = -67.7 dBm

	3.65 GHz	1x = -91 dBm, 2x = -86.1 dBm, 4x = -80.2 dBm, 6x = -73.1 dBm, 8x = -66 dBm
	5.4 GHz	1x = -88.7 dBm, 2x = -84 dBm, 4x = -77.6 dBm, 6x = -71.6 dBm, 8x = -63.7 dBm
	5.8 GHz	1x = -91.5 dBm, 2x = -87 dBm, 4x = -80.2 dBm, 6x = -73.1 dBm, 8x = -66 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	3.5 GHz	1x = -90.5 dBm, 2x = -86.4 dBm, 4x = -80.3 dBm, 6x = -73.4 dBm, 8x = -66.9 dBm
	3.65 GHz	1x = -89.1 dBm, 2x = -85.1 dBm, 4x = -78.1 dBm, 6x = -72.1 dBm, 8x = -64.5 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	2.4 GHz	1x = -89.9 dBm, 2x = -85.6 dBm, 4x = -80 dBm, 6x = -73.5 dBm, 8x = -66.9 dBm
	3.5 GHz	1x = -89.8 dBm, 2x = -85.6 dBm, 4x = -80 dBm, 6x = -73 dBm, 8x = -66.3 dBm
	3.65 GHz	1x = -89 dBm, 2x = -85.2 dBm, 4x = -78.1 dBm, 6x = -72.1 dBm, 8x = -64.5 dBm
	5.4 GHz	1x = -86.1 dBm, 2x = -82.2 dBm, 4x = -75.3 dBm, 6x = -69.3 dBm, 8x = -61.3 dBm
	5.8 GHz	1x = -86 dBm, 2x = -82.2 dBm, 4x = -75.1 dBm, 6x = -69 dBm, 8x = -60 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	2.4 GHz	1x = -88.4 dBm, 2x = -84.1 dBm, 4x = -77.1 dBm, 6x = -71.4 dBm, 8x = -65 dBm
	3.5 GHz	1x = -88.5 dBm, 2x = -84.5 dBm, 4x = -77.5 dBm, 6x = -71.5 dBm, 8x = -64.3 dBm
	3.65 GHz	1x = -87.4 dBm, 2x = -83.7 dBm, 4x = -76.3 dBm, 6x = -69.7 dBm, 8x = -62.2 dBm
	5.4 GHz	1x = -84.2 dBm, 2x = -80.2 dBm, 4x = -73.2 dBm, 6x = -67.2 dBm, 8x = -60 dBm
	5.8 GHz	1x = -85 dBm, 2x = -80 dBm, 4x = -74.3 dBm, 6x = -67 dBm, 8x = -58 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	2.4 GHz	1x = -85 dBm, 2x = -85 dBm, 4x = -79 dBm, 6x = -72 dBm, 8x = -66 dBm
	3.5 GHz	1x = -85 dBm, 2x = -85 dBm, 4x = -79 dBm, 6x = -72 dBm, 8x = -65 dBm
	3.65 GHz	1x = -86 dBm, 2x = -86 dBm, 4x = -78 dBm, 6x = -71 dBm, 8x = -63 dBm

	5.4 GHz	1x = -81 dBm, 2x = -81 dBm, 4x = -75 dBm, 6x = -68 dBm, 8x = -59 dBm
	5.8 GHz	1x = -82 dBm, 2x = -82 dBm, 4x = -75 dBm, 6x = -69 dBm, 8x = -60 dBm
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	2.4 GHz	1x = -85.4 dBm, 2x = -80.4 dBm, 4x = -74 dBm, 6x = -68 dBm, 8x = -61 dBm
	3.5 GHz	1x = -85.5 dBm, 2x = -81.5 dBm, 4x = -74.5 dBm, 6x = -68.2 dBm, 8x = -61.3 dBm
	3.65 GHz	1x = -84 dBm, 2x = -79.5 dBm, 4x = -73.4 dBm, 6x = -66.4 dBm, 8x = -59.2 dBm
	5.4 GHz	1x = -81 dBm, 2x = -76.9 dBm, 4x = -70.9 dBm, 6x = -63.8 dBm, 8x = -55.8 dBm
	5.8 GHz	1x = -80.9 dBm, 2x = -76.8 dBm, 4x = -70 dBm, 6x = -63.8 dBm, 8x = -55 dBm

Performance			
Subscribers Per Sector	Up to 238		
ARQ	Yes		
Cyclic Prefix	1/16		
Frame Period	2.5 ms or 5.0 ms		
Modulation Levels (Adaptive)	Modulation Levels	MCS	SNR (in dB)
	2x	QPSK	10
	4x	16QAM	17
	6x	64QAM	24
	8x	256QAM	32
Latency	3 - 5 ms for 2.5 ms Frame Period 6-10 ms for 5.0 ms Frame Period		
Maximum Deployment Range	Up to 40 miles (64 km)		
Packets Per Second	12,500		
GPS Synchronization	Yes, via CMM3, CMM4 or UGPS		
Quality of Service	Diffserv QoS		
Link Budget			

Antenna Gain (Does not include cable loss, ~1dB)	2.4 GHz	18 dBi Dual Slant
	3.5 GHz	16 dBi Dual Slant
	3.65 GHz	16 dBi Dual Slant
	5 GHz	17 dBi Horizontal and Vertical
Combined Transmit Power		-30 to +22 dBm (to EIRP limit by region) in 1 dB-configurable intervals (2.4 GHz, 5 GHz) -30 to +25 dBm (to EIRP limit by region) in 1 dB-configurable intervals (3.5 GHz) -30 to +25 dBm (to EIRP limit by region and channel bandwidth) in 1 dB-configurable intervals (3.6 GHz)
Maximum Transmit Power		22 dBm combined OFDM (2.4 GHz, 5 GHz) (dependent upon Region Code setting) 25 dBm combined OFDM (3.5 GHz, 3.6 GHz), (dependent upon Region Code setting)
Physical		
Wind Survival		200 mph (322 kph)
Antenna Connection		50 ohm, N-type (Connectorized version only)
Environmental		IP66, IP67
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F) / 0-95% non-condensing
Weight	2.4 GHz	15 kg (33 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
	3.5 GHz	15 kg (33 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
	3.6 GHz	15 kg (33 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
	5 GHz	5.9 kg (13 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
Dimension(HxWxD)	2.4 GHz	Radio: 27 x 21 x 7 cm (10.6” x 8.3” x 2.8”) Antenna: 112.2 x 24.5 x 11.7 cm (44.2” x 9.6” x 4.6”)
	3.5 GHz	Radio: 27 x 21 x 7 cm (10.6” x 8.3” x 2.8”)
	3.6 GHz	Radio: 27 x 21 x 7 cm (10.6” x 8.3” x 2.8”)
	5 GHz	Radio: 27 x 21 x 7 cm (10.6” x 8.3” x 2.8”)

	Antenna: 51 x 13 x 7.3 cm (20.2” x 5.1” x 2.9”)
Power Consumption	14 W
Input Voltage	22 to 32 VDC
Security	
Encryption	56-bit DES, AES

Specifications for PMP 450 Series - SM

The PMP 450 SM conforms to the specifications listed in Table 251.

Table 251 PMP 450 Series - SM specifications

Category		Specification
Model Number		PMP 450 SM
Spectrum		
Channel Spacing		5, 7, 10, 15, 20, 30, and 40 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range	900 MHz	902 – 928 MHz
	2.4 GHz	2400 – 2483.5 MHz
	3.5 GHz	3300 – 3600 MHz
	3.65 GHz	3500 – 3850 MHz
	5 GHz	5470 – 5875 MHz
Channel Bandwidth	900 MHz,	5, 7, 10, 15, and 20 MHz
	2.4 GHz, 3.5 GHz, 3.65 GHz and 5 GHz	5, 10, 15, 20, 30, and 40 MHz NOTE 2.4 GHz band does not support 40 MHz.
OFDM Subcarriers		512 FFT
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100 BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
	900 MHz	1x = -91 dBm, 2x = -91 dBm, 4x = -85 dBm, 6x = -78 dBm, 8x = -70 dBm

Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	2.4 GHz	1x = -92.5 dBm, 2x = -89.9 dBm, 4x = -82.9 dBm, 6x = -75.9, dBm, 8x = -67.9 dBm
	3.5 GHz	1x = -93.5 dBm, 2x = -89.4 dBm, 4x = -83.5 dBm, 6x = -76.4 dBm, 8x = -68.3 dBm
	3.65 GHz	1x = -91.3 dBm, 2x = -89.1 dBm, 4x = -82.2 dBm, 6x = -75.2 dBm, 8x = -67.3 dBm
	5.4 GHz	1x = -89.3 dBm, 2x = -87.3 dBm, 4x = -80.3 dBm, 6x = -74.3 dBm, 8x = -66.3 dBm
	5.8 GHz	1x = -89 dBm, 2x = -87 dBm, 4x = -80 dBm, 6x = -73.9 dBm, 8x = -64.9 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	900 MHz	1x = -91 dBm, 2x = -84 dBm, 4x = -83 dBm, 6x = -77 dBm, 8x = -71 dBm
	3.5 GHz	1x = -92.2 dBm, 2x = -88.5 dBm, 4x = -81.4 dBm, 6x = -74.5 dBm, 8x = -67.6 dBm
	3.65 GHz	1x = -90.4 dBm, 2x = -87.3 dBm, 4x = -80.6 dBm, 6x = -73 dBm, 8x = -65.6 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	900 MHz	1x = -90 dBm, 2x = -83 dBm, 4x = -80 dBm, 6x = -74 dBm, 8x = -68 dBm
	2.4 GHz	1x = -88 dBm, 2x = -88 dBm, 4x = -81 dBm, 6x = -75 dBm, 8x = -69 dBm
	3.5 GHz	1x = -88 dBm, 2x = -88 dBm, 4x = -81 dBm, 6x = -76 dBm, 8x = -68 dBm
	3.65 GHz	1x = -86 dBm, 2x = -86 dBm, 4x = -80 dBm, 6x = -73 dBm, 8x = -66 dBm
	5.4 GHz	1x = -84 dBm, 2x = -84 dBm, 4x = -78 dBm, 6x = -72 dBm, 8x = -63 dBm
	5.8 GHz	1x = -84 dBm, 2x = -84 dBm, 4x = -77 dBm, 6x = -71 dBm, 8x = -63 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	900 MHz	1x = -88.6 dBm, 2x = -85.4 dBm, 4x = -78.1 dBm, 6x = -72.2 dBm, 8x = -65.2 dBm
	2.4 GHz	1x = -88.5 dBm, 2x = -84.5 dBm, 4x = -77.5 dBm, 6x = -71.5 dBm, 8x = -64.5 dBm
	3.5 GHz	1x = -89.5 dBm, 2x = -84.5 dBm, 4x = -78.5 dBm, 6x = -71.5 dBm, 8x = -65.1 dBm
	3.65 GHz	1x = -87.3 dBm, 2x = -84.3 dBm, 4x = -77.3 dBm, 6x = -70.3 dBm, 8x = -62.2 dBm

	5.4 GHz	1x = -84.5dBm, 2x = -82.5 dBm, 4x = -75.5 dBm, 6x = -69.5 dBm, 8x = -59.5 dBm
	5.8 GHz	1x = -84 dBm, 2x = -84 dBm, 4x = -77 dBm, 6x = -71 dBm, 8x = -63 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	900 MHz	1x = -87 dBm, 2x = -80 dBm, 4x = -77 dBm, 6x = -72 dBm, 8x = -65 dBm
	2.4 GHz	1x = -86.9 dBm, 2x = -82.9 dBm, 4x = -75.9 dBm, 6x = -69.9 dBm, 8x = -63.5 dBm
	3.5 GHz	1x = -87.5 dBm, 2x = -83.5 dBm, 4x = -76.5 dBm, 6x = -69.5 dBm, 8x = -63.1 dBm
	3.65 GHz	1x = -86 dBm, 2x = -83 dBm, 4x = -76.2 dBm, 6x = -68.2 dBm, 8x = -61 dBm
	5.4 GHz	1x = -83.4 dBm, 2x = -81.7 dBm, 4x = -74.4 dBm, 6x = -67.2 dBm, 8x = -57.3 dBm
	5.8 GHz	1x = -84 dBm, 2x = -80.5 dBm, 4x = -74 dBm, 6x = -66.9 dBm, 8x = -56 dBm
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	2.4 GHz	1x = -85.9 dBm, 2x = -80.9 dBm, 4x = -73.9 dBm, 6x = -67.8 dBm, 8x = -60.9 dBm
	3.5 GHz	1x = -86.5 dBm, 2x = -81.5 dBm, 4x = -74.5 dBm, 6x = -68.2 dBm, 8x = -61.3 dBm
	3.65 GHz	1x = -84.3 dBm, 2x = -80.3 dBm, 4x = -74.3 dBm, 6x = -66.2 dBm, 8x = -58 dBm
	5.4 GHz	1x = -82 dBm, 2x = -78.3 dBm, 4x = -72.3 dBm, 6x = -65.3 dBm, 8x = -55.3 dBm
	5.8 GHz	1x = -81.7 dBm, 2x = -78.6 dBm, 4x = -71.6 dBm, 6x = -64.4 dBm, 8x = -54 dBm
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	3.5 GHz	1x=-83.1 dBm, 2x=-79.3 dBm, 4x=-72.9 dBm, 6x=-66 dBm, 8x=-56.3 dBm
	3.65 GHz	1x=-83.6 dBm, 2x=-79.6 dBm, 4x=-72.3 dBm, 6x=-65.3 dBm, 8x=-54.4 dBm
	5.4 GHz	1x=-82.4 dBm, 2x=-78 dBm, 4x=-71.2 dBm, 6x=-64.3 dBm, 8x=-51 dBm
	5.8 GHz	1x=-82.5 dBm, 2x=-78.8 dBm, 4x=-70.7 dBm, 6x=-64.8 dBm, 8x=-51 dBm
Performance		
Subscribers Per Sector		Up to 238

ARQ		Yes		
Cyclic Prefix		1/16		
Frame Period		2.5 ms or 5.0 ms		
Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		4x	16QAM	17
		6x	64QAM	24
		8x	256QAM	32
Latency		3 - 5 ms for 2.5 ms Frame Period 6-10 ms for 5.0 ms Frame Period		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Gain (Does not include cable loss, ~1dB)	900 MHz	12 dBi Yagi antenna		
	2.4 GHz	7 dBi Dual Slant, integrated patch		
	3.5 GHz	8 dBi Dual Slant, integrated patch		
		19 dBi Flat Plate, integrated patch		
	3.65 GHz	8 dBi Dual Slant, integrated patch		
		19 dBi Flat Plate, integrated patch		
	5 GHz	9 dBi H+V, integrated patch		
		25 dBi H+V, integrated dish		
Combined Transmit Power		-30 to +22 dBm (to EIRP limit by region) – 2.4, 5 GHz -30 to +25 dBm (to EIRP limit by region) – 3.5, 3.6 GHz 25 dBm - 3 GHz		
Maximum Transmit Power		22 dBm combined OFDM (2.4 GHz, 5 GHz) (dependent upon Region Code setting) 25 dBm combined OFDM (900 MHz, 3.5 GHz, 3.6 GHz), (dependent upon Region Code setting)		
Reflector antenna gain	2.4 GHz	+12 dBi		

	3.5 GHz	+11 dBi
	3.65 GHz	+11 dBi
	5 GHz	+15 dBi
Other antenna (5 GHz only)	CLIP Gain	+8 dBi
	LENS Gain	+5.5 dBi
Physical		
Wind Survival		200 mph (322 kph)
Antenna Connection		50 ohm, N-type (Connectorized version only)
Environmental		IP55
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F) / 0-95% non-condensing
Weight	2.4 GHz	15 kg (33 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
	3.5 GHz	15 kg (33 lbs) with antenna 2.5 kg (5.5 lbs) without antenna 2.5 kg (5.5 lbs) for 450 ruggedized
	3.6 GHz	15 kg (33 lbs) with antenna 2.5 kg (5.5 lbs) without antenna 2.5 kg (5.5 lbs) for 450 ruggedized
	5 GHz	5.9 kg (13 lbs) with antenna 2.5 kg (5.5 lbs) without antenna 3.5 kg (7.7 lbs) for 450d
Dimensions (H x W x D)		30 x 9 x 9 cm (11.75” x 3.4” x 3.4”) 50 x 50 x 38 cm (19.69” x 19.69” x 14.96”) for 450d 31.0 x 31.0 x 6.4 cm (12” x 12” x 2.5”) for 450 ruggedized
Power Consumption		12 W
Input Voltage		20 to 32 VDC
Security		
Encryption		56-bit DES, AES

Specifications for PTP 450 Series - BH

The PTP 450 BH conforms to the specifications listed in Table 252.

Table 252 PTP 450 Series - BH specifications

Category		Specification
Model Number		PTP 450 BH
Spectrum		
Channel Spacing		5, 7, 10, 15, 20, 30, and 40 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range		902 to 928 MHz
		3300 – 3600 MHz
		3500 – 3850 MHz
		5470 – 5875 MHz
Channel Bandwidth	900 MHz	5, 7, 10, 15, and 20 MHz
	3.5 GHz, 3.6 GHz, and 5 GHz	5, 7, 10, 15, 20 and 30 MHz 7 MHz Channel bandwidth configurable for 3.5 GHz and 3.65 GHz band only.
OFDM Subcarriers		512 FFT
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100 BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP, TFTP, RADIUS
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v2c and v3, TFTP, Syslog
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
	3.5 GHz	OFDM: 1x = -92 dBm, 2x = -90 dBm, 4x = -83 dBm, 6x = -76 dBm, 8x = -69 dBm

Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	3.6 GHz	OFDM: 1x = -94 dBm, 2x = -89.3 dBm, 4x = -82.3 dBm, 6x = -75.2 dBm, 8x = -68.4 dBm
	5.4 GHz	OFDM: 1x = -90.4 dBm, 2x = -86 dBm, 4x = -79.4 dBm, 6x = -73.2 dBm, 8x = -65.4 dBm
	5.8 GHz	OFDM: 1x = -90 dBm, 2x = -85.4 dBm, 4x = -79.4 dBm, 6x = -73.4 dBm, 8x = -64.9 dBm
Nominal Receive Sensitivity (w/ FEC) @7 MHz Channel	3.5 GHz	OFDM: 1x = -90 dBm, 2x = -88 dBm, 4x = -81 dBm, 6x = -74 dBm, 8x = -67 dBm
	3.6 GHz	OFDM: 1x = -92 dBm, 2x = -87.3 dBm, 4x = -81.3 dBm, 6x = -74.3 dBm, 8x = -66.4 dBm
Nominal Receive Sensitivity (w/ FEC) @10 MHz Channel	3.5 GHz	OFDM: 1x =-91 dBm, 2x = -87.2 dBm, 4x = -80 dBm, 6x = -73 dBm, 8x = -65.6 dBm
	3.6 GHz	OFDM: 1x =-90.4 dBm, 2x = -86.3 dBm, 4x = -80 dBm, 6x = -73 dBm, 8x = -64.5 dBm
	5.4 GHz	OFDM: 1x =-87.6 dBm, 2x = -82.5 dBm, 4x = -76.5 dBm, 6x = -70.5 dBm, 8x = -61.5 dBm
	5.8 GHz	OFDM: 1x =-87.5 dBm, 2x = -82.7 dBm, 4x = -76.8 dBm, 6x = -70.5 dBm, 8x = -61.4 dBm
Nominal Receive Sensitivity (w/ FEC) @15 MHz Channel	3.5 GHz	OFDM: 1x =-89 dBm, 2x = -85 dBm, 4x = -78 dBm, 6x = -71.1 dBm, 8x = -64.7 dBm
	3.6 GHz	OFDM: 1x =-89 dBm, 2x = -84.3 dBm, 4x = -78 dBm, 6x = -71 dBm, 8x = -63 dBm
	5.4 GHz	OFDM: 1x =-85.6 dBm, 2x = -81.6 dBm, 4x = -74.5 dBm, 6x = -68.5 dBm, 8x = -57.5 dBm
	5.8 GHz	OFDM: 1x =-85.6 dBm, 2x = -80.9 dBm, 4x = -75 dBm, 6x = -68 dBm, 8x = -58 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	3.5 GHz	OFDM: 1x =-88 dBm, 2x = -84 dBm, 4x = -77 dBm, 6x = -70 dBm, 8x = -62.2 dBm
	3.6 GHz	OFDM: 1x =-87.3 dBm, 2x = -83.3 dBm, 4x = -76.3 dBm, 6x = -69.3 dBm, 8x = -62 dBm
	5.4 GHz	OFDM: 1x =-84.5 dBm, 2x = -80.5 dBm, 4x = -73.4 dBm, 6x = -66.4 dBm, 8x = -56.4 dBm
	5.8 GHz	OFDM: 1x =-84.8 dBm, 2x = -80.8 dBm, 4x = -74.7 dBm, 6x = -66.4 dBm, 8x = -56 dBm
	3.5 GHz	OFDM: 1x =-86 dBm, 2x = -82 dBm, 4x = -75 dBm, 6x = -68 dBm, 8x = -60 dBm

Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	3.6 GHz	OFDM: 1x =-86 dBm, 2x = -81.3 dBm, 4x = -74.3 dBm, 6x = -67.3 dBm, 8x = -59 dBm		
	5.4 GHz	OFDM: 1x =-82.5 dBm, 2x = -78.5 dBm, 4x = -71.5 dBm, 6x = -64.4 dBm, 8x = -53.4 dBm		
	5.8 GHz	OFDM: 1x =-82.5 dBm, 2x = -78.5 dBm, 4x = -71.5 dBm, 6x = -64.4 dBm, 8x = -54 dBm		
	5.4 GHz	OFDM: 1x =-81.8 dBm, 2x = -77.5 dBm, 4x = -71.5 dBm, 6x = -63.5 dBm, 8x = -52.6 dBm		
	5.8 GHz	OFDM: 1x =-83.0 dBm, 2x = -78.0 dBm, 4x = -71.0 dBm, 6x = -63.3 dBm		
Performance				
ARQ		Yes		
Cyclic Prefix		1/16		
Frame Period		2.5 ms or 5.0 ms		
Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		4x	16QAM	17
		6x	64QAM	24
		8x	256QAM	32
Latency		3 - 5 ms for 2.5 ms frame period 6 - 10 ms for 5.0 ms frame period		
Packets Per Second		12,500		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes, via Autosync (CMM4)		
Quality of Service		Diffserv QoS		
Link Budget				
Combined Transmit Power	-	30 to +22 dBm (to EIRP limit by region) in 1 dB-configurable intervals (5 GHz) -30 to +25 dBm (to EIRP limit by region) in 1 dB-configurable intervals (3.5 GHz) -30 to +25 dBm (to EIRP limit by region and channel bandwidth) in 1 dB-configurable intervals (3.6 GHz)		
	3.5 GHz	8 dBi Dual Slant, integrated patch		

Antenna Gain (Does not include cable loss, ~1dB)		19 dBi Flat Plate, integrated patch
	3.65 GHz	8 dBi Dual Slant, integrated patch
		19 dBi Flat Plate, integrated patch
	5 GHz	9 dBi H+V, integrated patch
		25 dBi H+V, integrated dish
Transmit Power Range		40 dB dynamic range (to EIRP limit by region) (1 dB step)
Maximum Transmit Power		22 dBm combined OFDM (5 GHz) (dependent upon Region Code setting) 25 dBm combined OFDM (3.5 GHz, 3.6 GHz), (dependent upon Region Code setting)
Reflector antenna gain	3.5 GHz	+11 dBi
	3.65 GHz	+11 dBi
	5 GHz	+15 dBi
Other antenna (5 GHz only)	CLIP Gain	+8 dBi
	LENS Gain	+5.5 dBi
Physical		
Sync/AUX port	RJ45	• 10/100/1000BASE-T Ethernet Data • PoE output • Sync input or output (Connection and powering of UGPS Sync input)
Antenna Connection		50 ohm, N-type (Connectorized version only)
Surge Suppression EN61000-4-5		EN61000-4-5: 1.2us/50us, 500 V voltage waveform Recommended external surge suppressor: Cambium Networks Model # C000000L033A
Mean Time Between Failure		> 40 Years
Environmental		IP66, IP67
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing
Weight		15 kg (33 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
Wind Survival		200 mph (322 kph)

Dimension(HxWxD)	30 x 9 x 9 cm (11.75” x 3.4” x 3.4”)
Maximum Power Consumption	14 W
Input Voltage	22 to 32 VDC
Security	
Encryption	56-bit DES, AES

PSU specifications

The PMP/PTP 450i AC+DC Enhanced Power Injector conforms to the specifications listed in Table 253.

Table 253 PMP/PTP 450i AC power Injector specifications

Category	Specification
Dimensions	137 mm (5.4 in) x 56 mm (2.2 in) x 38 mm (1.5 in)
Weight	0.240 Kg (0.5 lbs)
Temperature	-40°C to +60°C
Humidity	90% non-condensing
Waterproofing	Not waterproof
Altitude	Sea level to 5000 meters (16000 ft)
AC Input	Min 90 V AC, 57 – 63 Hz, max 264 V AC, 47 – 53 Hz.
DC output voltage to the ODU	58V +2V/- 0V
AC connector	IEC-320-C8
Efficiency	Better than 85%, efficiency level 'VI'
Over Current Protection	Hiccup current limiting, trip point set between 120% to 150% of full load current
Hold up time	At least 10 milliseconds

Warning

Use the above PSU to only power up 450i and 450m products.

The PMP/PTP 450 power supply conforms to the specifications listed in Table 254.

Table 254 PMP/PTP 450 power supply specifications (part number: N000900L001A)

Category	Specification
Dimensions	118 mm (4.66 in) x 45 mm (1.75 in) x 32 mm (1.25 in)
Weight	0.240 Kg (0.5 lbs)
Temperature	0°C to +40°C
Humidity	20 to 90%
AC Input	90-264 VAC, 47 – 63 Hz, 0.5 A rms at 120 VAC, 0.25 A rms at 240 VAC.
DC output voltage to the ODU	30 V ± 5%
AC connector	IEC-320-C8
Efficiency	Better than 85%, efficiency level 'V'
Over Current Protection	Short circuit, with auto recovery; Should restart between every 0.5 to 2 sec.
Hold up time	10mS min at max load, 120VAC

Note

The 30V PSU (part number: #N000900L001A) has to be used for PMP 450 900 MHz SM.

Warning

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

Data network specifications

This section contains specifications of the PMP/PTP 450 platform Ethernet interface.

Ethernet interface

450m/450i Series

The 450m/450i Series Ethernet port conforms to the specifications listed in Table 255.

Table 255 450m/450i Series Main and Aux Ethernet bridging specifications

Ethernet Bridging	Specification
Protocol	IEEE 802.3 compatible
QoS	IEEE 802.1p, IEEE 802.1Q, IEEE 802.1ad, DSCP IPv4
Main Ethernet port	10/100/1000 BaseT, half/full duplex, rate auto negotiated
Aux Ethernet port	10/100 BaseT, half/full duplex, rate auto negotiated
Maximum Ethernet Frame Size	1700 Bytes

450/450b Series

Table 256 450 Series Ethernet bridging specifications

Ethernet Bridging	Specification
Protocol	IEEE 802.3 compatible
QoS	IEEE 802.1p, IEEE 802.1Q, IEEE 802.1ad, DSCP IPv4
Interface	10/100/1000 BaseT, half/full duplex, rate auto negotiated
Maximum Ethernet Frame Size	1700 Bytes

Note

Practical Ethernet rates depend on network configuration, higher layer protocols and platforms used.

Over the air throughput is restricted to the rate of the Ethernet interface at the receiving end of the link.

Wireless specifications

This section contains specifications of the 450 Platform Family wireless interface. These specifications include RF bands, channel bandwidth, spectrum settings, maximum power and link loss.

General wireless specifications

The wireless specifications that apply to all 450 Platform variants are listed under Table 257.

Table 257 450 Platform Family - wireless specifications

Item	Specification		
Channel selection	Manual selection (fixed frequency).		
Manual power control	To avoid interference to other users of the band, maximum power can be set lower than the default power limit.		
Duplex scheme	Adaptive TDD		
Range	**Band**	**Platform**	**Range**
	900 MHz	PMP 450i Series - AP and PMP 450 Series - SM	120 mi / 193 km
	2.4 GHz	PMP 450 Series	40 mi / 64 km
	3.5 GHz	PMP/PTP 450 Series	40 mi / 64 km (PMP) 186 mi/ 299 km (PTP)
	3.65 GHz	PMP/PTP 450 Series	40 mi / 64 km (PMP) 186 mi/ 299 km (PTP)
	5 GHz	PMP/PTP 450/450i/450b Series and PMP 450m Series AP	40 mi / 64 km (PMP) 186 mi/ 299 km (PTP)
Over-the-air encryption	DES, AES		
Error Correction	Rate 3/4 RS coder		

Link Range and Throughput

Link range and throughput estimates are based on site-specific attributes and configuration parameters. For the most up-to-date information on link range and throughput for your equipment see the *Capacity Planner and LINKPlanner software tools*:

- For average-deployment link range and throughput planning information, see: https://support.cambiumnetworks.com/files/capacityplanner/
- For site-specific link range and throughput planning information, see: https://support.cambiumnetworks.com/files/linkplanner

Country specific radio regulations

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

Caution

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

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 ODUs and installations.

The radio specification type approvals that have been granted for 450 Platform frequency variants are listed in Table 258.

Table 258 Radio certifications

Variant	Region	Specification (Type Approvals)
900 MHz PMP 450i	Canada	RSS Gen and RSS 210
	USA	FCC Part 15.247
	Mexico	NOM-121-SCT1-2009
2.4 GHz PMP 450	Canada	RSS Gen and RSS 210
	USA	FCC Part 15 Class B
3.5 GHz PMP/PTP 450	Canada	RSS Gen and RSS 192
	Europe	ETSI EN 302 326-2 V1.2.2
3.6 GHz PMP/PTP 450	Canada	RSS Gen and RSS 197
	USA	FCC Part 15 Class B
4.9 GHz PMP/PTP 450i/450b	USA	FCC Part 90 Subpart Y
	Canada	RSS Gen and RSS 111
5.1 GHz PMP/PTP 450i/450b	USA	FCC Part 15 Class B
5.1 GHz PMP/PTP 450m	USA	FCC Part 15E and Part 15B
	Europe	ETSI EN 302 625 V1.1.1
5.2 GHz PMP/PTP 450m	USA	FCC Part 15E and Part 15B

Variant	Region	Specification (Type Approvals)
5.2 GHz PMP/PTP 450i/450b	USA	FCC Part 15 Class B
	Canada	RSS Gen and RSS 247
5.4 GHz PMP/PTP 450 and 450i	Europe	ETSI EN 301 893 v1.6.1
	USA	FCC Part 15 Class B
5.4 GHz PMP/PTP 450m	USA	FCC Part 15E and Part 15B
	Canada	RSS Gen and RSS 247
	Europe	ETSI EN 301 893 v1.8.1 ETSI EN 301 893 v2.1.1 Clause 4.8
5.8 GHz PMP/PTP 450 and 450i	Canada	RSS Gen and RSS 210
	USA	FCC Part 15 Class B
	Europe	ETSI EN 302 502 v1.2.1
5.8 GHz PMP/PTP 450m	USA	FCC Part 15E and Part 15B
	Canada	RSS Gen and RSS 247
	Europe	ETSI EN 302 502 v2.1.1

DFS for 2.4 and 5 GHz Radios

Dynamic Frequency Selection (DFS) is a requirement in several countries and regions for 2.4 and 5 GHz unlicensed systems to detect radar systems and avoid co-channel operation.

The details of DFS operation and channels available for each Country Code, including whether DFS is active on the AP, SM, which DFS regulation apply, and any channel restrictions are shown in Table 259 on page 10-47.

Table 259 Country & Bands DFS setting

Region Code	Country Code	Band	AP	SM	Weather Radar Notch-Out
North America	USA	2.4 GHz	No effect	No effect	No
		5.2 GHz	FCC DFS	No effect	No
		5.4 GHz	FCC DFS	No effect	No
		5.8 GHz	No effect	No effect	No
	Canada	2.4 GHz	No effect	No effect	No
		5.2 GHz	FCC DFS	No effect	No
		5.4 GHz	FCC DFS	No effect	No

		5.8 GHz	No effect	No effect	No
	Mexico	2.4 GHz	No effect	No effect	No
		5.2 GHz	ANATEL Res506-2008	No effect	No
		5.4 GHz	ANATEL Res506-2008	No effect	No
		5.8 GHz	No effect	No effect	No
South America	Brazil	5.4 GHz	ETSI EN 301 893 v1.7.1 DFS	No effect	No
		5.8 GHz	No effect	No effect	No
Europe	ETSI	5.4 GHz	ETSI EN 301 893 v1.7.1 DFS	ETSI EN 301 893 v1.7.1 DFS	Yes
		5.8 GHz	ETSI EN 302 502 v1.2.1 DFS	ETSI EN 302 502 v1.2.1 DFS	Yes
Other-Regulatory	Other-FCC	2.4 GHz	No effect	No effect	No
		5.2 GHz	FCC DFS	No effect	No
		5.4 GHz	FCC DFS	No effect	No
		5.8-GHz	No effect	No effect	No
	Other-ETSI	5.4 GHz	ETSI EN 301 893 v1.7.1 DFS	ETSI EN 301 893 v1.7.1 DFS	No
		5.8 GHz	ETSI EN 302 502 v1.2.1 DFS	ETSI EN 302 502 v1.2.1 DFS	No

Equipment Disposal

Waste (Disposal) of Electronic and Electric Equipment

Waste (Disposal) of Electronic and Electric Equipment

Please do not dispose of Electronic and Electric Equipment or Electronic and Electric Accessories with your household waste. In some countries or regions, collection systems have been set up to handle waste of electrical and electronic equipment. In European Union countries, please contact your local equipment supplier representative or service center for information about the waste collection system in your country.

Country specific maximum transmit power

Maximum transmit power 900 MHz band

Table 260 Default combined transmit power per country – 900 MHz band PMP 450i Series

Countries	Device Type (AP/SM/BH)	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
USA, Mexico, Canada, Other FCC	Any	Any	5 MHz	-	36
			7 MHz	-	36
			10 MHz	-	36
			15 MHz	-	36
			20 MHz	-	36
Brazil, Panama, Colombia, Venezuela	Any	Any	5 MHz	-	36
			7 MHz	-	36
			10 MHz	-	36
			15 MHz	-	36
			20 MHz	-	36
Ecuador	Any	Any			

Countries	Device Type (AP/SM/BH)	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
			5 MHz	25 dBm	-
			7 MHz	25 dBm	-
			10 MHz	25 dBm	-
			15 MHz	25 dBm	-
			20 MHz	25 dBm	-
Other	Any	Any	Any	-	-
Australia, New Zealand	Any	Any	5 MHz	19 dBm	30
			7 MHz	19 dBm	30
			10 MHz	19 dBm	30
			15 MHz	19 dBm	36

Maximum transmit power 2.4 GHz band

Table 261 Default combined transmit power per country – 2.4 GHz band PMP/PTP 450 Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
USA, Canada, Other FCC	AP	Sector	Any	18	36
	SM, BH	Integrated	Any	-	36
		Reflector	Any	24	36
		Integrated Dish (450d)	Any	11	36
Other	Any	Any	Any	30	-

Maximum transmit power 3.5 GHz band

Table 262 Default combined transmit power per country – 3.5 GHz band PMP/PTP 450 Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
Other-ETSI	AP	Sector	Any	-	66
	SM, BH	Any	Any	-	63
Brazil, China, India, Indonesia, Mexico, Other	Any	Any	Any	-	-
Canada	Any	Any	Any	-	62
Australia	Any	Any	Any	-	63

Maximum transmit power 3.65 GHz band

Table 263 Default combined transmit power per country – 3.65 GHz band PMP/PTP 450

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
Australia, India, Indonesia, Mexico, Other	Any	Any	Any	-	-
Other-ETSI	AP	Any	Any	-	66
	SM, BH				63
Canada, USA, Other-FCC	AP	Sector	Any	25	43
	SM, BH	Integrated		-	
		Reflector		-	
		Integrated Dish (450d)		18	

Maximum transmit power 4.9 GHz band

Table 264 Default combined transmit power per country – 4.9 GHz band PMP/PTP 450i Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
USA, Mexico, Canada, Other FCC	AP	Sector	5 MHz	24	40
			10 MHz	24	40
			20 MHz	23	39
		Omni	5 MHz	24	35
			10 MHz	24	36
			20 MHz	23	35
	SM, BH	Flate plate	5 MHz	24	51
			10 MHz	24	51
			20 MHz	23	50
		4ft parabolic	5 MHz	24	52
			10 MHz	24	55

			20 MHz	23	56
		6ft parabolic	5 MHz	24	52
			10 MHz	24	55
			20 MHz	23	58
Brazil	Any	Any	5 MHz	23	54
			10 MHz	27	57
			20 MHz	27	60
Other	Any	Any	Any	27	-

Table 265 Default combined transmit power per country – 4.9 GHz band PMP 450b Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
FCC	SM	16 dBi	5 MHz	26	51
			10 MHz	26	51
			15 MHz	26	51
			20 MHz	24	51
			30 MHz	-	51
			40 MHz	-	51

Maximum transmit power 5.1 GHz band

Table 266 Default combined transmit power per Country – 5.1 GHz band PMP/PTP 450i Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
USA, Other FCC	AP	Sector	5 MHz	12	30
			10 MHz	15	33
			15 MHz	14	34
			20 MHz	16	36
			30 MHz	16	36
			40 MHz	16	36
		Omni	5 MHz	16	28
			10 MHz	19	31
			20 MHz	22	34
			40 MHz	23	35
	SM, BH	Flat plate	5 MHz	-2	47
			10 MHz	1	50
			15 MHz	-	51
			20 MHz	3	31
			30 MHz	3	31
			40 MHz	3	31
		4ft parabolic	5 MHz	6	39
			10 MHz	9	42
			20 MHz	9	43
			40 MHz	11	45
Mexico	Any	Any	5 MHz	-	17
			10 MHz	-	20
			15 MHz	-	21
			20 MHz	-	23
			30 MHz	-	23
			40 MHz	-	23

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
Other	Any	Any	Any	27	-
ETSI	Any	Any	5 MHz	-	33
			10 MHz	-	36
			15 MHz	-	37
			20 MHz	-	39
Other ETSI	Any	Any	5 MHz	-	33
			10 MHz	-	36
			15 MHz	-	37
			20 MHz	-	39

Table 267 Default combined transmit power per country – 5.1 GHz band PMP 450b Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
FCC	SM	16 dBi	5 MHz	24	47
			10 MHz	27	50
			15 MHz	27	51
			20 MHz	27	53
			30 MHz	27	53
			40 MHz	27	53

Table 268 Default combined transmit power per Country – 5.1 GHz band PMP 450m Series

Countries	Device Type	Antenna Type	Channel BW	EIRP Limit (dBm)
USA	AP	Sector	5 MHz	30
			10 MHz	33
			15 MHz	34
			20 MHz	36
			40 MHz	36
ETSI	AP	Sector	5 MHz	33
			10 MHz	36
			15 MHz	37
			20 MHz	39
Other	Any	Any	5 MHz	42
			10 MHz	42
			15 MHz	42
			20 MHz	42
Other ETSI	Any	Any	5 MHz	36
			10 MHz	36
			15 MHz	36
			20 MHz	36
Mexico	Any	Any	5 MHz	17
			10 MHz	20
			15 MHz	21
			20 MHz	23

Maximum transmit power 5.2 GHz band

Note

The selection of 5 MHz channel is not available for the PMP 450 AP and the PTP 450 BHM. It is available for the PMP/PTP 450i AP/SM and the PMP 450m AP.

Table 269 Default combined transmit power per country – 5.2 GHz band PMP/PTP 450i Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
USA, Other FCC	AP	Sector	5 MHz	6	24
			10 MHz	9	27
			15 MHz	-	28
			20 MHz	12	30
			30 MHz	-	30
			40 MHz	-	30
		Omni	5 MHz	10	22
			10 MHz	13	25
			20 MHz	16	28
	SM, BH	Flat plate	5 MHz	-7	20
			10 MHz	-4	23
			20 MHz	-1	26
		4ft parabolic	5 MHz	-13	19
			10 MHz	-11	22
			20 MHz	-8	25
Mexico	Any	Any	5 MHz	-	24
			10 MHz	-	27
			15 MHz	-	28
			20 MHz	-	30
			30 MHz	-	30
			40 MHz	-	30
Other	Any	Any	Any	27	-

Table 270 Default combined transmit power per country – 5.2 GHz band PMP 450b Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
FCC	SM	16 dBi	5 MHz	-	24
			10 MHz	22	27
			15 MHz	22	28
			20 MHz	22	30
			30 MHz	22	30
			40 MHz	22	30
Other	SM	16 dBi	5 MHz	27	-
			10 MHz	27	-
			15 MHz	27	-
			20 MHz	27	-
			30 MHz	27	-
			40 MHz	27	-

Table 271 Default combined transmit power per Country – 5.2 GHz band PMP 450m Series

Countries	Device Type	Antenna Type	Channel BW	EIRP Limit (dBm)
USA, Other FCC	AP	Sector	5 MHz	24
			10 MHz	27
			15 MHz	28
			20 MHz	30
			40 MHz	30
Mexico	Any	Any	5 MHz	24
			10 MHz	27
			15 MHz	28
			20 MHz	30
			40 MHz	30
Other	Any	Any	5 MHz	42
			10 MHz	42
			15 MHz	42
			20 MHz	42
			40 MHz	42

Maximum transmit power 5.4 GHz band

Table 272 Default combined transmit power per country – 5.4 GHz band PMP 450m Series

Countries	Device Type	Antenna Type	Channel BW	EIRP Limit (dBm)
FCC	AP	Sector	5 MHz	24
			10 MHz	27
			15 MHz	28
			20 MHz	30
			40 MHz	30
ETSI	AP	Sector	5 MHz	24
			10 MHz	27
			15 MHz	28
			20 MHz	30
			40 MHz	30
RoW	AP	Sector	5 MHz	42
			10 MHz	42
			15 MHz	42
			20 MHz	42
			40 MHz	42
RoW Other	-	-	-	No EIRP Limit

Note

- The selection of 5 MHz channel is not available for the PMP 450 AP and the PTP 450 BHM. It is available for the PMP/PTP 450i AP/SM and the PMP 450m AP.
- Power reduction at the band edges is required in some cases.

Table 273 Default combined transmit power per country – 5.4 GHz band PMP/PTP 450i Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
USA, Other FCC	AP	Sector	5 MHz	6	24
			10 MHz	9	27
			15 MHz	-	28
			20 MHz	12	30
			30 MHz	-	30
			40 MHz	-	30
		Omni	5 MHz	10	22
			10 MHz	13	25
			20 MHz	16	28
	SM, BH	Flat plate	5 MHz	-7	20
			10 MHz	-4	23
			20 MHz	-1	26
		4ft parabolic	5 MHz	-6	21
			10 MHz	-3	24
			20 MHz	0	27
Brazil	Any	Any	5 MHz	-	24
			10 MHz	19	27
			15 MHz	-	28
			20 MHz	23	30
			30 MHz	-	30
			40 MHz	-	30
Mexico	Any	Any	5 MHz	-	24
			10 MHz	-	27
			15 MHz	-	28
			20 MHz	-	30
			30 MHz	-	30
			40 MHz	-	30
Other	Any	Any	Any	27	-

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
ETSI	Any	Any	5 MHz	-	24
			10 MHz	-	27
			15 MHz	-	28
			20 MHz	-	30
			30 MHz	-	30
			40 MHz	-	30
Australia	Any	Any	5 MHz	-	24
			10 MHz	-	27
			15 MHz	-	28
			20 MHz	-	30
			30 MHz	-	30
			40 MHz	-	30

Table 274 Default combined transmit power per country – 5.4 GHz band PMP 450b Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
FCC	SM	16 dBi	5 MHz	-	24
			10 MHz	22	27
			15 MHz	22	28
			20 MHz	22	30
			30 MHz	22	30
			40 MHz	13	30
ETSI	SM	16 dBi	5 MHz	27	24
			10 MHz	27	27
			15 MHz	27	28
			20 MHz	27	30
			30 MHz	27	30
			40 MHz	27	30

Table 275 Default combined transmit power per country – 5.4 GHz band PMP 450 Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
United States, Canada, Brazil, Australia, Denmark, Finland, Germany, Greece, Liechtenstein, Norway, Portugal, Spain, UK, Vietnam	AP	Sector (18 dBi – 1dB cable loss)	5 MHz	-	24
			10 MHz	10	27
			15 MHz	-	28
			20 MHz	13	30
			30 MHz	-	30
			40 MHz	-	30
Austria, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, France, , Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Netherlands, Poland, Romania, Slovakia, Slovenia , Sweden	AP	Sector (18 dBi – 1dB cable loss)	5 MHz	-	24
			10 MHz	10	27*
			15 MHz	-	28
			20 MHz	13	30
			30 MHz	-	30
			40 MHz	-	30
Algeria	AP	Sector (18 dBi – 1dB cable loss)	5 MHz	-	30
			10 MHz	10	30
			15 MHz	-	30
			20 MHz	13	30
			30 MHz	-	30
			40 MH	-	30
Other	AP	Sector (18 dBi – 1dB cable loss)	5 MHz	-	No EIRP limit
			10 MHz	19	
			15 MHz	-	
			20 MHz	19	
			30 MHz	-	
			40 MH	-	

(*) At 5.4 GHz, EU regulations are harmonized. 5600 – 5650 MHz excluded, as ten minute Channel Availability Check (CAC) is required

Maximum transmit power 5.8 GHz band

Table 276 Default combined transmit power per Country – 5.8 GHz band PMP 450m Series

Countries	Device Type	Antenna Type	Channel BW	EIRP Limit (dBm)
USA, Other FCC	AP	Sector	5 MHz	36
			10 MHz	36
			15 MHz	36
			20 MHz	36
			40 MHz	36
Mexico	AP	Sector	5 MHz	30
			10 MHz	33
			15 MHz	34
			20 MHz	36
			40 MHz	36
Other	AP	Sector	5 MHz	42
			10 MHz	42
			15 MHz	42
			20 MHz	42
			40 MHz	42
ETSI	AP	Sector	5 MHz	30
			10 MHz	33
			15 MHz	34
			20 MHz	36
			40 MHz	36

Table 277 Default combined transmit power per country – 5.8 GHz band PMP/PTP 450i Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
	AP	Sector, Omni	5 MHz	-	36
			10 MHz	-	36
			15 MHz	-	36

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
USA, Canada, Brazil, Other FCC			20 MHz	-	36
			30 MHz	-	36
			40 MHz	-	36
	SM, BH	Flat plate, 4ft parabolic, 6ft parabolic	5 MHz	27	-
			10 MHz	27 (26 for 5733 MHz and below)	-
			15 MHz	27	-
			20 MHz	27	-
			30 MHz	27	-
			40 MHz	27	-
Mexico	Any	Any	5 MHz	-	30
			10 MHz	-	33
			15 MHz	-	34
			20 MHz	-	36
			30 MHz	-	36
			40 MHz	-	36
Other	Any	Any	5 MHz	27	-

Table 278 Default combined transmit power per country – 5.8 GHz band PMP 450b Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
FCC	SM	16 dBi	5 MHz	27	43
			10 MHz	27	43
			15 MHz	27	43
			20 MHz	27	43
			30 MHz	27	43
			40 MHz	27	43
ETSI	SM	16 dBi	5 MHz	27	30

			10 MHz	27	33
			15 MHz	27	34
			20 MHz	27	36
			30 MHz	27	36
			40 MHz	27	36
Other ETSI	SM	16 dBi	5 MHz	19	30
			10 MHz	19	33
			15 MHz	19	34
			20 MHz	19	36
			30 MHz	19	36
			40 MHz	19	36

Table 279 Default combined transmit power per country – 5.8 GHz band PMP 450 Series

Countries	Device Type	Antenna Type	Channel BW	Conducted Power Limit (dBm)	EIRP Limit (dBm)
Australia, India, United States	AP	Sector (18 dBi – 1dB cable loss)	5 MHz	19	36
			10 MHz	19	36
			15 MHz	-	36
			20 MHz	19	36
			30 MHz	-	36
Vietnam	AP	Sector (18 dBi – 1dB cable loss)	5 MHz	7	24
			10 MHz	10	27
			15 MHz	-	28
			20 MHz	13	30
			30 MHz	-	30
			40 MHz	-	30
Brazil	AP	Sector (18 dBi – 1dB cable loss)	5 MHz	-	36
			10 MHz	-	36
			15 MHz	-	36
			20 MHz	-	36
			30 MHz	-	36

			40 MHz	-	36
Canada	AP	Sector (18 dBi – 1dB cable loss)	5 MHz	9	26
			10 MHz	19	36
			15 MHz	-	36
			20 MHz	19	36
			30 MHz	-	36
			40 MHz	-	36
Denmark, Finland, Germany, Greece, Iceland, Ireland, Liechtenstein, Norway, Portugal, Serbia, Spain, Switzerland, United Kingdom,	AP	Sector (18 dBi – 1dB cable loss)	5 MHz	-	30
			10 MHz	16	33
			15 MHz	-	34
			20 MHz	19	36
			30 MHz	-	36
			40 MHz	-	36
Indonesia	AP	Sector (18 dBi – 1dB cable loss)	5 MHz	13	30
			10 MHz	19	33
			15 MHz	-	34
			20 MHz	19	36

Country specific frequency range

Frequency range 900 MHz band

Table 280 Frequency range per country – 900 MHz band

Region	Country	Channel center Frequency limits (MHz)	
		Lower	Upper
Other	Other	902	928
	Other-FCC	902	928
North America	Canada	902	928
	United States	902	928
	Mexico	902	928
	Puerto Rico	902	928
Oceania	Australia	915	928
	New Zealand	915 920.5 (7 MHz) 919.5 (5 MHz)	928 924.5 (7 MHz) 925.5 (5 MHz)
South America	Brazil	902 915	907.5 928
	Ecuador	902	928
	Colombia	902	928
	Panama	902	928
	Venezuela	902	928

Frequency range 2.4 GHz band

Table 281 Frequency range per country – 2.4 GHz band PMP/PTP 450 Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
Canada, United States, Other, Other-FCC	Any	5 MHz	2402.5	2481
		10 MHz	2405	2478.5
		15 MHz	2407.5	2476
		20 MHz	2410	2473.5
		30 MHz	2415	2468.5

Frequency range 3.5 GHz band

Table 282 Frequency range per country – 3.5 GHz band PMP/PTP 450/450i Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
Brazil, Other-ETSI	Any	5 MHz	3402.5	3597.5
		7 MHz	3403.5	3596.5
		10 MHz	3405	3595
		20 MHz	3410	3590
China, Indonesia	Any	5 MHz	3302.5	3397.5
		7 MHz	3303.5	3396.5
		10 MHz	3305	3395
		20 MHz	3310	3390

Frequency range 3.65 GHz band

Table 283 Frequency range per country – 3.65 GHz band PMP/PTP 450/450i Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
Australia, India, Other	Any	5 MHz	3302.5	3797.5
		7 MHz	3303.5	3796.5
		10 MHz	3305	3795
		15 MHz	3307.5	3792.5
		20 MHz	3310	3790
		30 MHz	3315	3785
		40 MHz	3320	3780
Other – ETSI	Any	5 MHz	3402.5	3847.5
		10 MHz	3405	3845
		15 MHz	3407.5	3842.5
		20 MHz	3410	3840
		30 MHz	3415	3835
		40 MHz	3420	3830
Indonesia	Any	5 MHz	3602.5	3797.5
		7 MHz	3603.5	3796.5
		10 MHz	3605	3795
		20 MHz	3610	3790
		40 MHz	3620	3780
Mexico	Any	5 MHz	3302.5	3747.5
		10 MHz	3305	3745
		20 MHz	3310	3740
		40 MHz	3320	3730

Frequency range 4.9 GHz band

Table 284 Frequency range per country – 4.9 GHz band PMP/PTP 450i/450b Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
USA, Mexico, Canada, Other FCC	Any	5 MHz	4942.5	4987.5
		10 MHz	4945	4985
		15 MHz	4947.5	4982.5
		20 MHz	4950	4980
Brazil	Any	5 MHz	4912.5	4987.5
		10 MHz	4915	4985
		15 MHz	4917.5	4982.5
		20 MHz	4920	4980
Other	Any	5 MHz	4942.5	4987.5
		10 MHz	4945	4985
		15 MHz	4947.5	4982.5
		20 MHz	4950	4980
		30 MHz	4955	4975
		40 MHz	4960	4970

Table 285 Frequency range per country – 4.9 GHz band PMP 450b Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
FCC	16 dBi	5 MHz	4942.5	4987.5
		10 MHz	4945	4985
		15 MHz	4947.5	4982.5
		20 MHz	4950	4980
		30 MHz	4955	4975
		40 MHz	4960	4970

Frequency range 5.1 GHz band

Table 286 Frequency range per country – 5.1 GHz band PMP/PTP 450i Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
United States, FCC	Any	5 MHz	5157.5	5247.5
		10 MHz	5160	5245
		15 MHz	5170	5242.5
		20 MHz	5170	5240
		30 MHz	5182.5	5235
		40 MHz	5187.5	5230
ETSI	Any	5 MHz	5155	5245
		10 MHz	5155	5245
		15 MHz	5157.5	5242.5
		20 MHz	5160	5240
Other	Any	5 MHz	5152.5	5247.5
		10 MHz	5155	5245
		15 MHz	5157.5	5242.5
		20 MHz	5160	5240
		30 MHz	5165	5235
		40 MHz	5170	5230

Table 287 Frequency range per country – 5.1 GHz band PMP 450b Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
FCC	16 dBi	5 MHz	5155	5247.5
		10 MHz	5155	5245
		15 MHz	5157.5	5242.5
		20 MHz	5160	5240
		30 MHz	5165	5235
		40 MHz	5170	5230

Table 288 Frequency range per country – 5.1 GHz band PMP 450m Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
United States, FCC	Any	5 MHz	5162.5	5247.5
		10 MHz	5160	5197.5
			5200	5245
		15 MHz	5165	5197.5
			5200	5242.5
		20 MHz	5170	5197.5
			5200	5240
ETSI	Any	5 MHz	5152.5 (1)	5247.5 (1)
		10 MHz	5155	5245
		15 MHz	5157.5	5242.5
		20 MHz	5160	5240
Other	Any	5 MHz	5152.5	5247.5
		10 MHz	5155	5245
		15 MHz	5157.5	5242.5
		20 MHz	5160	5240

Frequency range 5.2 GHz band

Table 289 Frequency range per country – 5.2 GHz band PMP/PTP 450i Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
United States, FCC	Any	5 MHz	5252.5	5342.5
		10 MHz	5255	5340
		15 MHz	5257.5	5335
		20 MHz	5260	5332.5
		30 MHz	5265	5332.5
		40 MHz	5270	5330
Other	Any	5 MHz	5252.5	5347.5
		10 MHz	5255	5345
		15 MHz	5257.5	5342.5
		20 MHz	5260	5340
		30 MHz	5265	5335
		40 MHz	5270	5330

Table 290 Frequency range per country – 5.2 GHz band PMP 450b Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
FCC	16 dBi	5 MHz	-	-
		10 MHz	5255	5340
		15 MHz	5257.5	5337.5
		20 MHz	5260	5337.5
		30 MHz	5265	5330
		40 MHz	5270	5330 (*)

(*) Last channel at full power is 5325. Channel centers 5327.5 and 5330 need a power backoff of 5 dB.

Table 291 Frequency range per country – 5.2 GHz band PMP 450m Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
United States, FCC	Any	5 MHz	5252.5	5347.5
		10 MHz	5255	5300
			5302.5	5340
		15 MHz	5257.5	5300
			5302.5	5335
		20 MHz	5260	5300
			5302.5	5340
Other	Any	5 MHz	5252.5	5347.5
		10 MHz	5255	5345
		15 MHz	5257.5	5342.5
		20 MHz	5260	5340

Frequency range 5.4 GHz band

Table 292 Frequency range per country – 5.4 GHz band PMP/PTP 450i Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
Mexico	Any	5 MHz	5472.5	5722.5
		10 MHz	5475	5720
		15 MHz	5477.5	5717.5
		20 MHz	5480	5715
		30 MHz	5485	5710
		40 MHz	5490	5685
Other	Any	5 MHz	5472.5	5722.5
		10 MHz	5475	5720
		15 MHz	5477.5	5717.5
		20 MHz	5480	5715
		30 MHz	5485	5710
		40 MHz	5490	5705
Other	FCC	5 MHz	5475	5720
		10 MHz	5477.5	5717.5
		15 MHz	5477.5	5717.5
		20 MHz	5480	5715
		30 MHz	5485	5710
		40 MHz	5490	5705
Other	ETSI	5 MHz	5472.5	5597.5
			5652.5	5722.5
		10 MHz	5475	5595
			5655	5720
		15 MHz	5477.5	5592.5
			5657.5	5717.5
		20 MHz	5480	5590
			5660	5715

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
Other	ETSI	30 MHz	5485	5585
			5665	5710
		40 MHz	5490	5580
			5670	5705

Table 293 Frequency range per country – 5.4 GHz band PMP 450b Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
FCC	16 dBi	5 MHz	-	-
		10 MHz	5477.5	5720
		15 MHz	5480	5717.5
		20 MHz	5482.5	5715
		30 MHz	5487.5	5710
		40 MHz	5490 (*)	5705
(*) First channel at full power is 5495. Channel centers 5490 and 5492.5 need a power backoff of 5 dB.				

Table 294 Frequency range per country – 5.4 GHz band PMP/PTP 450 Series

Region code	Country Code	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
Other	Any	5 MHz	5472.5	5722.5
		10 MHz	5475	5720
		15 MHz	5477.5	5717.5
		20 MHz	5480	5715
		30 MHz	5485	5710
		40 MHz	5490	5705
	Other-FCC (Any non-US country that follows FCC rules	5 MHz	5475	5720
		10 MHz	5477.5	5717.5
		15 MHz	5477.5	5717.5
		20 MHz	5480	5715
		30 MHz	5485	5710
		40 MHz	5490	5705
	Other-ETSI (Any country that follows ETSI rules	5 MHz	5472.5	5597.5
			5652.5	5722.5
		10 MHz	5475	5595
			5655	5720
		15 MHz	5477.5	5592.5
			5657.5	5717.5
		20 MHz	5460	5590
			5640	5715
		30 MHz	5485	5585
			5665	5710
		40 MHz	5490	5580
			5670	5705
Oceania	Australia	5 MHz	5472.5	5597.5
			5652.5	5722.5
		10 MHz	5475	5595
			5645	5720

Region code	Country Code	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
Oceania	Australia	15 MHz	5477.5	5592.5
			5657.5	5717.5
		20 MHz	5465	5490
			5640	5715
		30 MHz	5485	5585
			5665	5710
		40 MHz	5490	5580
			5670	5705
North America	Canada	10 MHz	5475	5597.5
			5655	5722.5
		15 MHz	5477.5	5592.5
			5657.5	5717.5
		20 MHz	5480	5590
			5660	5715
		30 MHz	5485	5585
			5665	5710
		40 MHz	5490	5580
			5670	5705
South America	Brazil	10 MHz	5475	5720
		15 MHz	5477.5	5717.5
		20 MHz	5480	5715
		30 MHz	5485	5710
		40 MHz	5490	5705
Asia	Vietnam	10 MHz	5475	5720
		15 MHz	5477.5	5717.5
		20 MHz	5480	5715
		30 MHz	5485	5710
		40 MHz	5490	5705

Region code	Country Code	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
Africa	Algeria	5 MHz	5472.5	5667.5
		10 MHz	5475	5665
		15 MHz	5477.5	5662.5
		20 MHz	5480	5660
		30 MHz	5485	5655
		40 MHz	5490	5650
Europe	Europe (Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Liechtenstein, Norway, Portugal, Serbia, Spain, Switzerland, United Kingdom)	10 MHz	5475	5595
			5655	5720
		15 MHz	5477.5	5592.5
			5657.5	5717.5
		20 MHz	5465	5490
			5660	5715
		30 MHz	5485	5585
			5665	5710
		40 MHz	5490	5580
			5670	5705

Table 295 Frequency range per country – 5.4 GHz band PMP 450m Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
United States, FCC	Any	5 MHz	5475	5720
		10 MHz	5475	5477.5
			5480	5720
		15 MHz	5477.5	5482.5
			5485	5717.5
		20 MHz	5480	5487.5
			5490	5715
ETSI	Any	5 MHz	5472.5	5597.5
			5652.5	5722.5
		10 MHz	5475	5595
			5655	5720
		15 MHz	5477.5	5592.5
			5657.5	5717.5
		20 MHz	5480	5590
			5660	5715
Other	Any	5 MHz	5472.5	5722.5
		10 MHz	5475	5720
		15 MHz	5477.5	5717.5
		20 MHz	5480	5715

Frequency range 5.8 GHz band

Table 296 Frequency range per country – 5.8 GHz band PMP/PTP 450i Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
USA, Canada, Brazil, Other FCC	Any	5 MHz	5730	5845
		10 MHz	5730	5845
		15 MHz	5732.5	5842.5
		20 MHz	5735	5840
		30 MHz	5740	5835
		40 MHz	5745	5830
Mexico	Any	5 MHz	5727.5	5847.5
		10 MHz	5730	5845
		15 MHz	5732.5	5842.5
		20 MHz	5735	5840
		30 MHz	5740	5835
		40 MHz	5745	5830
Other	Any	5 MHz	5727.5	5922.5
		10 MHz	5730	5920
		15 MHz	5732.5	5917.5
		20 MHz	5735	5915
		30 MHz	5740	5910
		40 MHz	5745	5905
ETSI	Any	5 MHz	5727.5	5872.5
		10 MHz	5730	5870
		15 MHz	5735	5867.5
		20 MHz	5737.5	5865
		30 MHz	5740	5860
		40 MHz	5745	5855

Table 297 Frequency range per country – 5.8 GHz band PMP 450b Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
FCC	16 dBi	5 MHz	5730	5845
		10 MHz	5730	5845
		15 MHz	5732.5	5842.5
		20 MHz	5735	5840
		30 MHz	5740	5835
		40 MHz	5745	5830

Table 298 Frequency range per country – 5.8 GHz band PMP/PTP 450 Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
Denmark, Norway, United Kingdom, Finland	Any	10 MHz	5730	5790
			5820	5845
		15 MHz	5732.5	5787.5
			5822.5	5842.5
		20 MHz	5735	5785
			5825	5840
		30 MHz	5740	5780
			5830	5835
		40 MHz	5745	5775
			5835	5830
Germany	Any	10 MHz	5760	5870
		15 MHz	5762.5	5867.5
		20 MHz	5765	5865
		30 MHz	5770	5860
		40 MHz	5775	5855
Spain	Any	10 MHz	5730	5790
			5820	5850
		15 MHz	5732.5	5787.5

			5822.5	5847.5
		20 MHz	5735	5785
			5825	5845
		30 MHz	5740	5780
			5830	5840
		40 MHz	5745	5775
			5835	5835
Greece	Any	10 MHz	5730	5790
		15 MHz	5732.5	5787.5
		20 MHz	5735	5785
		30 MHz	5740	5780
		40 MHz	5745	5775
Portugal, Iceland, Serbia	Any	10 MHz	5730	5870
		15 MHz	5732.5	5867.5
		20 MHz	5735	5865
		30 MHz	5740	5860
		40 MHz	5745	5855
Switzerland, Liechtenstein	Any	10 MHz	5730	5790
			5820	5870
		15 MHz	5732.5	5787.5
			5822.5	5867.5
		20 MHz	5735	5785
			5825	5865
		30 MHz	5740	5780
			5830	5860
		40 MHz	5745	5775
			5835	5855
Australia	Any	5 MHz	5727.5	5847.5
		10 MHz	5730	5845
		15 MHz	5732.5	5842.5
		20 MHz	5735	5840

		30 MHz	5740	5835
		40 MHz	5745	5830
Canada, United States	Any	5 MHz	5727.5	5847.5
		10 MHz	5730	5845
		15 MHz	5732.5	5842.5
		20 MHz	5735	5840
		30 MHz	5740	5835
		40 MHz	5745	5830
India	Any	5 MHz	5727.5	5872.5
		10 MHz	5730	5870
		15 MHz	5832.5	5867.5
		20 MHz	5735	5865
		30 MHz	5840	5860
		40 MHz	5845	5855
Brazil, Vietnam	Any	5 MHz	5727.5	5847.5
		10 MHz	5730	5845
		15 MHz	5732.5	5842.5
		20 MHz	5735	5840
		30 MHz	5740	5835
		40 MHz	5745	5830
Indonesia	Any	5 MHz	5727.5	5822.5
		10 MHz	5730	5820
		15 MHz	5732.5	5817.5
		20 MHz	5735	5815
Malaysia	Any	5 MHz	5727.5	5872.5
		10 MHz	5830	5870
		20 MHz	5835	5865

Table 299 Frequency range per country – 5.8 GHz band PMP 450m Series

Countries	Antenna Type	Channel BW	Channel center Frequency limits (MHz)	
			Lower	Upper
United States, FCC	Any	5 MHz	5730	5845
		10 MHz	5730	5845
		15 MHz	5732.5	5842.5
		20 MHz	5735	5840
ETSI	Any	5 MHz	5727.5	5872.5
		10 MHz	5730	5870
		15 MHz	5735	5867.5
		20 MHz	5737.5	5865
Other	Any	5 MHz	5727.5	5922.5
		10 MHz	5730	5920
		15 MHz	5732.5	5917.5
		20 MHz	5735	5915

FCC specific information

FCC compliance testing

With GPS synchronization installed, the system has been tested for compliance to US (FCC) specifications. It has been shown to comply with the limits for emitted spurious radiation for a Class B digital device, pursuant to Part 15 of the FCC Rules in the USA. These limits have been designed to provide reasonable protection against harmful interference. However the equipment can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to other radio communications. There is no guarantee that interference does not occur in a particular installation.

Note

A Class B Digital Device is a device that is marketed for use in a residential environment, notwithstanding use in commercial, business and industrial environments.

Note

Notwithstanding that Cambium has designed (and qualified) the 450 Platform Family ODUs to generally meet the Class B requirement to minimize the potential for interference, the 450 Platform Family ODU range is not marketed for use in a residential environment.

FCC IDs

Table 300 US FCC IDs

FCC ID	Product	Frequency Band	Channel Bandwidth	Frequencies	Maximum Combined Tx Output Power
Z8H89FT0021 and Z8H89FT0022	900 MHz PMP 450i AP & PMP 450 SM	900 MHz	5 MHz	904.5 – 925.5 MHz	25 dBm
			7 MHz	905.5 – 924.5 MHz	25 dBm
			10 MHz	907.0 – 923.0 MHz	25 dBm
			15 MHz	909.5 – 920.5 MHz	25 dBm
			20 MHz	912.0 – 918.0 MHz	25 dBm
Z8H89FT0003 and Z8H89FT004	2.4 GHz PMP 450 AP & SM	2.4 GHz	5 MHz	2402.5 – 2480.0 MHz	19 dBm
			10 MHz	2405.0 – 2477.5 MHz	19 dBm
			15 MHz	2407.5 – 2475.0 MHz	19 dBm
			20 MHz	2410.0 – 2472.5 MHz	19 dBm
			30 MHz	2415.0 – 2467.5 MHz	19 dBm
		3.5 GHz	5 MHz	3452.5 – 3647.5 MHz	25 dBm

FCC ID	Product	Frequency Band	Channel Bandwidth	Frequencies	Maximum Combined Tx Output Power
Z8H89FT0009 and Z8H89FT0010	3.5 GHz PMP 450i AP & SM		7 MHz	3453.5 – 3646.5 MHz	25 dBm
			10 MHz	3455.0 – 3645 MHz	25 dBm
			15 MHz	3457.5 – 3642.5 MHz	25 dBm
			20 MHz	3460.0 – 3640 MHz	25 dBm
			30 MHz	3465.0 – 3635 MHz	25 dBm
			40 MHz	3470.0 – 3630 MHz	25 dBm
	3.65 GHz PMP 450i AP & SM	3.65 GHz	5 MHz	3652.5 -3697.5 MHz	19 dBm
			7 MHz	3653.5 – 3696.5 MHz	21 dBm
			10 MHz	3655.0 – 3695.0 MHz	22 dBm
			15 MHz	3657.5 – 3692.5 MHz	24 dBm
			20 MHz	3660.0 – 3690.0 MHz	25 dBm
			30 MHz	3665.0 – 3685.0 MHz	25 dBm
			40 MHz	3670.0 – 3680.0 MHz	25 dBm
Z8H89FT0009 and Z8H89FT0010	3.5 GHz PMP 450 AP & SM	3.5 GHz	5 MHz	3452.5 – 3647.5 MHz	22 dBm
			7 MHz	3453.5 – 3646.5 MHz	22 dBm
			10 MHz	3455.0 – 3645 MHz	22 dBm
			15 MHz	3457.5 – 3642.5 MHz	22 dBm
			20 MHz	3460.0 – 3640 MHz	22 dBm
			30 MHz	3465.0 – 3635 MHz	22 dBm
			40 MHz	3470.0 – 3630 MHz	22 dBm
	3.65 GHz PMP 450 AP & SM	3.65 GHz	5 MHz	3652.5 -3697.5 MHz	19 dBm
			7 MHz	3653.5 – 3696.5 MHz	21 dBm
			10 MHz	3655.0 – 3695.0 MHz	22 dBm
			15 MHz	3657.5 – 3692.5 MHz	22 dBm
			20 MHz	3660.0 – 3690.0 MHz	22 dBm
			30 MHz	3665.0 – 3685.0 MHz	22 dBm
			40 MHz	3670.0 – 3680.0 MHz	22 dBm
	5 GHz	4.9 GHz	5 MHz	4942.5 – 4987.5 MHz	27 dBm

FCC ID	Product	Frequency Band	Channel Bandwidth	Frequencies	Maximum Combined Tx Output Power
Z8H89FT0001, Z8H89FT0002 and QWP-50450I	PMP 450/ 450i AP, SM & PTP 450/450i BH	(PMP/PTP 450i only)	10 MHz	4945.0 – 4985.0 MHz	27 dBm
			15 MHz	4947.5 – 4982.5 MHz	27 dBm
			20 MHz	4950.0 – 4980.0 MHz	27 dBm
			30 MHz	4955.0 – 4975.0 MHz	27 dBm
			40 MHz	4960.0 – 4970.0 MHz	27 dBm
		5.1 GHz (PMP/PTP 450i only)	NOTE Maximum transmission power for US is 19 dBm.		
			5 MHz	5157.5 – 5247.5 MHz	27 dBm
			10 MHz	5160.0 – 5245.0 MHz	27 dBm
			15 MHz	5162.5 – 5242.5 MHz	27 dBm
			20 MHz	5165.0 – 5240.0 MHz	27 dBm
			30 MHz	5170.0 – 5235.0 MHz	27 dBm
			40 MHz	5175.0 – 5230.0 MHz	27 dBm
		5.2 GHz (PMP/PTP 450i only)	NOTE Maximum transmission power for FCC/US/Mexico is 19 dBm.		
			5 MHz	5252.5 – 5347.5 MHz	27 dBm
			10 MHz	5255.0 – 5345.0 MHz	27 dBm
			15 MHz	5257.5 – 5342.5 MHz	27 dBm
			20 MHz	5260.0 – 5340.0 MHz	27 dBm
			30 MHz	5265.0 – 5335.0 MHz	27 dBm
			40 MHz	5270.0 – 5330.0 MHz	27 dBm
	5 GHz	5.4 GHz	NOTE Maximum transmission power for: • US/FCC is 19 dBm		

FCC ID	Product	Frequency Band	Channel Bandwidth	Frequencies	Maximum Combined Tx Output Power
Z8H89FT0001, Z8H89FT0002 and QWP-50450I	PMP 450i AP, SM & PTP 450i BH		• Australia/ETSI is 25 for 5 MHz Channel bandwidth as a result of restricted EIRP limit		
			5 MHz	5475.0 – 5720.0 MHz	27 dBm
			10 MHz	5477.5 –5717.5 MHz	27 dBm
			15 MHz	5477.5 – 5717.5 MHz	27 dBm
			20 MHz	5480.0 – 5715.0 MHz	27 dBm
			30 MHz	5485.0 – 5710 MHz	27 dBm
			40 MHz	5490.0 – 5705 MHz	27 dBm
		5.8 GHz	5 MHz	5730.0 – 5872.5 MHz	27 dBm
			10 MHz	5730.0 – 5870.0 MHz	27 dBm
			15 MHz	5732.5 – 5867.5 MHz	27 dBm
			20 MHz	5735.0 – 5865.0 MHz	27 dBm
			30 MHz	5740.0 – 5860.0 MHz	27 dBm
			40 MHz	5745.0 – 5855.0 MHz	27 dBm
Z8H89FT0032	5 GHz PMP 450b SM	4.9 GHz	5 MHz	4942.5 – 4987.5 MHz	27 dBm
			10 MHz	4945.0 – 4985.0 MHz	27 dBm
			15 MHz	4947.5 – 4982.5 MHz	27 dBm
			20 MHz	4950.0 – 4980.0 MHz	27 dBm
			30 MHz	4955.0 – 4975.0 MHz	27 dBm
			40 MHz	4960.0 – 4970.0 MHz	27 dBm
		5.1 GHz	5 MHz	5157.5 – 5247.5 MHz	27 dBm
			10 MHz	5160.0 – 5245.0 MHz	27 dBm
			15 MHz	5162.5 – 5242.5 MHz	27 dBm
			20 MHz	5165.0 – 5240.0 MHz	27 dBm
			30 MHz	5170.0 – 5235.0 MHz	27 dBm
			40 MHz	5175.0 – 5230.0 MHz	27 dBm
Z8H89FT0032	5 GHz	5.2 GHz	5 MHz	5252.5 – 5347.5 MHz	27 dBm

FCC ID	Product	Frequency Band	Channel Bandwidth	Frequencies	Maximum Combined Tx Output Power
	PMP 450b SM		10 MHz	5255.0 – 5345.0 MHz	27 dBm
			15 MHz	5257.5 – 5342.5 MHz	27 dBm
			20 MHz	5260.0 – 5340.0 MHz	27 dBm
			30 MHz	5265.0 – 5335.0 MHz	27 dBm
			40 MHz	5270.0 – 5330.0 MHz	27 dBm
		5.4 GHz	5 MHz	5475.0 – 5720.0 MHz	27 dBm
			10 MHz	5477.5 –5717.5 MHz	27 dBm
			15 MHz	5477.5 – 5717.5 MHz	27 dBm
			20 MHz	5480.0 – 5715.0 MHz	27 dBm
			30 MHz	5485.0 – 5710 MHz	27 dBm
			40 MHz	5490.0 – 5705 MHz	27 dBm
		5.8 GHz	5 MHz	5730.0 – 5872.5 MHz	27 dBm
			10 MHz	5730.0 – 5870.0 MHz	27 dBm
			15 MHz	5732.5 – 5867.5 MHz	27 dBm
			20 MHz	5735.0 – 5865.0 MHz	27 dBm
			30 MHz	5740.0 – 5860.0 MHz	27 dBm
			40 MHz	5745.0 – 5855.0 MHz	27 dBm
Z8H89FT0001, Z8H89FT0002 and QWP-50450I	5 GHz PMP 450 AP, SM & PTP 450 BH	5.4 GHz	10 MHz	4945.0 – 4985.0 MHz	27 dBm
			15 MHz	4947.5 – 4982.5 MHz	27 dBm
			20 MHz	4950.0 – 4980.0 MHz	27 dBm
			30 MHz	4955.0 – 4975.0 MHz	27 dBm
			40 MHz	4960.0 – 4970.0 MHz	27 dBm
			40 MHz	5490.0 – 5705 MHz	22 dBm
		5.8 GHz	NOTE Maximum transmission power for FCC/US/Mexico is 19 dBm.		

FCC ID	Product	Frequency Band	Channel Bandwidth	Frequencies	Maximum Combined Tx Output Power
Z8H89FT0001, Z8H89FT0002 and QWP-50450I	5 GHz PMP 450 AP, SM & PTP 450 BH	5.8 GHz	5 MHz	5730.0 – 5872.5 MHz	22 dBm
			10 MHz	5730.0 – 5870.0 MHz	22 dBm
			15 MHz	5732.5 – 5867.5 MHz	22 dBm
			20 MHz	5735.0 – 5865.0 MHz	22 dBm
			30 MHz	5740.0 – 5860.0 MHz	22 dBm
			40 MHz	5745.0 – 5855.0 MHz	22 dBm

(*) 27 dBm conducted power for 450i Series and 22 dBm conducted power for 450 Series

FCC approved antenna list

The lists of antennas which have been approved for operation by the FCC are provided in:

- Table 301 for 4.9 GHz
- Table 302 for 5.1 and 5.2 GHz
- Table 303 for 5.4 GHz
- Table 304 for 5.8 GHz

Note

Any antenna of the same type and of gain equal or lower than the one approved by the FCC can be used in the countries following the FCC rules.

Table 301 USA approved antenna list 4.9 GHz

Directivity	Type	Manufacturer	Reference	Stated Gain (dBi)
Directional	Integrated flat plate	Cambium Networks	N/A	23.0
	2 ft dual polarised flat plate	Mars Antennas	MA-WA56-DP-28N	28.0
	4 ft parabolic dual polarised	Gabriel Antennas	Dual QuickFire QFD4-49-N	33.7
	6 ft parabolic dual polarised	Gabriel Antennas	QuickFire QF6-49-N	37.2
Sector	Integrated 90° sector flat plate	Cambium Networks	A005240	16.0
	90° sectorised	Cambium Networks	85009324001	17.0
	60° sectorised	Cambium Networks	85009325001	17.0
Omni-directional	Dual polar omni-directional	KP	KPPA-5.7-DPOMA	13.0

Table 302 USA approved antenna list 5.1 and 5.2 GHz

Directivity	Type	Manufacturer	Reference	Stated Gain (dBi)
Directional	Integrated flat plate	Cambium Networks	N/A	23.0
	2ft dual polarised flat plate	Mars Antennas	MA-WA56-DP-28N	28.5
	4ft parabolic dual polarised	Gabriel Antennas	PX4F-52-N7A/A	34.5
Sector	Integrated 90° sector flat plate	Cambium Networks	A005240	16.0
	90° sectorised	Cambium Networks	85009324001	17.0
Omni-directional	Dual polar omni-directional	KP	KPPA-5.7-DPOMA	13.0
	Dual polar omni-directional	Mars Antennas	MA-WO56-DP10	10.0

Table 303 USA approved antenna list 5.4 GHz

Directivity	Type	Manufacturer	Reference	Stated Gain (dBi)
Directional	Integrated flat plate	Cambium Networks	N/A	23.0
	2 ft dual polarised flat plate	Mars Antennas	MA-WA56-DP-28N	28.5
	2 ft dual polarised parabolic	MTI	MT-486013-NVH	28.5
Sector	Integrated 90° sector flat plate	Cambium Networks	A005240	16.0
	90° sectorised	Cambium Networks	85009324001	17.0
Omni-directional	Dual polar omni-directional	KP	KPPA-5.7-DPOMA	13.0
	Dual polar omni-directional	Mars Antennas	MA-WO56-DP10	10.0

Table 304 USA approved antenna list 5.8 GHz

Directivity	Type	Manufacturer	Reference	Stated Gain (dBi)
Directional	Integrated flat plate	Cambium Networks	N/A	23.0
	2 ft dual polarised flat plate	Mars Antennas	MA-WA56-DP-28N	28.0
	4 ft parabolic dual polarised	Gabriel Antennas	PX4F-52-N7A/A	35.3
	6 ft Parabolic dual polarised	Gabriel Antennas	PX6F-52/A	38.1
Sector	Integrated 90° sector flat plate	Cambium Networks	A005240	16.0
	90° sectorised	Cambium Networks	85009324001	17.0
	60° sectorised	Cambium Networks	85009325001	17.0
Omni-directional	Dual polar omni-directional	KP	KPPA-5.7-DPOMA	13.0

Innovation Science and Economic Development Canada (ISEDC) specific information

900 MHz ISEDC notification

Radio Standards Specification RSS-247, Issue 1, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices, is a new standard to replace annexes 8 and 9 of RSS-210, Issue 8.

4.9 GHz ISEDC notification

The system has been approved under ISEDC RSS-111 for Public Safety Agency usage. The installer or operator is responsible for obtaining the appropriate site licenses before installing or using the system.

Utilisation de la bande 4.9 GHz FCC et ISEDC

Le système a été approuvé en vertu d’ ISEDC RSS-111 pour l'utilisation par l'Agence de la Sécurité publique. L'installateur ou l'exploitant est responsable de l'obtention des licences de appropriées avant d'installer ou d'utiliser le système.

5.2 GHz and 5.4 GHz ISEDC notification

This device complies with ISEDC RSS-247. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation. Users should be cautioned to take note that high power radars are allocated as primary users (meaning they have priority) of 5250 – 5350 MHz and 5650 – 5850 MHz and these radars could cause interference and/or damage to license-exempt local area networks (LELAN).

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 equivalent isotropically radiated power (EIRP) is not more than that permitted by the regulations. The transmitted power must be reduced to achieve this requirement.

Utilisation de la bande 5.2 and 5.4 GHz ISEDC

Cet appareil est conforme à ISEDC RSS-247. Son fonctionnement est soumis aux deux conditions suivantes: (1) Ce dispositif ne doit pas causer d'interférences nuisibles, et (2) Cet appareil doit tolérer toute interférence reçue, y compris les interférences pouvant entraîner un fonctionnement indésirable. Les utilisateurs doivent prendre garde au fait que les radars à haute puissance sont considères comme les utilisateurs prioritaires de 5250 à 5350 MHz et 5650 à 5850 MHz et ces radars peuvent causer des interférences et / ou interférer avec un réseau local ne nécessitant pas de licence.

Pour la version du produit avec 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 à celle permise par la règlementation. Il peut être nécessaire de réduire la puissance transmise doit être réduite pour satisfaire cette exigence.

ISEDC notification 5.8 GHz

RSS-GEN issue 3 (7.1.3) Licence-Exempt Radio Apparatus:

> This device complies with ISEDC license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

In Canada, high power radars are allocated as primary users (meaning they have priority) of the 5600 – 5650 MHz spectrum. These radars could cause interference or damage to license-exempt local area network (LE-LAN) devices.

Utilisation de la bande 5.8 GHz ISEDC

RSS-GEN issue 3 (7.1.3) appareil utilisant la bande sans licence:

> *Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.*

Au Canada, les radars à haute puissance sont désignés comme utilisateurs principaux (ils ont la priorité) dans la bande 5600 à 5650 MHz. Ces radars peuvent causer des interférences et / ou interférer avec un réseau local ne nécessitant pas de licence.

ISEDC certification numbers

Table 305 ISEDC Certification Numbers

ISEDC Cert.	Product	Frequency Band	Channel Bandwidth	Frequencies	Maximum Combined Tx Output Power
109AO-50450I (Pending)	5 GHz AP, SM & BHM	4.9 GHz	5 MHz	4942.5 – 4987.5 MHz	24 dBm
			10 MHz	4945.0 – 4985.0 MHz	24 dBm
			20 MHz	4950.0 – 4980.0 MHz	23.5 dBm
		5.8 GHz	5 MHz	5730.0 – 5845.0 MHz	28 dBm
			10 MHz	5730.0 – 5845.0 MHz	28 dBm
			20 MHz	5735.0 – 5840.0 MHz	28 dBm

Canada approved antenna list

Under ISEDC regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by ISEDC . To reduce potential radio interference to other users, the antenna type and its gain must be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (PIRE) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

This radio transmitter (identify the device by certification number) has been approved by ISEDC to operate with the antenna types listed in Country specific radio regulations, Innovation Science and Economic Development Canada (ISEDC) , Table 306 with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio (identifier le dispositif par son numéro de certification) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans la section Country specific radio regulations, Innovation Science and Economic Development Canada (ISEDC) , Table 306 et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Table 306 Canada approved antenna list 4.9 and 5.8 GHz

Antenna type	Description	Manufacturer	Reference	Gain (dBi)	
				4.9 GHz	5.8 GHz
Directional	Integrated flat plate	Cambium Networks	N/A	23	23
	2 ft dual polarised flat plate	MARS Antennas	MA-WA56-DP-28N	28.5	28
	4 ft parabolic dual polarised	Andrews Antennas	PX4F-52-N7A/A	N/A	35.3
	6 ft Parabolic dual polarised	Gabriel Antennas	QF6-49-N	37.2	N/A
Sector	Integrated 90° sector flat plate	Cambium Networks	A005240	16	16
	90°sector	Cambium Networks	85009324001	17	17
	60° sectorised	Cambium Networks	85009325001	16	16
Omni-directional	Omni-directional	KP Antennas	KPPA-5.7-DPOMA	13	13
	Omni-directional	MARS Antennas	MA-WO56-DP10	10	10

Table 307 Canada approved antenna list 5.2 and 5.4 GHz

Directivity	Type	Manufacturer	Reference	Stated Gain (dBi)
Directional	Integrated flat plate	Cambium Networks	N/A	23.0
	2ft dual polarised flat plate	Mars Antennas	MA-WA56-DP-28N	28.5
	2ft dual polarised parabolic	MTI	MT-486013-NVH	28.5
Sector	Integrated 90° sector flat plate	Cambium Networks	A005240	16.0
	90° sectorised	Cambium Networks	85009324001	17.0
Omni-directional	Dual polar omni-directional	KP	KPPA-5.7-DPOMA	13.0
	Dual polar omni-directional	Mars Antennas	MA-WO56-DP10	10.0

Chapter 11: Troubleshooting

This chapter contains procedures for identifying and correcting faults in a 450 Platform Family link. These procedures can be performed either on a newly installed link, or on an operational link if communication is lost, or after a lightning strike.

The following topics are described in this chapter:

General troubleshooting procedure

General planning for troubleshooting

Effective troubleshooting depends in part on measures that you take before you experience trouble in your network. Cambium recommends the following measures for each site:

- Identify troubleshooting tools that are available at your site (such as a protocol analyzer).
- Identify commands and other sources that can capture baseline data for the site. These may include:
  - Ping
  - Tracert or traceroute
  - Link Capacity Test results
  - Throughput data
  - Configuration tab captures
  - Status tab captures
  - Session logs
  - Web browser used
- Start a log for the site.
- Include the following information in the log:
  - Operating procedures
  - Site-specific configuration records
  - Network topology
  - Software releases, boot versions and FPGA firmware versions
  - Types of hardware deployed
  - Site-specific troubleshooting processes
  - Escalation procedures
- Capture baseline data into the log from the sources listed above

General fault isolation process

Effective troubleshooting also requires an effective fault isolation methodology that includes the following:

- Attempting to isolate the problem to the level of a system, subsystem, or link, such as
  - AP to SM
  - AP to CMM4
  - AP to GPS
  - Backhaul(BH)
  - Backhaul(BH) to CMM4
  - Power
- Researching Event Logs of the involved equipment
- Interpreting messages in the Event Log
- Answering the questions listed in the following sections.
- Reversing the last previous corrective attempt before proceeding to the next.
- Performing only one corrective attempt at a time.

Questions to help isolate the problem

When a problem occurs, attempt to answer the following questions:

- What is the history of the problem?
  - Have we changed something recently?
  - Have we seen other symptoms before this?
- How wide-spread is the symptom?
  - Is the problem on only a single SM? (If so, focus on that SM.)
  - Is the problem on multiple SMs? If so

    is the problem on one AP in the cluster? (If so, focus on that AP)

    is the problem on multiple, but not all, APs in the cluster? (If so, focus on those APs)

    is the problem on all APs in the cluster? (If so, focus on the CMM4 and the GPS signal.)
- Based on data in the Event Log
  - does the problem correlate to External Hard Resets with no WatchDog timers? (If so, this indicates a loss of power. Correct your power problem.)
  - is intermittent connectivity indicated? (If so, verify your configuration, power level, cables and connections and the speed duplex of both ends of the link).
  - does the problem correlate to loss-of-sync events?
- Are connections made via *shielded* cables?
- Does the GPS antenna have an *unobstructed* view of the entire horizon?
- Has the site grounding been verified?

Secondary Steps

After preliminary fault isolation is completed through the above steps, follow these:

- Check the Canopy knowledge base (https://support.cambiumnetworks.com/forum) to find whether other network operators have encountered a similar problem.
- Proceed to any appropriate set of diagnostic steps. These are organized as follows:
  - Module has lost or does not establish connectivity on page 11-5
  - NAT/DHCP-configured SM has lost or does not establish connectivity on page 11-7
  - SM Does Not Register to an AP on page 11-8
  - Module has lost or does not gain sync on page 11-9
  - Module does not establish Ethernet connectivity on page 11-10
  - CMM4 does not pass proper GPS sync to connected modules on page 11-11
  - Module Software Cannot be Upgraded on page 11-12
  - Module Functions Properly, Except Web Interface Became Inaccessible on page 11-12

Troubleshooting procedures

Proceed to any appropriate set of diagnostic steps. These are organized as follows:

Module has lost or does not establish connectivity

To troubleshoot a loss of connectivity, perform the following steps:

Procedure 37 Troubleshooting loss of connectivity

1. Isolate the end user/SM from peripheral equipment and variables such as routers, switches and firewalls.
2. Set up the minimal amount of equipment.
3. On each end of the link:
   - Check the cables and connections.
   - Verify that the cable/connection scheme—straight-through or crossover—is correct.
   - Verify that the LED labeled LNK is green.
   - Access the General Status tab in the Home page of the module.
   - Verify that the SM is registered.
   - Verify that Received Power Level is -87 dBm or higher.
   - Access the IP tab in the Configuration page of the module.
   - Verify that IP addresses match and are in the same subnet.
   - If RADIUS authentication is configured, ensure that the RADIUS server is operational

4 On the SM end of the link:

- Verify that the PC that is connected to the SM is correctly configured to obtain an IP address through DHCP.
- Execute **ipconfig** (Windows) or **ifconfig** (linux)
- Verify that the PC has an assigned IP address.

5 On each end of the link:

- Access the **General** tab in the Configuration page of each module.
- Verify that the setting for **Link Speeds** (or negotiation) matches that of the other module.
- Access the **Radio** tab in the Configuration page of each module.
- Verify that the **Radio Frequency Carrier** setting is checked in the Custom Radio Frequency Scan Selection List.
- Verify that the **Color Code** setting matches that of the other module.
- Access the browser LAN settings (for example, at **Tools > Internet Options > Connections > LAN Settings** in Internet Explorer).
- Verify that none of the settings are selected.
- Access the **Link Capacity Test** tab in the Tools page of the module.
- Perform a link test
- Verify that the link test results show efficiency greater than 90% in both the uplink and downlink
- Execute **ping**.
  - Verify that no packet loss was experienced.
  - Verify that response times are not significantly greater than
    - 4 ms from AP to SM
    - 15 ms from SM to AP
  - Replace any cables that you suspect may be causing the problem.

Note

A ping size larger than 1494 Bytes to a module times out and fails. However, a ping of this size or larger to a system that is behind a Canopy module typically succeeds. It is generally advisable to ping such a system, since Canopy handles that ping with the same priority as is given all other transport traffic. The results are unaffected by ping size and by the load on the Canopy module that brokers this traffic.

6 After connectivity has been re-established, reinstall network elements and variables that you removed in Step 1.

NAT/DHCP-configured SM has lost or does not establish connectivity

Before troubleshooting this problem, identify the NAT/DHCP configuration from the following list:

- 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

To troubleshoot a loss of connectivity for a SM configured for NAT/DHCP, perform the following steps.

Procedure 38 Troubleshooting loss of connectivity for NAT/DHCP-configured SM

1. Isolate the end user/SM from peripheral equipment and variables such as routers, switches and firewalls.
2. Set up the minimal amount of equipment.
3. On each end of the link:
   - Check the cables and connections.
   - Verify that the cable/connection scheme—straight-through or crossover—is correct.
   - Verify that the LED labeled LNK is green.
4. At the SM:
   - Access the NAT Table tab in the Logs web page.
   - Verify that the correct NAT translations are listed.
     RESULT: NAT is eliminated as a possible cause if these translations are correct.
5. If this SM is configured for NAT with DHCP, then at the SM:
   - Execute **`ipconfig`** (Windows) or **`ifconfig`** (Linux)
   - Verify that the PC has an assigned IP address.
   - If the PC *does not* have an assigned IP address, then
     - enter ipconfig /release *"Adapter Name"*.
     - enter ipconfig /renew *"Adapter Name"*.
     - reboot the PC.
     - after the PC has completed rebooting, execute **`ipconfig`**
     - if the PC has an assigned IP address, then
     - access the NAT DHCP Statistics tab in the Statistics web page of the SM.
     - verify that DHCP is operating as configured.
6. After connectivity has been re-established, reinstall network elements and variables that you removed in Step 1.

SM Does Not Register to an AP

To troubleshoot a SM failing to register to an AP, perform the following steps.

Procedure 39 Troubleshooting SM failing to register to an AP

1. Access the Radio tab in the Configuration page of the SM.
2. Note the **Color Code** of the SM.
3. Access the Radio tab in the Configuration page of the AP.
4. Verify that the **Color Code** of the AP matches that of the SM.
5. Note the **Radio Frequency Carrier** of the AP.
6. Verify that the value of the **RF Frequency Carrier** of the AP is selected in the **Custom Radio Frequency Scan Selection List** parameter in the SM.
7. In the AP, verify that the **Max Range** parameter is set to a distance slightly greater than the distance between the AP and the furthest SM that must register to this AP.
8. Verify that no obstruction significantly penetrates the Fresnel zone of the attempted link.
9. Access the **General Status** tab in the Home page of each module.
10. Remove the bottom cover of the SM to expose the LEDs.
11. Power cycle the SM.
    RESULT: Approximately 25 seconds after the power cycle, the green LED labeled LNK must light to indicate that the link has been established. If the orange LED labeled SYN is lit instead, then the SM is in Alignment mode because the SM failed to establish the link.
12. If the AP is configured to require authentication, ensure proper configuration of RADIUS or Pre-shared AP key.
13. In this latter case and if the SM has encountered no customer-inflicted damage, then request an RMA for the SM.

Module has lost or does not gain sync

To troubleshoot a loss of sync, perform the following steps.

Procedure 40 Troubleshooting loss of sync

1. Access the Event Log tab in the Home page of the SM
2. Check for messages with the following format:
   RcvFrmNum =
   ExpFrmNum =
3. If these messages are present, check the Event Log tab of another SM that is registered to the same AP for messages of the same type.
4. If the Event Log of this second SM *does not* contain these messages, then the fault is isolated to the first SM.

   If the Event Log page of this second SM contains these messages, access the GPS Status page of the AP.
5. If the **Satellites Tracked** field in the GPS Status page of the AP indicates fewer than 4 or the **Pulse Status** field does not indicate Generating Sync, check the GPS Status page of another AP in the same AP cluster for these indicators. GPS signal acquisition must not take longer than 5 minutes from unit startup.
6. If these indicators are present in the second AP, then:
   - Verify that the GPS antenna still has an unobstructed view of the entire horizon.
   - Visually inspect the cable and connections between the GPS antenna and the CMM4. If this cable is not shielded, replace the cable with shielded cable
7. If these indicators *are not* present in the second AP, visually inspect the cable and connections between the CMM4 and the AP antenna. If this cable is not shielded, replace the cable with shielded cable.

Module does not establish Ethernet connectivity

To troubleshoot a loss of Ethernet connectivity, perform the following steps:

Procedure 41 Troubleshooting loss of Ethernet connectivity

1. Verify that the connector crimps on the Ethernet cable are not loose.
2. Verify that the Ethernet cable is not damaged.
3. If the Ethernet cable connects the module to a network interface card (NIC), verify that the cable is pinned out as a straight-through cable.
4. If the Ethernet cable connects the module to a hub, switch, or router, verify that the cable is pinned out as a crossover cable.
5. Verify that the Ethernet port to which the cable connects the module is set to auto-negotiate speed.
6. Verify VLAN configuration in the network, which may cause loss of module access if the accessing device is on a separate VLAN from the radio.
7. Power cycle the module.
   RESULT: Approximately 25 seconds after the power cycle, the green LED labeled LNK must light up to indicate that the link has been established. If the orange LED labeled SYN is lit instead, then the module is in Alignment mode because the module failed to establish the link.
8. In this latter case and if the module has encountered no customer-inflicted damage, then request an RMA for the module.

CMM4 does not pass proper GPS sync to connected modules

If the Event Log tabs in all connected modules contain Loss of GPS Sync Pulse messages, perform the following steps.

Procedure 42 Troubleshooting CMM4 not passing sync

1. Verify that the GPS antenna has an unobstructed view of the entire horizon.
2. Verify that the GPS coaxial cable meets specifications.
3. Verify that the GPS sync cable meets specifications for wiring and length.
4. If the web pages of connected modules indicate any of the following, then find and eliminate the source of noise that is being coupled into the GPS sync cable:
   - In the GPS Status page:
     - anomalous number of **Satellites Tracked** (greater than 12, for example)
     - incorrect reported **Latitude** and/or **Longitude** of the antenna
   - In the Event Log page:
     - garbled GPS messages
     - large number of Acquired GPS Sync Pulse messages

   GPS signal acquisition must not take longer than 5 minutes from unit startup.
5. If these efforts fail to resolve the problem, then request an RMA for the CMM4.

Module Software Cannot be Upgraded

If your attempt to upgrade the software of a module fails, perform the following steps.

Procedure 43 Troubleshooting an unsuccessful software upgrade

1. Download the latest issue of the target release and the associated release notes.
2. Verify that the latest version of CNUT is installed.
3. Compare the files used in the failed attempt to the newly downloaded software.
4. Compare the procedure used in the failed attempt to the procedure in the newly downloaded release notes.
5. If these comparisons reveal a difference, retry the upgrade, this time with the newer file or newer procedure.
6. If, during attempts to upgrade the FPGA firmware, the following message is repeatable, then request an RMA for the module:

   ```
   Error code 6, unrecognized device
   ```

Module Functions Properly, Except Web Interface Became Inaccessible

If a module continues to pass traffic and the SNMP interface to the module continues to function, but the web interface to the module does not display, perform the following steps:

Procedure 44 Restoring web management GUI access

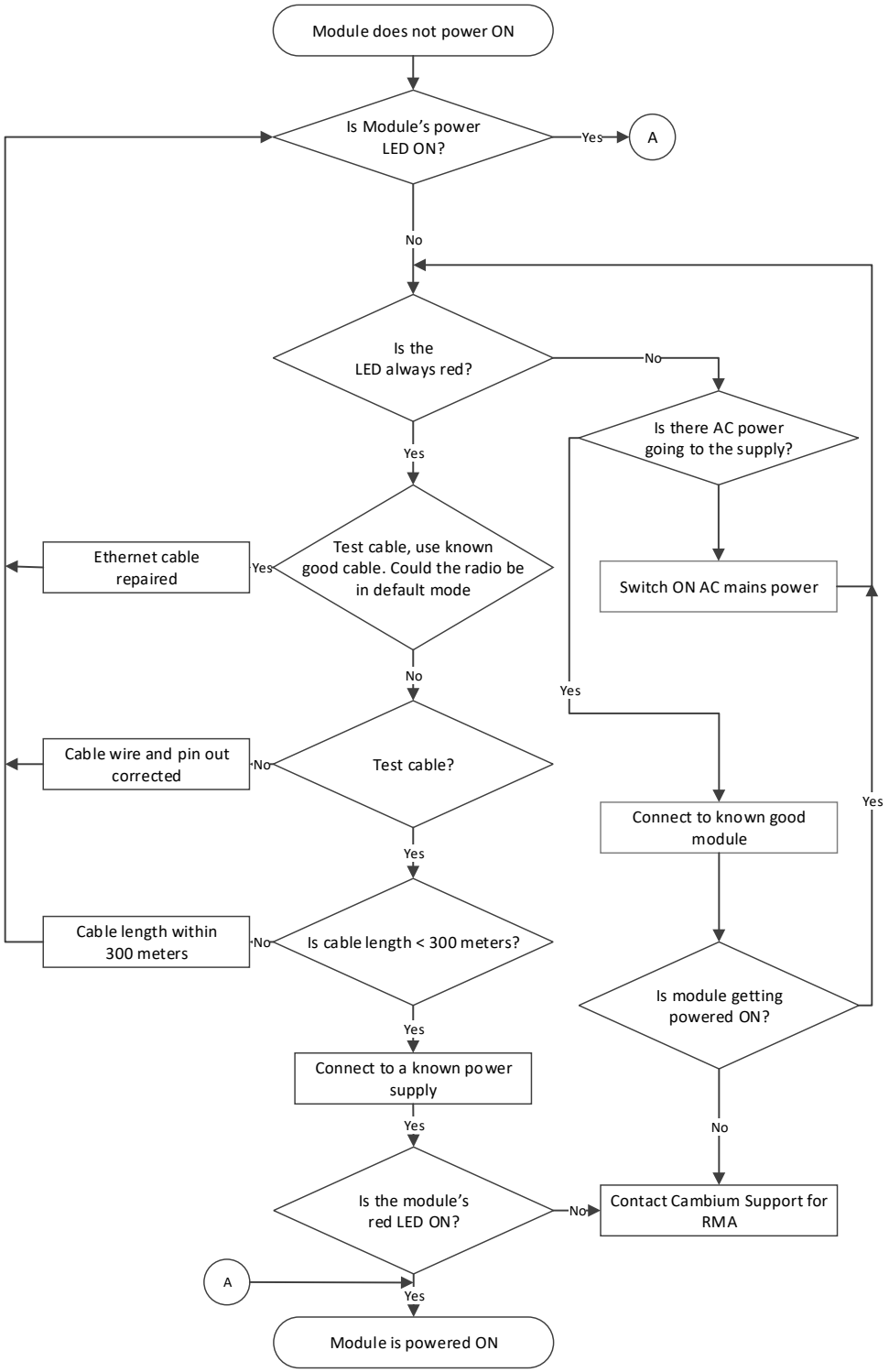
1. Enter **telnet *DottedIPAddress***.
   RESULT: A telnet session to the module is invoked.
2. At the Login prompt, enter **root**.
3. At the Password prompt, enter ***PasswordIfConfigured***.
4. At the Telnet +> prompt, enter **reset**.
   RESULT: The web interface is accessible again and this telnet connection is closed.

   Note

   The module may also be rebooted via an SNMP-based NMS (Wireless Manager, for example)
5. If the issue persists, turn off any SNMP-based network/radio monitoring software and repeat steps 1-4.

Power-up troubleshooting



Registration and connectivity troubleshooting

SM/BMS Registration

If no SMs are registered to this AP, then the Session Status tab displays the simple message **No sessions**. In this case, try the following steps.

1. More finely aim the SM or SMs toward the AP.
2. Recheck the Session Status tab of the AP for the presence of LUIDs.
3. If still no LUIDs are reported on the Session Status tab, click the **Configuration** button on the left side of the **Home** page.
   RESULT: The AP responds by opening the AP Configuration page.
4. Click the Radio tab.
5. Find the **Color Code** parameter and note the setting.
6. In the same sequence as you did for the AP directly under **Configuring Link for Test** on Page 5-16, connect the SM to a computing device and to power.
7. On the left side of the SM Home page, click the **Configuration** button.
   RESULT: The Configuration page of the SM opens.
8. Click the Radio tab.
9. If the transmit frequency of the AP is not selected in the **Custom Radio Frequency Scan Selection List** parameter, select the frequency that matches.
10. If the **Color Code** parameter on this page is not identical to the **Color Code** parameter you noted from the AP, change one of them so that they match.
11. At the bottom of the Radio tab for the SM, click the **Save Changes** button.
12. Click the **Reboot** button.
13. Allow several minutes for the SM to reboot and register to the AP.
14. Return to the computing device that is connected to the AP.
15. Recheck the Session Status tab of the AP for the presence of LUIDs.

Logs

Persistent Logging

PMP 450 SM supports logging information such as session logs, authentication logs, and authorization logs that are persistent through reboots and connectivity losses.

Navigate to Logs to view:

- SM Session
- SM Authentication
- SM Authorization

All the SM logs are saved to flash and displayed upon reboot.

Figure 202 SM Logs

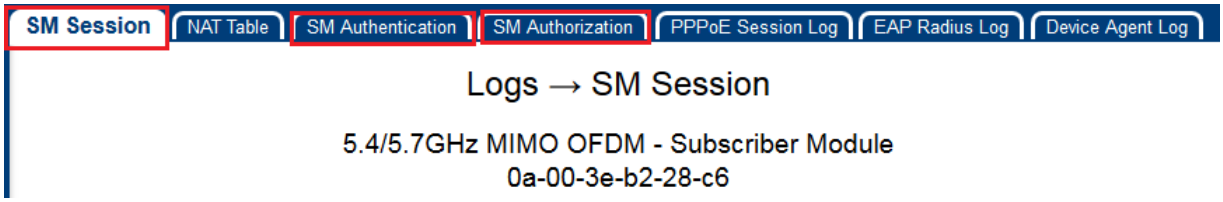


Figure 203 SM Session log

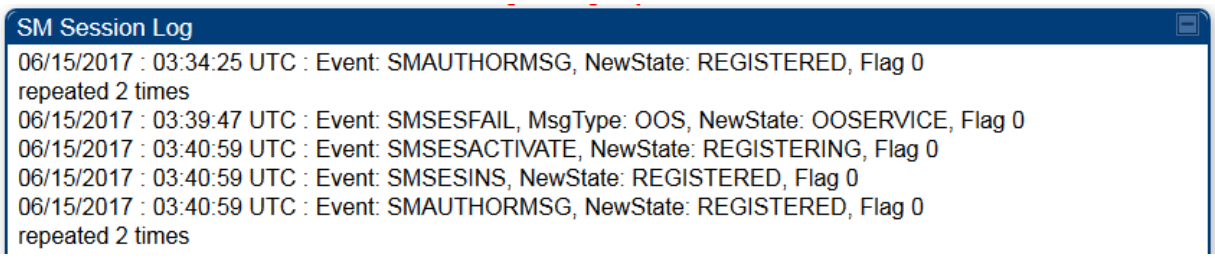


Figure 204 SM Authentication log

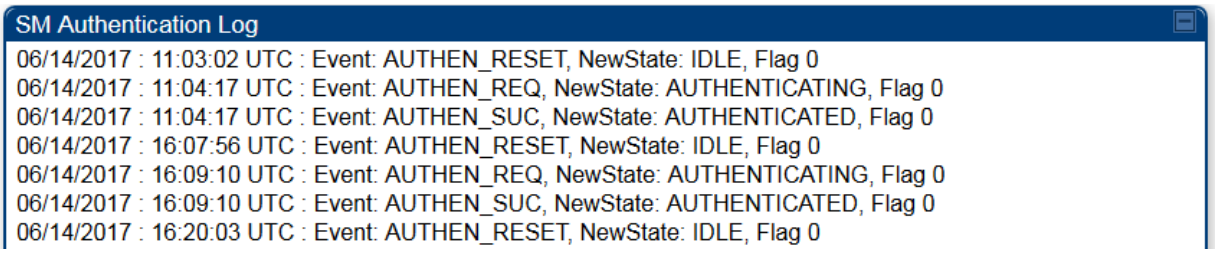
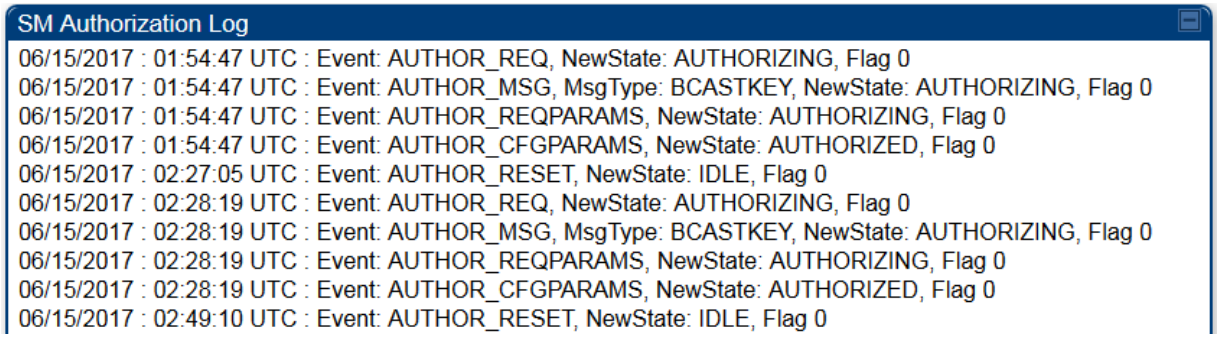


Figure 205 SM Authorization log



Appendix A - 450m information Reference

A.1 Specifications

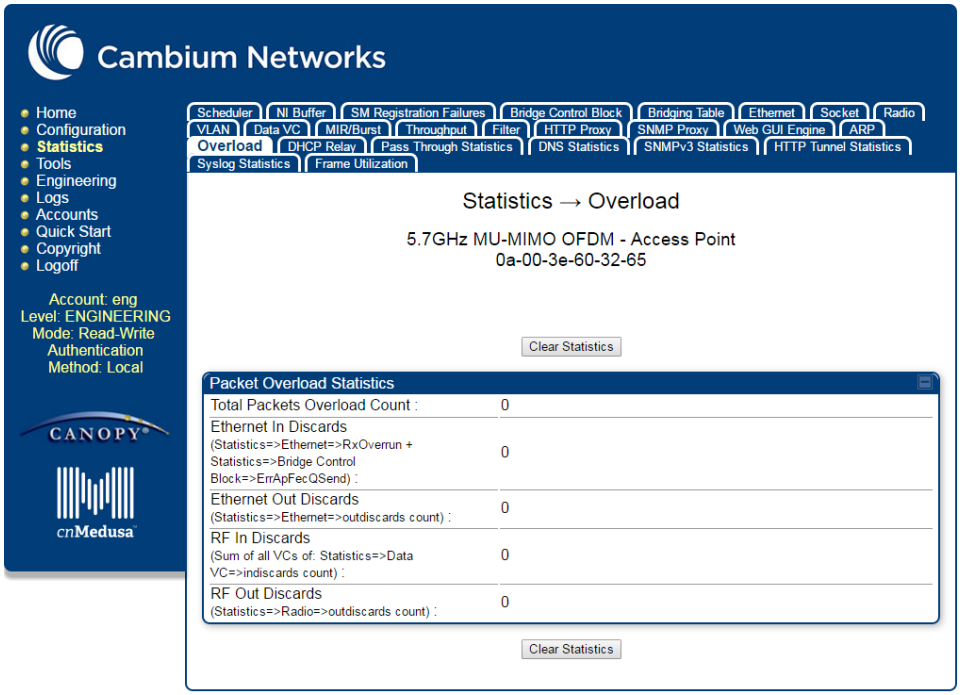
Please see the Specification sheets listed on the Cambium Networks website for the most up-to-date 450m Series cnMedusa AP specifications:

http://www.cambiumnetworks.com/resources/pmp-450m/

A.2 450m overload

The 450m Series AP is designed to handle high load in terms of high throughput and high PPS. In terms of throughput, 450m is designed to achieve 3x or more throughput improvement over 450 and 450i Series products. In terms of packets per second (PPS), 450m is designed to handle up to 100k PPS.

Overload occurs when the offered load exceeds the above limits. When overload occurs, 450m will start discarding packets and TCP throughput will degrade due to packet loss. The 450 family of products have a set of overload statistics that can be used to monitor overload conditions (Statistics >Overload tab).



The above statistics shall be monitored over time for overload conditions over consecutive periods. Refer to Interpreting Overload statistics for description of those statistics.

It's worth noting that Frame Utilization statistics (Statistics >Frame Utilization tab: Frame Utilization: Downlink and Uplink) are not necessarily indicative of overload condition. They show how much the TDD frame is utilized. High frame utilization depends on:

1. high traffic during busy periods: those statistics will be close to 100% and almost all slots will be utilized. In this case if the Overload statistics show that packets are discarded then this is an indication of overload condition.
2. high percentage of VCs with low modulation with moderate traffic. Those VCs will require more slots to service them (due to low modulation) and the frame utilization will be high. In this case the TDD frame is fully utilized but the system is at low capacity and is not in an overload condition.

450m has higher PPS than 450 and 450i and supports higher throughput through spatial multiplexing, therefore when a 450m replaces an overloaded 450 or 450i AP the 450m will not be overloaded under the same conditions but the frame utilization may still show close to 100%; this should not alarm the customer. The overload statistics shall be monitored on 450m to see if it is overloaded or not.

Glossary

Term	Definition
10Base-T	Technology in Ethernet communications that can deliver 10 Mb of data across 328 feet (100 meters) of CAT 5 cable.
169.254.0.0	Gateway IP address default in Cambium fixed wireless broadband IP network modules.
169.254.1.1	IP address default in Cambium fixed wireless broadband IP network modules.
255.255.0.0	Subnet mask default in Cambium fixed wireless broadband IP network modules and in Microsoft and Apple operating systems.
802.3	An IEEE standard that defines the contents of frames that are transferred through Ethernet connections. Each of these frames contains a preamble, the address to which the frame is sent, the address that sends the frame, the length of the data to expect, the data, and a checksum to validate that no contents were lost.
Access Point Cluster	Two to six Access Point Modules that together distribute network or Internet services to a community of subscribers. Each Access Point Module covers a 60° or 90° sector. This cluster covers as much as 360°. Also known as AP cluster.
Access Point Module	Also known as AP. One module that distributes network or Internet services in a 60° or 90° sector.
ACT/4	Second-from-left LED in the module. In the operating mode, this LED is lit when data activity is present on the Ethernet link.
Address Resolution Protocol	Protocol defined in RFC 826 to allow a network element to correlate a host IP address to the Ethernet address of the host. See http://www.faqs.org/rfcs/rfc826.html.
Aggregate Throughput	The sum of the throughputs in the uplink and the downlink.
AP	Access Point Module. One module that distributes network or Internet services to subscriber modules.
ARP	Address Resolution Protocol. A protocol defined in RFC 826 to allow a network element to correlate a host IP address to the Ethernet address of the host. See http://www.faqs.org/rfcs/rfc826.html.
APs MIB	Management Information Base file that defines objects that are specific to the Access Point Module. See also Management Information Base.

Term	Definition
ASN.1	Abstract Syntax Notation One language. The format of the text files that compose the Management Information Base.
Attenuation	Reduction of signal strength caused by the travel from the transmitter to the receiver, and caused by any object between. In the absence of objects between, a signal that has a short wavelength experiences a high degree of attenuation nevertheless.
BER	Bit Error Rate. The ratio of incorrect data received to correct data received.
BHM	Backhaul Timing Master (BHM)- a module that is used in a point to point link. This module controls the air protocol and configurations for the link..
BHS	Backhaul Timing Slave (BHS)- a module that is used in a point to point link. This module accepts configuration and timing from the master module.
Bit Error Rate	Ratio of incorrect data received to correct data received.
Box MIB	Management Information Base file that defines module-level objects. See also Management Information Base.
Bridge	Network element that uses the physical address (not the logical address) of another to pass data. The bridge passes the data to either the destination address, if found in the simple routing table, or to all network segments other than the one that transmitted the data. Modules are Layer 2 bridges except that, where NAT is enabled for an SM, the SM is a Layer 3 switch. Compare to Switch and Router, and see also NAT.
Buckets	Theoretical data repositories that can be filled at preset rates or emptied when preset conditions are experienced, such as when data is transferred.
Burst	Preset amount limit of data that may be continuously transferred.
CAT 5 Cable	Cable that delivers Ethernet communications from module to module. Later modules auto-sense whether this cable is wired in a straight-through or crossover scheme.
CIR	Committed Information Rate. For an SM or specified group of SMs, a level of bandwidth that can be guaranteed to never fall below a specified minimum (unless oversubscribed). In the Cambium implementation, this is controlled by the Low Priority Uplink CIR, Low Priority Downlink CIR, High Priority Uplink CIR, and High Priority Downlink CIR parameters.
Cluster Management Module	Module that provides power, GPS timing, and networking connections for an AP cluster. Also known as CMM4.
CMM	Cluster Management Module. A module that provides power, GPS timing, and networking connections for an Access Point cluster.

Term	Definition
CodePoint	See DiffServ.
Color Code Field	Module parameter that identifies the other modules with which communication is allowed. The range of valid values is 0 to 255.
Community String Field	Control string that allows a network management station to access MIB information about the module.
Connectorized	The 450 Platform Family Connectorized Radio solution provide RF port to connect external antenna. It gives flexibility to connect to a variety of external antennas.
Country Code	A parameter that offers multiple fixed selections, each of which automatically implements frequency band range restrictions for the selected country. Units shipped to countries other than the United States must be configured with the corresponding Region Code and Country Code to comply with local regulatory requirements.
CRCError Field	This field displays how many CRC errors occurred on the Ethernet controller.
Data Encryption Standard	Over-the-air link option that uses secret 56-bit keys and 8 parity bits. Data Encryption Standard (DES) performs a series of bit permutations, substitutions, and recombination operations on blocks of data.
Demilitarized Zone	Internet Protocol area outside of a firewall. Defined in RFC 2647. See http://www.faqs.org/rfcs/rfc2647.html.
DES	Data Encryption Standard. An over-the-air link 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.
DFS	See Dynamic Frequency Selection
DHCP	Dynamic Host Configuration Protocol, defined in RFC 2131. Protocol that 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 system. See http://www.faqs.org/rfcs/rfc2131.html. See also Static IP Address Assignment.

Term	Definition
DiffServ	Differentiated Services, consistent with RFC 2474. A byte in the type of service (TOS) field of packets whose values correlates to the channel on which the packet should be sent. The value is a numeric code point. Cambium modules map each of 64 code points to values of 0 through 7. Three of these code points have fixed values, and the remaining 61 are settable. Values of 0 through 3 map to the low-priority channel; 4 through 7 to the high-priority channel. The mappings are the same as 802.1p VLAN priorities. (However, configuring DiffServ does not automatically enable the VLAN feature.) Among the settable parameters, the values are set in the AP for all downlinks within the sector and in the SM for each uplink.
DMZ	Demilitarized Zone as defined in RFC 2647. An Internet Protocol area outside of a firewall. See http://www.faqs.org/rfcs/rfc2647.html.
Dynamic Frequency Selection	A requirement in certain countries and regions for systems to detect interference from other systems, notably radar systems, and to avoid co-channel operation with these systems.
Dynamic Host Configuration Protocol	See DHCP.
Electronic Serial Number	Hardware address that the factory assigns to the module for identification in the Data Link layer interface of the Open Systems Interconnection system. This address serves as an electronic serial number. Same as MAC Address.
ESN	Electronic Serial Number. The hardware address that the factory assigns to the module for identification in the Data Link layer interface of the Open Systems Interconnection system. This address serves as an electronic serial number. Same as MAC Address.
Ethernet Protocol	Any of several IEEE standards that define the contents of frames that are transferred from one network element to another through Ethernet connections.
ETSI	European Telecommunications Standards Institute
Fade Margin	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. Standard operating margin.
FCC	Federal Communications Commission of the U.S.A.
Field-programmable Gate Array	Array of logic, relational data, and wiring data that is factory programmed and can be reprogrammed.

Term	Definition
File Transfer Protocol	Utility that transfers of files through TCP (Transport Control Protocol) between computing devices that do not operate on the same platform. Defined in RFC 959. See http://www.faqs.org/rfcs/rfc959.html.
FPGA	Field-programmable Gate Array. An array of logic, relational data, and wiring data that is factory programmed and can be reprogrammed.
Free Space Path Loss	Signal attenuation that is naturally caused by atmospheric conditions and by the distance between the antenna and the receiver.
Fresnel Zone	Space in which no object should exist that can attenuate, diffract, or reflect a transmitted signal before the signal reaches the target receiver.
FTP	File Transfer Protocol, defined in RFC 959. Utility that transfers of files through TCP (Transport Control Protocol) between computing devices that do not operate on the same platform. See http://www.faqs.org/rfcs/rfc959.html.
Global Positioning System	Network of satellites that provides absolute time to networks on earth, which use the time signal to synchronize transmission and reception cycles (to avoid interference) and to provide reference for troubleshooting activities.
GPS	Global Positioning System. A network of satellites that provides absolute time to networks on earth, which use the time signal to synchronize transmission and reception cycles (to avoid interference) and to provide reference for troubleshooting activities.
GPS/3	Third-from-left LED in the module. In the operating mode for an Access Point Module, this LED is continuously lit as the module receives sync pulse. In the operating mode for a Subscriber, this LED flashes on and off to indicate that the module is not registered.
GUI	Graphical user interface.
High-priority Channel	Channel that supports low-latency traffic (such as Voice over IP) over low-latency traffic (such as standard web traffic and file downloads). To recognize the latency tolerance of traffic, this channel reads the IPv4 Type of Service DiffServ Control Point (DSCP) bits. Enabling the high-priority channel reduces the maximum number of SMs that can be served in the sector.
HTTP	Hypertext Transfer Protocol, used to make the Internet resources available on the World Wide Web. Defined in RFC 2068. See http://www.faqs.org/rfcs/rfc2068.html.
HTTPS	Hypertext Transfer Protocol Secure (HTTPS)

Term	Definition
ICMP	Internet Control Message Protocols defined in RFC 792, used to identify Internet Protocol (IP)-level problems and to allow IP links to be tested. See http://www.faqs.org/rfcs/rfc792.html.
Integrated	The 450 Platform Family Integrated Radio solution provides integrated antenna..
IP	Internet Protocol defined in RFC 791. The Network Layer in the TCP/IP protocol stack. This protocol is applied to addressing, routing, and delivering, and re-assembling data packets into the Data Link layer of the protocol stack. See http://www.faqs.org/rfcs/rfc791.html.
IP Address	32-bit binary number that identifies a network element by both network and host. See also Subnet Mask.
IPv4	Traditional version of Internet Protocol, which defines 32-bit fields for data transmission.
ISM	Industrial, Scientific, and Medical Equipment radio frequency band, in the 900-MHz, 2.4-GHz, and 5.8-GHz ranges.
L2TP over IPSec	Level 2 Tunneling Protocol over IP Security. One of several virtual private network (VPN) implementation schemes. Regardless of whether Subscriber Modules have the Network Address Translation feature (NAT) enabled, they support VPNs that are based on this protocol.
Late Collision Field	This field displays how many late collisions occurred on the Ethernet controller. A normal collision occurs during the first 512 bits of the frame transmission. A collision that occurs after the first 512 bits is considered a late collision. A late collision is a serious network problem because the frame being transmitted is discarded. A late collision is most commonly caused by a mismatch between duplex configurations at the ends of a link segment.
Line of Sight	Wireless path (not simply visual path) direct from module to module. The path that results provides both ideal aim and an ideal Fresnel zone.
LNK/5	Furthest left LED in the module. In the operating mode, this LED is continuously lit when the Ethernet link is present. In the aiming mode for a Subscriber Module, this LED is part of a bar graph that indicates the quality of the RF link.
Logical Unit ID	Final octet of the 4-octet IP address of the module.
LOS	Line of sight. The wireless path (not simply visual path) direct from module to module. The path that results provides both ideal aim and an ideal Fresnel zone.
LUID	Logical Unit ID. The final octet of the 4-octet IP address of the module.

Term	Definition
MAC Address	Media Access Control address. The hardware address that the factory assigns to the module for identification in the Data Link layer interface of the Open Systems Interconnection system. This address serves as an electronic serial number.
Management Information Base	Space that allows a program (agent) in the network to relay information to a network monitor about the status of defined variables (objects).
Maximum Information Rate (MIR)	The cap applied to the bandwidth of an SM or specified group of SMs. In the Cambium implementation, this is controlled by the Sustained Uplink Data Rate, Uplink Burst Allocation, Sustained Downlink Data Rate, and Downlink Burst Allocation parameters.
MIB	Management Information Base. Space that allows a program (agent) in the network to relay information to a network monitor about the status of defined variables (objects).
MIR	See Maximum Information Rate.
MU-MIMO	Multi User- Multiple Input Multiple Output
NAT	Network Address Translation defined in RFC 1631. A scheme that isolates Subscriber Modules from the Internet. See http://www.faqs.org/rfcs/rfc1631.html.
NEC	National Electrical Code. The set of national wiring standards that are enforced in the U.S.A.
NetBIOS	Protocol defined in RFC 1001 and RFC 1002 to support an applications programming interface in TCP/IP. This interface allows a computer to transmit and receive data with another host computer on the network. RFC 1001 defines the concepts and methods. RFC 1002 defines the detailed specifications. See http://www.faqs.org/rfcs/rfc1001.html and http://www.faqs.org/rfcs/rfc1002.html.
Network Address Translation	Scheme that defines the Access Point Module as a proxy server to isolate registered Subscriber Modules from the Internet. Defined in RFC 1631. See http://www.faqs.org/rfcs/rfc1631.html.
Network Management Station	See NMS.
NMS	Network Management Station. A monitor device that uses Simple Network Management Protocol (SNMP) to control, gather, and report information about predefined network variables (objects). See also Simple Network Management Protocol.

Term	Definition
Default Mode	Device that enables the operator to regain control of a module that has been locked by the No Remote Access feature, the 802.3 Link Disable feature, or a password or IP address that cannot be recalled. This device can be either fabricated on site or ordered.
PMP	See Point-to-Multipoint Protocol.
Point-to-Multipoint Protocol	Defined in RFC 2178, which specifies that data that originates from a central network element can be received by all other network elements, but data that originates from a non-central network element can be received by only the central network element. See http://www.faqs.org/rfcs/rfc2178.html. Also referenced as PMP.
PPPoE	Point to Point Protocol over Ethernet. Supported on SMs for operators who use PPPoE in other parts of their network operators who want to deploy PPPoE to realize per-subscriber authentication, metrics, and usage control.
PPS	Packet Per Second
PPTP	Point to Point Tunneling Protocol. One of several virtual private network implementations. Regardless of whether the Network Address Translation (NAT) feature enabled, Subscriber Modules support VPNs that are based on this protocol.
Protective Earth	Connection to earth (which has a charge of 0 volts). Also known as ground.
Proxy Server	Network computer that isolates another from the Internet. The proxy server communicates for the other computer, and sends replies to only the appropriate computer, which has an IP address that is not unique or not registered.
PTP	A Point-to-Point connection refers to a communications connection between two nodes or endpoints.
Radio Signal Strength Indicator	Relative measure of the strength of a received signal. An acceptable link displays a Radio Signal Strength Indicator (RSSI) value of greater than 700.
Reflection	Change of direction and reduction of amplitude of a signal that encounters an object larger than the wavelength. Reflection may cause an additional copy of the wavelength to arrive after the original, unobstructed wavelength arrives. This causes partial cancellation of the signal and may render the link unacceptable. However, in some instances where the direct signal cannot be received, the reflected copy may be received and render an otherwise unacceptable link acceptable.

Term	Definition
Region Code	A parameter that offers multiple fixed selections, each of which automatically implements frequency band range restrictions for the selected region. Units shipped to regions other than the United States must be configured with the corresponding Region Code to comply with local regulatory requirements.
RF	Radio frequency. How many times each second a cycle in the antenna occurs, from positive to negative and back to positive amplitude.
RJ-12	Standard cable that is typically used for telephone line or modem connection.
RJ-45	Standard cable that is typically used for Ethernet connection. This cable may be wired as straight-through or as crossover. Later modules auto-sense whether the cable is straight-through or crossover.
Router	Network element that uses the logical (IP) address of another to pass data to only the intended recipient. Compare to Switch and Bridge.
RSSI	Radio Signal Strength Indicator. A relative measure of the strength of a received signal. An acceptable link displays an RSSI value of greater than 700.
Self-interference	Interference with a module from another module in the same network.
SFP	Small Form-factor Pluggable
Simple Network Management Protocol	Standard that is used for communications between a program (agent) in the network and a network management station (monitor). Defined in RFC 1157. See http://www.faqs.org/rfcs/rfc1157.html.
SM	Customer premises equipment (CPE) device that extends network or Internet services by communication with an Access Point Module or an Access Point cluster.
SNMP	See Simple Network Management Protocol, defined in RFC 1157.
SNMPv3	SNMP version 3
SNMP Trap	Capture of information that informs the network monitor through Simple Network Management Protocol of a monitored occurrence in the module.
Static IP Address Assignment	Assignment of Internet Protocol address that can be changed only manually. Thus static IP address assignment requires more configuration time and consumes more of the available IP addresses than DHCP address assignment does. RFC 2050 provides guidelines for the static allocation of IP addresses. See http://www.faqs.org/rfcs/rfc2050.html. See also DHCP.

Term	Definition
Subnet Mask	32-bit binary number that filters an IP address to reveal what part identifies the network and what part identifies the host. The number of subnet mask bits that are set to 1 indicates how many leading bits of the IP address identify the network. The number of subnet mask bits that are set 0 indicate how many trailing bits of the IP address identify the host.
Subscriber Module	Customer premises equipment (CPE) device that extends network or Internet services by communication with an Access Point Module or an Access Point cluster.
Sustained Data Rate	Preset rate limit of data transfer.
Switch	Network element that uses the port that is associated with the physical address of another to pass data to only the intended recipient. Compare to Bridge and Router.
Sync	GPS (Global Positioning System) absolute time, which is passed from one module to another. Sync enables timing that prevents modules from transmitting or receiving interference. Sync also provides correlative time stamps for troubleshooting efforts.
TCP	Alternatively known as Transmission Control Protocol or Transport Control Protocol. The Transport Layer in the TCP/IP protocol stack. This protocol is applied to assure that data packets arrive at the target network element and to control the flow of data through the Internet. Defined in RFC 793. See http://www.faqs.org/rfcs/rfc793.html.
TDD	Time Division Duplexing. Synchronized data transmission with some time slots allocated to devices transmitting on the uplink and some to the device transmitting on the downlink.
telnet	Utility that allows a client computer to update a server. A firewall can prevent the use of the telnet utility to breach the security of the server. See http://www.faqs.org/rfcs/rfc818.html, http://www.faqs.org/rfcs/rfc854.html and http://www.faqs.org/rfcs/rfc855.html.
Tokens	Theoretical amounts of data. See also Buckets.
TxUnderrun Field	This field displays how many transmission-underrun errors occurred on the Ethernet controller.
UDP	User Datagram Protocol. A set of Network, Transport, and Session Layer protocols that RFC 768 defines. These protocols include checksum and address information but does not retransmit data or process any errors. See http://www.faqs.org/rfcs/rfc768.html.
udp	User-defined type of port.

Term	Definition
U-NII	Unlicensed National Information Infrastructure radio frequency band, in the 5.1GHz through 5.8 GHz ranges.
VID	VLAN identifier. See also VLAN.
VLAN	Virtual local area network. An association of devices through software that contains broadcast traffic, as routers would, but in the switch-level protocol.
VPN	Virtual private network for communication over a public network. One typical use is to connect remote employees, who are at home or in a different city, to their corporate network over the Internet. Any of several VPN implementation schemes is possible. SMs support L2TP over IPSec (Level 2 Tunneling Protocol over IP Security) VPNs and PPTP (Point to Point Tunneling Protocol) VPNs, regardless of whether the Network Address Translation (NAT) feature enabled.