Canopy™ Access Point Cluster and Gen II Cluster Management Module

USER MANUAL

AP_CMM2-UM-en
Issue 4 Draft
November 2003

© 2003 Motorola, Inc. All rights reserved. Printed in the U.S.A.

NOTICES

Important Note on Modifications

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

U.S. Federal Communication Commision (FCC) and Industry Canada (IC) Notification

This device complies with part 15 of the U. S. FCC Rules and Regulations and with RSS-210 of Industry Canada. 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. In Canada, 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).

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the U.S. FCC Rules and with RSS-210 of Industry Canada. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with these instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to correct the interference by one or more of the following measures:

- Increase the separation between the affected equipment and the unit;
- Connect the affected equipment to a power outlet on a different circuit from that which the receiver is connected to;
- Consult the dealer and/or experienced radio/TV technician for help.

FCC IDs and Industry Canada Certification Numbers are listed in the following table:

Module Types	Operating Frequency Range	Maximum Transmitter Power	Reflector	FCC ID	Industry Canada Cert Number
SM AP BH	ISM 2403-2483 MHz	250mW	Allowed on SM and BH	ABZ89FC5808	109W-2400
SM AP BH	U-NII 5250-5350 MHz	200mW	Not Allowed	ABZ89FC3789	109W-5200
SM AP BH	U-NII 5725-5825 MHz	200mW	Allowed on SM and BH	ABZ89FC4816	109W-5700
SM AP BH	ISM 5725-5850 MHz	200mW	Allowed on SM and BH	ABZ89FC5804	109W-5700

The term "IC:" before the radio certification number only signifies that Industry Canada technical specifications were met.

European Community Notification

Notification of Intended Purpose of Product Uses

This product is a two-way radio transceiver suitable for use in Broadband RLAN systems. It uses operating frequencies which are not harmonized through the EC. All licenses must be obtained before using the product in any EC country.

Declaration of conformity:
Motorola declares the GHz radio types listed below comply with the essential requirements and other relevant provisions of Directive1999/5/EC.

Relevant Specification
EN 301 893 or similar - radio spectrum
EN301489-17 - EMC
EN60950 - safety

Product Details for Products Tested for Compliance with Relevant EC Directives

Module Type	Band Frequency Range	Maximum Transmitter Power	Effective Isotropic Radiated Power (EIRP)	Modulation Type	Operating Channels	Non-overlapping Channel Spacing
Access Point	5.725 to 5.825 GHz	200mW RMS	1 Watt EIRP	High Index 2-level FSK	5745 to 5805 MHz in 5 MHz increments	20 MHz
Subscriber Module	5.725 to 5.825 GHz	200mW RMS	1 Watt EIRP	High Index 2-level FSK	5745 to 5805 MHz in 5 MHz increments	20 MHz
Subscriber Module with Reflector	5.725 to 5.825 GHz	200mW RMS	63 Watts EIRP	High Index 2-level FSK	5745 to 5805 MHz in 5 MHz increments	20 MHz
Backhaul	5.725 to 5.825 GHz	200mW RMS	1 Watt EIRP	High Index 2-level or 4-level FSK	5745 to 5805 MHz in 5 MHz increments	20 MHz

Backhaul with Reflector	5.725 to 5.825 GHz	200mW RMS	63 Watts EIRP	High Index 2-level or 4-level FSK	5745 to 5805 MHz in 5 MHz increments	20 MHz

Canopy can be configured to operate at a range of frequencies, but at this time, only channels from 5745 MHz through 5805 MHz of the 5.7 GHz product have been tested for compliance with relevant EC directives. Before configuring equipment to operate outside this range, please check with your regulator.

Exposure Note

The Canopy Subscriber Module (SM) must be installed to provide a separation distance of at least 20 cm (7.9 in) from all persons, when adding the Canopy reflector dish (in the 2.4 or 5.7 GHz band), the reflector dish must be installed to provide a separation distance of at least 1.5m (59.1 in) from all persons and does not emit a RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada's website http://www.hc-sc.gc.ca/rpb.

In both configurations the maximum RMS power does not exceed 200mW.

The applicable power density exposure limit is 10 Watt/m^2, according to the FCC OET Bulletin 65, the ICNIRP guidelines, and the Health Canada Safety Code 6. The corresponding compliance distances referenced above have been determined by assuming worst-case scenarios. The peak power density (S) in the far-field of a radio-frequency source with rms transmit power P and antenna gain G at a distance d is

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

In the case of the Canopy SM *without* reflector, the gain is 8 dBi (a factor of 6.3), so the peak power density equals the exposure limit at a distance of 10 cm. A four-fold additional compliance margin is artificially introduced by doubling the distance to 20 cm.

In the case of the Canopy SM *with* reflector, the gain is 26 dBi (a factor of 400), so the peak power density equals the exposure limit at a distance of about 80 cm. An almost four-fold additional compliance margin is artificially introduced by defining the compliance distance of 1.5 m. The compliance distance is greatly overestimated in this case because the far-field equation neglects the physical dimension of the antenna, which is modeled as a point-source.

Software License Terms and Conditions

ONLY OPEN THE PACKAGE, OR USE THE SOFTWARE AND RELATED PRODUCT IF YOU ACCEPT THE TERMS OF THIS LICENSE. BY BREAKING THE SEAL ON THIS DISK KIT / CDROM, OR IF YOU USE THE SOFTWARE OR RELATED PRODUCT, YOU ACCEPT THE TERMS OF THIS LICENSE AGREEMENT. IF YOU DO NOT AGREE TO THESE TERMS, DO NOT USE THE SOFTWARE OR RELATED PRODUCT; INSTEAD, RETURN THE SOFTWARE TO PLACE OF PURCHASE FOR A FULL REFUND. THE FOLLOWING AGREEMENT IS A LEGAL AGREEMENT BETWEEN YOU (EITHER AN INDIVIDUAL OR ENTITY), AND MOTOROLA, INC. (FOR ITSELF AND ITS LICENSORS). THE RIGHT TO USE THIS PRODUCT IS LICENSED ONLY ON THE CONDITION THAT YOU AGREE TO THE FOLLOWING TERMS.

Now, therefore, in consideration of the promises and mutual obligations contained herein, and for other good and valuable consideration, the receipt and sufficiency of which are hereby mutually acknowledged, you and Motorola agree as follows:

Grant of License. Subject to the following terms and conditions, Motorola, Inc., grants to you a personal, revocable, non-assignable, non-transferable, non-exclusive and limited license to use on a single piece of equipment only one copy of the software contained on this disk (which may have been pre-loaded on the equipment)(Software). You may make two copies of the Software, but only for backup, archival, or disaster recovery purposes. On any copy you make of the Software, you must reproduce and include the copyright and other proprietary rights notice contained on the copy we have furnished you of the Software.

Ownership. Motorola (or its supplier) retains all title, ownership and intellectual property rights to the Software and any copies, including translations, compilations, derivative works (including images) partial copies and portions of updated works. The Software is Motorola's (or its supplier's) confidential proprietary information. This Software License Agreement does not convey to you any interest in or to the Software, but only a limited right of use. You agree not to disclose it or make it available to anyone without Motorola's written authorization. You will exercise no less than reasonable care to protect the Software from unauthorized disclosure. You agree not to disassemble, decompile or reverse engineer, or create derivative works of the Software, except and only to the extent that such activity is expressly permitted by applicable law.

Termination. This License is effective until terminated. This License will terminate immediately without notice from Motorola or judicial resolution if you fail to comply with any provision of this License. Upon such termination you must destroy the Software, all accompanying written materials and all copies thereof, and the sections entitled Limited Warranty, Limitation of Remedies and Damages, and General will survive any termination.

Limited Warranty. Motorola warrants for a period of ninety (90) days from Motorola's or its customer's shipment of the Software to you that (i) the disk(s) on which the Software is recorded will be free from defects in materials and workmanship under normal use and (ii) the Software, under normal use, will perform substantially in accordance with Motorola's published specifications for that release level of the Software. The written materials are provided "AS IS" and without warranty of any kind. Motorola's entire liability and your sole and exclusive remedy for any breach of the foregoing limited warranty will be, at Motorola's option, replacement of the disk(s), provision of downloadable patch or replacement code, or refund of the unused portion of your bargained for contractual benefit up to the amount paid for this Software License.

THIS LIMITED WARRANTY IS THE ONLY WARRANTY PROVIDED BY MOTOROLA, AND MOTOROLA AND ITS LICENSORS EXPRESSLY DISCLAIM ALL OTHER WARRANTIES, EITHER EXPRESS OF IMPLIED, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. MOTOROLA DOES NOT WARRANT THAT THE OPERATION OF THE SOFTWARE WILL BE UNINTERRUPTED OR ERROR-FREE, OR THAT DEFECTS IN THE SOFTWARE WILL BE CORRECTED. NO ORAL OR WRITTEN REPRESENTATIONS MADE BY MOTOROLA OR AN AGENT THEREOF SHALL CREATE A WARRANTY OR IN ANY WAY INCREASE THE SCOPE OF THIS WARRANTY. MOTOROLA DOES NOT WARRANT ANY SOFTWARE THAT HAS BEEN OPERATED IN EXCESS OF SPECIFICATIONS, DAMAGED, MISUSED, NEGLECTED, OR IMPROPERLY INSTALLED. BECAUSE SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF IMPLIED WARRANTIES, THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU.

Limitation of Remedies and Damages. Regardless of whether any remedy set forth herein fails of its essential purpose, IN NO EVENT SHALL MOTOROLA OR ANY OF THE LICENSORS, DIRECTORS, OFFICERS, EMPLOYEES OR AFFILIATES OF THE FOREGOING BE LIABLE TO YOU FOR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, SPECIAL OR SIMILAR DAMAGES WHATSOEVER (including, without limitation, damages for loss of business profits, business interruption, loss of business information and the like), whether foreseeable or unforeseeable, arising out of the use or inability to use the Software or accompanying written materials, regardless of the basis of the claim and even if Motorola or a Motorola representative has been advised of the possibility of such damage. Motorola's liability to you for direct damages for any cause whatsoever, regardless of the basis of the form of the action, will be limited to the price paid for the Software that caused the damages. THIS LIMITATION WILL NOT APPLY IN CASE OF PERSONAL INJURY ONLY WHERE AND TO THE EXTENT THAT APPLICABLE LAW REQUIRES SUCH LIABILITY. BECAUSE SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, THE ABOVE LIMITATION MAY NOT APPLY TO YOU.

Maintenance and Support. Motorola shall not be responsible for maintenance or support of the software. By accepting the license granted under this agreement, you agree that Motorola will be under no obligation to provide any support, maintenance or service in connection with the Software or any application developed by you. Any maintenance and support of the Related Product will be provided under the terms of the agreement for the Related Product.

Transfer. In the case of software designed to operate on Motorola equipment, you may not transfer the Software to another party except: (1) if you are an end-user, when you are transferring the Software together with the Motorola equipment on which it operates; or 2) if you are a Motorola licensed distributor, when you are transferring the Software either together with such Motorola equipment or are transferring the Software as a licensed duly paid for upgrade, update, patch, new release, enhancement or replacement of a prior version of the Software. If you are a Motorola licensed distributor, when you are transferring the Software as permitted herein, you agree to transfer the Software with a license agreement having terms and conditions no less restrictive than those contained herein. You may transfer all other Software, not otherwise having an agreed restriction on transfer, to another party. However, all such transfers of Software are strictly subject to the conditions precedent that the other party agrees to accept the terms and conditions of this License, and you destroy any copy of the Software you do not transfer to that party. You may not sublicense or otherwise transfer, rent or lease the Software without our written consent. You may not transfer the Software in violation of any laws, regulations, export controls or economic sanctions imposed by the U.S. Government.

Right to Audit. Motorola shall have the right to audit annually, upon reasonable advance notice and during normal business hours, your records and accounts to determine compliance with the terms of this Agreement.

Export Controls. You specifically acknowledge that the software may be subject to United States and other country export control laws. You shall comply strictly with all requirements of all applicable export control laws and regulations with respect to all such software and materials.

U.S. Government Users. If you are a U.S. Government user, then the Software is provided with "RESTRICTED RIGHTS" as set forth in subparagraphs (c)(1) and (2) of the Commercial Computer Software-Restricted Rights clause at FAR 52 227-19 or subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.227-7013, as applicable.

Disputes. You and Motorola hereby agree that any dispute, controversy or claim, except for any dispute, controversy or claim involving intellectual property, prior to initiation of any formal legal process, will be submitted for non-binding mediation, prior to initiation of any formal legal process. Cost of mediation will be shared equally. Nothing in this Section will prevent either party from resorting to judicial proceedings, if (i) good faith efforts to resolve the dispute under these procedures have been unsuccessful, (ii) the dispute, claim or controversy involves intellectual property, or (iii) interim relief from a court is necessary to prevent serious and irreparable injury to that party or to others.

General. Illinois law governs this license. The terms of this license are supplemental to any written agreement executed by both parties regarding this subject and the Software Motorola is to license you under it, and supersedes all previous oral or written communications between us regarding the subject except for such executed agreement. It may not be modified or waived except in writing and signed by an officer or other authorized representative of each party. If any provision is held invalid, all other provisions shall remain valid, unless such invalidity would frustrate the purpose of our agreement. The failure of either party to enforce any rights granted hereunder or to take action against the other party in the event of any breach hereunder shall not be deemed a waiver by that party as to subsequent enforcement of rights or subsequent action in the event of future breaches.

Hardware Warranty in U.S.

Motorola U.S. offers a warranty covering a period of days from the date of purchase by the customer. If a product is found defective during the warranty period, Motorola will repair or replace the product with the same or a similar model, which may be a reconditioned unit, without charge for parts or labor.

IN NO EVENT SHALL MOTOROLA BE LIABLE TO YOU OR ANY OTHER PARTY FOR ANY DIRECT, INDIRECT, GENERAL, SPECIAL, INCIDENTAL, CONSEQUENTIAL, EXEMPLARY OR OTHER DAMAGE ARISING OUT OF THE USE OR INABILITY TO USE THE PRODUCT (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION, LOSS OF BUSINESS INFORMATION OR ANY OTHER PECUNIARY LOSS, OR FROM ANY BREACH OF WARRANTY, EVEN IF MOTOROLA HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. (Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion or limitation may not apply to you.) IN NO CASE SHALL MOTOROLA'S LIABILITY EXCEED THE AMOUNT YOU PAID FOR THE PRODUCT.

Trademarks, Product Names, and Service Names

MOTOROLA, the stylized M Logo and all other trademarks indicated as such herein are trademarks of Motorola, Inc. ® Reg. U.S. Pat & Tm. Office. Canopy is a trademark of Motorola, Inc. All other product or service names are the property of their respective owners.

Motorola, Inc
Broadband Wireless Technology Center
50 East Commerce Drive
Schaumburg, IL 60173
USA

http://www.motorola.com/canopy

TABLE OF CONTENTS

GETTING STARTED 8
Welcome 8
Intended Use 8
Document Change History 8

PRODUCT DESCRIPTION 8
Operation 9
Configuration 9

BACKGROUND INFORMATION on NETWORKING 12

SYSTEM OVERVIEW AND SITE PLANNING 13
Site Selection Criteria 14
General Considerations 15
Channel Plans 16
2.4 GHz Recommended Frequencies 16
5.2 GHz Recommended Frequencies 16
5.7 GHz Recommended Frequencies 16
Single Access Point Module 17
Single Access Point Cluster 17
Multiple Access Points Clusters 17
Networking Information 19
Lightning Protection 19
Electrical Requirements 19

ADVANCED FEATURES 20
Security - DES Encryption 20
Security - AES Encryption 20
Bandwidth Management 21
High Priority Bandwith 21
Branding 22
SNMP 23

INSTALLATION 24
Unpack the Canopy Products 24
Configuration of the Access Point Modules 24
Configuration of the Cluster Management Module 25
Installation of the Equipment 25
Verification 28

CABLING 29

THE INTERFACE SCREENS 31
Quick Start 31
Status Page 32
Configuration 34
Canopy Default Plug 38
Event Log 39
LUID Select 39
Link Test 40

Time & Date 40
Sessions 41
GPS Status 43
Ethernet Stats 43
Expanded Stats 44

ACCESSORIES 45

APPENDIX 46

SPECIFICATIONS 46
Access Point Module 47
Cluster Management Module Gen II 47
Physical 47
AC Power 48
DC Power (24V) Option 48
DC Power (12V) Option 48
Cable Specifications 48

TABLE OF FIGURES

Figure 1: Canopy Access Point Module 9
Figure 2: Front view of Cluster Management Module, Installed 10
Figure 3: Bottom view of Cluster Management Module, Installed 11
Figure 4: System Wiring Diagram 14
Figure 5: Fresnel Zone 15
Figure 6: Laying out multiple Access Point clusters 18
Figure 7: Location of 115/230 V Switch 25
Figure 8: Detail of pole mounting 26
Figure 9: Detail of GPS antenna mounting 27
Figure 10: Port indicator LED on Ethernet switch 28
Figure 11: Quick Start web page 31
Figure 12: Status web page 32
Figure 13: Configuration web page 34
Figure 14: LUID Select web page 39
Figure 15: Link Test web page 40

GETTING STARTED

WELCOME

Thank you for your purchase of a Motorola Canopy Access Point cluster and/or Cluster Management Module. This new technology is the latest innovation in high speed wireless networking. Some of the Canopy system features are:

- Network speeds of 10/100 BaseT
- Small compact design
- No special set up on your PC.

INTENDED USE

This manual is intended to be used with Canopy software release version 3.x or greater. The intended audience for this manual is system operators and equipment installers.

DOCUMENT CHANGE HISTORY

New in Issue 4:

- Modules operating in the 2.4 GHz ISM band are described
- One year warranty

New in Issue 3:

- AES product described, along with DES product
- 5.7 GHz ISM supports 6 channels (up from 4 with 5.7 GHz U-NII)
- 5.7 GHz ISM frequencies approved for use in Canada, as well as US
- Maximum power used by an Access Point module increases to 8.4 watts
- Shielded cables strongly recommended for all infrastructure cabling connecting APs, BHs, and CMM
- MAC addresses of older non-autosensing modules are listed (non-autosensing modules require correct choice of straight-thru vs crossover cables)

New in Issue 2:

- Updated Notices section including European Community Notification, RF Exposure Note, and Software License Terms and Conditions.
- Measurement units internationalized with metric as well as English units
- Updates for new hardware features:
  - Currently shipping modules now auto-sense the Ethernet termination – either a straight-thru or crossover RJ-45 cable can be used to connect to either a network interface card or hub, switch, or router.
  - The currently shipping CMM has additional cable openings to ease the use of shielded cable.
- References to the Canopy Bandwidth and Authentication Manager (BAM), and the additional bandwidth and security features it offers beyond the features provided by an Access Point with no BAM in the network.
- Specifications changed to reflect expanded lower temperature limit of -40°F (-40°C) for all equipment.
- Specifications clarified and edited for CE Listing for European Community

PRODUCT DESCRIPTION

OPERATION

The Canopy Access Point module's simple design allows for deployment ease. The Canopy Cluster Management Module provides everything necessary to make a system of single or multiple Canopy Access Point modules operational. It provides power, GPS synchronization and Ethernet connectivity.

CONFIGURATION

Access Point Module

As shown below, the base cover of the module snaps off to expose the Ethernet and GPS sync connectors as well as diagnostic LEDs. The base cover is released by depressing a lever on the back side of the base cover.

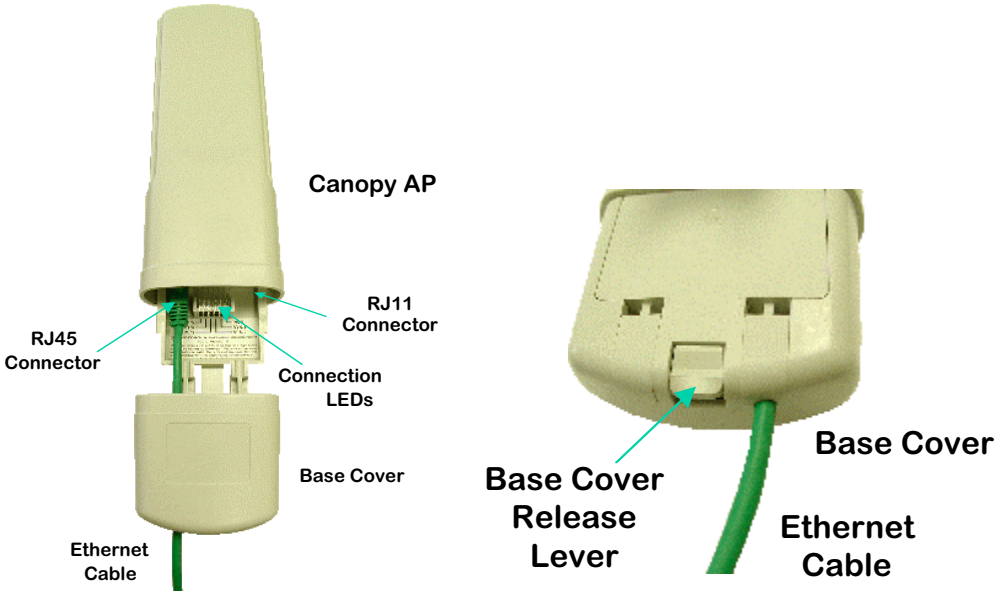


Figure 1: Canopy Access Point Module

The diagnostic LEDs report information about the current status of the Access Point module. The following descriptions explain the function of each LED from left to right.

LNK: The link LED displays the status of the Ethernet link to the Canopy module. The LED will be constantly lit if there is an Ethernet link present. The LED is colored green.

ACT/4: The activity LED displays the status of any data activity on the Ethernet link. The LED will flash (at no particular speed) when data is being transferred on the Ethernet link. The LED is colored orange.

GPS/3: The GPS LED displays the status of the sync pulse and is lit constantly when the pulse is being received. The LED is red.

SES/2: The session LED is not used on the Access Point module. The LED is green.

SYN/1: The sync LED displays sync status. In short, this LED will lit all the time on an Access Point module. The LED is orange.

PWR: The power LED displays the status of power to the module. The LED will be constantly lit if power is applied correctly. The LED is red.

Cluster Management Module generation II

There are four major assemblies contained inside the Cluster Management Module. They are the Ethernet switch, the power transformer, the interconnect board and the GPS receiver.

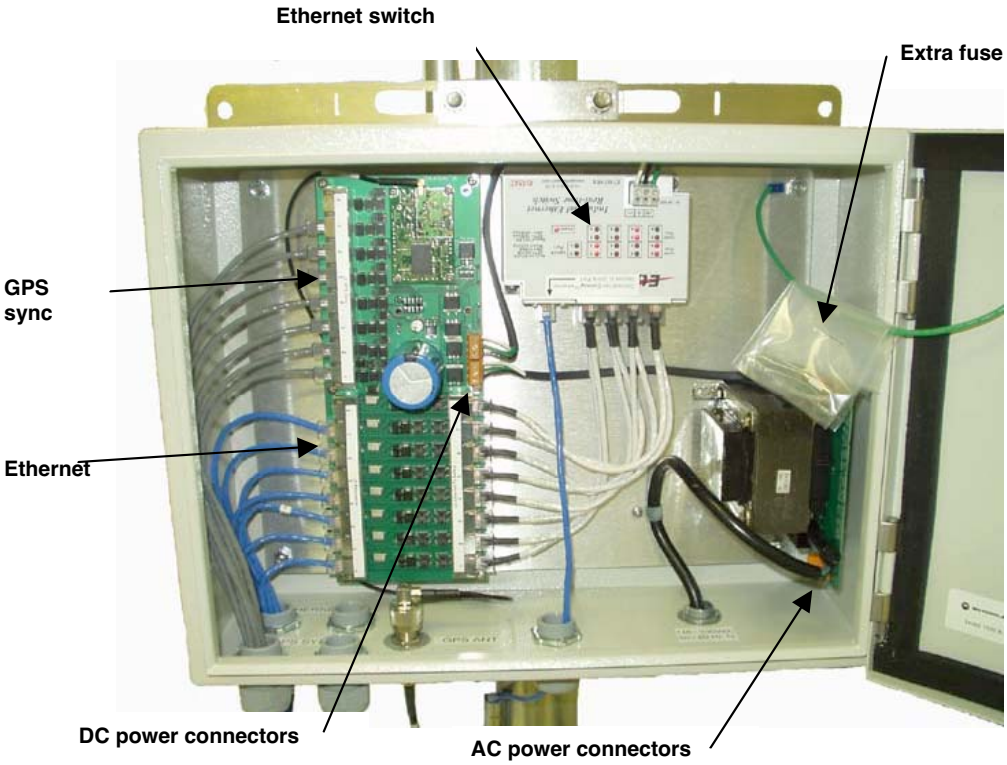


Figure 2: Front view of Cluster Management Module, Installed

Earlier units had four openings on the bottom of the Cluster Management Module as shown in the following figure. Currently shipping units have two additional Ethernet cable and GPS sync cable openings, to allow use of thicker, shielded cables.

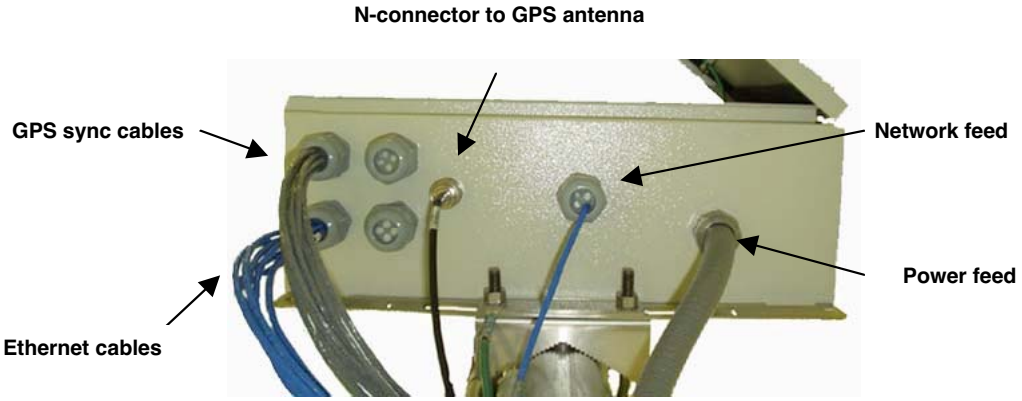


Figure 3: Bottom view of Cluster Management Module, Installed

Mains AC power feed should be either 12 AWG or 14 AWG (4 mm^2 or 2.5 mm^2) wire, with the thicker gauge recommended for longer power runs.

BACKGROUND INFORMATION ON NETWORKING

Computers are assigned IP addresses by network operators, which have two methods available, static or dynamic IP addressing. The user of this document will need to understand how IP addressing is done at their particular location.

All Canopy radio products (Subscriber Modules, Access Point Modules, and Backhaul Modules) have the default IP address of 169.254.1.1. For a computer to talk to Canopy, as it comes from the factory, either of the following conditions must be met:

- If the computer is **not** configured for DHCP, then it has to have a static IP address on the 169.254 network (i.e. 169.254.1.5)
- If the computer is configured for DHCP, then it will automatically obtain an IP address on the 169.254 network after minute or two as long as it is not connected to the network.

SYSTEM OVERVIEW AND SITE PLANNING

Definitions:

Access Point Module – one (1) module that is used to distribute Internet services in a 60-degree sector of up to 200 subscribers.

Access Point Cluster – two (2) to six (6) Access Point modules used to distribute Internet service to a community of up to 1200 subscribers. Each Access Point module will cover a 60-degree sector for a total of up to 360 degrees.

Cluster Management Module – a module that contains power, GPS timing, and networking for an Access Point cluster. Canopy Backhaul Modules can also be connected to the Cluster Management Module making it the central connectivity point for an entire site.

Overview:

In the Canopy System, each subscriber module communicates with an Access Point module in an assign time slot that is controlled by the Access Point. The Access Point module coordinates the data needs of the subscriber in both the downlink and the uplink to allow for seamless communication throughout the entire network.

Access Point modules use a multipoint protocol to communication with each of the subscriber modules registered in the system. Access Point modules can be deployed in the 2.4, the 5.2 GHz, or the 5.7 GHz band allowing for a very versatile system architecture to reach out through the last-mile to all potential customers.

The maximum connection distances are shown in the following table:

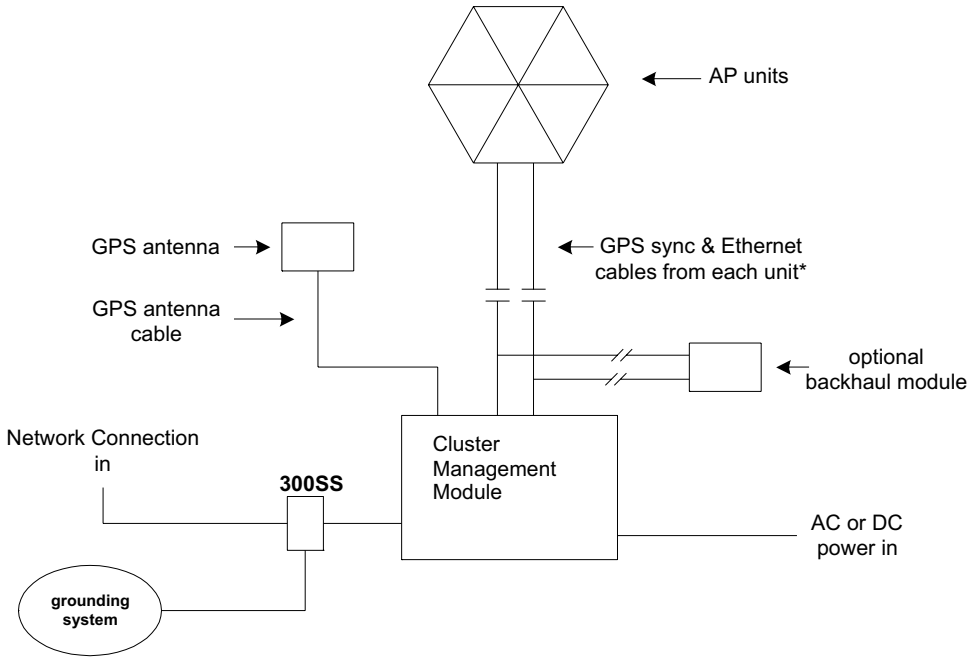
Band	Passive Reflector on SM?	Maximum range
2.4 GHz	No	5 miles (8 km)
2.4 GHz	Yes	15 miles (24 km)
5.2 GHz	Not allowed	2 miles (3.6 km)
5.7 GHz	No	2 miles (3.6 km)
5.7 GHz	Yes	10 miles (16 km)

Note: *Distances will based on terrain and other line of sight issues.*

To bring a network feed out to a remotely located Access Point cluster, the Canopy Backhaul Module can be used to create a point-to-point link out to the location. The Canopy Backhaul Module will interface with the Cluster Management Module to seamlessly integrate the entire system. For more information on the *Canopy Backhaul Module* see its user manual.

The Cluster Management Module is key to the operation of the Canopy System. At one cluster site or throughout the system the Cluster Management Module provides a GPS timing pulse to each module so that their transmission cycles are synchronized. If one Access Point module were to not be synchronized then it may be transmitting during a receive cycle of the other modules and cause the receiver to be desensitized. This is also true of the Canopy Backhaul timing master Modules.

System Wiring Diagram



* Cables from only 1 sector are shown in diagram. There are 2 cables, Ethernet and GPS sync, that would connect each sector unit to the AP Installation kit.

Figure 4: System Wiring Diagram

SITE SELECTION CRITERIA

There are various issues that need to be taken into consideration when choosing a location for the network infrastructure. The following is a list of those considerations. There may be others, as each site is unique.

- Height is essential when installing Canopy Access Points. The Canopy Access Point modules must be mounted higher than other objects located immediately around them such as trees, buildings, and tower legs, but at least 2 feet (0.6 m) below the highest point on the tower or pole for lightning protection.
- There should be no obstructions that will interfere with the unit's internal antenna. The area immediately in front of an Access Point module must be clear of all obstructions.
- Will the installation area change in the future? Will there be structures high enough to interfere with the signal? Will trees grow into the line-of-sight path?
- When possible, avoid high RF energy sites (i.e. AM/FM stations, high powered antennas, etc.) Do not place Canopy equipment in the same plane as other RF equipment.
- The means used by the installer to attach the Access Point cluster to the tower, rooftop, or pole should be rigid and should not move or flex due to wind or other vibrations.
- Tower availability…will a tower have to be erected?
- There must be grounding systems available for protection of the Canopy equipment.

- Lighting arrestors are required in installation area to transport lightning strikes away from equipment.

GENERAL CONSIDERATIONS

Fresnel Loss - The Fresnel Zone is a theoretical area around the line of sight of an antenna transmission that can affect the signal strength. Objects that penetrate the Fresnel Zone can cause fading of the transmitted signal. This fading is caused by the cancellation of the signal due to out-of-phase reflections and absorption of the signal. An unobstructed line of sight is important, but it is not the only determination of an adequate placement. Even though the path has a clear line of sight, if obstructions (such as terrain, vegetation, metal roofs, cars, etc.) penetrate the Fresnel zone, there may be signal loss. The following illustrates a Fresnel zone.

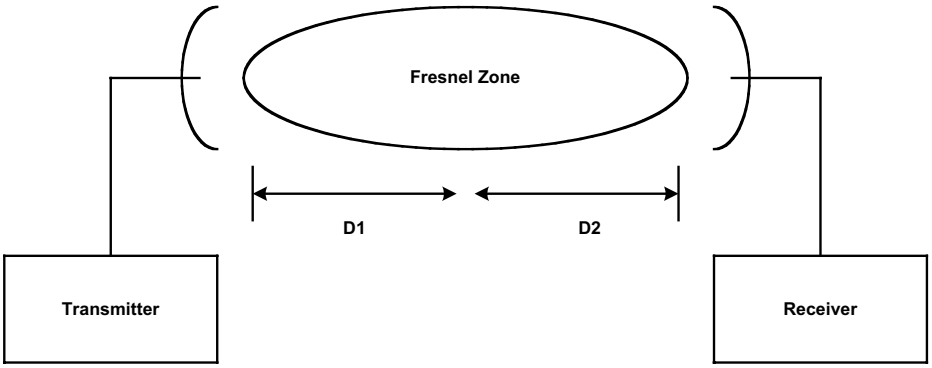


Figure 5: Fresnel Zone

Free Space Path Loss – As an RF signal travels through space, it is attenuated by the distance from the initial transmission point. The farther away from the transmission point, the weaker the RF signal.

Foliage Loss – Tree and plant foliage will cause additional signal loss. Seasonal density, moisture content of the foliage, and other factors such as wind may change the amount of loss. Caution should be used when a link may transmit though this type of environment.

Carrier to Interference – describes how much signal advantage must be engineered into the radio link to tolerate an interfering transmission.

How many Access Point clusters are being planned for deployment? Each cluster will need to use a Cluster Management Module for seamless operation within the entire Canopy System.

How many Access Point modules are being planned for each site in the deployment? Access Point modules can be distributed; they do not necessarily have to be mounted immediately next to each other for operation. For example, if the site is a three-legged tower, two Access Point modules can be mounted to each of the tower legs.

How will the subscriber modules be deployed relative to planned Access Point clusters?

CHANNEL PLANS

Whether using 2.4, 5.2, or 5.7 GHz modules, frequencies should never be placed closer than 20 MHz. 5.2 and 5.7 GHz modules allow the operator to chose frequencies every 5 MHz. 2.4 GHz modules allow the operator to chose frequencies every 2.5 MHz. This is so that in the event of co-location with other equipment the operator can customize the channel layout for interoperability.

Backhauls and APs operating in the same frequency band (within the 2.4 GHz band, within the 5.2 GHz band, or within the 5.7 GHz band) need 100 feet (30 m) of physical separation, as their different transmit and receive frame structures otherwise would cause interference.

2.4 GHz Recommended Frequencies

The following are the 3 non-overlapping channels that are recommended by the Canopy team for use with an Access Point cluster:

- 2.415 GHz
- 2.435 GHz
- 2.4575 GHz

Note this gives 20 MHz of separation between one pair of channels, and 22.5 MHz of separation between the other pair. Depending on the RF environment you are operating in, you may want to put the middle channel at 2.4375 GHz and give additional separation between it and the 2.435 GHz channel, or move the top channel down to 2.455, or the bottom channel up to 2.4175, as long as you maintain at least 20 MHz of separation between channels. You can use the Spectrum Analysis feature in an SM or BHS, or a standalone spectrum analyzer, to help evaluate the RF environment and guide you in site-specific frequency engineering.

5.2 GHz Recommended Frequencies

The following are the 3 non-overlapping channels that are recommended by the Canopy team for use with an Access Point cluster:

- 5.275 GHz
- 5.300 GHz
- 5.325 GHz

5.7 GHz Recommended Frequencies

The following are the 6 non-overlapping channels that are recommended for use in an Access Point cluster when the ISM frequencies are available. ***Note:*** *only 3 channels are actually needed for the fully populated cluster. Any of the six channels can also used for backhaul point-to-point links*:

- 5.735 GHz
- 5.755 GHz
- 5.775 GHz
- 5.795 GHz
- 5.815 GHz
- 5.835 GHz

Canopy 5.7 GHz modules can operate up to 5.840 GHz. If your frequency engineering plan allows, consider using the additional 5 MHz of separation between your AP frequencies and your backhaul frequencies.

Single Access Point Module

A single Access Point module can use any of the frequency channels that are available.

Single Access Point Cluster

Use the following table as a recommendation to assign frequency channels and sector IDs (see section on Configuration interface screen for information on sector IDs). Each frequency is reused on the sector that is at a 180-degree offset. Symbol refers to the layout in the diagram below (Figure 6).

2.4 GHz Plan

Direction of Access Point sector	Frequency	Sector ID	Symbol
North – (0°)	2.415 GHz	0	A
Northeast – (60°)	2.435 GHz	1	B
Southeast – (120°)	2.4575 GHz	2	C
South – (180°)	2.415 GHz	3	A
Southwest – (240°)	2.435 GHz	4	B
Northwest – (300°)	2.4575 GHz	5	C

5.2 GHz Plan

Direction of Access Point sector	Frequency	Sector ID	Symbol
North – (0°)	5.275 GHz	0	A
Northeast – (60°)	5.300 GHz	1	B
Southeast – (120°)	5.325 GHz	2	C
South – (180°)	5.275 GHz	3	A
Southwest – (240°)	5.300 GHz	4	B
Northwest – (300°)	5.325 GHz	5	C

5.7 GHz Plan

Direction of Access Point sector	Frequency	Sector ID	Symbol
North – (0°)	5.735 GHz	0	A
Northeast – (60°)	5.755 GHz	1	B
Southeast – (120°)	5.775 GHz	2	C
South – (180°)	5.735 GHz	3	A
Southwest – (240°)	5.755 GHz	4	B
Northwest – (300°)	5.775 GHz	5	C

Multiple Access Points Clusters

When deploying multiple Access Point cluster in a given area it is recommended that the clusters be aligned in the following manner.

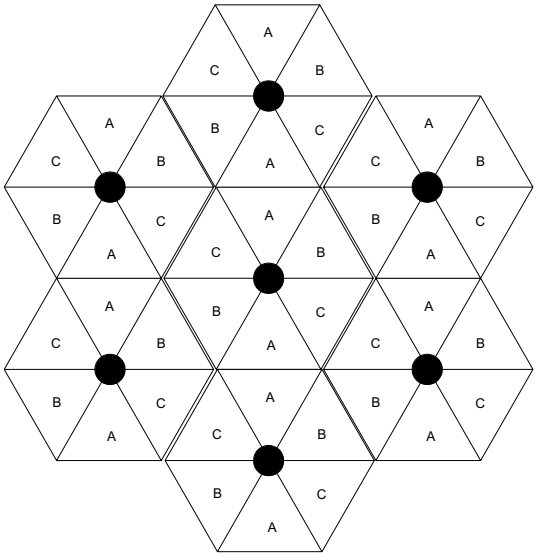


Figure 6: Laying out multiple Access Point clusters

NETWORKING INFORMATION

The Canopy Access Point module will each use an IP address on the operator's network. It is recommended that the Access Point modules ***never*** be placed directly onto the Internet. IP addresses may be assigned sequentially clockwise around an Access Point cluster for easier manageability. The operator will also need to identify the appropriate subnet mask and network gateway each of the modules.

From the factory, each Access Point module is assigned a unique MAC address and the following default networking information:

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

LIGHTNING PROTECTION

- The Canopy Access Point module, Cluster Management Module, and GPS antenna must be mounted at least 2 feet below the highest point at the site for lightning strike mitigation. It is highly recommended that the site have a lightning protection system installed.
- Ensure the location is properly grounded for lightning protection according to all applicable national and local codes.
- To protect operator equipment from surges on the Ethernet cable that is connected to the Canopy System, the Canopy surge suppressor must be used.

ELECTRICAL REQUIREMENTS

- Specifications for the voltages and distance can be found in the *Specification* section of this manual.
- There is a fuse in the CMM for short-circuit protection. In addition, good electrical practice requires a circuit breaker in the electrical circuit supplying the CMM, or other means to provide a disconnect device and back-up short-circuit protection.
- Make certain the installation conforms to applicable country and local codes, such as the . National Electrical Code (NEC) in the US. If uncertain of code requirements, obtain the services of a licensed electrician.

ADVANCED FEATURES

These features may be used in the Canopy System but are not required for basic operation.

SECURITY - DES ENCRYPTION

Standard Canopy modules provide Data Encryption Standard (DES) encryption. DES is a secret key encryption scheme using a 56 bit key. The basics of DES are that it performs a series of bit permutations, substitutions, and recombination operations on blocks of data using a secret key.

On the Canopy system, encryption of the over the air link is enabled or disabled per Access Point module or per Backhaul timing master module. The Canopy modules contain unique factory programmed secret keys to establish the encrypted link. If an authentication key (must be the same key on each end of the backhaul link) has been entered using the Backhaul Configuration page, then that key is also used to establish the DES encryption key. Encryption does not affect the performance or throughput of the system.

SECURITY - AES ENCRYPTION

Motorola also offers Canopy products that provide Advanced Encryption Standard (AES) encryption. Like DES, AES is a secret key encryption scheme, but AES uses the Rijndael algorithm and 128 bit keys to establish a higher level of security than DES.
Due to the level of security provided by AES, the US government has established export controls on communications products that use AES. These export controls may mean that outside of the US AES products are only available in certain regions – check with your Canopy distributor or reseller for availability in your area.

Canopy AES products run the same software as DES products, so the features available are exactly the same and work the same with the only exception being that the AES products provide AES instead of DES encryption when enabled for encryption on the Configuration screen. All the interface screens, Status pages, Configuration pages, etc. are identical. As new software features become available on DES products, the same software and the same features will be available for AES products.

DES backhauls are available in both 10 Mbps and 20 Mbps signaling rates. AES backhauls are only available with a 10 Mbps signaling rate.

Canopy DES products are not upgradeable to AES. To have the option of AES encryption, you must purchase AES products.

Canopy AES products use a different FPGA load than DES products. However, the FPGA will be upgraded as needed to provide new features or services similar to the DES products.

The same as with DES, encryption of the over the air link is enabled or disabled per Access Point module or per Backhaul timing master module. The Canopy modules contain unique factory programmed secret keys to establish the encrypted link. If an authentication key (must be the same key on each end of the backhaul link) has been entered using the Backhaul Configuration page, then that key is also used to establish the AES encryption key.

Canopy AES products and DES products do not interoperate when enabled for encryption, as DES and AES are different encryption schemes. An AES AP with encryption enabled can only communicate with AES SMs, and similarly an AES Backhaul timing master module with encryption enabled can only communicate with an AES Backhaul timing slave module. However, if encryption is disabled, AES modules can communicate with DES modules.

BANDWIDTH MANAGEMENT

Subscriber Module bandwidth management is set per Access Point. All Subscriber Modules which register to an Access Point module will receive and use the same bandwidth management information.

The software uses "token buckets" to manage each subscriber's bandwidth. Each subscriber's bucket (actually two buckets, one for uplink and one for downlink) is constantly being filled with tokens at the Sustained rate, up to the Burst size (the size of their bucket). When they use the internet, they have full bandwidth until they "drain" their bucket, then they only have the Sustained rate, until they quit draining their bucket, and let it refill a bit.

After a burst is fully or partially used, it then "recharges" at the Sustained rate. Short bursts recharge quickly, often before the next burst. Large bursts take longer to recharge.

The way bandwidth management appears to the subscriber is that as long as they are doing normal web browsing and e-mail handling, small file transfers, and short streaming video, they will rarely be speed limited, depending on what the bandwidth management is set to. If they do large downloads (software upgrades, streaming video, and so on), or a series of medium-size downloads, they will have high bandwidth until they hit the burst limit, then drop down in speed to the sustained setting. When they are idle, the burst limit will then "recharge" at the sustained rate.

To manage bandwidth separately for each SM, Canopy offers the Bandwidth and Authentication Manager (BAM). The BAM supports per-SM setting of Sustained Uplink, Sustained Downlink, Uplink Burst, and Downlink Burst, as well as SM authentication and user-specification of DES keys. The BAM is a Canopy software product running on a networked Linux PC.

HIGH PRIORITY BANDWITH

To support traffic with a low latency requirement such as VoIP (voice over IP), the Canopy System implements a high priority data pipe. This implementation does not affect the inherent latencies in the Canopy System but allows high priority traffic to be serviced immediately. The high priority pipe separates low latency trafiic from traffic that is latency tolerant such as standard web surfing and file downloads. This traffics is separated by the Canopy System via the IPv4 TOS (type of service) Low Latency bit. If this bit is set, the packet will be sent on the high priority pipe. This pipe is serviced before any normal priority traffic.

The high priority system is enabled via four fields found in the Configuration web page. The fields are:

- High Priority Uplink Percentage
- Uacks Reserved High
- Dacks Reserved High
- NumCtrlSlots Reserved High

The High Priority Uplink Percentage parameter describes the percentage of the uplink bandwidth that will be dedicated to low latency traffic. When set, this percentage of RF link bandwidth will be permanently allocated to low latency traffic regardless of the amount of this kind of traffic present. There is no corresponding downlink parameter as this bandwidth is allocated on as-needed basis by the scheduling algorithms.

The UAcks (Uplink ACK) Reserved High parameter describes the number of slots used to acknowledge high priority data that is received by a subscriber module. The Canopy team recommends that this parameter be set to 3 and then the TotalNumUAcksSlots parameter should be set to 6.

The DAcks (Downlink ACK) Reserved High parameter describes the number of slots used to acknowledge high priority data that is received by an Access Point module. The Canopy team recommends that this parameter be set to 3 and NumDAckSlots parameter should be set to 6.

The NumCtrlSlots Reserved High parameter describes the number of slots used to send control messages to an Access Point module. The Canopy team recommends that this parameter be set to 3 and the NumCtlSlots parameter should be set to 6.

When all these parameters are configured, all high priority traffic in the uplink direction will be serviced via this pipe at the percentage configured. This is true even if the high priority traffic volume exceeds the configured capacity and there is no non-high priority traffic.

BRANDING

On each Canopy module, the web-based interface screens have a Canopy logo that can be replaced with an operator's company logo. The Canopy logo file is called *canopy.jpg* and the replacement file must also be called *canopy.jpg*. The new file is transferred via FTP to the module and then added to a special filesystem through a telnet session. The following command can be used during a telnet session:

- addwebfile – add a custom logo file to the filesystem
- clearwebfile – clear the customer logo file from the filesystem
- lsweb – list the custom logo file and display the storage space available on the filesystem

The following is a sample FTP session:

```
> ftp 169.254.1.1
Connected to 169.254.1.1
220 FTP server ready
Name (169.254.1.1:none): root
331 Guest login ok
Password: <password-if-configured>
230 Guest login ok, access restrictions apply.

ftp> binary
200 Type set to I
ftp> put canopy.jpg
ftp> quit
221 Goodbye
```

The following is a sample telnet session:

```
/---------\
C A N O P Y

Motorola Broadband Wireless Technology Center
(Copyright 2001, 2002 Motorola Inc.)

Login: root
Password: <password-if-configured>

Telnet+> lsweb

Flash Web files
free directory entries: 32
free file space     64336 bytes

Telnet+> addwebfile canopy.jpg
Telnet +> lsweb

Flash Web files
/canopy.jpg     7867
free directory entries: 31
free file space: 56468
```

```
Telnet +> clearwebfile
Telnet+> lsweb

Flash Web files
free directory entries: 32
free file space     64336 bytes
```

SNMP

Simple Network Management Protocol (SNMP) can be used to monitor the Canopy modules. The standard MIB-II (systems and interfaces) objects are programmed into the modules. For specific information on this MIB see *RFC 1213* for details.

With Canopy Release 3.2, the Canopy Enterprise MIB is available for additional information reporting and control. Consult the Release 3.2 Software Release Notes for additional information.

INSTALLATION

The following steps are required to install the Canopy Access Point module(s), the Cluster Management Module, and the GPS antenna:

- Unpack the Canopy products
- Configuration of the Access Point modules
- Configuration of the Cluster Management Module
- Installation of the Access Point modules, Cluster Management Module, and GPS antenna
- Verification

UNPACK THE CANOPY PRODUCTS

Upon receipt, carefully inspect all shipping boxes for signs of damage. If there is damage, immediately notify the transporatation company.

Unpack equipment, making sure that all ordered components have arrived. It is recommended that you save all the packing materials. They can be used for transportation of the equipment to and from installation sites.

CONFIGURATION OF THE ACCESS POINT MODULES

In all cases, for configuration changes to take effect, the operator must

1. Make the configuration change or changes on a module's web page.
2. Save the configuration change or changes, using the **Save** button.
    a. Make and Save additional configuration changes if desired.
3. Reboot the module, using the **Reboot** button.

The configuration changes don't take effect until the module is rebooted.

The are two methods that can be used to configure each of the Access Point modules. The first method is to use the *Quick Start* feature of the product. For more information on *Quick Start* see *The Interface Screens.* The second is to manually set each of the parameters.

The Access Point module, from the factory, is configured to ***not transmit*** on any frequency. This is done so that an operator does not accidentally turn on an unsynchronized Access Point module. An operator will need to verify the following information:

- Will the Access Point module need to generate its own sync pulse or will it receive it from the Cluster Management Module?
- The operator will assign a RF frequency for the module to transmit.
- The operator may assign value for uplink and downlink bandwidth capping. If the Access Point module is in a cluster with other modules then this parameters on all units ***must*** be set exactly the same.
- The operator will assign an IP address to the module for the network it will be installed on and assign an appropriate subnet mask and network gateway.
- The operator must configure the appropriate color code on the Access Point module so that subscriber modules can register with it. The color codes must match for registration.
- The operator must configure the maximum range that the Access Point module will register a subscriber module. If the Access Point module is in a cluster with other modules then this parameter on all units ***must*** be set exactly the same.
- The operator can prevent unauthorized users from connectig to the Access Point module's web based interface by assigning a password. There is no default password and password protection is turn off is turn off from the factory.

- Passwords can be from 1 to 16 characters. Any combination of characters is allowed, except for these special characters: " , . ' { } / \ ; : [ ] ( ) ` ~
- **NOTE:** If the operator forgets either the password or the IP address for the module, a Canopy default plug can be used to regain access. For details, see the section on the default plug under Interface Screens.
- There are two types of passwords that can be configured: display-only or full-access. The display-only password allows the operator to view the module's current status. The full-access password allows the operator to view the module's current status and change its configuration. By viewing the red lettering to the right of the entry fields, the operator can tell that a password is set, but can't see the password.

- The operator can enter information about the Site Name, Location, and Contact. This is optional.

CONFIGURATION OF THE CLUSTER MANAGEMENT MODULE

The operator will need to verify the following when configuring a Cluster Management Module:

- What type of power will the module use, AC or DC?
  - If using AC power, there is a **switch** to choose 115V or 230V on the power transformer. This switch must be set correctly before power is applied, or the unit may be damaged. See the schematic inside the Cluster Management Module for further information.

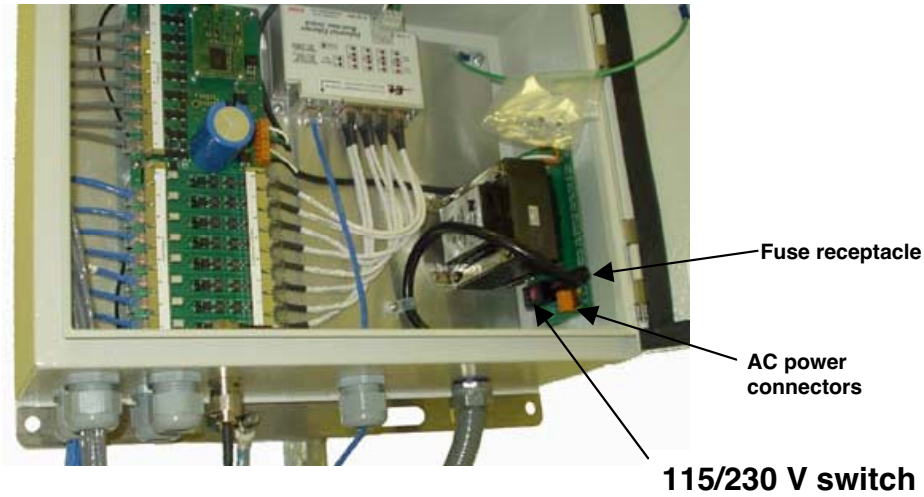


Figure 7: Location of 115/230 V Switch

- The AC power connectors are labeled
  - N for Neutral
  - L for Line
  - PE for Protective Earth (PE) ⏚ (ground)
- The maximum thickness wire to be used is 12 AWG (4 mm^2).

INSTALLATION OF THE EQUIPMENT

The following tools may be needed during installation:

- 3/8" nut driver

- 12” adjustable wrench
- 7/16” wrench for installation of GPS mounting bracket
- 14mm wrench for installation of Cluster Management Module pole-mounting brackets
- Needle-nose pliers

When power is applied to a Canopy module or the unit reset via the web-based interface, the module will take approximately 25 seconds to boot up. During this boot up time, power on self-tests and other diagnostics are being performed.

The following steps are needed to install the Canopy equipment:

- Remove the base cover from all Canopy Access Point modules to be installed.
- Remove the GPS sync cable knockout from the base cover with needle-nose pliers.
- Mount the Access Point modules:
  - The modules can be mounted in a variety of locations, choose the best location for your particular application. Modules do not have to mounted directly next to each other, they can be distributed throughout a given site. Mounting can be done by using stainless steel hose clamps or another equivalent fastener.
- Mount the Cluster Management Module
  - Mount the module in a location that will allow access for service if necessary.
  - The farthest that the Access Point modules can be from the Cluster Management Module is 328 feet (100 meters).
  - The module should not be mounted closer than 10 feet (3 meters) to the Access Point modules or Backhaul Modules
  - The module box has flanges for ease of installation. Hardware is included to support different mounting options:
    - Directly to a wall (screws or bolts not included)
    - Around irregular shaped objects (via adjustable stainless steel bands, included)
    - To a pole with an outside diameter of 1.25 to 3.00 inches (approximately 3 to 8 cm). (toothed V brackets, included).

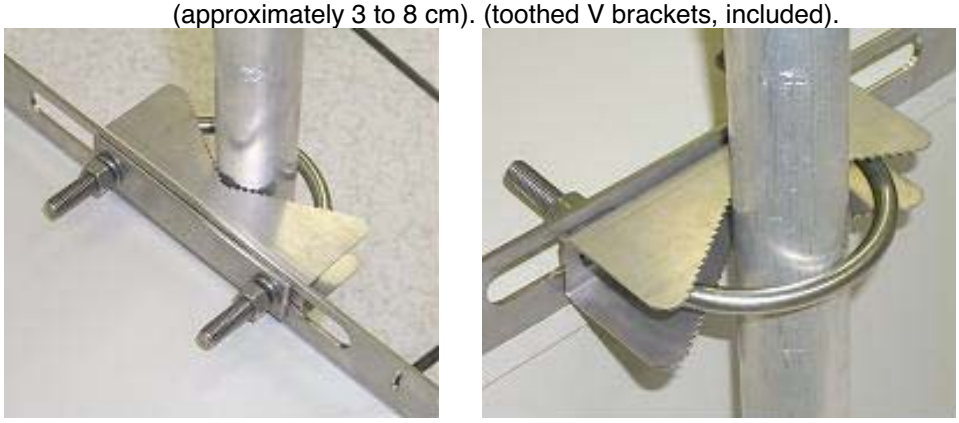


Figure 8: Detail of pole mounting

- Mount the GPS antenna
  - The GPS antenna must be located so that it has an unobstructed view of the sky (20-degrees off the horizon) and is not the highest item at the installation site (for lightning).
  - The GPS antenna mount is provided with U-bolts for pole sizes of 1.25 to 1.50 inches (approximately 3 to 4 cm).

Figure 9: Detail of GPS antenna mounting

- Route the Ethernet cables from the Access Point modules to the Cluster Management Module. The strain relief plugs on the CMM already have precut holes. Each hole of the strain relief is designed to hold two CAT 5 UTP cables, or one if it is shielded cable.
    - The Ethernet cables use RJ-45 connectors (standard Ethernet) that connect to matching ports within the Cluster Management Module. The ports are labeled with a "*J3*". ***Always connect modules starting at port 1. This port is the master port for the CMM.***
    - A total of 8 ports are available on the Cluster Management Module to accommodate any combination of Access Point modules and Backhaul Modules.
    - Connect the remaining Ethernet cables in the same manner.
- Route the GPS sync (serial) cables from the Access Point modules to the Cluster Management Module.
    - The GPS sync cables use 6 conductor RJ-11 connectors that connect to matching ports within the Cluster Management Module. The ports are labeled with a "*J1*". ***Always connect modules starting with port 1. This port is the master port for the CMM.***
    - Connect the remaining GPS sync cables in the same manner.
- If necessary, route a network cable into the Cluster Management Module and connect to the uplink port on the switch. As with any such installed devices, proper grounding of the Ethernet cable is necessary. The Canopy Surge Suppressor is such a device for this situation.
- Connect GPS coax cable to N-connector on the outside of the Cluster Management Module.
- Connect AC or DC power to the Cluster Management Module.
- When power is applied the "*power*" LED on the Ethernet switch should come on as well a green LED on the circuit board as show in the following figure.

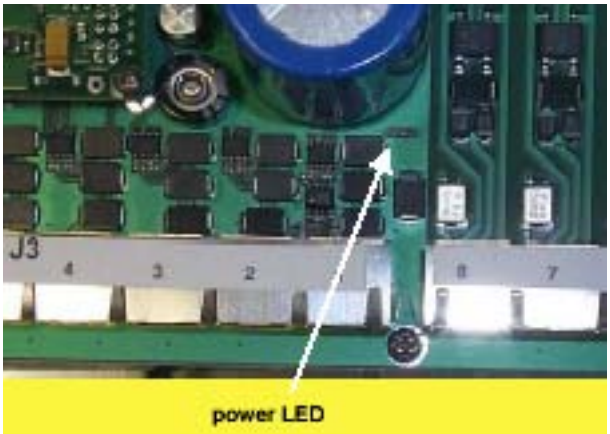


Figure 10: Port indicator LED on Ethernet switch

- Verify that all of the Access Point modules are reliably connected to the Ethernet switch by observing that each port indicator LED on the Ethernet switch is lit.
- Replace the base cover on all of the Access Point modules.
- Close and lock the Cluster Management Module.

All Canopy modules connected to the Cluster Management Module must be configured to "*Sync to Received Signal*". Otherwise GPS timing pulse will not be transmitted to the modules.

VERIFICATION

- Access the web based interface for each Access Point module by opening up http://<ip-address> where the <*ip-address*> is the address of the individual module.
- Click on "GPS Status" from the menu located on the left hand side of the web page.
- Verify that the Access Point module is seeing and tracking satellites. The module must be tracking at least 4 satellites for the timing pulse to be generated.
- Take a subscriber module into the area surrounding the newly installed Access Point cluster and verify that the subscriber module registers to each of the installed Access Point modules. The subscriber must have the same color code as the Access Point for successful registration (assuming that there is also a clear line-of-sight).
- When the subscriber module is registered, verify the following:
    - Frequency of the Access Point module registered to
    - Sector ID of the Access Point module registered to
    - Physical position of the Access Point Module registered to

If the information that is reported back does not conform to your initial deployment plan, reconfigure the Access Point cluster to bring it into compliance.

CABLING

It is strongly recommended to use shielded cable for all Canopy infrastructure cabling associated with Backhauls, Access Points, and Cluster Management Modules. The environment these modules operate in often has significant or unknown or varying RF energy, and experience has been that the additional cost of shielded cabling is more than compensated by predictable operation and reduced debugging and support costs.

The following information describes the wiring standards for installing a Canopy system. All diagrams use the EIA/TIA 568B color standard.

Currently shipping modules auto-sense the Ethernet cable type – either RJ-45 straight-thru cable or RJ-45 crossover cable can be used to connect a network interface card (NIC), hub, router, or switch to a module.

The following table shows MAC Addresses of Auto-sensing modules:

MAC Address (ESN)	Non-auto-sensing	Auto-sensing
2.4 Modules		All
5.2 Modules	≤ 0a003e0021c8	≥ 0a003e0021c9
5.7 Modules	≤ 0a003ef00f79	≥ 0a003ef00f7a

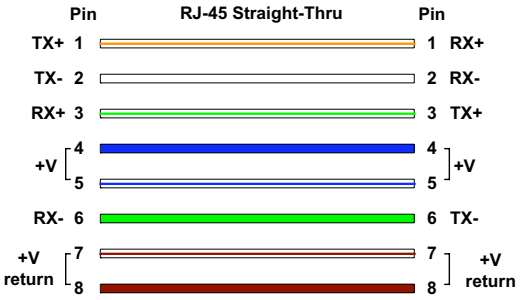
Very early modules did not auto-sense. In cases where older modules are used:

- When connecting a Canopy device directly to a network interface card (NIC) use a RJ-45 straight-thru cable.
- When connecting a Canopy device directly to a hub, switch, or router use a RJ-45 crossover cable.

When using the Canopy AC wall adapter the +V is +11.5VDC to +30VDC with a nominal value of +24 VDC, and the maximum Ethernet cable run with the AC wall adapter is 328 feet (100 meters).

RJ-45 Straight-Thru:

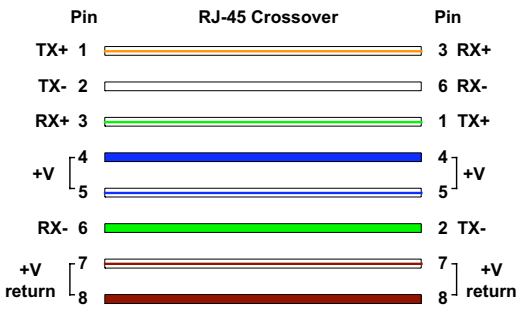
- pin 1 → white / orange ← pin 1
- pin 2 → orange ← pin 2
- pin 3 → white / green ← pin 3
- pin 4 → blue ← pin 4
- pin 5 → white / blue ← pin 5
- pin 6 → green ← pin 6
- pin 7 → white / brown ← pin 7
- pin 8 → brown ← pin 8



Pins 4, 5, 7, and 8 are used to carry power to the Canopy modules.

RJ-45 Crossover:

- pin 1 → white / orange ← pin 3
- pin 2 → orange ← pin 6
- pin 3 → white / green ← pin 1
- pin 4 → blue ← pin 4
- pin 5 → white / blue ← pin 5
- pin 6 → green ← pin 2
- pin 7 → white / brown ← pin 7
- pin 8 → brown ← pin 8

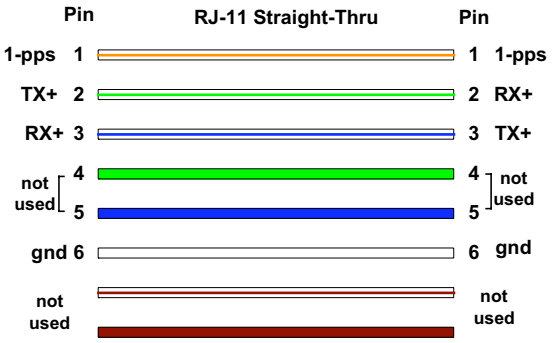


Pins 4, 5, 7, and 8 are used to carry power to the Canopy modules.

RJ-11 Straight-Thru (for GPS sync cable)

Using CAT 5 cable and 6-pin RJ-11 connectors, the following diagram shows the wiring of the cable for GPS sync.

- pin 1 → white / orange ← pin 1
- pin 2 → white / green ← pin 2
- pin 3 → white / blue ← pin 3
- pin 4 → green ← pin 4
- pin 5 → blue ← pin 5
- pin 6 → orange ← pin 6
- the 4th pair is not used



THE INTERFACE SCREENS

The Canopy Access Point module contains a series of web pages that are used to interface to the unit. The following is a quick reference to interface screens. Note: These screens are subject to change by subsequent software versions. To access the web based interface you first must be on a computer that is in some way connected to the Access Point module. This can be done either directly or through a network. Enter the IP address of the Access Point module (default is 169.254.1.1) into the address bar of your browser and hit enter on your keyboard. The following web based interface pages are accessible:

- Quick Start
- Status
- Configuration
- Event Log
- LUID Select
- Link Test
- Time & Date
- Sessions
- GPS Status
- Ethernet Stats
- ExtendedStats

QUICK START

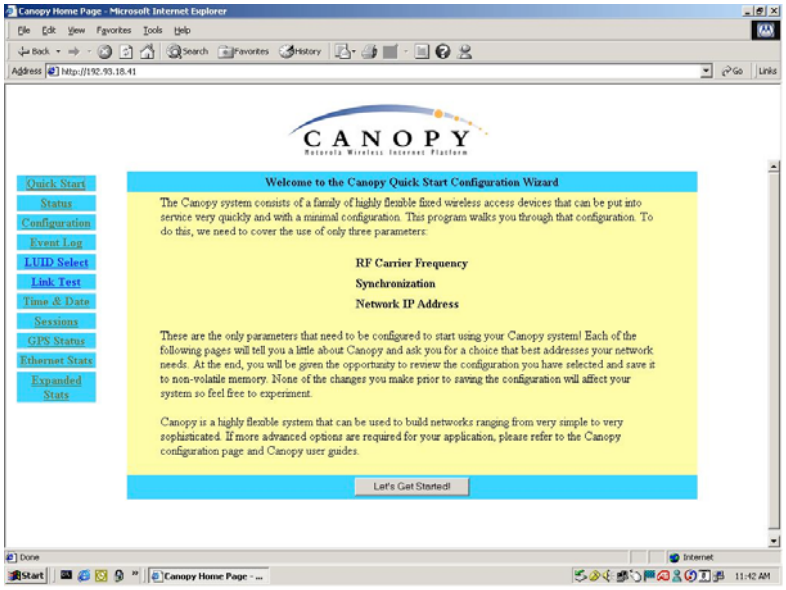


Figure 11: Quick Start web page

The Canopy System consists of a family of highly flexible, fixed wireless access devices that can be put into service quickly and with a minimal configuration. The Quick Start is a wizard that walks the operator through that configuration. To place an Access Point module into operation, only three parameters need to be configured:

- RF Carrier Frequency
- Synchronization
- Network IP Address

Each of the pages in the Quick Start will explain a little about Canopy and ask the operator for a choice that best addresses the network requirements. At the end, the operator will be given the opportunity to review the configuration selected and save it to non-volatile memory. None of the changes made prior to saving the configuration will affect the system so experimentation with the interface is encouraged.

STATUS PAGE

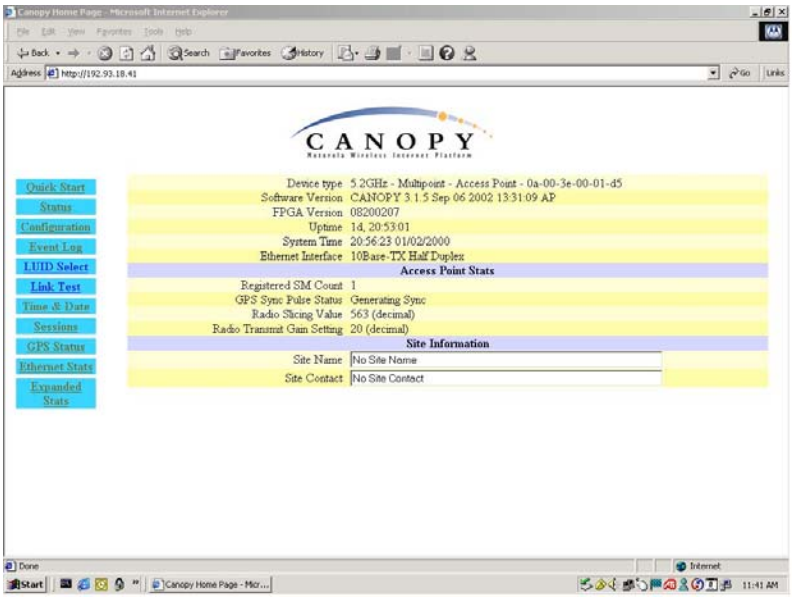


Figure 12: Status web page

The Status page contains information on the operation of the product. It is the default web page. The following parameters are displayed:

Device Type: displays the type of Canopy module that is currently being viewed. This field will let the operator know the frequency band of the module, the protocol that it is utilizing, and the MAC address of the module. The frequency band can either be in the 5.2 GHz or 5.7 GHz band.

Software Version: displays the version of the software that is currently loaded into the module. Please make note of this information when obtaining technical support.

FPGA Version: displays the version of the FPGA (field programmable gate array) that is currently loaded into the module. Please make not of this information when obtaining technical support.

Uptime: displays the length of time the module has been operating since power was applied.

System Time: displays the current time. If the Access Point module is connected to a Cluster Management Module (CMM) then the time will be Greenwich Mean Time (GMT). Any subscriber module that registers to the Access Point module will inherit the system time.

Ethernet Interface: displays the configuration of the Ethernet interface on the module.

Registered SM Count: displays the number of subscriber modules currently registered to the Access Point module.

GPS Sync Pulse Status: displays the current status of the type of synchronization the Access Point module is receiving. There are 3 values that could be displayed:

- *Generating sync*: If the module is set to generate its own sync pulse then this message will be displayed.
- *Receiving Sync*: If the module is set to receive a sync pulse from an outside source (not itself) and is actually receiving the pulse then this message will be displayed.
- *ERROR: No Sync Pulse*: If the module is set to receive a sync pulse from an outside source (not itself) and it is currently not receiving the pulse this message will be displayed. When this message is displayed the Access Point module will turn its transmitter off so as to not create any self-interference within the Canopy System.

Radio Slicing Value: displays information to be used be Canopy technical support.

Radio Transmit Gain Setting: displays information to be used by Canopy technical support.

Site Name: displays information relating to the name of the physical module. This parameter can be set by the operator on the *Configuration* web page. This information is set into the *sysName* SNMP MIB-II object and can be polled via a SNMP management server.

Site Contact: displays contact information for the physical module. This parameter can be set by the operator on the *Configuration* web page. This information is set into the *sysContact* SNMP MIB-II object and can be polled via a SNMP management server.

CONFIGURATION

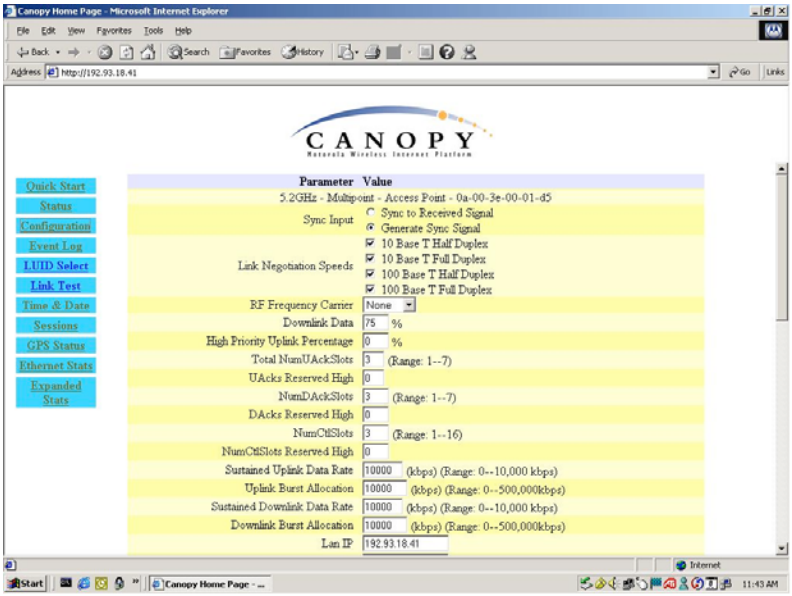


Figure 13: Configuration web page

The Configuration web page contains information and configurable parameters pertaining to the operation of the product. The first line of information on the Configuration screen is a repeat of the *Device Type* from the Status web page. The following are the parameters and their descriptions.

Sync Input: choose the type of synchronization that this Access Point module will use.

If “Sync to Received Signal” is chosen, then it is assumed that:

- this Access Point module it connected to a Cluster Management Module and will be receiving a sync pulse via GPS
- this Access Point module is connected to another Access Point module that is generating its own sync pulse.

If “Generate Sync Signal” is chosen then it is assumed that:

- this Access Point module is a stand-alone module with no other Access Point modules within a 5 mile radius.
- this Access Point module is generating the sync pulse for a cluster of Access Point modules and there are no other Access Point modules within a 5-mile radius.

Link Negotiation Speeds: choose the type of link speed desired for the Ethernet connection. The default for this parameter is for all the choices to be checked.

RF Frequency Carrier: choose the frequency that the module will transmit on. The default from the factory is to have this parameter set to none.

Downlink Data: choose the percentage of the aggregate throughput that is needed for the downlink (i.e going from the Access Point module to the subscriber). For example, if the aggregate throughput on the Access Point module is 6 Mbits, then configuring this parameter for 75% will allocate 4.5 Mbits for the downlink and 1.5 Mbits for the uplink. If the Access Point module is in a

cluster with other modules then this parameter on all units ***must*** be set exactly the same. The default for this parameter is 75%.

High Priority Uplink Percentage: describes the percentage of the uplink bandwidth that will be dedicated to low latency traffic. When set, this percentage of RF link bandwidth will be permanently allocated to low latency traffic regardless of the amount of this kind of traffic present. There is no corresponding downlink parameter as this bandwidth is allocated on as-needed basis by the scheduling algorithms.

Total NumUAckSlots: describes the total number of slots used to acknowledge data that is received by a subscriber module. If the Access Point module is in a cluster with other modules then this parameter on all units ***must*** be set exactly the same. The default should be set to 3.

Uacks Reserved High: describes the number of slots used to acknowledge high priority data that is received by a subscriber module. The Canopy team recommends that this parameter be set to 3 and then the Total NumUAcksSlots parameter should be set to 6.

NumDAckSlots: describes the total number of slots used to acknowledge data that is received by an Access Point module. If the Access Point module is in a cluster with other modules then this parameter on all units ***must*** be set exactly the same. The default should be set to 3.

Dacks Reserved High: describes the number of slots used to acknowledge high priority data that is received by an Access Point module. The Canopy team recommends that this parameter be set to 3 and NumDAckSlots parameter should be set to 6.

NumCtlSlots: describes the total number of slots used to send control messages to an Access Point module. If the Access Point module is in a cluster with other modules then this parameter on all units ***must*** be set exactly the same. The default should be set to 3.

NumCtlSlots Reserved High: describes the number of slots used to send control messages to an Access Point module. The Canopy team recommends that this parameter be set to 3 and the NumCtlSlots parameter should be set to 6.

Sustained Uplink Data Rate: choose the rate at which each Subscriber Module registered to this AP will be capped in the uplink direction. The default is 10,000 kbps, which means that there is no restriction on the uplink.

Uplink Burst Allocation: choose the maximum value that each individual subscriber module will have for burst traffic in the uplink direction. The default is 10,000 kb.

Sustained Downlink Data Rates: choose the rate at which each Subscriber Module registered to this AP will be capped in the downlink direction. The default is 10,000 kbps, which means that there is no restriction on the downlink.

Downlink Burst Allocation: choose the maximum value that each individual subscriber module will have for burst traffic in the downlink direction. The default is 10,000 kb.

LAN IP: enter in the IP address that will be associated with the Ethernet connection on this module. The default address is 169.254.1.1. If the IP address is forgotten, the operator will need physical access to the module and will need to create a Canopy “default plug”. See steps at the end of this section for use of a default plug.

LAN Subnet Mask: enter in an appropriate subnet mask for the module to "talk" on the network. The default value for this parameter is 255.255.255.0.

Default Gateway: enter in the appropriate gateway for the module to "talk" on the network. The default for this parameter is 169.254.0.0.

Private IP: the default for this parameter is 192.168.101.1. It is recommended that the operator not change this parameter. A flat, class C subnet is used to communicate with each of the subscriber modules that have registered. The Access Point uses a combination of the private IP and the logical unit ID (LUID) of the subscriber module.

For example, if there are two subscriber modules (LUID 2 and LUID 3) registered to an Access Point module, then the Access Point uses the following to communicate to each:

Unit	***LUID***	***Private IP***
Access Point module	1	192.168.101.1
subscriber module 1	2	192.168.101.2
subscriber module 2	3	192.168.101.3

If the private IP address is changed then it must designate a Class C subnet that is not used for anything else and the address must be in the form of xxx.xxx.xxx.1, where 1 is the last octet of the address.

Color Code: enter in a value (0-254). The color code on the subscriber module and the Access Point module ***must*** match in order for registration to occur. Color code is not a security feature. It is a means for the Canopy System operator to segregate an individual network or neighbor Canopy networks. Also, color code can be used to force a subscriber module to only register to a specific Access Point module even though the subscriber module may be able to see multiple Access Point modules. The default value for this parameter is 0 on all Canopy modules.

Sector ID: choose an ID number to give to this Access Point module. This parameter does not affect the operation of the module in any way. Its purpose is just another means to identify the Access Point module. When observing a subscriber module's *AP Eval Data* web page, the sector ID is one of the distinguishing fields present to help the operator understand what Access Point module is seen. It is recommended that when constructing an Access Point cluster (2-6 modules) that each sector be given a different ID and that the pattern be repeated throughout the entire Canopy System for manageability.

Max Range: enter in a distance (in miles). This parameter controls the maximum distance that a subscriber module will be allowed to register. The subscriber module must still meet minimum requirements for an acceptable link in order to register. If the Access Point module is in a cluster with other modules then this parameter on all units ***must*** be set exactly the same. The default for this parameter is 2 miles.

Display-Only Access: enter the same password in both fields for verification. The display-only password, when used, will allow only view activities to the module. When the display-only password is set and not the full-access password, the display-only password will be tied to telnet and FTP sessions to the module. If the full-access password is also set then it has precedence on the telnet and FTP sessions. If the password is forgotten, the operator will need physical access to the module and will need to create a Canopy "default plug" to override the unit. See steps at end of section for use and creation of a default plug.

Full Access: enter the same password in both fields for verification. The full-access password, when used, will allow view and change activities to the module. When the full-access password is set, the password will also be tied to telnet and FTP sessions to the module. When prompted for the password via the web-based interface, there is no username required; however when prompted for the password via a telnet or FTP session, the user that MUST be used is "root". If the password is forgotten, the operator will need physical access to the module and will need to create a Canopy "default plug" to override the unit. See steps at end of this section for use of a default plug.

Webpage Auto Update: enter time period (in seconds) desired to have the web browser refresh the web-based interface. The default setting is 0, which will cause the web-based interface to never refresh.

Airlink Security: choose the type of air link security that is to be used on this Access Point module. There are two choices:

- *Normal*: With this mode there is no encryption on the air link. This is the default operation.
- *DES*: With this mode the air link is encrypted using single DES, using a factory programmed secret key that is unique for each module.

Bridge Entry Timeout: choose the appropriate bridge timeout for correct network operation with existing network infrastructure. It is important that this parameter be set for a longer time period than the ARP (address resolution protocol) cache timeout of the router being used to feed the network. ***Note: Failure to properly configure this may lead to temporary loss of communication to specific end users.***

AP Background BER Mode: choose to have this feature turned on or off. Bit Error Rate (BER) mode will allow an operator another means to verify the functionality of a link. When BER mode is turn on a bit error rate can be read on the subscriber side to determine the quality of a registered link. If the Access Point module is in a cluster with other modules then this parameter on all units ***must*** be set exactly the same. Continually, when this feature is on the aggregate available bandwidth will decrease by ~200 Kbps.

Community String: enter a string that will allow a SNMP management server accessibility to the SNMP information. There must not be any spaces in the community string. The default for this parameter is "Canopy".

Accessing Subnet: enter the network that will be allowed to access SNMP information from the canopy module. There are two pieces of information needed:

- The network in the form of xxx.xxx.xxx.xxx
- The CIDR (Classless Interdomain Routing) prefix length in the form of /xx

An example would be 198.32.0.0/16 where /16 is a subnet mask of 255.255.0.0. An Internet search on Classless Interdomain Routing will provide greater detail on this subject for the inexperienced network operator. The default is to allow all networks access.

Trap Address: enter in an IP address (xxx.xxx.xxx.xxx) of an SNMP management server where trap information can be sent. A trap is a way for the module to tell the monitoring system that something has happened. The following are scenarios where traps would be sent:

- after a reboot of the module
- if a SNMP management server tried to access agent information and supplied the wrong community string, wrong SNMP version number, or came from the wrong accessing subnet.

Site Name: enter information relating to a name given to the physical module. This parameter will set the supplied information into the *sysName* SNMP MIB-II object and can be polled by a SNMP management server. The buffer size for this field is 128 characters.

Site Contact: enter contact information relating to the module. This parameter will set the supplied information into the *sysContact* SNMP MIB-II object and can be polled by a SNMP management server. The buffer size for this field is 128 characters.

Site Location: enter information relating to the physical location of the module. This parameter will set the supplied information into the *sysLocation* SNMP MIB-II object and can be polled by a SNMP management server. The buffer size for this field is 128 characters.

Save Changes: by clicking on this button, any changes that have been made on the *Configuration* page will be committed to flash memory and will take effect after the next module reboot.

Undo Save Changes: by clicking on this button, any changes that have been made and ***not*** committed through a reboot of the module will be undone.

Set to Factory Defaults: depressing this button will change all of the configurable parameters (all of which are contained on the *Configuration* page) back to their factory settings.

Reboot: depressing this button will reboot the module.

CANOPY DEFAULT PLUG

When inserted, the default plug brings the module up with a default configuration. This allows the operator to regain control of a module, which may be using an IP address and/or password that has been forgotten. The default plug will also override the passwords for access and change control and set the LAN1 IP address back to 169.254.1.1. This does not, by itself, change any configuration, rather, it allows the operator to attach to the module using the default configuration so that they can read the actual non-default values and set them accordingly.

The following steps outline the creation of a default plug (this plug can also be purchase for a nominal fee at *http://www.best-tronics.com/motorola*):

- Obtain a RJ-11, 6-pin connector and a small length of CAT 5 cable.
- Pin-out all 6-pins and then short (i.e. solder) together pins 4 and 6 on the other end. Remaining wires should not be connected to anything.

  - pin 1 → white / orange
  - pin 2 → white / green
  - pin 3 → white / blue
  - pin 4 → green solder to orange
  - pin 5 → blue
  - pin 6 → orange solder to green

- Insert “default plug” in the GPS sync port of the module and apply power to the module via its Ethernet cable.

When the module is booted up (power applied) it will be in default mode where the IP address will be 169.254.1.1 and the passwords will be blank. All other configurations will have been preserved.

EVENT LOG

This page contains information that is recorded from the subscriber module for troubleshooting purposes. Please make note of the information that is gathered here when calling for technical support.

Clear Event Log: this button will clear the event log.

LUID SELECT

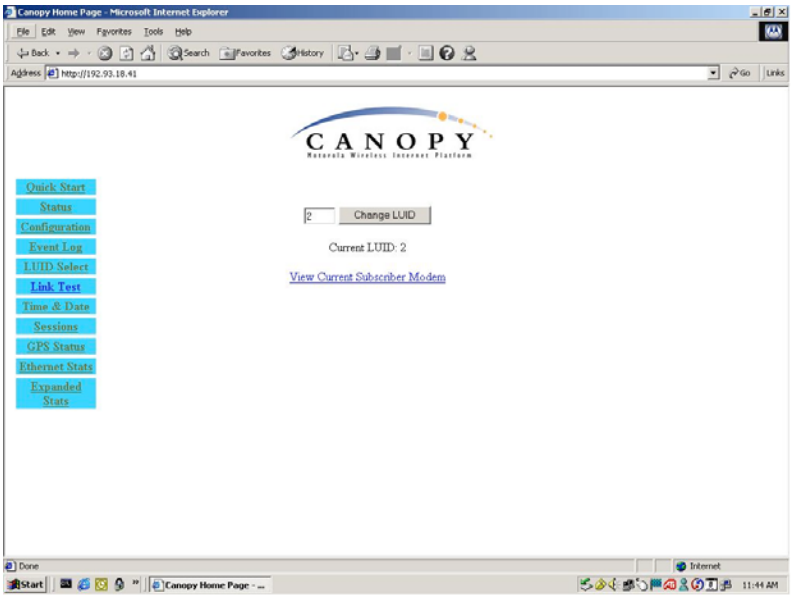


Figure 14: LUID Select web page

This web page makes is possible for the operator to view the web pages of registered subscriber modules over the RF link. The operator should view the *Sessions* web page to determine what the logical unit ID (LUID) is for the subscriber module in question. Enter the LUID into the supplied field and click the "*Change LUID*" button to set the parameter. Click "*View Current Subscriber Modem*" to then access the subscriber module.

LINK TEST

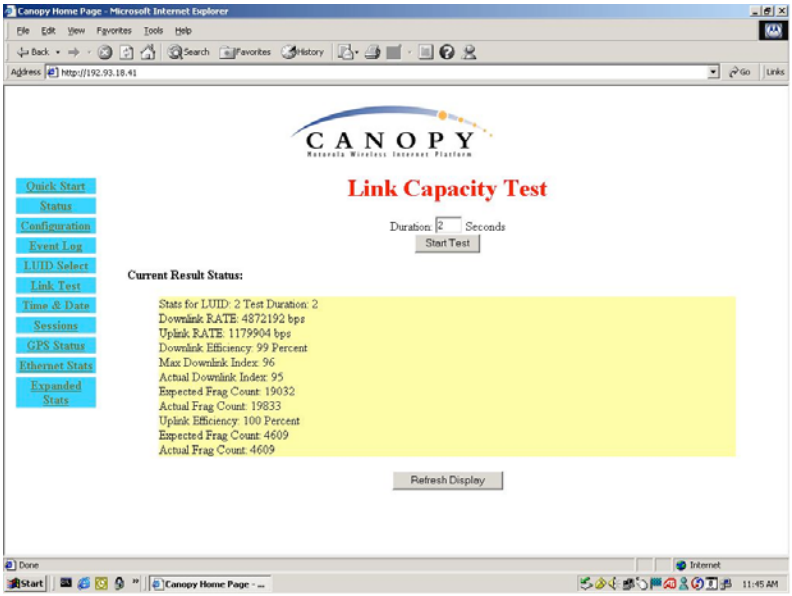


Figure 15: Link Test web page

The Link Test is a test for measuring the throughput and efficiency of the RF link between two Canopy modules.

To perform a link test enter a number into the field labeled "*Duration*". The duration is the number of seconds the RF link will be tested. Start the link test by clicking the "*Start Test*" button. The test will now run for the set duration. If the web page is not set to automatically refresh, click the "*Refresh Display*" button to see the results. For a Canopy System link to be considered acceptable it is necessary for the efficiencies of the link test to be greater than 90% in both the uplink and downlink direction. It is recommended that when a new link is installed that a link test be executed to ensure that the efficiencies are within recommended guidelines.

The key fields are:

- Downlink RATE, bits per second
- Uplink RATE, bits per second
- Downlink Efficiency, percent
- Uplink Efficiency, percent

TIME & DATE

This web page is used to set the time and date of the Access Point module when it is not connected to a Cluster Management Module (CMM). The time and date would need to be set every time there is a power cycle. The format for the entry is:

Time: *hh:mm:ss* Date: mm/dd/yyyy

- hh: two digit hour in military time
- mm: two digit minute
- ss: two digit second
- mm: two digit month
- dd: two digit day

- yyyy: four digit year

Enter in the appropriate information and click the *Set Time and Date* button.

SESSIONS

The Session web page contains information on each of the subscriber modules that has registered to the Access Point module. For each of the subscriber modules certain bits of information are shown on this web page. An example of such information is:

```
LUID: 002 : MAC: 0a-00-3e-00-02-2f State: IN SESSION
Software Version : CANOPY 3.1 Aug 21 2002 13:52:12
FPGA Version : 08200207
Session Timeout: 7, AirDelay 5
Session Count: 2, Reg Count 2, Re-Reg Count 2
Average RSSI: 1842, Last RSSI: 1873
Average Jitter: 6, Last Jitter: 5
```

Descriptions of the parameters that are useful for managing and troubleshooting a Canopy System are:

LUID: displays the logical unit ID of the subscriber module. As each subscriber module registers to the Access Point module it is assigned a LUID. The LUID range starts at 2. If a subscriber module were to lose its registration with the Access Point and then regain the registration it will retain the same LUID, as long power has not cycled on the Access Point module.

MAC: displays the MAC address (or electronic serial number) of the subscriber module.

State: displays the current status of the subscriber module. There are two states:

- *IN SESSION:* the subscriber module is currently registered to the Access Point module.
- *IDLE:* the subscriber module was registered to the Access Point module at one time, but is not currently.

Software Version: displays the version of software that is running on the subscriber module. If this parameter is not present, then a software version prior to release version 3.1 is on that module.

FPGA Version: displays the version of FPGA that is running on the subscriber module. If this parameter is not present, then a FPGA version prior to release version 082002 is on the module.

AirDelay: displays the distance of the subscriber module from the Access Point module. The number presented needs to be multiplied by 49 to convert the number to feet.

Session Count: displays the number of sessions that this subscriber module has had with the Access Point module. If this value is excessive large compared to other subscriber modules registered with this Access Point, there may be an issue with the installation of the subscriber.

Reg Count: displays the number of registration request messages the Access Point module has seen from the subscriber module. If this value is excessive large compared to other subscriber modules registered with this Access Point, there may be an issue with the installation of the subscriber.

Re-Reg Count: displays the number of registration request messages the Access Point module has seen from the subscriber module that is already in session. If this value is excessive large compared to other subscriber modules registered with this Access Point, there may be an issue with the installation of the subscriber.

Average RSSI: displays the average RSSI value for the subscriber module.

Last RSSI: displays the last RSSI value for the subscriber module.

Average Jitter: displays the average Jitter value for the subscriber module.

Last Jitter: displays the last Jitter value for the subscriber module.

GPS STATUS

The GPS Status web page displays information about satellites seen and tracked when the Access Point module is configured to "*sync to the received signal"* and is connected to a Cluster Management Module.

ETHERNET STATS

The Packet Stats web page reports TCP throughput and error information for the Ethernet connection of the subscriber module. The following definitions are available:

inoctets count: displays the total number of octets received on the interface, including framing characters.

inucastpkts count: displays the total number of subnetwork-unicast packets delivered to a higher layer protocol

innucastpkts count: displays the total number of non-unicast (i.e. subnetwork-broadcast or subnetwork-multicast) packets delivered to a higher layer protocol.

indiscards count: displays the total number of inbound packets which were chosen to be discarded even though no errors had been detected to prevent their be deliverable to higher layer protocol. One possible reason to discard could be to free up buffer space.

inerrors count: displays the total number of inbound packets that contained errors preventing them from being delivered to a higher layer protocol.

inunknownprotos count: displays the total number of packets received via the interface which were discards because of an unknown or unsupported protocol.

outoctets count: displays the total number of octets transmitted out of the interface, including framing characters.

outucastpkts count: displays the total number of packets that higher-level protocols requested be transmitted to a subnetwork-unicast address, including those that were discarded or not sent.

outnucastpkts count: displays the total number of packets that higher-level protocols requested be transmitted to a non-unicast (i.e. subnetwork-broadcast or subnetwork-multicast) address, including those that were discarded or not sent.

outdiscards count: displays the total number of outbound packets which were chosen to be discarded even though no errors had been detected to prevent their being transmitted. One possible reason for discarding such a packet could be to free up buffer space.

outerrrors count: displays the total number of outbound packets that could not be transmitted because of errors.

RxBabErr: displays the total number of receiver babble errors.

EthBusErr: displays the total number of Ethernet bus errors on the Ethernet controller.

CRCError: displays the total number of CRC errors on the Ethernet controller.

RxOverrun: displays the total number of receiver-overrun errors on the Ethernet controller.

Late Collision: displays the total number of late collisions on the Ethernet controller. A normal collision occurs during the first 512 bits of the frame transmission. If a collision occurs after the 512 bit times, then it is considered a late collision. A late collision should be taken as a serious network problem, since it causes the frame being transmitted to be discarded. The most common cause of late collisions is a mismatch between duplex configurations at each end of a link segment.

RetransLimitExp: displays the total number of retransmit limit expirations.

TxUnderrun: displays the total number of transmission-underrun errors on the Ethernet controller.

CarSenseLost: displays the total number of carrier sense lost errors occurred on the Ethernet controller.

EXPANDED STATS

Clicking on the *Expanded Stats* link will display a number of pages of statistics that are maintained by the Canopy module. Canopy Technical Support may ask the operator for specific information in this section when troubleshooting an issue.

ACCESSORIES

The following accessories are available for use with the Canopy System. To purchase accessories, please contact an authorized Canopy dealer, unless otherwise noted.

- Universal mounting bracket
- Passive reflector dishes for use with 2.4 and 5.7 GHz subscriber modules
- 102-132 V AC power supply with North American plug, part number ACPS110
- 100-240 V AC power supply with North American, UK, and Euro plugs, part number ACPSSW-02
- Cable assemblies for the Canopy System can be ordered from Best-Tronics Manufacturing Inc. by going to their website at *http://www.best-tronics.com/motorola*. Due to the RF environment Canopy Backhauls, Access Points, and Cluster Management Modules often operate in, it is strongly recommended to use shielded cable for infrastructure cabling connecting these modules.

APPENDIX

There are two basic concepts that are needed for a basic understanding of networking, IP addresses and subnet masks. IP addresses are 32-bit binary numbers that have two corresponding parts or sub-addresses, the first part identifying the network and the second part identifying the hosts on the network. An imaginary boundary separates the first part from the second. This imaginary boundary is marked by way of the subnet mask. The subnet mask is another 32-bit binary number the acts like a filter on the IP address. When a subnet mask has a bit set to 1, the corresponding bit in the IP address is part of the network address. A subnet is classified as either a class A, class B, or class C network. The following table shows the common subnet mask classes:

Class	Network Portion	Host Portion
A	11111111	00000000 00000000 00000000
B	11111111 11111111	00000000 00000000
C	11111111 11111111 11111111	00000000

For example, if you have an IP address of 169.254.1.1 and a subnet mask of 255.255.0.0, then the first 16-bits of the 32-bit IP address identify the network.

10101001 11111110 00000001 00000001	*IP address*
11111111 11111111 00000000 00000000	*Subnet Mask*

There are 2^{16} (65,536) addressable hosts in this example and 169.254 is the network. There is one last piece of information that is needed here. Subnet masks are not shipped around in the IP packet, the packet only contains the 32-bit IP address of the destination. So without this valuable piece of information devices have no idea what portion of the IP address is part of the network and which is part of the host address. How does data know where it is supposed to go? IP systems developed a unique form of logic to make this determination. Class A network addresses always have the first bit of their IP address set to 0. Class B network addresses always have their first bit set to 1 and their second bit set to 0. Class C network addresses always have their first two bits set to 1 and the third bit set to 0. By examining these first bits of the IP address a device can determine what subnet mask should be applied to the IP address and determine where to route the data.

The following is a synopsis of an Internet Draft (http://www.ietf.org/internet-drafts/draft-ietf-zeroconf-ipv4-linklocal-05.txt) that describes how Microsoft and Apple operating systems react when a DHCP server is not found on the network. In general, a computer needs certain configuration information to operate on a network. Those configurations are an IP address, a subnet mask, and possibly a gateway address. A DHCP server will automatically assign this configuration information to a computer on a network or an operator is required to manually input these configurable items. When a computer is brought online and a DHCP server is not accessible (i.e. server is down or the computer is not plugged into the network) Microsoft and Apple operating systems will default to an IP address and subnet mask of 169.254.x.x and 255.255.0.0 (169.254/16).

SPECIFICATIONS

ACCESS POINT MODULE

Operating Frequency Ranges	2.4 Modules: ISM 2.4 to 2.4835 GHz 5.2 Modules: U-NII: 5.25 to 5.35 GHz 5.7 Modules: ISM: 5.725 to 5.850 GHz
Access Method	TDD/TDMA
Signaling Rate	10 Mbps
Modulation Type	High Index 2-level Frequency Shift Keying (FSK) (Optimized for interference rejection)
Carrier to Interference (C/I)	3dB nominal
Receiver Sensitivity	-83dBm 10^{-4} BER
Operating Range	Up to 15 miles (24 km) with passive reflector in the 2.4 GHz band. Up to 2 miles (3.6 km) with integrated antenna in the 5.2 GHz band. Up to 10 miles (16 km) with passive reflector in the 5.7 GHz band.
Transmitter Power	Meets FCC U-NII/ISM and IC LELAN ERP Limit
DC Power measured at DC converter	0.3A @ 24 VDC (7.2 watts) typical 0.35 A @ 24 VDC (8.4 watts) max (long cable runs, high ambient temperature, high transmit ratio (set by downlink percentage))
Interface	10/100 BaseT, half/full duplex Rate auto negotiated (802.3 compliant)
Protocols Used by CANOPY	IPV4, UDP, TCP, ICMP, Telnet, HTTP, FTP, SNMP, DES
Protocols Supported by Canopy	Switched Layer 2 Transport with support for all common Ethernet protocols including IPV6, NetBIOS, DHCP, IPX, etc.
Software Upgrade Path	Remotely downloaded into flash memory
Network Management	HTTP, TELNET, FTP, SNMP
Operation Temperature	-40°F to +131°F (-40°C to +55°C)
Weight	1 lb. (.45kg)
Dimensions	11.75” H x 3.4” W x 3.4” D (29.9 cm H x 8.6 cm W x 8.6 cm D)

CLUSTER MANAGEMENT MODULE GEN II

PHYSICAL

Max length from Cluster Management Module to any radio	328 cable feet (100 meters)
Max length from Cluster Management Module to GPS antenna	100 cable feet (30.5 meters)
Dimensions	17.00” H x 12.88” W x 6.50” D (43.18 cm H x 32.72 cm W x 16.51 cm D)
Weight	25.0 lbs. (11.3 kg)
Operation Temperature	-40°F to +131°F (-40°C to +55°C)
Overall	Meets CE IP44 according to EN60529:2000

AC POWER

Input Voltage and Frequency	100 V – 240 V~, 0.7 A – 0.35 A, settable to either 230 V or 115 V nominal input. 50 Hz – 60 Hz Note: Applying 230 V to a unit which is set to 115 V may damage the unit.
Input power	Nominal 66 watts, max 92 watts with 8 modules connected to the CMM at max cable length.

DC POWER (24V) OPTION

Input voltage	18 to 32 VDC, measured at CMM
Input power	Nominal 60 watts. Maximum 84 watts with 8 modules connected to the CMM at maximum cable length. 9A inrush upon start-up.
Use note	If using a typical “24V +/-5%” power supply, ensure that CMM is within 400 cable feet (120 m) of the power supply. Use minimum 12 AWG (4 mm^2) copper wire.

DC POWER (12V) OPTION

Input voltage	11.5 to 32 VDC, measured at CMM
Use note	If using a 12V power source (typically an automobile battery in a test or emergency situation), use 12 AWG (4 mm^2) wire between the power supply and the CMM, ensure that the CMM is within 10 cable feet (3 m) of the power supply, and ensure the modules are within 20 cable feet (6 m) of the CMM.

CABLE SPECIFICATIONS

Ethernet, GPS sync, and GPS coax cables	The use of cables that conform to the operational temperature of the product as well as being UV light protected is mandatory. See *Accessories* for retailer of cables.