# Canopy ™ Backhaul Module

# USER MANUAL

**BH02-UM-en**
**Draft for Regulatory Review**
**December 2003**

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# 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.

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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).

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- 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 | Frequency Band Range | Maximum Transmitter Power | Reflector | FCC ID | Industry Canada Cert Number |
|---|---|---|---|---|---|
| SM AP BH | ISM 2400-2483.5 MHz | 340mW | Allowed on SM and BH | ABZ89FC5808 | 109W-2400 |
| SM AP BH | U-NII 5250-5350 MHz | 200mW | Not Allowed | ABZ89FC3789 | 109W-5200 |
| SM BH | U-NII 5250-5350 MHz | 3.2mW | Recommended | ABZ89FC5807 | 109W-5210 |
| 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 | Frequency Band 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

A Canopy module 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, the reflector dish must be installed to provide a separation distance of at least 1.5m (59.1 in) from all persons. When so installed, the module's RF field is within 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 340mW.

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 13 cm for 2.4 GHz product and 10 cm for 5.2 and 5.7 GHz product. A power compliance margin of over 2 is artificially introduced by setting the distance to a consistent 20 cm across all modules, giving a power compliance margin of x2.4 for 2.4 GHz modules and x4 for 5.2 and 5.7 GHz modules.

In the case of the Canopy SM *with* reflector, the gain depends on frequency and ranges from 19 dBi (a factor of 80) for 2.4 GHz modules to 26 dBi (a factor of 400) for 5.2 GHz Extended Range and 5.7 GHz modules, so the peak power density equals the exposure limit at a distance of 10 to 80 cm. A power compliance margin is artificially introduced by defining a consistent compliance distance of 1.5 m across all modules with reflectors, giving a power compliance margin of x10 for 2.4 GHz modules, x220 for 5.2 GHz Extended Range modules, and x3.5 for 5.7 GHz modules. 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.

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# GETTING STARTED

## WELCOME

Thank you for your purchase of a Motorola Canopy Backhaul 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. Additional information on new features in new releases is available in the Canopy Software Release Notes, available on the Canopy web site at http://www.motorola.com/canopy.

## 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 a Backhaul module increases to 9.1 watts
- Backhaul distances clarified – for 10 Mbps and 20 Mbps BHs; with and without reflectors
- Shielded cables strongly recommended for all infrastructure cabling connecting APs, BHs, and CMM
- MAC addresses of 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
- 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.
- Maximum distance for Backhaul now 35 miles (56 km)
- Specifications changed to reflect expanded lower temperature limit of -40°F (-40°C) for all equipment.

# PRODUCT DESCRIPTION

## Canopy Backhaul

Backhaul links provide point-to-point connectivity either as a standalone link or feeding an Access Point cluster as part of a Canopy network.

Backhaul modules are available in 2.4, 5.2, and 5.7 bands and in both 10 and 20 Mbps. 2.4 and 5.7 backhauls can be used with reflectors on either or both ends. Regular 5.2 backhauls cannot be used with reflectors in the US or Canada due to regulatory agency restrictions. Extended Range (ER) 5.2 Backhauls have very low transmit power and it is recommended to use reflectors at both ends.

The following table shows typical ranges for each type of backhaul.

| Module Type | Modulation Rate | Reflectors | Typical Range |
|---|---|---|---|
| 5200 BH10 (DES)<br>5201 BH10 (AES) | 10 | None allowed in US or Canada | 2 miles (3.2 km) |
| 5200 BH10 ER (DES)<br>5201 BH10 ER (AES) | 10 | One end | 2 miles (3.2 km) |
| 5200 BH10 ER (DES)<br>5201 BH10 ER (AES) | 10 | Both ends | 10 miles (16 km) |
| 5200 BH20 ER | 20 | One end | 1 mile (1.6 km) |
| 5200 BH20 ER | 20 | Both ends | 5 miles (8 km) |
| 5700 BH10 (DES)<br>5701 BH10 (AES) | 10 | None | 2 miles (3.2 km) |
| 5700 BH10 (DES)<br>5701 BH10 (AES) | 10 | One end | 10 miles (16 km) |
| 5700 BH10 (DES)<br>5701 BH10 (AES) | 10 | Both ends | 35 miles (56 km) |
| 5700 BH20 | 20 | None | 1 mile (1.6 km) |
| 5700 BH20 | 20 | One end | 5 miles (8 km) |
| 5700 BH20 | 20 | Both ends | 35 miles (56 km) |
| 2400 BH10 (DES)<br>2401 BH10 (AES) | 10 | None | 5 miles (8 km) |
| 2400 BH10 (DES)<br>2401 BH10 (AES) | 10 | One end | 15 miles (24 km) |
| 2400 BH10 (DES)<br>2401 BH10 (AES) | 10 | Both ends | 35 miles (56 km) |
| 2400 BH20 | 20 | None | 3 miles (4.8 km) |
| 2400 BH20 | 20 | One end | 5 miles (8 km) |
| 2400 BH20 | 20 | Both ends | 35 miles (56 km) |

When using Backhauls in standalone links, the type of Backhaul is selected based on RF environment, throughput, and range needed. When using Backhauls in a network and co-locating a BH with Access Points, the type of backhaul is usually selected based on having the BH in a different band than the APs. In other words, if the APs are 5700s, the BH could be a 5200 or a 2400. If the APs are 2400s, the BH could be a 5200 or a 5700. While distance separation of 100 vertical feet (30 m) on a tower can allow co-locating APs and BHs from the same band, choosing cross-band APs and BHs is usually the better choice.

## Module Description

The base cover of your Canopy Backhaul is easily removed by depressing the release lever on the back of the cover.

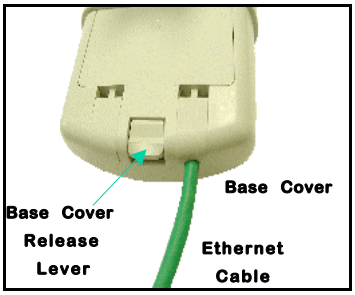



**FIGURE 1**

Remove the base cover as shown in FIGURE 1 to access the Ethernet connection and the Connection LED alignment indicators.

- The RJ-45 connector is used to attach the Ethernet cable
- The RJ-11 connector is used to attach the GPS sync cable
- The LED's indicate system status and are used for alignment.

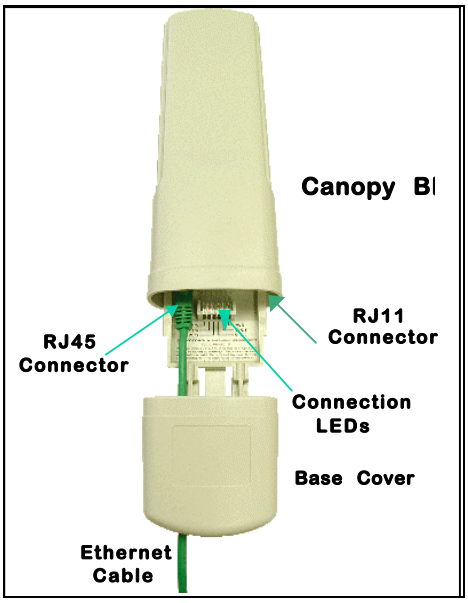



**FIGURE 2**

The diagnostic LEDs report information about the current status of the access point module. The following descriptions explain the function of each LED.

### *Operational Mode*

**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:** If the module is a backhaul timing master the GPS LED displays the status of the sync pulse and is lit constantly when the pulse is being received. If the module is a backhaul timing slave this LED is not utilized. 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.

If the module is a backhaul timing slave and is not registered to a backhaul timing master then the SYN/1, SES/2, and GPS/3 LEDs will cycle on and off from left to right.

### *Alignment Mode*

When a backhaul timing slave module is placed in *Alignment Mode* the LEDs take on an entirely different purpose. The power LED will still indicate whether or not power is applied to the module. The 6 LEDs and are turned into a 6-position bar graph. The more LEDs that are lit, the better the RSSI and Jitter values the module is seeing. The colors of the LEDS have no particular meaning other than to assist is distinguishing one position from the next. See Alignment section for more information.

# 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:**

*Backhaul Timing Master* – a module that is used in a point-to-point link. This module controls the air protocol and configurations for the link.

*Backhaul Timing Slave* – a module that is used in a point-to-point link. This module accepts configuration from the master module.

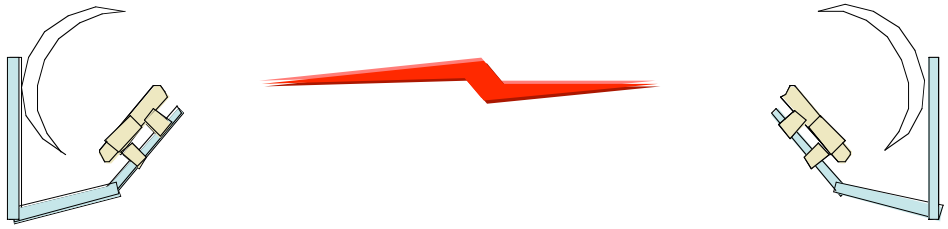
*Cluster Management Module* – a module that contains power, GPS timing, and networking for backhaul timing master(s). Can also be utilized in conjunction with an access point cluster.

In the Canopy System, the point-to-point link is achieved utilizing backhaul modules in either the 2.4 GHz, 5.2 GHz, or 5.7 GHz band. The backhaul modules utilize passive reflector to achieve distances of up to 35 miles (56 km). ***Note:*** *Distances may vary based on terrain and other line of sight issues.*

In its basic form the point-to-point link is made up of a backhaul timing master and a backhaul timing slave. The cluster management module is key to the operation of the Canopy System. Backhaul timing masters must be connected to a cluster management module so that a GPS timing pulse can synchronize their transmission cycles. If one backhaul timing master module were to not be synchronized then it may be transmitting during a receive cycle of the other modules and cause de-sense. This is also true of the Canopy access point modules.

The following are some simple network diagrams of the proper way to layout single and multi-hopped point-to-point links.

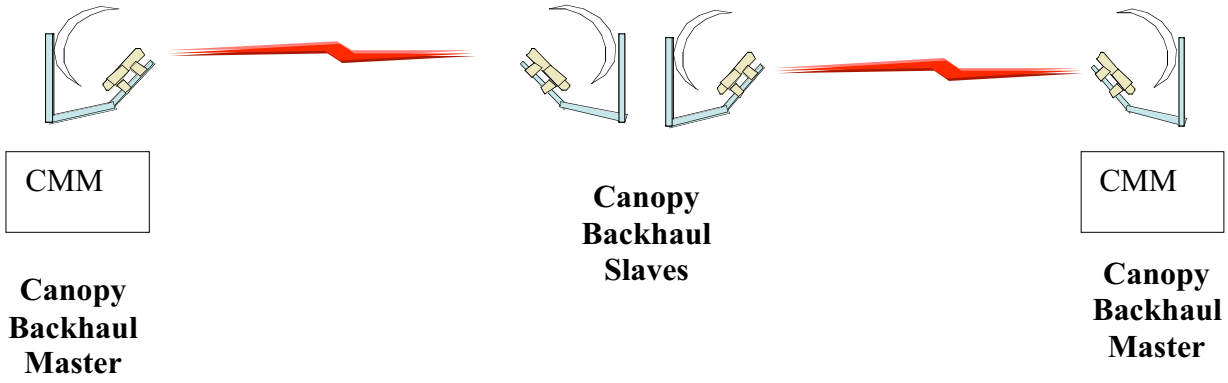
***Example 1:*** The single hop.



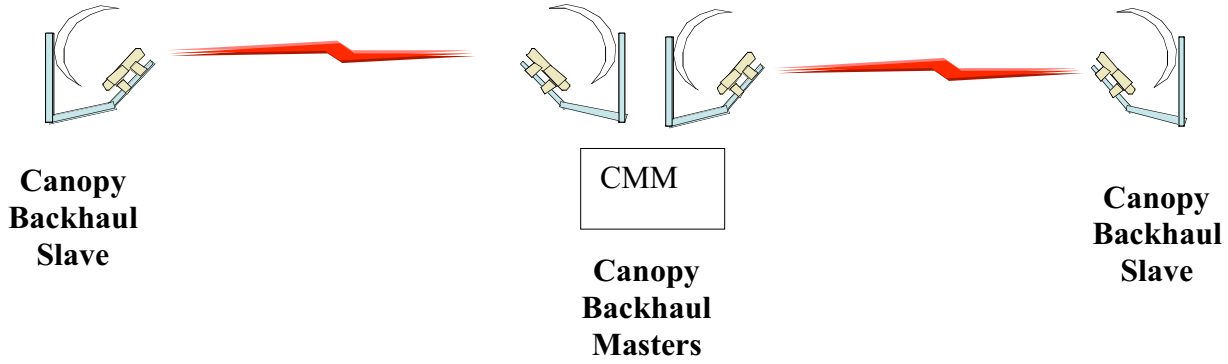
**Canopy Backhaul Master**

**Canopy Backhaul Slave**

***Example 2:*** The multiple hop with the backhaul master modules at the ends of the link.




***Example 3:*** The multiple hop with the backhaul master modules in the middle of the link.




From these diagrams it can be seen that at each location there is only like kind backhaul modules. In all cases where there is a cluster management module an access point cluster could be placed also. In the case of *Example 2*, a cluster management module could be placed where the two backhaul timing slaves are located to install an access point cluster; however the timing slaves do not need to be connected to he CMM for timing purposes.

## 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.

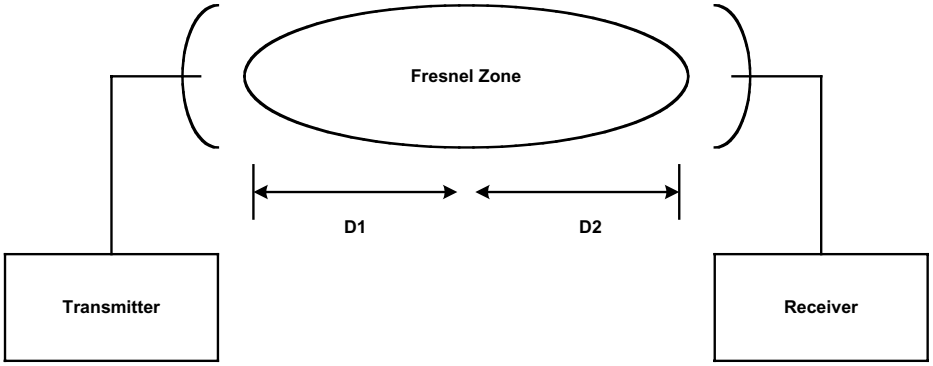
- Height is essential when installing a Canopy backhaul module. The Canopy backhaul module must be mounted higher than other objects located immediately around it such as trees, buildings, tower legs, etc.
- There should be no obstructions that will interfere with the unit's internal antenna. The area 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.  Do not place Canopy equipment in the same plane as other RF equipment.
- The means used by the installer to attach the backhaul module 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 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. 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 will be signal loss. The following illustrates a 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 point-to-point links are being planned for deployment? Each backhaul timing master will need to utilize a cluster management module for seamless operation within the entire Canopy System.
- How will the access point clusters be deployed relative to planned point-to-point links?

## 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 the backhaul module:

- 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 for use with the backhaul module:

- 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 with the backhaul module when the ISM frequencies are available:

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

20 Mbps backhaul modules have less “margin” at the edges of their 20 MHz channel. When using

20 Mbps Backhauls, consider using 25 MHz spacing if site engineering allows it, especially if you are engineering backhauls with less than 6° directional separation.

## 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

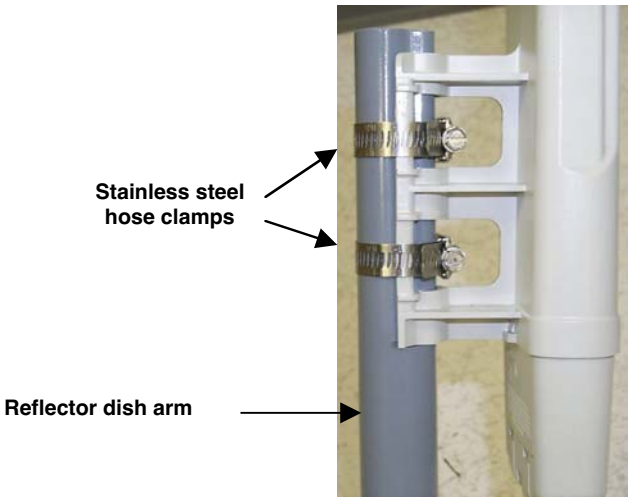
- The Canopy access point module, cluster management module, and GPS antenna must be mounted at least 2 feet below the highest point at the site for lightning strike mitigation. It is highly recommended that the site have a lightning protection system installed.
- Ensure the location is properly grounded 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.
- Make certain the installation conforms to the National Electrical Code (NEC), country and local codes. If uncertain of code requirements, obtain the services of a licensed electrician.

## Reflector dishes

The passive reflector arm is molded to receive the plastic housing of the backhaul module. Use stainless steel hose clamps to secure the module to the arm. The module is now properly aligned within the reflector. The following figure shows this installation.



# 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 the same and work the same, The only exception is 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 do. The AES 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 not enabled, AES modules can communicate with DES modules.

## 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 utilized 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.

# INSTALLATION

The following steps are required to install the Canopy backhaul module:

- Unpack the Canopy products
- Configuration of the backhaul modules
- Installation of the backhaul modules
- Alignment

## Unpack the Canopy Products

Upon receipt, carefully inspect all shipping boxes for signs of damage. If there is damage, immediately notify the transportation 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 Backhaul Modules

In all cases, when a configuration parameter is modified, the change must be saved and the module must be rebooted.

All backhaul module, from the factory are configured as backhaul timing slaves. The following are items that an operator will need to verify and/or configure for each module:

- Will the module be a timing master or timing slave?

***If it is a Timing Master***

The are two methods that can be utilized to configure each of the backhaul timing masters. The first method is to utilize 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.

- Will the backhaul 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 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 backhaul timing master module so that the backhaul timing slave module can register with it. The color codes must match for registration.

***If it is a Timing Slave***

- The backhaul timing slave module will utilize a network accessible IP address for its LAN IP address. From the factory, the timing slave module is programmed to utilize an IP address of 169.254.1.1. Continually, the appropriate subnet mask and default gateway must be utilized for the operator network infrastructure.
- The operator must configure the appropriate color code on the backhaul timing slave

module so that it can register with a backhaul timing master module. The color codes must match.

The operator can prevent unauthorized users from connectig to the backhaul 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. See Configuration for information on the default plug.

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 discern that a password is set.

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

See the *Access Point Cluster and Cluster Management Module* user manual for details on configuration and installation of a cluster management module.

## Installation of the equipment

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 backhaul timing master modules to be installed.
- Remove the GPS sync cable knockout from the base cover with needle-nose pliers.
- Mount the backhaul modules:
    - The modules can be mounted in a variety of locations, choose the best location for your particular application. Mounting can be done by utilizing stainless steel hose clamps or another equivalent fastener.
- Route the Ethernet cable from the backhaul module to the cluster management module.
    - The Ethernet cables use RJ-45 connectors (standard Ethernet) that connect to matching ports within the cluster management module.
    - A total of 8 ports are available on the cluster management module, to accommodate a combination of access point modules and backhaul timing master modules.
- Route the GPS sync (serial) cable from the backhaul timing master module 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.

- Replace the base cover on all of the backhaul modules.

## Alignment

- If the backhaul modules are not utilizing passive reflectors, then visually align the units.

If the backhaul modules are utilizing passive reflectors then visually align if possible or utilize compass headings and initiate *step 1* in the following process

***IF USING A 5.7 GHz SUBSCRIBER MODULE****:* the passive reflector will change the radiated pattern to 6° horizontal by 6° vertical.

***IIF USING A 2.4 GHz SUBSCRIBER MODULE****:* the passive reflector will change the radiated pattern to 17° horizontal by 6° vertical.

1. Lock down timing master module
2. On the timing slave module, utilize RSSI only mode of alignment web page:
   - Choose the frequency to monitor from the pick list (this would be the same frequency that the backhaul timing master module is transmitting on)
   - Click the radio button to highlight "*Enable*" on RSSI Only mode
   - Click "*Enable Aiming Mode*"

   The module will now report back the level of RF energy present at that specific frequency. To refresh the screen, click the *Enable Aiming Mode* button as appropriate or configure the web page auto-refresh option. The minimum RSSI level for a link is greater than 700.
3. When RSSI value is above minimum, disable *RSSI Only mode* and monitor the Status web page:
   a. Watch for "Syncing", then "Registering", then "Registered". When the unit is registered, move on to Step 4.
4. While monitoring RSSI and Jitter, at the incrementally move the timing slave module in the vertical plane. Observe where the values are at their best and lock down the unit. Now, incrementally move the timing slave module in the horizontal plane. Observe where the values are at their best and lock down the unit. Alignment is complete when reported values are at their best and the unit is registered.
5. If necessary, incrementally move the timing master module a couple (2-3) degrees and go back to Step 1.

# 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 and most modules in the field 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 |

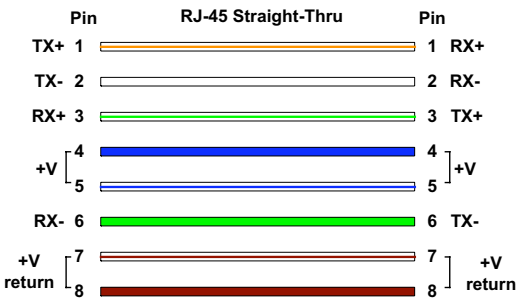
Very early modules did not auto-sense. In cases where older, non-auto-sensing modules are used:

- 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:**

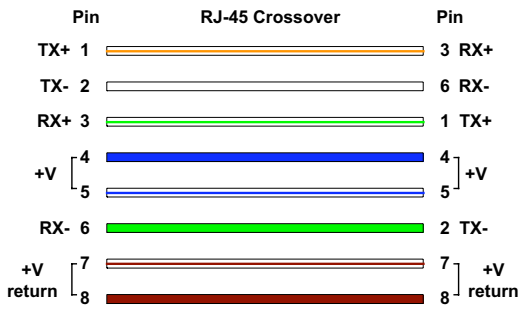
- pin 1 → white / orange ← pin 1
- pin 2 → orange ← pin 2
- pin 3 → white / green ← pin 3
- pin 4 → blue ← pin 4
- pin 5 → white / blue ← pin 5
- pin 6 → green ← pin 6
- pin 7 → white / brown ← pin 7
- pin 8 → brown ← pin 8




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

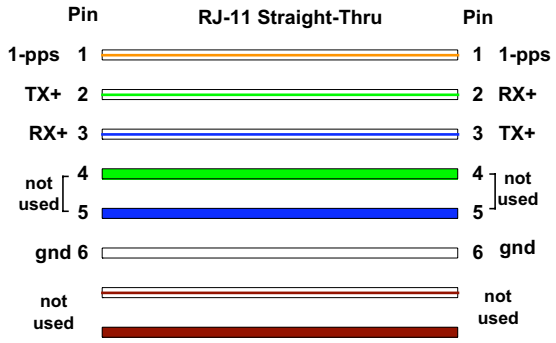



Pins 4, 5, 7, and 8 are used to carry power to the Canopy modules.

**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 backhaul 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 backhaul module (default is 169.254.1.1) into the address bar of your browser and hit enter on your keyboard.

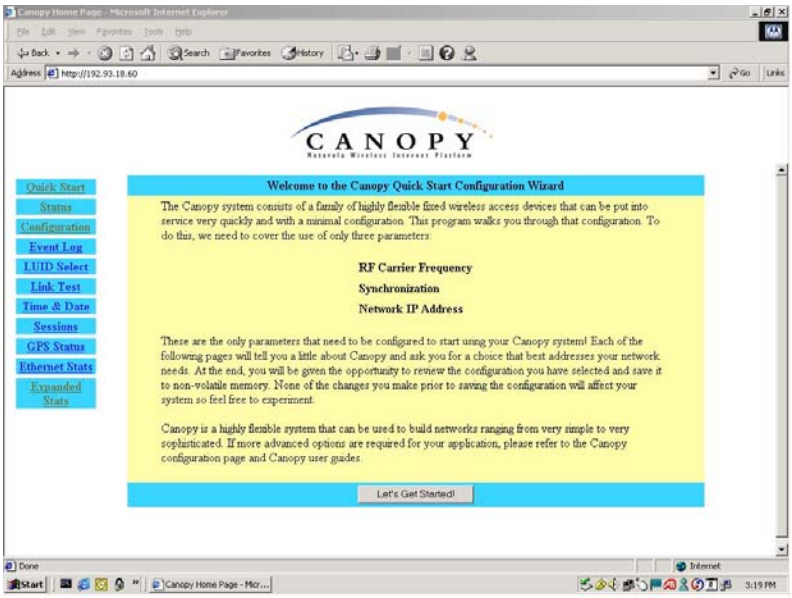
The backhaul module will have two different sets of interface screens, one for the timing master and one for the timing slave. The master and slave's interface screens are very similar to that of the access point module and subscriber module respectively.

The following web based interface pages are accessible:

| **Timing Master** | **Timing Slave** |
|---|---|
| Quick Start | Status |
| Status | Configuration |
| Configuration | Event Log |
| Event Log | AP Eval Data |
| LUID Select | Ethernet Stats |
| Link Test | Extended Stats |
| Time & Date | |
| Sessions | |
| GPS Status | |
| Ethernet Stats | |
| Extended Stats | |

## *THE TIMING MASTER*

# Quick Start

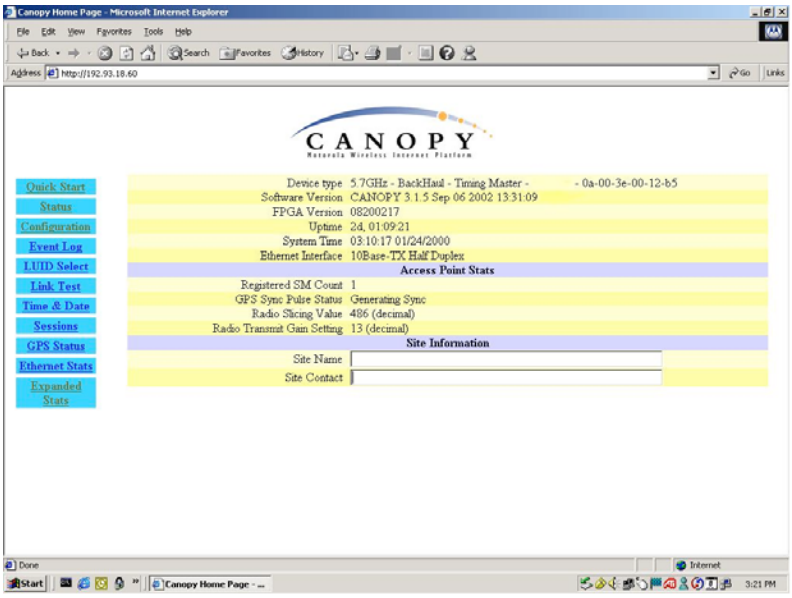



The Canopy System consists of a family of highly flexible, fixed wireless access devices that can be put into service quickly and with a minimal configuration. The Quick Start is a wizard that walks the operator through that configuration. To place an access point module into operation, only three parameters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




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.

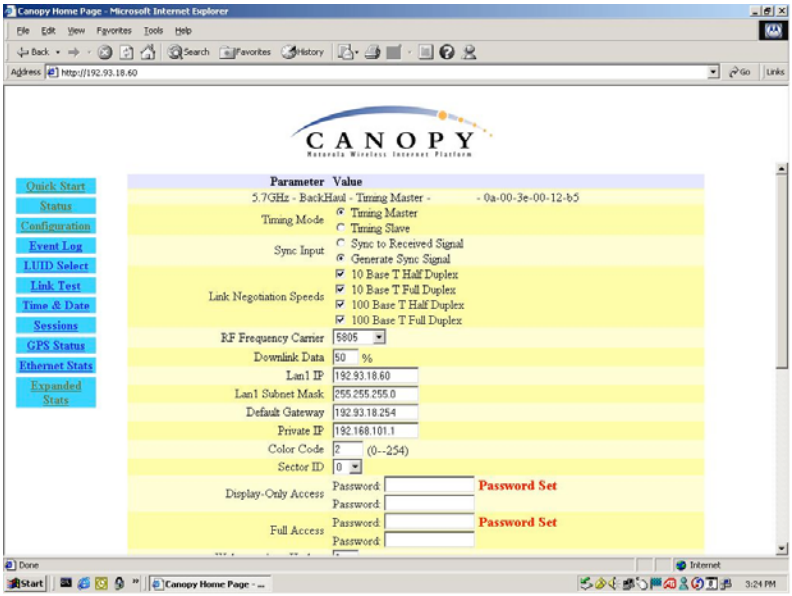
**Radio Slicing Value:** displays information to be used be Canopy technical support.

**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




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.

**Timing Mode:** choose whether this module will be a timing master or a timing slave. If the operator is changing this mode, change only this parameter, save the changes and reboot. Upon reboot different set of web based interface pages will present themselves and offer the operator different manageable as well as configurable features.

**Sync Input:** choose the type of synchronization that this access point module will utilize. 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 backhaul timing master to the backhaul timing slave). For example, if the aggregate throughput on the backhaul master is 6 Mbits, then configuring this parameter for 75% will allocate 4.5 Mbits for the downlink and 1.5 Mbits for the uplink. The default for this parameter is 50%.

**LAN 1 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.

**LAN1 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 169.254.1.1.

**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 utilizes 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 s not utilized 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.

**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 utilized on this access point module. There are two choices:

- *Normal*: If utilizing this mode there is no encryption on the air link. This is the default operation.
- *DES*: If utilizing this mode the air link is encrypted using single DES.

**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.

**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 according the following diagram and then short (i.e. solder) together pins 4 and 6 on the other end. Remaining wires should not be connected to anything.

The following diagram shows the wiring of a default plug:

- 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.

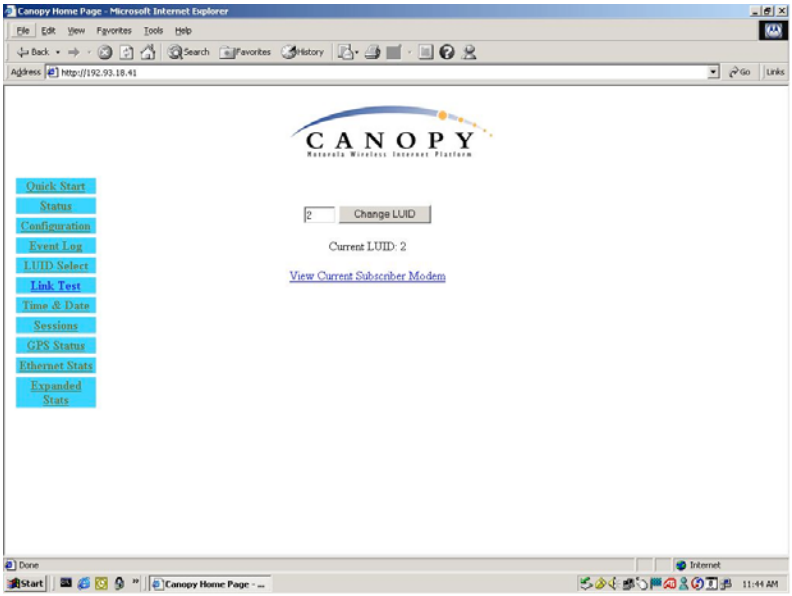
When the module is booted up (power applied) it will be in default mode where the IP address will be 169.254.1.1 and the passwords will be blank. All other configurations will have been preserved.

## 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.

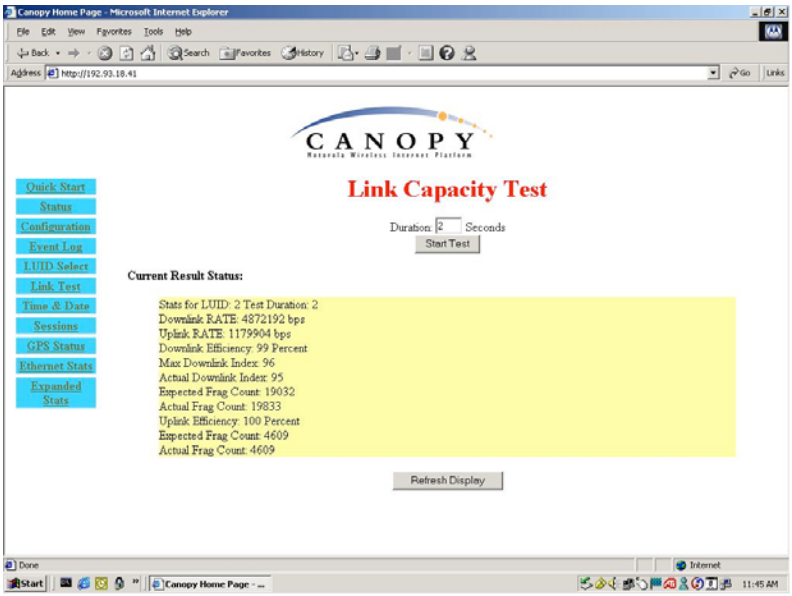
**Clear Event Log:** this button will clear the event log.

## LUID Select




This web page connects to a registered unit over the RF link, to view its internal webpages. The Sessions webpage determines which LUID corresponds to a specific unit. Enter the LUID in the field displayed and then click “Change LUID” to set the parameter. Click “View Current Subscriber Modem” to access the unit with that LUID.

## Link Test




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 utilized 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 latitude, longitude, height, satellites seen and tracked when the access point module is configured to sync to 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.

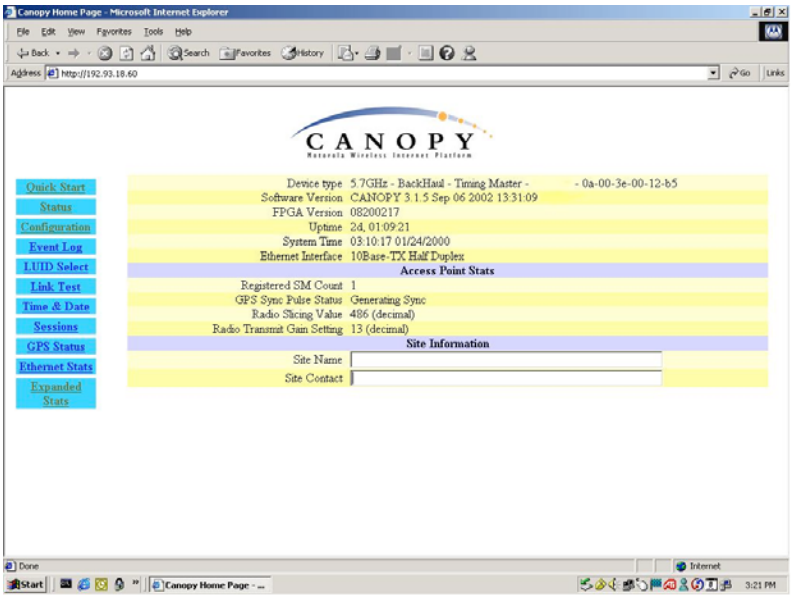
**CarSenseLost:** displays the total number of carrier sense lost errors occurred on the Ethernet controller.

## 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.

## *THE TIMING SLAVE*

## Status




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. The protocol for a subscriber module must be *multipoint*. The MAC address will be in the following format, 0a-00-3e-xx-xx-xx.

**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, which is inherited from the Canopy System via the registration to an access point module. When the module is registered to a Canopy System where a Cluster Management Module (CMM) is being utilized the time is displayed in Greenwich Mean Time (GMT).

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

**Session Status:** displays the current session state the module is in. There are four (5) options that will display in this field, *scanning, syncing, registering*, *registered, and alignment*

- ***Scanning*** – module is cycling through the RF frequencies that it is configured to scan and looking for

an access point module.

- ***Syncing*** – module is attempting to synchronize timing to a single access point module
- ***Registering*** – module sent a request for registration and is awaiting a response
- ***Registered*** – module is locked on to a specific access point module and ready to transmit and receive data packets
- ***Alignment*** – module is in alignment mode

**RSSI:** displays the current value for the Radio Signal Strength Indicator. This parameter will only display information when the module is registered to an access point module and the value is only updated by either refreshing the web browser screen or configuring the Canopy module to auto-refresh (see *Configuration* web page.) An acceptable RSSI value for a registered link is greater than 700; however it is important to view this value in conjunction with the *Jitter* value.

**Jitter:** displays the current value for the quality of the received signal. This parameter will only display information when the module is registered to an access point module and the value is only updated by either refreshing the web browser screen or configuring the Canopy module to auto-refresh (see Configuration web page.) The value range for Jitter is 5-15, with the quality being better on the low end of the scale. ***Jitter must be below 9 for a link to be of acceptable quality.***

**Air Delay:** display the distance from the subscriber module to the registered access point module. At close range, 0-200 feet, the distance will not report accurately.

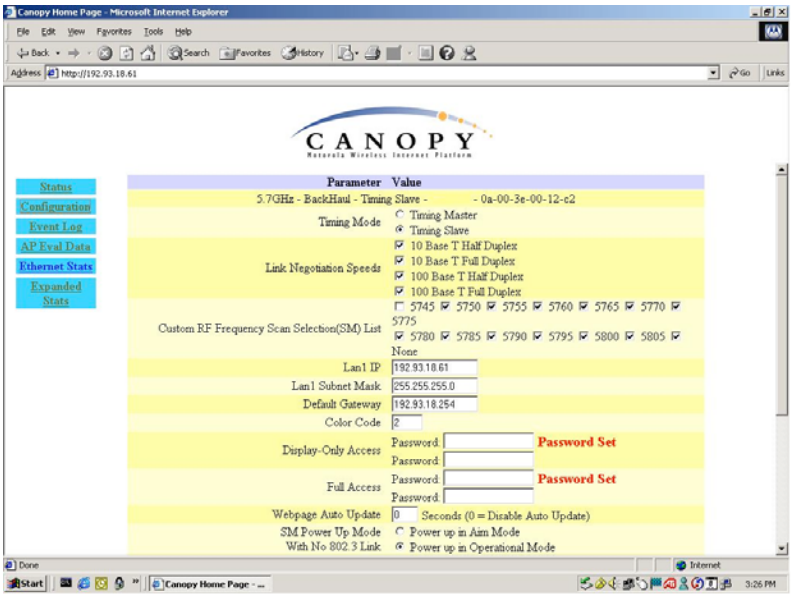
**Radio Slicing Value:** displays information to be used be Canopy technical support.

**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 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.

**Timing Mode:** choose whether this module will be a timing master or a timing slave. If the operator is changing this mode, change only this parameter, save the changes and reboot. Upon reboot different set of web based interface pages will present themselves and offer the operator different manageable as well as configurable features.

**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.

**Custom RF Frequency Scan Selection (SM) List:** Choose the frequencies that the subscriber module will scan when looking for a Backhaul – timing master. For 5.2 and 5.7 GHz modules, 20 MHz wide channels are centered every 5 MHz. The default for this parameter for 5.2 and 5.7 GHz modules is to scan all available frequencies – all check boxes are selected by default, For 2.4 GHz modules, 20 MHz wide channels are centered every 2.5 MHz. The default for this parameter for 2.4 GHz modules is to scan 2415 MHz, 2435 MHz, and 2457.5 Mhz – only those 3 check boxes are selected by default.

Select 2.4 GHz scan frequencies at least 5 MHz apart. Do not simply select all frequencies by checking every box, like you might do with the 5.2 and 5.7 GHz SMs. Canopy gives you checkboxes in the 2.4 GHz band for channels centered every 2.5 MHz, so you have flexibility for RF engineering based on your local RF environment. However, if you select scan frequencies only 2.5 MHz apart (in other words, if you check two boxes in sequence), there is potential for the BHS to successfully register to an BHM that is actually transmitting at a frequency 2.5 MHz higher as it scans up the selected frequencies. Registration may be successful, but the link is not as good as if it had registered 2.5 MHz higher, on the actual BHM frequency. The 5 MHz spacing for channels on 5.2 and 5.7 GHz BHSs are far enough apart

this doesn't happen.

**LAN1 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.

The radio buttons to the right of the IP address field offer the ability to make the LAN 1 IP either a local or publicly accessible address. If the address is designated a local address it will only be accessible via the host computer (network) that is connected to the module via the Ethernet cable. If the address is designated a public address it will be accessible network-wide. The default for this feature is for the address to be local. 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 to create and use a default plug in the section on the Timing Master.

**LAN1 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 an appropriate gateway address for the module. The default value for this parameter is 169.254.0.0.

**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.

**Display-Only Password:** 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 to create and use a default plug in the section on the Timing Master.

**Full-Access Password:** 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 to create and use a default plug in the section on the Timing Master.

**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.

**SM Power Up Mode with No 802.3 Link:** choose which mode the module will default to when there is no Ethernet connection sensed by the module. There are two modes available, the first is Alignment mode and the second is Operational mode. Operational mode is the default setting.

**Bridge Timeout Entry:** 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.

**Authorization Key:** each module ships with a unique, pre-programmed authorization key to be used when an operator configures the Canopy System for DES encryption.

**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 256 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 256 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 256 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.

**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.

## Event Log

See the Timing Master section. Information is exactly the same.

## AP Eval Date

The AP Eval Data web page contains information on each of the access point modules that the subscriber module has visibility to. For each access point module that can be seen certain bits of information are shown on this web page. An example of the information shown on this web page for each access point module:

```
Index: 0 Frequency: 0 MHz ESN: 0a-00-3e-00-01-d5
Jitter: 5 RSSI: 1295 Beacon Count: 37
Type: Multipoint Avail: 1 Age: 0 Lockout: 0 RegFail 0 Range: 245 feet TxBER: 1
Session Count: 3 No LUIDS: 0 Out of Range: 0 Rescan Req: 0
FrameNumber: 568 SectorID: 0 Color Code: 0 BeaconVersion: 1 SectorUserCount: 1
PercentDataDwn: 75 PercentDataUpHi: 0 NumDAckSlots: 3 NumContSlots: 3 NumUAckSlots: 3
```

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

**Index:** each access point module that a subscriber module can see is assigned an index value for purposes of this web page only. The index number starts with 0 and increases by 1. This index is used to tell the operator which access point module the subscriber is currently registered to. For

example, the first line of text on the web page says "*Current entry index: 5"*, the operator would then scroll down the list of access point modules to the module with "*Index: 5"* to view information about the link.

**Frequency:** displays the transmit frequency of the access point module.

**ESN:** displays the electronic serial number (MAC address) of the access point module.

**Jitter:** displays the last jitter value captured between the subscriber and access point module.

**Range:** displays the distance (in feet) between the subscriber and access point module. This parameter will only be valid when observing the data for the access point module that the subscriber is currently registered to.

**Session Count:** displays the number of times the subscriber module has gone in and out of session with the access point. If this number is particularly large, it typically signifies that there is some sort of issue with the link (i.e. non line of sight, interferers, etc.)

**Out of Range:** displays a counter for the number of times the access point module has seen a subscriber module who has attempted to register and has been farther away than the *max range* parameter on the access point.

**Sector ID:** displays the sector ID of the access point module.

**Color Code:** displays the color code of the access point module.

**Sector User Count:** displays the numbers of registered subscriber modules on the access point.

**Rescan APs:** click on this button to force the subscriber module to redo the scanning process. The subscriber module will scan, through the frequencies checked on the *Configuration* web page, for all available access point modules and register to the one that provides the best results for RSSI, Jitter, and number of registered users.

## Ethernet Stats

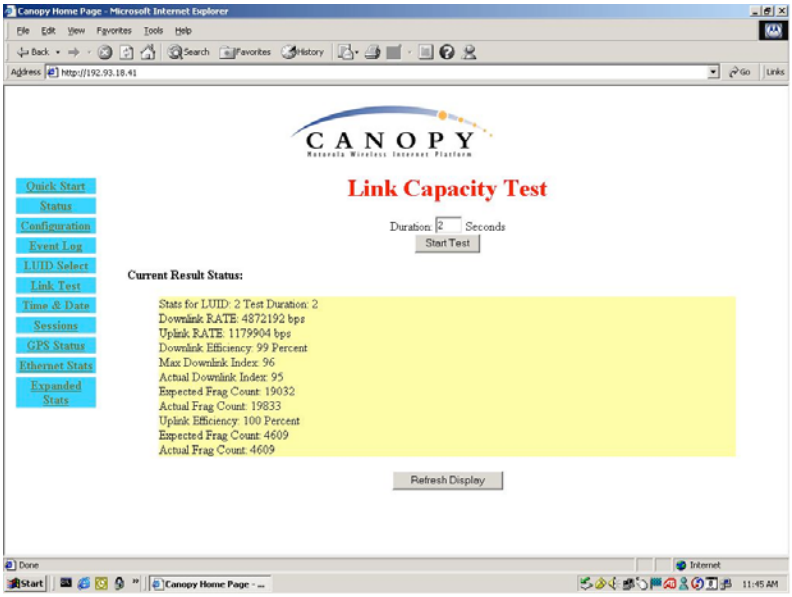
See the Backhaul Timing Master section. The information is exactly the same.

## 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. There are 3 areas in the *Expanded Stats* that an operator can use for managing and troubleshooting a Canopy System. Those 3 areas are:

- Link Test
- Alignment
- BER Display

## *Link Test*




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

## *Alignment*

The Alignment web page contains tools to assist in the alignment of a subscriber module to an access point module. There are two modes that can be utilized when aligning a module: 1) RSSI only and 2) normal alignment mode.

RSSI Only is a mode where the module will report the signal strength based on the amount of energy present at a selected frequency. The subscriber module does not have to be registered to an access point module for information on signal strength to be reported back. This can simplify the aiming process for long links when the Canopy passive reflector (5.7GHz band only) is being used.

To utilize RSSI only mode:

- Choose the frequency to monitor from the pick list (this would be the same frequency that the backhaul timing master module is transmitting on)
- Click the radio button to highlight "*Enable*" on RSSI Only mode
- Click "*Enable Aiming Mode*"

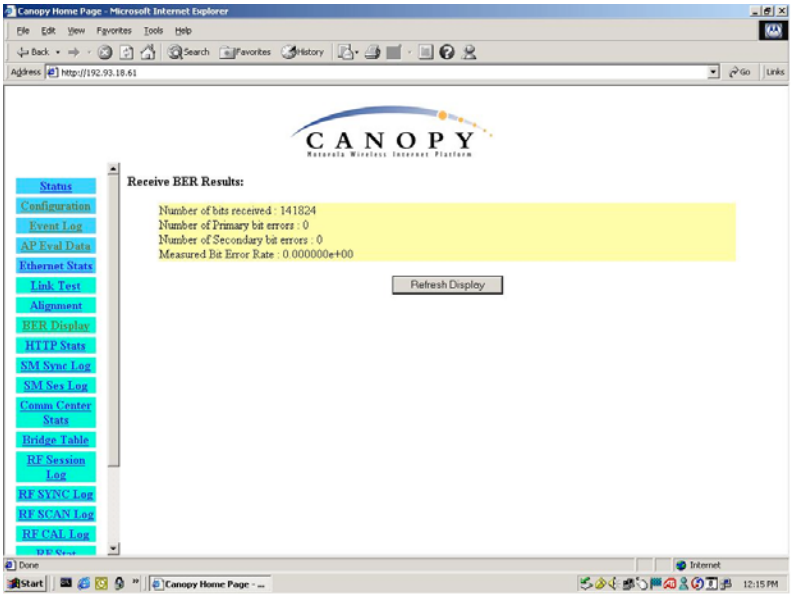
The module will now report back the level of RF energy present at that specific frequency. To refresh the screen, click the *Enable Aiming Mode* button as appropriate or configure the web page auto-refresh option.

The normal operation of alignment mode will report information as it relates to the RSSI level and Jitter value. To utilize normal alignment mode, ensure that the *Disabled* radio button is checked and then click *Enable Aiming Mode* button. As with the previous mode to refresh the mode either continue clicking the *Enable Aiming Mode* button or configure the auto-refresh option. Also, during normal alignment mode the LEDs on the outside of the Canopy module will report back information on the performance of the link. There are 6 LEDs and when in alignment mode the LEDs are turned into a 6-position bar graph. The more LEDs that are lit, the better the RSSI and Jitter values the module is seeing. The colors of the LEDS have no particular meaning other than to assist is distinguishing one position from the next.

The minimum values that are needed for an acceptable link are RSSI this above 700, Jitter that is between 5 and 9, and link efficiencies that are greater than 90% in both the up and down link. If any one of these criteria are not met the link may still be operational but may have issues time to time.

***Note: If a Canopy module is placed into Alignment Mode it will automatically drop into Operational Mode after 15 minutes***.

## *BER Display*




Bit Error Rate (BER) Display is utilized by the operator to measure the amount bit errors present in a link. BER Display will only work if the access point module is configured to send the BER stream.

*****IMPORTANT** If one access point module in a cluster is set to send a BER stream then all other access point modules in that cluster must be configured in the same fashion.***

The field, Measured Bit Error Rate, will display a value that corresponds to the BER at the moment of web browser refresh. An acceptable link will have a BER that is less than $10^{-4}$. If the BER is greater than $10^{-4}$ then the operator needs to evaluate the subscriber and/or access point module installation for potential issues. To refresh the screen, click the *Refresh Display* button as appropriate or configure the web page auto-refresh option.

# 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 5.7 GHz subscriber modules.
- 90-220V AC power supply (part number ACPSSW-01)

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

| | |
|---|---|
| Frequency Band Range | 2.4 Modules: ISM 2.4 to 2.4835 GHz<br>5.2 Modules: U-NII: 5.25 to 5.35 GHz<br>5.7 Modules: ISM: 5.725 to 5.850 GHz |
| Access Method | Time Division Multiple Access (TDMA) |
| Signaling Rate | 10 Mbps or 20 Mbps |
| Modulation Type | High Index 2-level or 4-level Frequency Shift Keying (FSK)<br>(Optimized for interference rejection) |
| Carrier to Interference (C/I) | 3 dB nominal for 10 Mbps, 10 dB nominal for 20 Mbps |
| Receiver Sensitivity | -83 dBm at $10^{-4}$ BER for 10 Mbps, -79 dBm at $10^{-4}$ BER for 20 Mbps |
| Operating Range (All Weather) | |

| Module Type | Modulation Rate | Reflectors | Typical Range |
|---|---|---|---|
| 5.2 BH10 | 10 | None allowed in US or Canada | 2 miles (3.2 km) |
| 5.2 BH10 ER | 10 | One end | 2 miles (3.2 km) |
| 5.2 BH10 ER | 10 | Both ends | 10 miles (16 km) |
| 5.2 BH20 ER | 20 | One end | 1 mile (1.6 km) |
| 5.2 BH20 ER | 20 | Both ends | 5 miles (8 km) |
| 5.7 BH10 | 10 | None | 2 miles (3.6 km) |
| 5.7 BH10 | 10 | One end | 10 miles (16 km) |
| 5.7 BH10 | 10 | Both ends | 35 miles (56 km) |
| 5.7 BH20 | 20 | None | 1 mile (1.6 km) |
| 5.7 BH20 | 20 | One end | 5 miles (8 km) |
| 5.7 BH20 | 20 | Both ends | 35 miles (56 km) |
| 2.4 BH10 | 10 | None | 5 miles (8 km) |
| 2.4 BH10 | 10 | One end | 15 miles (24 km) |
| 2.4 BH10 | 10 | Both ends | 35 miles (56 km) |
| 2.4 BH20 | 20 | None | 3 miles (4.8 km) |
| 2.4 BH20 | 20 | One end | 5 miles (8 km) |
| 2.4 BH20 | 20 | Both ends | 35 miles (56 km) |

| | |
|---|---|
| Transmitter Power | Meets FCC U-NII/ISM and IC LELAN ERP Limit |
| DC Power measured at DC converter | 0.34 A @ 24 VDC (8.2 watts) typical<br>0.38 A @ 24 VDC (9.1 watts) max (long cable runs, high ambient temperature, high transmit ratio (set by downlink percentage)) |
| Interface | 10/100 BaseT, half/full duplex<br>Rate auto negotiated (802.3 compliant) |

| | |
|---|---|
| | Rate auto negotiated (802.3 compliant) |
| Protocols Used by Canopy | IPV4, UDP, TCP, ICMP, Telnet,<br>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 via RF link |
| Network Management | HTTP, TELNET, FTP, SNMP |
| Temperature | -40°C to +55°C (-40ºF - +131ºF) |
| 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) |
| Weight<br><br>with passive reflector | 1 lb. (.45kg)<br><br>6.5 lbs. (3 kg) |