Canopy™ Subscriber Module

USER MANUAL

SM02-UM-en
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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.

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

This device complies with part 15 of the U. S. FCC Rules and Regulations and with RSS-210 of Industry Canada. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation. In Canada, users should be cautioned to take note that high power radars are allocated as primary users (meaning they have priority) of 5250 – 5350 MHz and 5650 – 5850 MHz and these radars could cause interference and/or damage to license-exempt local area networks (LELAN).

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

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

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

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

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

European Community Notification

Notification of Intended Purpose of Product Uses

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

Declaration of conformity:

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

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

Product Details for Products Tested for Compliance with Relevant EC Directives

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

Canopy can be configured to operate at a range of frequencies, but at this time, only channels from 5745 MHz through 5805 MHz of the

5.7 GHz product have been tested for compliance with relevant EC directives. Before configuring equipment to operate outside this range, please check with your regulator.

Exposure Note

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

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

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

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

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

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

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

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GETTING STARTED

WELCOME

Congratulations on the purchase of the Canopy subscriber module from Motorola! The Canopy subscriber module is the latest innovation in high-speed wireless networking that lets you easily network at high speeds.

FEATURES

The following is a subset of features included with your Canopy subscriber module:

- Broadband network speeds.
- Small, compact design.
- No special setup 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
- MAC addresses of older non-autosensing modules are listed (non-autosensing modules require correct choice of straight-through vs crossover cables)

New in Issue 2:

- Updated Notices section including European Community Notification, RF Exposure Note, and Software License Terms and Conditions.
- Measurement units internationalized with metric as well as English units
- Updates for new hardware features:
  - Currently shipping modules now auto-sense the Ethernet termination – either a straight-thru or crossover RJ-45 cable can be used to connect to either a network interface card or hub, switch, or router.
- Specifications changed to reflect expanded lower temperature limit of -40°F (-40°C) for all equipment.

PRODUCT DESCRIPTION

Canopy Subscriber Module

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

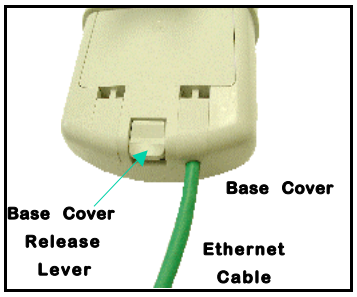


FIGURE 1

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

- The RJ-45 connector is used to attach the Ethernet cable.
- The LED's indicate system status and can be used for alignment.

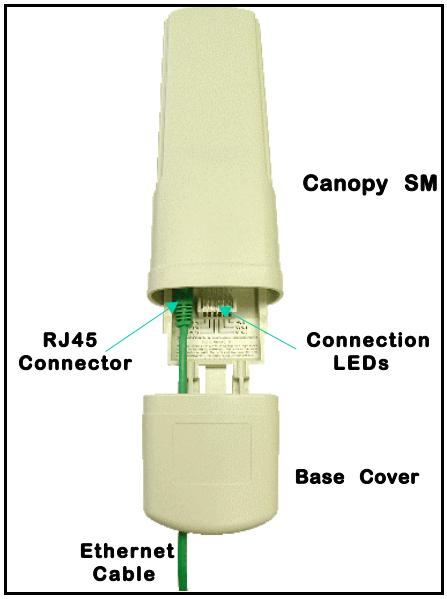


FIGURE 2

The Connection LEDs report information about the current status of the subscriber module. The following descriptions explain the function of each LED.

Operational Mode

When looking at the LEDs on the module the following descriptions go from left to right.

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

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

GPS/3: This LED is not used on the subscriber module.

SES/2: The session LED displays status of whether or not a subscriber module is in session (registered). The LED will be constantly lit if the unit is in session. The LED is green.

SYN/1: The sync LED displays sync status. In short, this LED will be lit if the unit is in session (i.e. registered – SES/2 LED is lit). The operator should minimize any flicker in this LED. 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.

When the subscriber module is not registered to an access point module the SYN/1, SES/2, and GPS/3 LEDs will cycle on and off from left to right.

Alignment Mode

When a subscriber 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 on alignment mode.

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.

INSTALLATION

The following steps are required to install the Canopy subscriber module.

- Unpack the Canopy products
- Configure the subscriber module for the Canopy network
- Install the module
- Align the module

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 packaging materials. They can be used for transportation of the equipment to and from installation sites.

CONFIGURING THE SUBSCRIBER MODULE

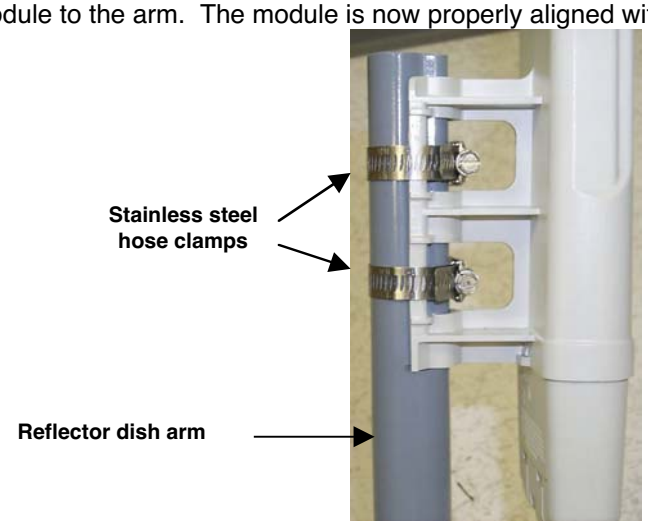
In all cases, when a configuration parameter is modified, the change must be saved and the module must be rebooted.

The subscriber module, from the factory, is configured to scan all available frequencies in its specific frequency band. An operator will need to verify the following information:

- The operator may program a unique IP address into the subscriber module or can leave it at its defaults. The subscriber module is programmed to utilize the local IP address of 169.254.1.1. When configured in this manner the IP address is not accessible from the far side of a RF link to the module. If the operator requires that the LAN IP of the subscriber module be accessible from across the RF link then the public IP address feature is recommended. This feature will require that a routable IP address and appropriate subnet mask and gateway be utilized.
- The operator must configure the appropriate color code on the subscriber module so that it can register with an access point module. The color codes must match.
- The operator can prevent unauthorized users from connecting to the subscriber module's web based interface by assigning a password. There is no default password and password protection is turned 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 subscriber module, a Canopy default plug can be used to regain access. See Configuration section for information on 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.

In the 2.4 GHz band, the Canopy passive reflector can be used to establish links up to 15 miles. In the 5.7 GHz bandIf the subscriber module is in the 5.7 GHz band and the operator will be using the Canopy passive reflector to obtain a link at distances of 10 miles or less, The subscriber module should be mounted to the reflector in the following manner. The reflector arm is molded to receive

the plastic housing of the subscriber module. Utilize stainless steel hose clamps to secure the module to the arm. The module is now properly aligned within the reflector.



INSTALLATION OF THE SUBSCRIBER MODULE

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 must be performed for successful installation:

- Select a mounting location that is free from objects, such as buildings, large trees, etc., that will interfere with the line of sight to the Access Point cluster location. Be mindful of the Fresnel Zone.
- The Canopy module should be mounted vertically as shown in FIGURE 3. All Canopy modules' antennas are vertically polarized in this direction.
- Mount the Canopy subscriber module to a secured location on the side/roof of the building. The mount must be rigid and the subscriber module must not sway from outside forces.
- Illustrated in FIGURE 3 is an example of mounting the unit to an antenna mast. Stainless steel hose-clamps, or any suitable outdoor equivalent, may be used to secure the unit to the mast.

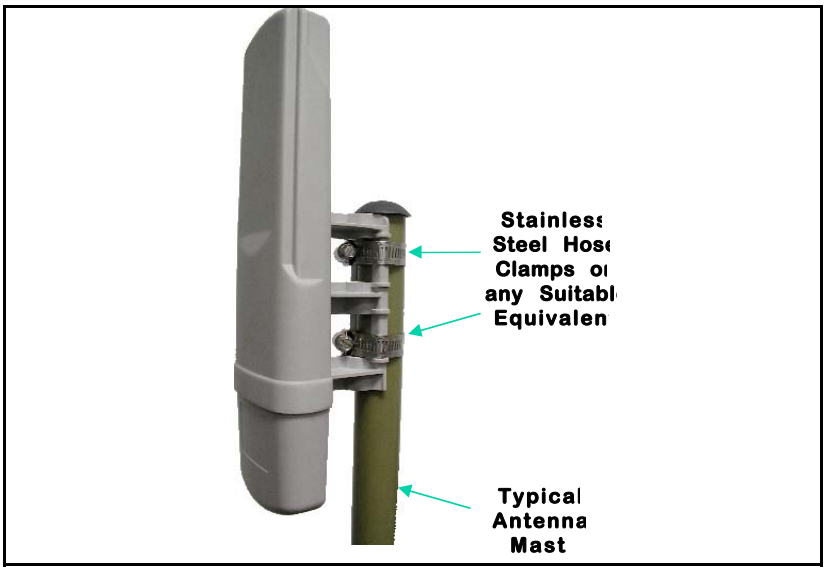


FIGURE 3

- Leave the unit mounting means loose enough to allow for movement when performing the alignment procedure. They must be tightened after the alignment procedure is completed.

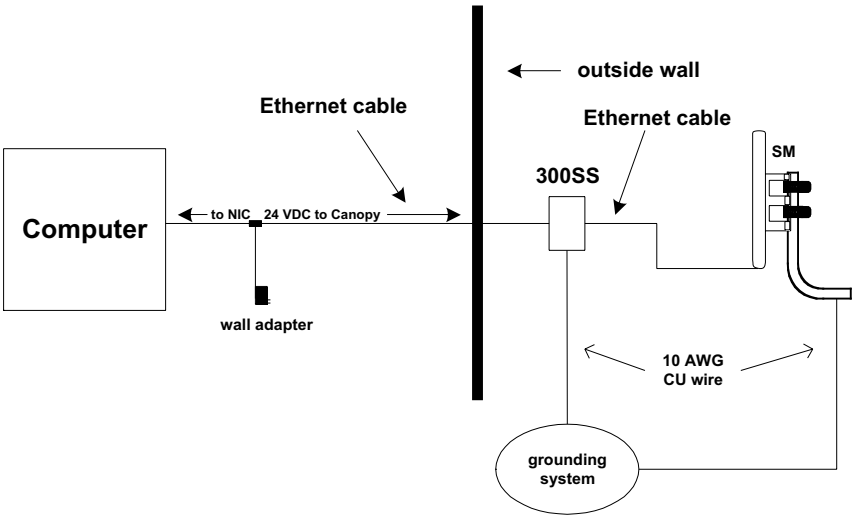
As with any such installed devices, the Canopy subscriber module and the Ethernet cable must be grounded in accordance with the latest revision of the *National Electrical Code* (NEC) and/or all country and local electrical codes to provide some protection against damage caused by near-miss lightning strikes and other electrical discharges. The Canopy Ethernet surge suppressor is such a device for this situation.

- Connect one end of an Ethernet cable to the Canopy subscriber module RJ-45 connector**.**
- Connect other end of the Ethernet cable to the RJ-45 connector in the Canopy surge suppressor. Refer to the *Surge Suppressor User Manual* for specifications.
- Connect one end of another Ethernet cable to the other RJ-45 connector in the Canopy Surge Suppressor.
- Connect the other end of the Ethernet cable to the AC adapter.

The unused pins of the Ethernet cable (4,5,7 and 8) transmit power to the Canopy subscriber module. ***DO NOT*** place other networking equipment on the Ethernet cable between the AC adapter and the subscriber module. The module can be up to 328 feet (100 meters) from the power supply.

- Plug the AC Adapter into an AC outlet.
- Plug the other side of the AC adapter's Ethernet "pig tail" into the computer or network computer's Ethernet port. ***DO NOT*** plug the Ethernet "pig tail" from the AC adapter into the subscriber module. See following wiring diagram.

Wiring Diagram of Canopy subscriber module to Computer with Surge Suppressor



ALIGN THE SUBSCRIBER MODULE

There are two methods that can be utilized for aligning a subscriber module to an access point module. The first is to monitor the RSSI and Jitter values on the subscriber. The second is to utilize the built-in alignment tool on the subscriber module. In either case it is necessary for a computer to be connected to the subscriber module to gain access to the web-based interface.

Monitoring RSSI and Jitter

The RSSI (received signal strength indicator) and Jitter are two parameters that can be used for alignment of a subscriber module. The RSSI level must be above 700 and the Jitter must be 9 or below (with 5 being the best) for a link to be acceptable.

- Point subscriber module in direction of the access point. Remember that when using the internal patch antenna the energy is radiated out in a 60° horizontal by 60° vertical pattern.

IF USING A PASSIVE REFLECTOR on 2.4 or 5.7 GHz SUBSCRIBER MODULE*:* the passive reflector will change the radiated pattern to 6° horizontal by 6° vertical.

- The module has a series of states that it will go through to register to an access point. Those states are: scanning, syncing, registering, and registered. RSSI and Jitter will not report on the web page till the unit is registered. If the module will not register ensure that there is line-of-sight, the access point module is transmitting, the color codes match, and that the subscriber is within the appropriate distance to the access point as specified by the max range value on the access point module.
- After the module has registered, slowly adjust the positioning of the subscriber module until RSSI has been maximized and Jitter has been minimized. Lock down the module when appropriate.
- Perform a link test to check the efficiency of the link. See Link Test for further information. The efficiencies must be above 90% in both the up and down link for packet loss to not occur.

USing Alignment Mode

The Alignment web page will display, in graphical form, levels for RSSI, Jitter, and the number of registered users at the access point.

- Point subscriber module in direction of the access point. Remember that when utilizing the internal patch antenna the energy is radiated out in a 60° horizontal by 60° vertical pattern.

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

- Set the web page to auto-refresh (see Configuration section for further information)
- Go to Alignment web page. Ensure that "*RSSI Only Mode*" is disabled.
- Click "*Enable Aiming Mode*" button.
- The module has a series of states that it will go through to register to an access point. Those states are: scanning, syncing, registering, and registered. RSSI and Jitter will not report on the web page till the unit is registered. If the module will not register ensure that there is line-of-sight, the access point module is transmitting, the color codes match, and that the subscriber is within the appropriate distance to the access point as specified by Canopy.
- Slowly adjust the positioning of the subscriber module and monitor the Alignment web page for a reading of the RSSI and Jitter. Lock down the module when appropriate.
- Click "*Disable Aiming Mode*" button.
- Perform a link test to check the efficiency of the link. See Link Test section for further information. The efficiencies must be above 90% in both the up and down link for major packet loss to not occur.

CABLING

The RF environment the Subscriber Module operates in often will permit use of unshielded cable. However, in cases where cable interference issues are suspected, or as part of A/B comparisons to debug field problems, use of shielded cable with Subscriber Modules may be warranted.

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

The following information describes the wiring standards for installing a Canopy system. All diagrams use the EIA/TIA 568B color standard.
Currently shipping modules auto-sense the Ethernet cable type – either RJ-45 straight-thru cable or RJ-45 crossover cable can be used to connect a network interface card (NIC), hub, router, or switch to a module.

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

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

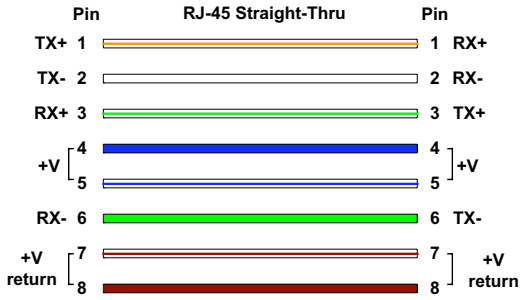
Very early modules did not auto-sense. In cases where older modules are used:

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

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

RJ-45 Straight-Thru:

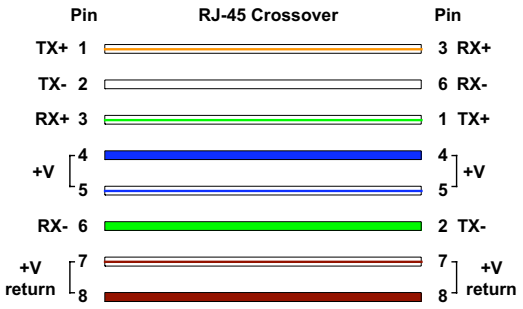
- pin 1 → white / orange ← pin 1
- pin 2 → orange ← pin 2
- pin 3 → white / green ← pin 3
- pin 4 → blue ← pin 4
- pin 5 → white / blue ← pin 5
- pin 6 → green ← pin 6
- pin 7 → white / brown ← pin 7
- pin 8 → brown ← pin 8



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

RJ-45 Crossover:

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



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

ADVANCED FEATURES

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

SECURITY - DES ENCRYPTION

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

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

SECURITY - AES ENCRYPTION

Motorola also offers Canopy products that provide Advanced Encryption Standard (AES) encryption. Like DES, AES is a secret key encryption scheme, but AES uses the Rijndael algorithm and 128 bit keys to establish a higher level of security than DES.

Due to the level of security provided by AES, the US government has established export controls on communications products that use AES. These export controls may mean that outside of the US AES products are only available in certain regions – check with your Canopy distributor or reseller for availability in your area.

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

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

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

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

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

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

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
```

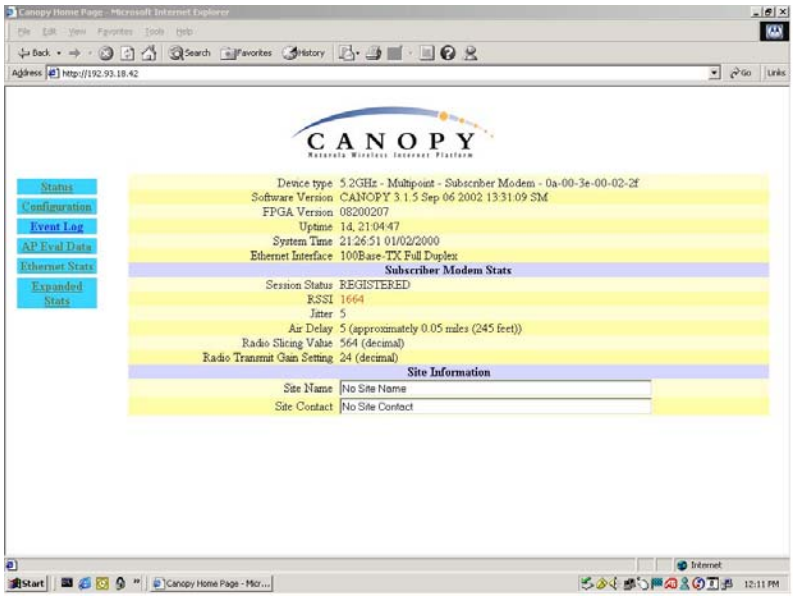
THE INTERFACE SCREENS

The Canopy subscriber 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 subscriber module. This can be done either directly or through a network. Enter the IP address of the subscriber module (default is 169.254.1.1) into the address bar of your browser and hit enter on your keyboard. The following web based interface pages are accessible:

- Status
- Configuration
- Event Log
- AP Eval Data
- Ethernet Stats
- Expanded Stats

The default page, when accessing the IP address of the Canopy unit is, the Status page.

STATUS PAGE



The Status page contains information on the operation of the product. It is the default webpage. 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 is *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 note of this information when obtaining technical support.

Uptime: displays the length of time the module has been operating since a rest of the module occurred.

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 five (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.

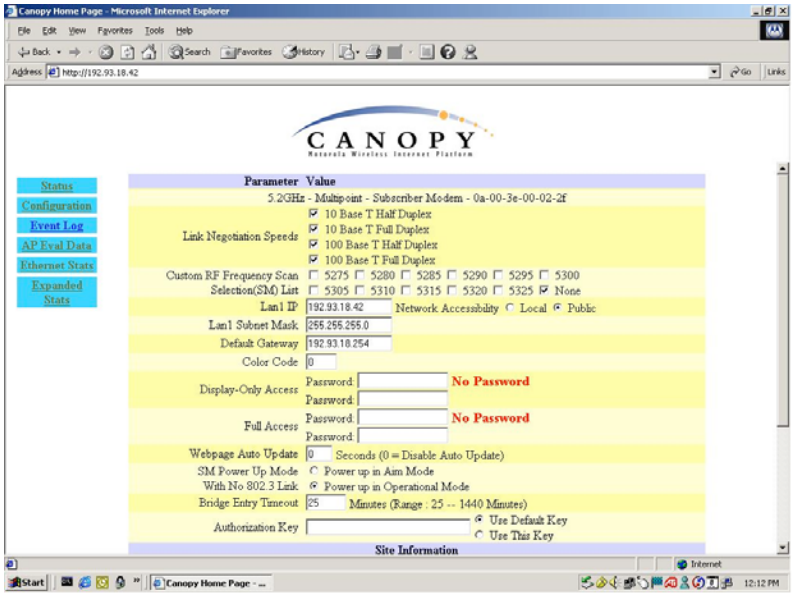
Radio Slicing Value: displays information to be used by Canopy technical support.

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 webpage 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.

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 access point modules. 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 SM to successfully register to an AP 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 AP frequency. The 5 MHz spacing for channels on 5.2 and 5.7 GHz SMs 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 at the end of this section for creation and 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 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 neighboring 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 at end of section for use and creation of a default plug.

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 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.

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. See Alignment section for more information. *Operational Mode* is the default setting.

Bridge Timeout Entry: choose the appropriate bridge timeout for correct network operation with existing network infrastructure.

Authorization Key: each module ships with a unique, pre-programmed authorization key that is to be utilized when an operator configures the Canopy System for DES encryption of the over the air link. The default key is permanently stored on the module.

Site Name: enter information relating to a name given to the physical module. This parameter will

set the supplied information into the *sysName* SNMP MIB-II object and can be polled by a SNMP management server. The buffer size for this field is 128 characters.

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

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

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

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

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

Reboot: depressing this button will reboot the module.

Canopy Default Plug

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

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

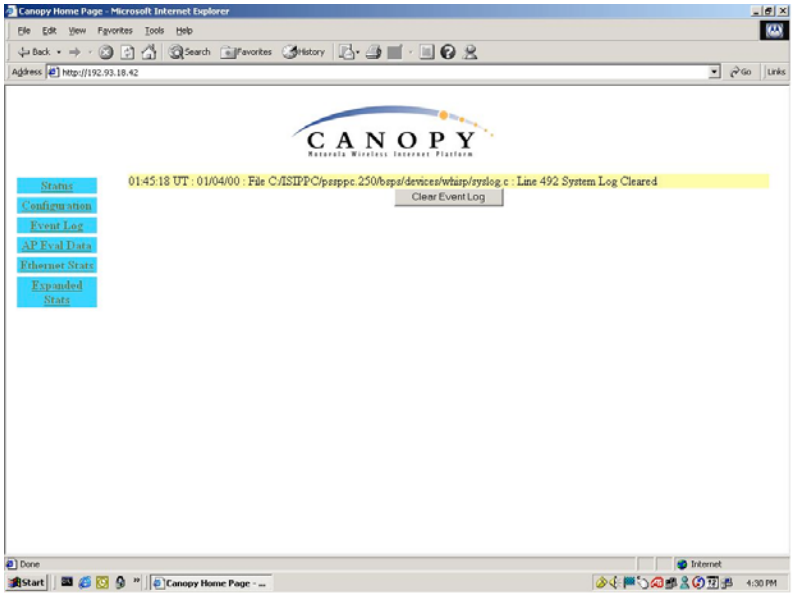
- Obtain a RJ-11, 6-pin connector and a small length of CAT 5 cable.
- Pin-out all 6-pins according the following diagram and then short (i.e. solder) together pins 4 and 6 on the other end. Remaining wires should not be connected to anything.

  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.

AP EVAL DATA

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 module.

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

The Ethernet 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.

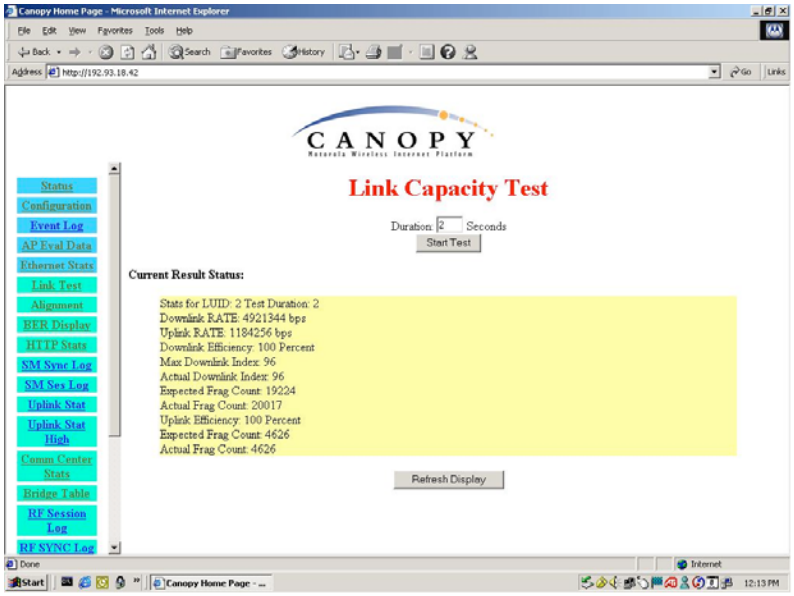
EXPANDED STATS

When clicking on the Expanded Stats button and then clicking on one of the standard web page (i.e. Status or Configuration) more fields may be displayed on that page. To go back to the non-Expanded Stats view just have the web browser refresh on the IP address of the module.

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



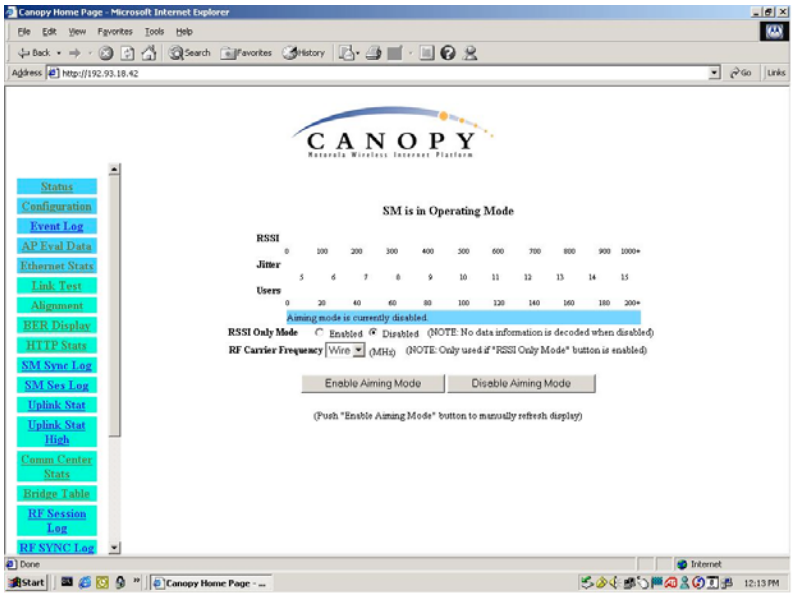
The Link Test is a test for measuring the throughput and efficiency of the RF link between two Canopy modules.

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 access point module is transmitting on)
- Click the radio button to highlight "*Enable*" on RSSI Only mode
- Click "*Enable Aiming Mode*"

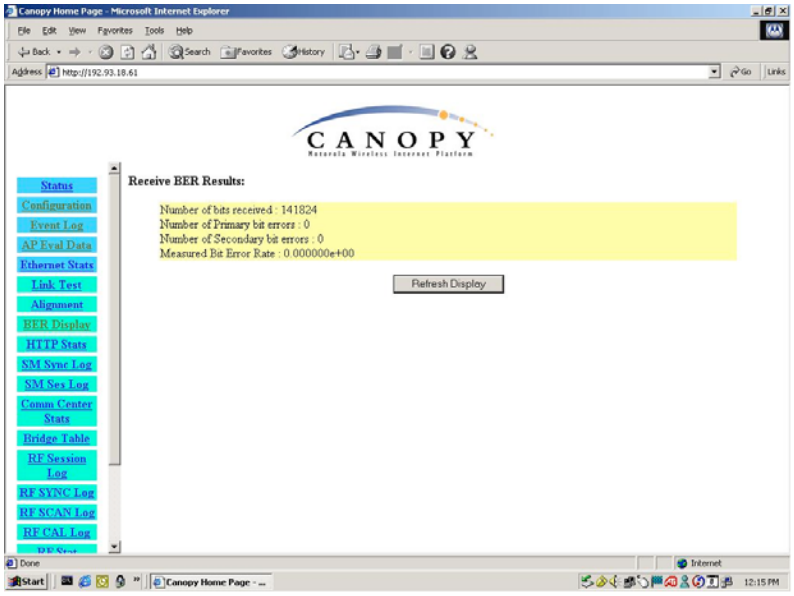
The module will now report back the level of RF energy present at that specific frequency. To refresh the screen, click the *Enable Aiming Mode* button as appropriate or configure the web page auto-refresh option.

The normal operation of alignment mode will report information as it relates to the RSSI level, Jitter value, and number of users on the access point module. 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.

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 (part number SMMB-1)
- Passive reflector dishes for use with 5.7 GHz subscriber modules (part number 27RD)
- 102-132 V AC power supply with North American plug, part number ACPS110
- 100-240 V AC power supply with North American, UK, and Euro plugs, part number ACPSSW-02
- Cable assemblies for the Canopy System can be ordered from Best-Tronics Manufacturing Inc. by going to their website at *http://www.best-tronics.com/motorola*. Due to the RF environment Canopy Backhauls, Access Points, and Cluster Management Modules often operate in, it is strongly recommended to use shielded cable for infrastructure cabling connecting these modules.

APPENDIX

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

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

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

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

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

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

SPECIFICATIONS

Operating Frequency Ranges	2.4 Modules: ISM 2.4 to 2.4835 GHz 5.2 Modules: U-NII: 5.25 to 5.35 GHz 5.7 Modules: ISM: 5.725 to 5.850 GHz
Access Method	TDD/TDMA
Signaling Rate	10 Mbps
Modulation Type	High Index 2-level Frequency Shift Keying (FSK) (Optimized for interference rejection)
Carrier to Interference (C/I) also known as Jitter	3dB nominal
Receiver Sensitivity	-83dBm 10^{-4} BER
Operating Range (All Weather)	Up to 15 miles (24 km) with passive reflector in the 2.4 GHz band. Up to 2 miles (3.6 km) with integrated antenna in the 5.2 GHz band. Up to 10 miles (16 km) with passive reflector in the 5.7 GHz band.
Transmitter Power	Meets FCC U-NII/ISM and IC LELAN ERP Limit
DC Power measured at DC converter	0.3A @ 24 VDC (7.2 watts) typical
Interface	10/100 BaseT, half/full duplex Rate auto negotiated (802.3 compliant)
Protocols Used by Canopy	IPV4, UDP, TCP, ICMP, Telnet, HTTP, FTP, SNMPv2c, 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 (-40°F to +131°F)
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	1 lb. (.45kg)