Supplement to the Canopy System Release 8 User Guide

PMP 400 Series Networks
PTP 200 Series Bridges
Release 8.4.3

Issue 2

September 2008

Notices

See important safety notice on exposure distance in Section 6.3 on page 37.

See important regulatory and legal notices in Section 2 on page 6.

Trademarks, Product Names, and Service Names

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1   Introduction

This guide provides product description, planning, configuration, and installation information specific to the PMP 400 Series networks and PTP 200 Series bridges. It should be used along with the *Canopy System Release 8 User Guide*, which covers general information, including all network features, RF control features, and GUI (Graphical User Interface) features common across PMP 100, 200 and 400 Series networks and PTP 100 and 200 Series bridges. The *Canopy System Release 8 User Guide* is available from the "User Guides" section of the Canopy Document Library, http://motorola.canopywireless.com/support/library/?region=1&cat=8.

This guide assumes that the reader has general RF (Radio Frequency) and Internet Protocol (IP) knowledge and background.

This issue, Issue 2, is consistent with features provided by Canopy Release 8.4.3. Separate *Release Notes for Canopy Software Release 8.4.3* are available and include open issues and other notes.

Previously this guide was titled *PMP 400 and PTP 200 Series User Guide (OFDM AP and SM)*. It has been re-titled to reflect that Release 8.4.3 supports PTP 200 Series bridges using the same technology and hardware and software platform as the PMP 400 Series products.

1.1   ABBREVIATIONS

The following abbreviations may be used in these notes:

1X	1X operation, with typical max aggregate (up and down) throughput of 7 Mbps (2 Mbps for 900 MHz)
2X	2X operation, with typical max aggregate (up and down) throughput of 14 Mbps (4 Mbps for 900 MHz)
3X	3X operation, with typical max aggregate (up and down) throughput of over 20 Mbps
AP	Access Point Module
BH	Backhaul Module, either timing master or timing slave
BHM	Backhaul Module – timing master
BHS	Backhaul Module – timing slave
CMM	Cluster Management Module
CNUT	Canopy Network Updater Tool
DFS	Dynamic Frequency Selection for radar avoidance
EIRP	Equivalent Isotropically Radiated Power
ETSI	European Telecommunications Standards Institute
FSK	Frequency Shift Keying
MIB	Management Information Base for SNMP
OFDM	Orthogonal Frequency Division Multiplexing
PtP	Point-to-Point (Backhauls)
PtMP	Point-to-Multi-Point (AP to SMs)
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
SM	Subscriber Module

1.2   DOCUMENT CHANGE HISTORY

Issue 1   First Issue

Issue 2   Significant changes for:
- PTP 200 Series bridges (BHs)
- Products using AES encryption
- Release 8.4.3 features

1.3   FEEDBACK ON DOCUMENTATION

Is this document accurate, complete, and clear? How can it be improved? Please send your feedback on Canopy documentation to technical-documentation@canopywireless.com.

1.4   TECHNICAL SUPPORT

Tip! Don't clear the Event Log after you encounter issues – it may be useful to Technical Support if you need to escalate the issue.

Here is the escalation path for resolution of a problem:

1. Check documentation:

   - This document
   - Canopy System Release 8 User's Guide, available at http://motorola.canopywireless.com/support/library/

2. Consider checking the Canopy Community Forum at http://motorola.canopywireless.com/support/community.

3. Consider checking the Canopy Knowledge Base at http://motorola.canopywireless.com/support/knowledge/

4. Escalate the problem to your Canopy supplier or reseller.

5. Escalate the problem to Canopy Technical Support or other designated Tier 3 technical support:

Worldwide Canopy Technical Support

email: technical-support@canopywireless.com

1-888-605-2552 or **+1 217 824 9742**

Canopy Technical Support, Europe

email: essc@motorola.com

+44 (0)1793 564680

Calls are logged 24 x 7, cases are worked Mon-Fri 09:00 - 17:00 GMT

When you send e-mail or call, please include, as appropriate, software release on each module, IP addresses, MAC addresses, and features enabled, like NAT, VLAN, high priority channel, or CIR. You may be asked to run the Support Tool on CNUT or Prizm to provide a complete network picture.

2 Product Description

PMP 400 Series networks and PTP 200 Series bridges add OFDM-based (Orthogonal Frequency Division Multiplexing) products to the Canopy family. SMs are available with either an integrated antenna or an external N-type connector on a short length of coaxial cable for connecting to a connectorized antenna. APs are always connectorized, and sold either with a connectorized antenna as a kit, or with no antenna. BHs are available with either an integrated antenna or an external N-type connector on a short length of coaxial cable for connecting to a connectorized antenna.

Table 1 shows the Motorola PMP 400 Series and PTP 200 Series products available.

Table 1: Products and Model Numbers

Model Number	Series	Module	DES or AES	Antenna Type	Antenna included ?	Picture	Specs
5440SM	PMP 400	5.4 GHZ OFDM SM	DES	Integrated	Yes	Figure 1	2.7.1
5441SM	PMP 400	5.4 GHZ OFDM SM	AES	Integrated	Yes	Figure 1	2.7.1
5440SMC	PMP 400	5.4 GHZ OFDM SM	DES	Connectorized	No	Figure 1	2.7.2
5441SMC	PMP 400	5.4 GHZ OFDM SM	AES	Connectorized	No	Figure 1	2.7.2
5440AP	PMP 400	5.4 GHz OFDM AP	DES	Connectorized	Yes	Figure 2	2.7.3
5441AP	PMP 400	5.4 GHz OFDM AP	AES	Connectorized	Yes	Figure 2	2.7.3
5440APC	PMP 400	5.4 GHz OFDM AP	DES	Connectorized	No	Figure 1	2.7.2
5441APC	PMP 400	5.4 GHz OFDM AP	AES	Connectorized	No	Figure 1	2.7.2
5440BH	PTP 200	5.4 GHz OFDM BH	DES	Integrated	Yes	Figure 1	2.7.1
5441BH	PTP 200	5.4 GHz OFDM BH	AES	Integrated	Yes	Figure 1	2.7.1
5440BHC	PTP 200	5.4 GHz OFDM BH	DES	Connectorized	No	Figure 1	2.7.2
5441BHC	PTP 200	5.4 GHz OFDM BH	AES	Connectorized	No	Figure 1	2.7.2

Figure 1: PMP 400 Series SM or AP, PTP 200 Series BH

Figure 2: PMP 400 AP (connectorized radio and antenna)

A Canopy CMMmicro or CMM4 provides synchronization and power to the PMP 400 Series APs and PTP 200 Series BHMs, and a 600SSC surge suppressor, a successor to the 300SS and 600SSB surge suppressors, provides over-voltage and over-current protection to APs, SMs, and BHs in various configurations.

2.1   TECHNOLOGY AND BENEFITS

These radios automatically selects QPSK (Quadrature Phase Shift Keying), 16-QAM (Quadrature Amplitude Modulation), or 64-QAM based on RF environment to provide 1X, 2X, and 3X operation, respectively. This provides 3 speeds and a throughput of over 20 Mbps aggregate (sum of up plus down) compared FSK Canopy products with 2 speeds and a throughput of up to 14 Mbps.

The OFDM radios feature lower receive sensitivity, FEC (Forward Error Correction), and higher antenna gain, all of which combine to provide longer range within regulatory-specified EIRP (Equivalent Isotropic Radiated Power).

Details on performance are listed in Table 2 on page 11.

The PMP 400 and PTP 200 Series radios use an OFDM physical layer with 10 MHz channels and 256 sub-carriers. Due to the different carrier and modulation schemes between these OFDM radios and FSK Canopy radios, the two do not interoperate over the air. For example, an OFDM SM cannot connect to an FSK AP.

2.1.1   NLOS and nLOS Benefits and Limitations

The use of OFDM technology will help in many cases of NLOS (Non Line-of-Sight) and nLOS near Line-of-Sight (nLOS) links. LOS (Line-of-Sight) means the installer can see the AP from the SM and the first Fresnel zone is clear. An example of nLOS is when the installer can see the AP from the SM, but a portion of the first Fresnel is blocked. An example of NLOS is when the

installer cannot see the AP from the SM, and a portion or even much of the first Fresnel is blocked, but subsequent Fresnel zones are open. Figure 3 shows examples of such links.
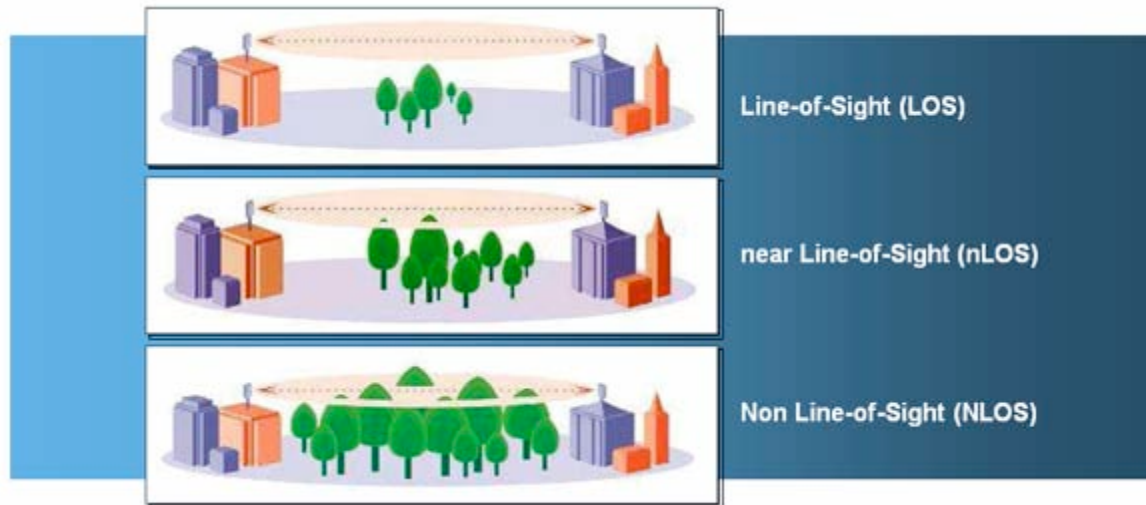

Figure 3: LOS, nLOS, and NLOS

Whereas multi-pathing degrades a link in some technologies, like FSK, OFDM can often use multi-pathing to advantage to overcome nLOS and NLOS, especially in cases where the Fresnel zone is only partially blocked by buildings, "urban canyons", or foliage. OFDM tends to help especially when obstacles are near the middle of the link, and less so when the obstacles are very near the SM, AP, or BH.

However, attenuation through walls and trees is substantial for any use of the 5.4 GHz frequency band. Even with OFDM, 5.4 GHz products should not be expected to penetrate walls or extensive trees and foliage.

2.2   APPLICATIONS

Applications for the PMP 400 and PTP 200 Series systems include

- •   NLOS/nLOS video surveillance in metro areas
- •   High throughput enterprise applications
- •   Extend networks into urban areas
- •   Extend networks into areas with foliage

2.3   CONFIGURATION OPTIONS – RF, IP, DFS

These systems use the Canopy Media Access Controller (MAC) layer. Settings like Downlink Data %, Range, and Control Slots are similar to Canopy FSK radios. An AP can communicate to over 200 SMs, similar to a Canopy FSK AP.

The GUI (Graphical User Interface) is almost identical to Canopy's, with a few additions to support OFDM-specific features.

Network features like High Priority using DiffServ, MIR, CIR, NAT, DHCP and VLAN are available for the PMP 400 and PTP 200 Series OFDM radios, and are configured in the same way as they are for the PMP 100 and 200 Series and PTP 100 Series radios.

DFS (Dynamic Frequency Selection) is provided for regulatory compliant operation in the 5.4 GHz band, and is activated using the "Region Code" feature. Two alternate frequencies can be

configured to provide service in the unlikely case a module detects radar and triggers DFS, the same as standard Canopy. "External Antenna Gain" may need to be configured consistent with any antennas used, to avoid making the system overly sensitive to radar detection. "Whitening," a technique used to avoid self-interference on Canopy FSK radios is not offered as an option on the PMP 400 and PTP 200 Series radios, as whitening is not a technology applicable to an OFDM signal.

2.4   RELEASE NUMBERING

Release numbering has the following meaning:

- Release 8.2.x runs on Canopy FSK radios (PMP 100 and 200 and PTP 100 Series radios). Release 8.4.x does not.
- Release 8.4.x runs on PMP 400 and PTP 200 Series OFDM radios. Release 8.2.x does not
- "Release 8.3" is not planned to be used for release numbering.

2.5   POWER AND GROUNDING

The PMP 400 and PTP 200 Series radios use a 30 VDC nominal power system, instead of the 24 VDC nominal power system used previously in standard Canopy. A new 30 VDC power supply is available for the CMMmicro, and a new 30 VDC nominal (specified and labeled as 29.5 VDC) power supply is available for the SM.

The new 30 VDC power supplies can also be used for standard Canopy, and are replacing the 24 VDC power supplies in the Canopy product line.

The PMP 400 and PTP 200 Series radios have slightly higher power use than Canopy FSK radios, and the higher voltage is needed to carry the higher wattage on cable runs approaching the 100 meter (328 ft) maximum length. CMMmicro 24 VDC power supplies and the latest version of SM 24 VDC power supplies can power PMP 400 and PTP 200 Series radios for shorter runs. Earlier versions of SM 24 VDC power supplies, especially the earlier heavier transformers, cannot. The best practice is to use 30 VDC power supplies with PMP 400 and PTP 200 Series radios, and avoid potential issues and cable-length-specific engineering.

Due to the full metallic connection to the tower or support structure through the AP's antenna or a connectorized BH's antenna, grounding of the AP or BH and a 600SSC surge suppressor within 3 ft (1 m) of the AP or BH is strongly recommended to suppress overvoltages and overcurrents, such as those caused by near-miss lightning. APs and BHs provide a grounding lug for grounding to the tower or support structure. A pole mount kit is available for the 600SSC, and provides a grounding lug that can be used for terminating grounding straps from both the 600SSC and the AP.

2.6   ADMINISTRATION SYSTEMS

Standard Canopy administration systems are used to support the PMP 400 and PTP 200 Series products, with the only requirement being that the administration systems must be at the appropriate release level:

- Prizm 3.1 is the element management system for PMP 400 and PTP 200 Series products. In addition to managing and monitoring Canopy modules, Prizm 3.1 can be used to update them.
- CNUT 3.1 (Canopy Network Update Tool) is the stand-alone update tool for PMP 400 and PTP 200 Series products for operators not using Prizm.

2.7　TECHNICAL DETAILS, SPECIFICATIONS, PERFORMANCE

The following sections show technical details for various radio form factors.

2.7.1　Integrated antenna radio specifications

- Radio with an integrated, internal antenna
- 18° x 18° 3 dB beam
- 17 dBi gain for antenna
- Auto TPC (Transmit Power Control), set by the AP to provide power leveling for close-in SMs, with a range of -30 to 10 dBm, and a default of 10 dBm (17 dBi antenna gain plus 10 dBm transmit power gives the regulatory max 27 dBm EIRP)
- 12.5 W DC power
- 2.8 lb, 13.25 x 8.25 x 3.75 in (hwd) (~1.3 kg, 34 x 21 x 9.5 cm)

2.7.2　Connectorized radio specifications

- Connectorized radio only (antenna to be provided by operator) – N-type connector
- -30 to 15 dBm transmit power, with the factory default set to 10 dBm
- 12.5 W DC power
- Same form factor as SM - 2.8 lb, 13.25 x 8.25 x 3.75 in (hwd) (~1.3 kg, 34 x 21 x 9.5 cm)

2.7.3　Kitted connectorized radio specifications (antenna included)

- Connectorized radio and connectorized antenna kitted together – N-type connector
- 90° sectors
- Antenna optimized for system coverage vs system self-interference for 90° sectors (3 dB beam pattern of 60° azimuth by 5° elevation, with near-in null fill)
- 17 dBi gain for antenna
- -30 to 15 dBm transmit power, with the factory default set to 10 dBm (17 dBi antenna gain plus 10 dBm transmit power gives the regulatory max 27 dBm EIRP)
- 12.5 W DC power
- 13 lb, 28 x 8.25 x 11 in (hwd) (~6 kg, 71 x 21 x 28 cm)

2.7.4　System technical details

- Standard Canopy temperature range of -40° C to +55° C
- Latency of 5-7 msec roundtrip
- Products available with either DES or AES encryption

Table 2 shows performance details for the PMP 400 and PTP 200 Series system, with the standard Canopy 5.4 GHz FSK details shown for comparison.

Table 2: Performance Details

Product	Channel Width	Parameters	Performance Details		
			1X	2X	3X
5.4 GHz OFDM	10 MHz	Modulation	QPSK	16 QAM	64 QAM
		Typical Maximum Range	5 mi/8 km	2.5 mi/4 km	1.25 mi/2 km
		Typical Maximum Aggregate (up+down) Throughput	7 Mbps	14 Mbps	20 Mbps
		Nominal Receive Sensitivity (including FEC)	-89 dBm	-78 dBm	-70 dBm
5.4 GHz FSK (for comparison)	20 MHz	Modulation	2-level FSK	4-level FSK	none
		Typical Maximum Range	2 mi/3.2 km	1 mi/1.6 km	none
		Typical Maximum Aggregate (up+down) Throughput	7 Mbps	14 Mbps	none
		Nominal Receive Sensitivity	-86 dBm	-70 dBm	none

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3 Planning

PMP 400 and PTP 200 Series systems use a 10 MHz channel size configurable on 5 MHz centers. This channel size, along with some different characteristics due to the use OFDM carrier technology and QPSK, 16 QAM, or 64 QAM modulation, supports somewhat different channel planning than for standard Canopy. (For reference, PMP 100/200 Series uses 20 MHz channels configurable on 5 MHz centers, single carrier technology, and 2-level and 4-level FSK modulation.)

3.1   TOWER CHANNEL PLANNING

For a single cluster of 4 APs on a tower, 2-channel re-use with channels on 10 MHz channel center spacing gives good performance. In channel design parlance, this can be stated as ABAB channel planning, with no guard band needed between A and B. A typical arrangement might be to use radios configured for 5480 MHz aimed north and south, and radios configured for 5490 MHz aimed east and west.

(For reference, standard Canopy uses 2-channel re-use with clusters of 6 APs on a tower with channel center spacing of either 25 MHz for Advantage APs or 20 MHz for non-Advantage APs. This is ABCABC channel planning, with 5 MHz guard band between the 20 MHz channels for Advantage APs and no guard band needed for non-Advantage.)

Available channel center frequencies for each region are shown in Table 3. These vary by region due to

- different band edge RF specifications (for example, between Canada/US and Europe)
- requirements in Europe and Canada to not impinge on the frequencies between 5600 and 5650 MHz, which are frequencies on which some weather radar operate

Table 3: Channel Center Frequencies, by Region

Region	Range of Center Frequencies Available (MHz) (on **5 MHz centers** within this range, inclusive)
US	5480 - 5710
Canada	5480 – 5595, 5655 - 5710
Europe	5475 - 5595, 5655 - 5715
US FSK (for comparison)	5495 - 5705
Canada FSK (for comparison)	5495 - 5575, 5675 - 5705

The best practice for channel planning for APs is to conduct extensive site RF surveys before choosing channels. The PMP 400 Series For those with the equipment and expertise, use commercial and industrial spectrum analysis equipment. The PMP 400 and PTP 200 Series APs and SMs do not provide a spectrum analyzer in the first release (planned for a subsequent release), but standard 5.4 GHz FSK SMs can be used to give useful information on the RF environment in the planned PMP 400 and PTP 200 Series AP deployment location.

3.2   DOWNTILT

The standard AP antenna produces a 3 db beam elevation (up and down) of 5°, with near-in null fill that allows good coverage of close-in SMs that otherwise would be affected by the narrow pattern. This is a narrower pattern than operators may be used to with standard Canopy's 60° 3 dB beam, and may require downtilt on the antenna. The standard antenna has provision for

measured downtilt. The operator should estimate downtilt based on antenna height above the service area and using one of the many radio analysis and mapping tools or on-line calculation tools for calculating downtilt.

3.3   WEATHER RADAR

Spectrum between 5600 and 5650 MHz (sometimes called the "weather notch") is used by some weather radar and is not allowed for use by regulations in some regions, including Canada and, for new equipment, Europe. When the Canopy module is set to one of those regions (configured on the "Configuration => General" page of the module), it will not allow configuration of the appropriate frequencies, as shown in Table 3. Even in regions where use of the spectrum between 5600 and 5650 MHz is allowed, such as the US, the best practice is to not use these channels if there are any other usable channels available. Only use the channels in this "weather notch" after performing long-term site surveys (minimum of a week) to ascertain the spectrum is clear and that there don't appear to be any weather radar in the area that will cause interference to your Canopy system.

3.4   RANGE AND THROUGHPUT PLANNING

PMP 400 and PTP 200 Series modules provide up to 20 Mbps aggregate throughput at distances of 1.25 mi (~1 km) in RF environments with clear line-of-sight and low background interference levels. Additional performance details are shown in Table 2 on page 11. RF environments with occluded Fresnel zones or higher background interference levels may give lower, but still very good, performance, depending on the specifics of the environment.

Similar to standard Canopy, at any given instant, any radios operating at 1X or 2X take more "air time" to transmit a given amount of data than if they were running at 3X. Similar to standard Canopy, PMP 400 and PTP 200 Series modules may see reduced total throughput when handling traffic with a high percentage of small packets.

The effect of this, again similar to standard Canopy, is that at any given instant total throughput depends on

- Mix of links running at 3X, 2X, and 1X
- Mix of packet sizes

3.5   COLLOCATION WITH STANDARD 5.4 GHZ CANOPY FSK

When locating 5.4 GHz PMP 400 and PTP 200 Series OFDM APs near 5.4 GHz standard Canopy FSK APs (especially on the same tower, but also in the same geographical area), the following practices should be followed to avoid interference between the two systems:

- Plan spacing between OFDM and FSK channels to provide **25 MHz center spacing**, which gives a 10 MHz guard band between the 10 MHz OFDM channel and the 20 MHz FSK channel.
- **Coordinate** Downlink Data %, Range, and Control Slot settings using both the OFDM and the FSK **frame calculators**

The following paragraphs give more details on these recommended practices.

3.5.1   Channel Spacing

Center spacing of 25 MHz between collocated FSK and OFDM APs provides a 10 MHz guard band between the 20 MHz and 10 MHz channels, which has proven useful and needed in field testing. Alternatively, in cases where channel planning is severely restricted and the 10 MHz guard band (25 MHz spacing) is not possible, using vertical separation of 5 feet or more between

the OFDM and FSK APs may allow collocation with no guard band (15 MHz spacing) in some deployments.

3.5.2   Frame Calculations and Configuration Settings

Interference between collocated Canopy systems can be avoided by following two practices:

1. Use a CMM. This synchronizes frame start, so that all collocated APs begin transmitting at the same time each 2.5 millisecond frame.

2. Use the frame calculators in each module, OFDM and FSK (the frame calculators are different, as frame details are different) to select Downlink Data %, Range, and Control Slots for each system that produce "Rec SEQ Start" values that are within 300 bit times. This ensures that all collocated APs end transmission each frame before any collocated AP begins to receive.

When collocating only Canopy OFDM APs together, or collocating only Canopy hardware-scheduled FSK APs together, the simple practice of setting the Downlink Data %, Range, and Control Slots the same on all APs ensures they won't interfere with each other. (These parameters are set on the "Configuration => Radio" page of the AP.) However, due to the different "physical" layer between Canopy OFDM and Canopy FSK, this doesn't necessarily work when collocating OFDM and FSK together.

You will need to use frame calculators on both the OFDM and FSK modules, as they are different frame calculators. For the same Downlink Data %, Range, and Control Slots, the frame calculators give different results. Use of the frame calculators is similar to the previous use when collocating software-scheduled and hardware-scheduled APs.

Procedure 1: Finding collocation values using Frame Calculators

1. Using the "Tools => Frame Calculator" on an OFDM module, enter the desired Downlink Data %, Range, and Control Slot settings, click Calculate, and observe the "Rec SEQ Start" value.

2. Using the "Tools => Frame Calculator" on an FSK module, enter the desired Downlink Data %, Range, and Control Slot settings, click Calculate, and observe the "Rec SEQ Start" value.

3. Iterate, usually adjusting the FSK Downlink Data % and the OFDM Downlink Data % values by a few percent each time, until the "Rec SEQ Start" times of all collocated modules are within 300 bit times of each other.

4. Configure the OFDM modules using the resulting OFDM values, and the FSK modules using the resulting FSK values.

========================= end of procedure =====================

4   Configuring

Most Canopy Series 400 configuration items are identical or very similar to configuration items in standard FSK Canopy modules. This section discusses those that are new or changed and also remarks on some that remain unchanged.

4.1   LINK OPERATION – 1X/2X/3X

PMP 400 and PTP 200 Series products offer three levels or speeds of operation – 1X, 2X, and 3X - instead of the two levels offered by standard Canopy. 3X supports a typical maximum aggregate (sum of up and down) throughput of over 20 Mbps at up to 1.25 mi (~1 km). If received power is less due to distance between the AP/BHM and the SM/BHS or due to obstructions, or interference affects the RF environment, the Canopy system will automatically and dynamically adjust links to the best operation level. Distance, rates and other information associated with the operation levels are shown in Table 2 on page 11.

Similar to standard Canopy, the system chooses its operation rate dynamically, based on Canopy's internal ARQ (Automatic Repeat reQuest) error control method. With ARQ, every data slot of every frame sent over the air (expect downlink broadcast) is expected to be acknowledged by the receiver, and if acknowledgement is not received, the data is resent. The sending unit monitors these resends, and adjusts the operation rate accordingly. A normal system may have links that move from 3X to 2X and back (or 1X) as the RF environment changes, or links. Furthermore, the links operate independently, and it is normal, for example, for the downlink to run at 3X while the uplink RF environment only supports 2X.

The default is for both AP/BHM and SM/BHS to be enabled for 3X operation. An operator may "lock down" a link to 2X and 1X operation, or to only 1 X operation, using the Dynamic Rate Adapt parameter on the SM's "Configuration => General" page as shown in Figure 3 on page 15 . This parameter locks down both uplink and downlink operation. An operator may lock down an entire sector to 2X and 1X operation, or to only 1 X operation, using the Dynamic Rate Adapt parameter on the AP's "Configuration => General" page. This parameter locks down uplink and downlink of all links in the sector, and overrides any SM 1X/2X/3X settings. That is, if an individual link is set for 3X operation at the SM, but the sector is set for 1X operation at the AP, that link (and all links in the sector) will be locked down to 1X operation.

Figure 4: Dynamic Rate Adapt on AP "Configuration => General" page

In most cases, an operator is well-served to leave the setting at 1X/2X/3X and let the system automatically and dynamically choose the best rate for each link. Cases when it may be useful to lock down a link to 1X include

- Some aiming and alignment efforts, although usually aiming and alignment and link optimization work well with 3X operation allowed. If you are having trouble aiming a link or getting it to register, locking the link down to 2X or 1X may help in some cases.
- If the link is suspected to be oscillating between operation rates to the detriment of throughput. Usually, even if the link is moving rapidly between operation rates, overall link throughput and sector capacity are highest if the link is left at 3X and the link can choose its own rate dynamically.
- General link troubleshooting

Note that it is useful for as many links as possible to run at 3X to provide as much capacity as possible for the sector. In particular, just because you want to limit throughput to an individual subscriber *does not* mean you should set that link to 1X operation. Use MIR (Maximum Information Rate) settings to cap the SM's bandwidth use, but let the link run at as high an operation rate as the RF environment will allow. This ensures that when transmitting data the link uses as little "air time" as possible, leaving more "air time" for other SMs.

4.2   TRANSMITTER OUTPUT POWER (AND NO JITTER)

The AP/BHM's Transmitter Output Power is configured on the AP/BHM's "Configuration => Radio" page. Transmitter Output Power is settable in a range from –30 dBm to 12 dBm, with a factory default setting of 10 dBm.

In most regulatory regions, including the US, Canada, and Europe, PMP 400 and PTP 200 Series modules operating in the 5.4 GHz band are limited to 27 dBm EIRP (Equivalent Isotropic Radiated Power). This is different than the 30 dBm EIRP allowed for Canopy FSK modules

operating in the 5.4 GHz band because the regulations are for spectral power density and with half the channel size (10 MHz vs 20 MHz), PMP 400 and PTP 200 Series radios are allowed half the power (27 dBm vs 30 dBm).

To meet 27 dBm EIRP with the connectorized 18 dBi antenna (with 1 dB of cable loss) that comes with the 5440AP or 5441AP, or the integrated 17 dBi antenna that comes with a 5440BH or 5441BH, the maximum setting allowed is **10 dBm** (the default) since 27-17=10.

If a connectorized AP or BHM has been purchased and the operator has provided the antenna, the Transmitter Output Power must be configured based on that antenna and consistent with local or regional regulations. For example, if a 5440APC is being used with a 12 dBi antenna, then the maximum setting allowed to meet 27 dBm EIRP is the full 15 dBm of which the radio is capable, since 27-12=15.

> ### IMPORTANT!
> It is the responsibility of the operator and professional installer to ensure Transmitter Output Power is set within regulatory limits for their country or region. These must be set or confirmed on initial configuration and after a module is reset to factory defaults, and should be confirmed after the software on a module is upgraded.

In most cases, the operator will want to set the AP's Transmitter Output Power to the maximum allowed so as to have the greatest overall range and the greatest range for 3X operation. It may be useful to reduce Transmitter Output Power when Canopy systems are located close together, with good coverage given because of their proximity and full power isn't needed, or in cases where an operator is trying to reduce interference from the Canopy system to other systems.

Each SM's Transmitter Output Power is automatically set by the AP, not by the operator. The AP's Auto-TPC (Transmit Power Control) sets each SM's Transmitter Output Power to the lesser of

- 10 dBm, the maximum allowed on the SM since it has an integrated 17 dBi antenna and a regulatory maximum EIRP of 27 dBm (27-17=10)
- a power level so that the received power at the AP from that SM is not greater than 60 dBm.

PMP 400 Series networks use Auto-TPC because OFDM technology is more sensitive to large differences in power levels from SMs operating at various distances from the AP than the single carrier technology used in Canopy FSK.

PTP 200 Series networks do not use Auto-TPC – the operator sets Transmitter Output Power on the "Configuration => Radio" page of both the BHM and the BHS.

PMP 400 and PTP 200 Series modules display the typical Canopy "Receive Power Level" but due to the different modulation technique no "jitter" is calculated or displayed.

4.3   DOWNLINK DATA %, RANGE, AND CONTROL SLOTS

The Downlink Data % parameter on the AP's and BHM's "Configuration => General" page can be set in 1% increments between 10% and 90%. (Standard Canopy can be set between 1% and 99%, although internal calculations don't result in that extreme of slot assignment between uplink and downlink.) The default is 75%, the same as standard Canopy.

The default Range, set on the AP's "Configuration => General" page, is 5 miles, but can be set in 1 mile increments between 1 and 10 miles. The BHM performs its own ranging and so no range need be set for it.

If the Range is set to greater than 5 miles, then the Downlink Data % can be a maximum of 85%, else some close-in SMs won't register due to details of the Canopy scheduler. For example, a Range of 6 miles and a Downlink Data % of 90% is not allowed. Operationally,

- if the Downlink Data % is set to greater than 85% and the user enters a range greater than 5 miles, the module will reset the Downlink Data % to 85%
- if the range is set to greater than 5 miles and the user enters a Downlink Data % of greater than 85%, the module will reset the Downlink Data % to 85%.

Suggested Control Slot settings as a function of number of SMs in the sector are shown in Table 4. Generally all APs in a cluster should use the same number of control slots so as to keep the frame structures, and thereby the send and receive timing, the same.

Table 4: Control Slot Settings

Number of SMs that Register to the AP	Number of Control Slots Recommended
1 to 10	0
11 to 50	1
51 to 150	2
151 to 200	3

In some cases, operators may find that sectors with high levels of small packet requests, such as might be seen in a sector handling several VoIP streams, benefit overall from slightly higher Control Slot settings. If different sectors require different numbers of Control Slots, the operator should use the Frame Calculator to find a combination of settings that put "Rec SEQ Start" times within 300 bit times. See section 3.5.2 on page 14 for details.

Control Slots are reserved for SMs' bandwidth requests and never handle data. A higher number of control slots gives higher probability that an SM's bandwidth request will be heard when the system is heavily loaded, but with the tradeoff that sector capacity is reduced by about 100 kbps for each Control Slot configured, so there will be less capacity to handle the request.

Uplink Data Slots are used first for data, but if not needed for data in a given frame can be used by the SMs for bandwidth requests. So, even with zero control slots configured, the SMs can still make bandwidth requests, using any unused data slots.

BHMs do not have settings for control slots, as there is no contention on the one-to-one link.

Downlink Data %, Range, and Control Slots should be set consistent with the results of any collocation planning done using OFDM and FSK frame calculators in section 3.5.2 on page 14.

4.4   DFS AND REGULATORY PARAMETERS

Dynamic Frequency Selection (DFS) is a requirement in several countries and regions for 5 GHz unlicensed systems to detect radar systems and avoid co-channel operation. DFS and other regulatory requirements drive the settings for the following parameters, as discussed in this section:

- Region Code
- Primary Frequency
- Alternate 1 and Alternate 2 Frequencies
- External Antenna Gain

Release 8.4 has a new page, "Home => DFS Status", that shows current DFS status of all three frequencies and a DFS log of past DFS events. Note, unlike standard Canopy, the PMP 400 and PTP 200 Series AP, SM, and BH do not offer "Whitening", as the OFDM technology obviates the need for it.

4.4.1 Background and Operation

The modules use region-specific DFS based on the "Region Code" selected on the module's "Configuration => General" page. By directing installers and technicians to set the Region Code correctly, the operator gains confidence the module is operating according to national or regional regulations, without having to deal with the details for each region.

Available "Region Codes" include Other, United States, Canada, Europe, Brazil, Russia, and Australia. Operators in regions or countries not listed and with requirements aligned with one of the listed countries should set the Region Code to that country. Operators in regions or countries with no requirements for DFS should use the "Other" Region Code.

New APs and BHMs from the factory will show a Region Code of "None", and will not transmit until the Region Code is set to a value other than "None".

Canada and, for new equipment, Europe, have requirements to avoid certain frequencies used by some weather radar. To meet this requirement, modules set to a Region Code of Canada or Europe will display the center channel frequencies shown in Table 3 on page 12 on the AP's and BHM's Carrier Frequency pop-up and on the SM's and BHS's Frequency Scan Selection List.

Table 5 shows the details of DFS operation and channels available for each Region Code, including whether DFS is active on the AP/BHM, SM/BHS, which DFS regulation apply, and any channel restrictions..

Table 5: Release 8.4 Operation based on Region Code

Region Code[1]	5.4 GHz		
	AP	SM	Center Channel Frequencies Available[2] (MHz)
United States	FCC/IC DFS[3]	No effect	5480 - 5710
Canada	FCC/IC DFS	No effect	5480 – 5595, 5655 - 5710
Europe	ETSI DFS[4]	ETSI DFS	5475 - 5595, 5655 - 5715
Brazil	ETSI DFS	No effect	5475 - 5715
Australia	FCC/IC DFS	No effect	5480 – 5595, 5655 - 5710
Russia	NA	NA	5480 - 5710
Other	No effect	No effect	5480 - 5710
1. **In all cases, set the Region Code to the region you are in, and the equipment will provide DFS consistent with that regions's regulations.** For countries or regions not listed, use a Region Code that provides DFS functionality and channels consistent with your country's regulatory			

Region Code[1]	5.4 GHz		
	AP	SM	Center Channel Frequencies Available[2] (MHz)

requirements.

2. In some countries and regions, 5600 MHz to 5650 MHz is "notched" out to meet requirements to not transmit in weather radar frequencies.

3. FCC/IC indicates compliance with FCC Report and Order 03-287 and Industry Canada requirements.

4. ETSI DFS indicates compliance with ETSI EN 301 893 v1.3.1

After an AP or BHM with DFS boots, it performs a channel availability check on its main carrier frequency for 1 minute, monitoring for the radar signature, without transmitting. If no radar signature is detected during this minute, the module then proceeds to normal beacon transmit mode. If it does detect a radar signature, the frequency is marked for a 30 minute non-occupancy period, and the module moves to its 1st alternate carrier frequency. It continues this behavior through its 2nd alternate carrier frequency if needed, then will wait until the first frequency ends its 30 minute non-occupancy period. If while in operation, the AP or BHM detects the radar signature, it mark its current carrier frequency for a 30 minute non-occupancy period, and move to trying the next-in-line carrier frequency.

Since an SM or BHS only transmits if it is receiving beacon from an AP or BHS, the SMs or BHSs in the sector are also not transmitting when the AP or BHM is not transmitting.

The FCC and IC require DFS only on APs and BHMs. Europe applies the ETSI specificiation to both APs/BHMs and SMs/BHSs, while Brazil applies it only to APs and BHMs. In the ETSI case, when an SM or BHS boots, it scans to see if an AP is present (if it can detect a Canopy beacon). If an AP or BHM is found, the SM performs a channel availability check on that frequency for 1 minute, monitoring for the radar signature, without transmitting.

- If no radar pulse is detected during this 1 minute, the SM or BHS proceeds through normal steps to register to an AP or BHM.
- If the SM or BHS does detect radar, it locks out that frequency for 30 minutes and continues scanning other frequencies in its scan list.

Note, after an SM or BHS with DFS has seen a radar signature on a frequency and locked out that frequency, it may connect to a different AP or BHM if color codes, AP/BHM transmitting frequencies, and SM/BHS scanned frequencies support that connection.

To simplify operation and ensure compliance, an SM or BHS takes on the DFS type of the AP it is registering to. For example, when an SM in Europe registers to an AP with the Region Code set to "Europe", that SM will use ETSI DFS, no matter what its Region Code is set to, even if its Region Code is set to "None". Note, the operator should still configure the Region Code in the SM correctly, as future releases may use the Region Code for additional region-specific options.

For all modules running DFS, the module displays its DFS state on its Home => General Status page as one of the following:

- `Checking Channel Availability Remaining time` n `seconds`, where n counts down from 60 to 1.
- `Normal Transmit`
- `Radar Detected Stop Transmitting for` n `minutes`, where n counts down from 30 to 1.

- `Idle,` only for SM or BHS, indicates module is scanning, but has not detected a beacon from an AP or BHM. Once it detects beacon, the SM or BHS begins a Channel Availability Check on that frequency.

4.4.2   Setting DFS and Regulatory Parameters

Setting the Region Code

All modules display a Region Code pop-up on the :Configuration => General" page, as shown in Figure 5.

On new modules from the factory, or after resetting to factory defaults, the operator should set this Region Code consistent with their country or region. For countries or regions not listed in the Region Code pop-up, set the Region Code consistent with your country's regulatory requirements. (For example, several countries in South America follow the same DFS regulations as Brazil, so in those countries the Region Code should be set to "Brazil".)

> **IMPORTANT!**
> Operators under regulatory requirements for DFS must ensure the new Canopy parameter "Region Code" is set correctly. This applies to initial configuration, after a module is reset to factory defaults, or after a module is upgraded.

An AP or BHM will not transmit if the Region Code is configured to "None".

> **IMPORTANT!**
> On APs or BHMs received from the factory, with Region Code set to "None", the operator must set the Region Code before the module will transmit. The same is true of APs and BHMS which have been reset to factory defaults.
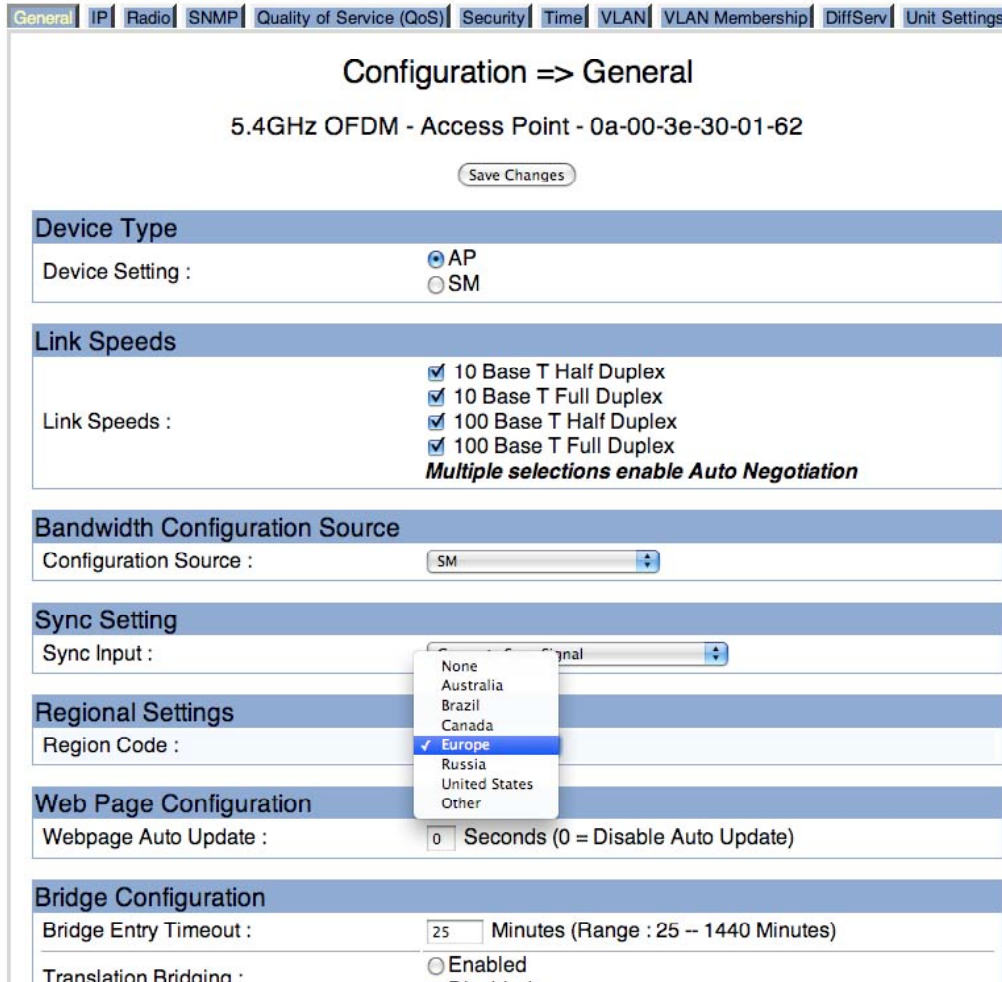
Figure 5: Region Code on AP "Configuration => General" page

An SM or BHS has both a configurable Region Code and, once it registers to an AP or BHM, an active Region Code. After an SM/BHS registers to an AP/BHM, it uses the Region of the AP/BHM to determine its DFS behavior and displays the AP's or BHM's Region Code on its Home => General Status page, as shown in Figure 7.

The two Region Codes should be the same in normal operation, but will not be the same if, for example, as shown in Figure 6 and Figure 7, an SM configured with a Region Code of "None" has registered to an AP with a Region Code of Europe.
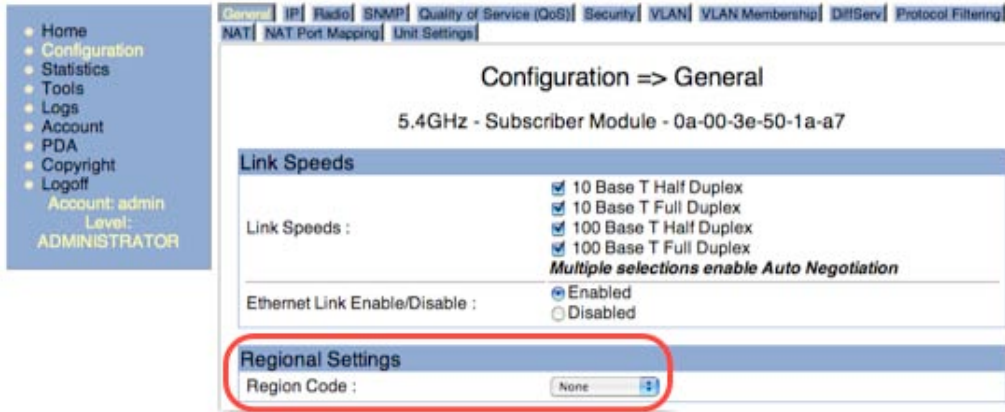
Figure 6: Configured Region Code on SM Configuration => General page
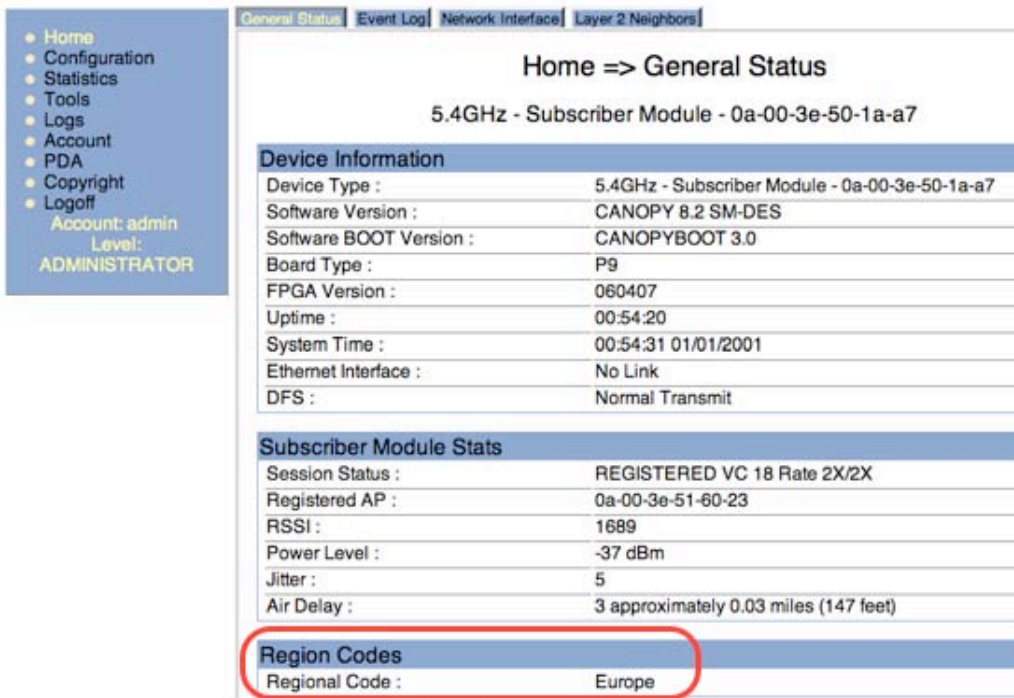
Figure 7: Active Region Code on SM Home => General Status page

The AP or BHM always operates under its manually configured Region Code (the one on the Configuration => General page), and so does not show a Region Code on its Home => General Status page.

Under normal operations, APs and BHMs operating with DFS (see Table 5) will experience an additional minute after power-up or reboot before they will register any SMs or BHSs. SMs and BHSs operating with DFS (see Table 5) will experience an additional minute after they reboot before they will register to an AP or BHM.

It takes two reboots to set the parameters described below on a module starting from factory defaults. Set the Region Code as described above, "Save Changes", and "Reboot". If the module then invokes DFS (based on the Region Code and frequency band as shown in Table 5), the Radio Frequency Carriers and External Antenna Gain parameters will be displayed. Set them as described below, "Save Changes", and "Reboot" again.

> **!** **IMPORTANT!**
> Set the Region Code, "Save Changes", and "Reboot" to see the context-sensitive DFS parameters. Unlike with many context-sensitive parameters, these do not appear in the GUI with only a "Save Changes".

Setting Radio Frequencies

APs and BHMs running DFS include an option for setting up to two alternate frequencies on the "Configuration => Radio" page, in addition to the primary frequency, as shown in Figure 8. These alternate frequencies are used in the unlikely event radar is detected and the main frequency is locked out due to DFS detection. If these are left at "None", no backup frequencies will be used in the case of DFS detection, and the AP or BHM will lock itself out from any transmission for 30 minutes.

If radar is detected on the main frequency, either at startup or during operation, a Channel Availability Check will be performed on the 1st alternate frequency before it is then used for transmission. If radar is detected on the 1st alternate frequency, either during Channel Availability Check or during operation, a Channel Availability Check will be performed on the 2nd alternate frequency before it is then used for transmission. If radar is detected on the 2nd alternate frequency, either during Channel Availability Check or during operation, the radio will cease transmission unless or until the primary channel clears its 30 minute lock-out.

The alternate frequencies configured in the AP or BHM must be included in the SM's or BHS's Frequency Scan List, or the SMs/BHSs can't follow their AP/BHM if it switches to a new channel. Additional frequencies may checked in the Frequency Scan List depending on local practices, for example if an operator wants to configure an SM to only register on certain frequencies to drive a known SM to AP mapping, or configure an SM to register on many frequencies so that it may find another AP to register to if its usual AP isn't available.

Note, use site surveys and RF planning to choose alternate frequencies useful for each sector, and consider testing on the alternate frequencies to ensure compatibility with the sector's RF environment.

Figure 8: Alternate Frequencies, and Antenna Gain on "Configuration => Radio" page

4.5   NET ANTENNA GAIN FIELD

An AP, SM, or BH needs to know the gain of its antenna to perform DFS and Auto-TPC (Automatic Transmit Power Control) (SM only) consistent with regional or national regulations. The Release 8.4.3 GUI includes a **Net Antenna Gain** field to support this.

Key points about the **Net Antenna Gain** field include:

- **Net Antenna Gain** is defined as the gain of the antenna minus the loss in the coaxial cable and connectors.

- The **Net Antenna Gain** is set on the Configuration -> Radio page of each module (AP, SM, BHM, or BHS)

- The default on a new unit, or when the unit is reset to factory defaults, is **17** dB.

- The range is 0 to 35 dB.

- An SM or BH with an integrated antenna has a **Net Antenna Gain** of **17** dB.

- The antenna sold with the connectorized AP has a gain of 18 dB and cable loss of approximately 1 dB, giving a **Net Antenna Gain** of **17** dB.

- Any radio using DFS will use the **Net Antenna Gain** to appropriately adjust sensitivity to radar signals. The use of DFS is determined by the **Region Code** setting on the Configuration => Home page.

- The Auto-TPC used by the PMP 400 Series system takes into account the **Net Antenna Gain** so as not to exceed national or regional EIRP limits.

Procedure for setting the Net Antenna Gain

1. If using a BH or SM with an integrated antenna, or a connectorized AP with the connectorized antenna sold with it, leave the **Net Antenna Gain** on the Configuration => Radio page set to the factory default of **17** dB.

2. If using another antenna, set the **Net Antenna Gain** to the gain of the antenna minus the loss in coaxial cable and connectors.

Important! Ensure the **Net Antenna Gain** is set correctly. Setting it low or high can lead to either a system overly sensitive to DFS events or a system not transmitting at its full legal power.

4.6

4.7   NETWORK CONTROL PARAMETERS

Network control parameters are configured the same as they are in standard Canopy. These include, High Priority/DiffServ, NAT, DHCP, VLAN, MIR, and CIR. MIR and CIR are configured the same way as in standard Canopy, but the operator may (or may not) want to take advantage of the higher MIR possible to provide greater bandwidth to a given SM.

4.8   FORWARD ERROR CORRECTION

PMP 400 and PTP 200 Series adios use FEC (Forward Error Correction) to extend the range of the modules. They use Reed-Solomon error correction optimized at 3/4 coding. The coding rate is not settable by the operator.

4.9   CYCLIC PREFIX (CONFIGURABLE ONLY ON BH)

OFDM technology uses a cyclic prefix, where a portion of the end of a symbol (slot) is repeated at the beginning of the symbol (slot) to allow multi-pathing to settle before receiving the desired data. A 1/4 cyclic prefix means that for every 4 bits of throughput data transmitted, an additional bit is used, A 1/8 cyclic prefix means that for every 8 bit of throughput data transmitted, an additional bit is used.

PMP 400 Series networks use a cyclic prefix of 1/4 that is not configurable by the user.

PTP 200 Series modules (OFDM BHs) are settable for either 1/8 or 1/4 cyclic prefix. The use of 1/8 cyclic prefix provides about 11% higher maximum throughput, and is recommended in most cases.

- The **Cyclic Prefix** is set on the Configuration => Radio page of the BHM.

- The default on a new unit, or when the unit is reset to factory defaults, is **1/4 Cyclic Prefix**.
- In most deployments, **1/8 Cyclic Prefix** will provide a high quality, higher throughput link. In cases with severe multi-pathing or obstructions, **1/4 Cyclic Prefix** may give better overall results.

Procedure for setting the Cyclic Prefix

3. Set the **Cyclic Prefix** on the Configuration => Radio page of both the BHM and the BHS to **1/8** before deployment.

Important!   The **Cyclic Prefix** must be set the same on both the BHM and the BHS. If they don't match, the BHS will not register to the BHM.

4. During installation use Link Tests to confirm link quality per standard installation and alignment procedures.
5. If a Link Test shows low throughput or efficiency, consider changing the Cyclic Prefix to **1/4** on *both* the BHM and the BHS along with other standard installation troubleshooting procedures such as re-aiming, off-axis aiming, changing location, raising or lowering the height of the radio, adjusting **Transmission Power** up or down, or identifying and mitigating sources of interference.

5   Installation

> **WARNING!**
> Installing an AP or a BH usually involves height and electricity and exposure to RF (Radio Frequency) energy. To avoid personal injury, know and follow applicable national and local safety regulations and industry best practices, and follow the specific guidelines in this document, including Exposure Separation Distances in section 6.3 on page 37.

5.1   INSTALLING AN AP WITH ITS KITTED ANTENNA

This section addresses installation aspects specific to the PMP 400 and PTP 200 Series AP. General communications equipment, infrastructure, and facilities site design should be performed in line with Motorola's "Standards and Guidelines for Communications Sites" (also known as the R56 manual), available from
http://www.motorola-wls.com/Dynamic/Course_Description.asp?number=ANT001-CD&CourseKey=125

The AP ships either as a kit consisting of a connectorized antenna and a connectorized radio, or just the connectorized radio, with the antenna provided by the operator. These instructions focus on the former case, but are also generally applicable to the latter case for APs, SMs, or BHs where the antenna is purchased separately by the operator.

A short coaxial cable from the radio terminates in a male N connector. The antenna has a chassis-mounted female N connector. The antenna includes tower mount brackets with adjustable down-tilt.

Installing an AP typically consists of 4 phases:

1. Configuring the AP in a depot or at the job site using the information and decisions from section 3, Planning, and section 4 Configuring
2. Assembling the AP (radio and antenna and brackets) and physically installing it using Procedure 2, along with physically installing a CMMmicro or CMM4 and backhauls, if any.
3. Cabling the AP to the CMMmicro or CMM4, and grounding it to Protective Earth – PE using Procedure 3. This phase can also include cabling to backhauls, or running terrestrial feeds.
4. Confirming operation, using SMs on the ground.

Local practices and choices of installation options will dictate the actual processes used. For example, installing on a building requires somewhat different procedures.. Also, operators may use their own procedures to attach one or more APs to a pipe mount while on the ground, and then lift the assembled unit up a tower for final attachment. These generalized procedures will not be applicable in every case, but should give good insight into the steps necessary.

Procedure 2: Assembling the AP, and attaching to tower

1. Perform a parts check to ensure all parts are present.

2. Assemble the upper bracket, per the diagram that comes with the antenna.

3. Connect the radio to the antenna by sliding it into the captive space. Secure the radio to the antenna using the two bolts provided.

4. Assemble the lower bracket on the antenna assembly.
   Although it may seem intuitive to attach both brackets to the tower or pole and then hang the antenna, it usually works better to have the bottom bracket already attached to the antenna before climbing.

5. Weatherproof the connector using standard practices, with waterproof wrap.

6. Use standard work and safety practices for tower climbing, and connect the upper bracket to a pole, mounting fixture, or the tower.

7. Hang the antenna assembly on the upper bracket

8. Connect the lower bracket to the pole or tower, using the quick-connect system provided

9. The quick-connect system allows easy attachment and detachment and adjustment without any lose parts.

10. Adjust downtilt as desired, per previous calculations done during Planning. If any doubts, confirm downtilt after the radio is operational using SMs in the field at selected test locations.

=========================== **end of procedure** =====================

Procedure 3: Cabling and Grounding/Earthing the AP

1. Standard Canopy installation practices apply, including using shielded Ethernet cable for all infrastructure cabling, using drip loops, providing extra cable for future use at any termination, and ensuring the tower or structure is fully grounded (Protective Earth – PE).

2. Use dielectric grease on all connections and in all RJ-45 Ethernet connectors. (Dielectric grease is generally available in the trade, and is specially formulated so as to be uniformly non-conducting.) The best practice is to use enough grease to fill the RJ-45 female connector, and then insert the RJ-45 male connector and push the grease further into the Canopy unit and around the RJ-45 connector. Excess grease can be wiped over the connector area to provide some resistance to water ingress around the connector.

3. Use a 600SSC surge suppressor within 3 ft (~1 m) of the AP, and ground it to known good ground (Protective Earth - PE) on the tower or support structure with a 10 AWG ground strap.

   A pole mount kit is available for mounting the 600SSC to the tower or mast. The mount includes a termination point for the ground strap from the 600SSC.

4. Run a 10 AWG ground strap from the grounding lug on the AP (see Figure 9) to known good ground (Protective Earth - PE) to complete the grounding and protection of the AP. The termination point on the 600SSC pole mount kit may be used for this.

=========================== **end of procedure** =====================

Figure 9: Ground lug highlighted on AP

Unlike standard Canopy APs, the PMP 400 and PTP 200 Series AP have metal-to-metal contact from the tower or support structure, through the antenna, through the coax cable, to the radio. Due to this, to provide the best protection from near lightning hits, it is strongly recommended to install surge suppression at the AP.

The 600SSC surge suppressor replaces earlier surge suppressors, and supports up to three 600SSCs on an Ethernet link in series, for example, a 600SSC within 3 ft (~1 m) of an AP, another 600SSC where the Ethernet cable enters a telecommunications hut, and the equivalent of a 600SSC built into each of the 8 ports on a CMM4. A pole mount kit, Model No. SGHN5169A, is available to facilitiate mounting the 600SSC close (within 3 ft or 1 m) of the AP.

The CMMmicro uses a different protection scheme and and up to 3 600SSCs can be used in-line on Ethernet links terminated to the CMMmicro.

5.2   INSTALLING AN SM OR BH WITH AN INTEGRATED ANTEANNA

Installing an SM or BH with an integrated antenna is very similar to installing standard Canopy SMs as described in the *Canopy System Release 8 User Guide*, with the differences outlined below.

Use an SMMB2 SM mounting bracket, not an SMMB1 typically used with standard Canopy SMs. The PMP 400 Series SM or the PTP 200 Series BH is heavier and has a higher windload than a classic Canopy module, and so the stronger SMMB2 is required. The SMMB2 is the mounting arm used with Canopy 900 MHz integrated APs and SMs, and used with reflectors.

Use dielectric grease on all connections and in all RJ-45 Ethernet connectors. (Dielectric grease is generally available in the trade, and is specially formulated so as to be uniformly non-conducting.) The best practice is to use enough grease to fill the RJ-45 female connector, and then insert the RJ-45 male connector and push the grease further into the Canopy unit and around the RJ-45 connector. Excess grease can be wiped over the connector area to provide some resistance to water ingress around the connector.

The PMP 400 SM and PTP 200 BH have a ground/Protective Earth lug, just like the AP. Although not as critical as in the case of the AP (where there is metal-to-metal connectivity through the coax and antenna to ground), the lug can be used to ground the SM for additional protection. Similarly, a 600SSC can be used within 3 ft (~1 m) of the SM or BH to provide additional protection. Especially for a BH, or in cases where the SM is mounted high and is more exposed, or in known difficult areas for lightning, consider using these two techniques to increase the radio's resistance to lightning.

PMP 400 and PTP 200 Series modules do not display a jitter value. Use "Received Power Level" for aiming and then use Link Tests to confirm, similar to standard Canopy practice.

Be mindful when using the "Receive Power Level" that it is a relative, not absolute, value. The "Receive Power Level" on a module is useful during installation to aid in aiming, where relative values over a short period of time are of interest. However, the displayed "Receive Power Level" is not designed to be highly accurate over time. Even if the actual received power is not varying, the displayed "Receive Power Level" will vary with board-level temperature and may vary from module to module. Know the limitations and use caution and judgment for any other use of "Receive Power Levels", including monitoring a link over time. deciding if the link is within operating margins. deciding if a link is serviceable (link tests give a much better indication), or comparing the link to other links.

The alignment headset will play a tone that varies in pitch (received power level), but not volume (jitter), since PMP 400 and PTP 200 Series modules don't calculate a jitter.

6 Regulatory and Legal Notices

6.1 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.

6.2 NATIONAL AND REGIONAL REGULATORY NOTICES

6.2.1 U.S. Federal Communication Commission (FCC) Notification

The FCC has not approved these devices for operation in the US. Until they are approved, they are not available for sale in the US, and the information in this section is provisional and preliminary.

This device complies with Part 15 of the US FCC Rules and Regulations. 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.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the US FCC Rules. 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 the specific configurations covered are listed in Table 6.

Table 6: US FCC IDs and Industry Canada Certification Numbers and Covered Configurations

FCC ID	Industry Canada Cert Number	Frequencies	Module Families	Antenna, LENS, or Reflector	Maximum Transmitter Output Power
ABZ89FT7629	---	10 MHz channels, centered on 5480-5710 in 5 MHz increments (within the 5470-5725 MHz U-NII band)	5440 AP	17 dBi connectorized antenna (60° x 5° -3 dB beam width)	10 dBm
			5440 SM	17 dBi integrated antenna (18° x 18° -3 dB beam width)	10 dBm
---	109W-5440	10 MHz channels, centered on 5480-5595 and 5655-5710 MHz in 5 MHz increments (within the 5470-5725 MHz U-NII band with 5600-5650 MHz excluded)	5440 AP	17 dBi connectorized antenna (60° x 5° -3 dB beam width)	10 dBm
			5440 SM	17 dBi integrated antenna (18° x 18° -3 dB beam width)	10 dBm

6.2.2   Industry Canada (IC) Notification

Industry Canada has not approved these devices for operation in Canada. Until they are approved, they are not available for sale in Canada, and the information in this section is provisional and preliminary.

This device complies 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.

Users should be cautioned to take note that in Canada high power radars are allocated as primary users (meaning they have priority) of 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 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.

To reduce potential radio interference to other users, the antenna type and its gain should be chosen so its Equivalent Isotropic Radiated Power (EIRP) is not more than that permitted for successful communication.

Industry Canada Certification Numbers and the specific configurations covered are listed in Table 6.

This device has been designed to operate with the antennas listed in Table 6 and having a maximum gain as shown in Table 6. Antennas not included in Table 6 or having a gain greater than as shown in Table 6 are strictly prohibited from use with this device. Required antenna impedance is 50 ohms.

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

When operated in accordance with the instructions for use, Motorola Canopy Wireless equipment operating in the 5.4 GHz bands is compliant with CEPT Recommendation 70-03 Annex 3 for Wideband Data Transmission and HIPERLANs. For compliant operation in the 5.4 GHz band, the transmit power (EIRP) from the integrated antenna or a connectorized antenna shall be no more than 0.5 W (27 dBm).

For EU member states, RLAN equipment in the 5.4GHz bands is exempt from individual licensing under Commission Recommendation 2003/203/EC. Contact the appropriate national administrations for details on the conditions of use for the bands in question and any exceptions that might apply. Also see www.ero.dk for further information.

10 MHz channels are used, centered on 5475 to 5595 and 5655 to 5715 in 5 MHz increments. This is within the 5470 to 5725 MHz U-NII band with 5600 to 5650 MHz excluded.

Motorola Canopy Radio equipment operating in the 5470 to 5725 MHz band are categorized as "Class 1" devices within the EU in accordance with ECC DEC(04)08 and are "CE" marked $C\,E$ to show compliance with the European Radio & Telecommunications Terminal Equipment (R&TTE) directive 1999/5/EC. The relevant Declaration of Conformity can be found at http://motorola.canopywireless.com/doc.php.

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

Consequently, these 5.4GHz products are only marked with the $C\,E$ symbol and may be used in any member state.

For further details, see http://europa.eu.int/information_society/policy/radio_spectrum/ref_documents/index_en.htm

6.2.4   Equipment Disposal

Waste (Disposal) of Electronic and Electric Equipment

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

6.2.5   EU Declaration of Conformity for RoHS Compliance

Motorola hereby declares that these Motorola products are in compliance with the essential requirements and other relevant provisions of Directive 2002/95/EC, Restriction of the use of certain Hazardous Substances (RoHS) in electrical and electronic equipment.

The relevant Declaration of Conformity can be found at http://www.canopywireless.com/doc.php.

6.2.6   Luxembourg Notification

5.4GHz products can only be used for mobile services.

6.2.7   Czech Republic Notification

5.4 GHz products can be operated in accordance with the Czech General License
No. GL-30/R/2000.

6.2.8   Greece Notification

The outdoor use of 5470-5725MHz is under license of EETT but is being harmonized according
to the CEPT Decision ECC/DEC/(04) 08, of 9th July. End users are advised to contact the EETT
to determine the latest position and obtain any appropriate licenses.

6.2.9   Brazil Notification

**Brazil regulatory authorities have not approved these devices for operation in Brazil. Until
they are approved, they are not available for sale in Brazil, and the information in this
section is provisional and preliminary.**

For compliant operation in the 5.4 GHz band, the Equivalent Isotropic Radiated Power from the
integrated antenna or connectorized anteanna shall not exceed 27 dBm (0.5 W).

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

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

6.2.10   Labeling and Disclosure Table for China

The People's Republic of China requires that Motorola's products comply with China
Management Methods (CMM) environmental regulations. (China Management Methods refers to
the regulation *Management Methods for Controlling Pollution by Electronic Information Products*.)
Two items are used to demonstrate compliance; the label and the disclosure table.

The label is placed in a customer visible position on the product.

- • Logo 1 means that the product contains no substances in excess of the maximum
     concentration value for materials identified in the China Management Methods
     regulation.
- • Logo 2 means that the product may contain substances in excess of the maximum
     concentration value for materials identified in the China Management Methods
     regulation, and has an Environmental Friendly Use Period (EFUP) in years, fifty
     years in the example shown.

Logo 1   Logo 2

The Environmental Friendly Use Period (EFUP) is the period (in years) during which the Toxic
and Hazardous Substances (T&HS) contained in the Electronic Information Product (EIP) will not
leak or mutate causing environmental pollution or bodily injury from the use of the EIP. The EFUP
indicated by the Logo 2 label applies to a product and all its parts. Certain field-replaceable parts,
such as battery modules, can have a different EFUP and are marked separately.

The Disclosure Table (see Table 7) is intended only to communicate compliance with China requirements; it is not intended to communicate compliance with EU RoHS or any other environmental requirements.

Table 7: Disclosure Table

部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr^{6+})	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
金属部件	×	○	×	×	○	○
电路模块	×	○	×	×	○	○
电缆及电缆组件	×	○	×	×	○	○
塑料和聚合物部件	○	○	○	○	○	×

○：　表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。

×：　表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006 标准规定的限量要求。

6.3   EXPOSURE SEPARATION DISTANCES

To protect from overexposure to RF energy, install Canopy radios so as to provide and maintain the minimum separation distances from all persons shown in Table 8.

Table 8: Exposure Separation Distances

Module Type	Separation Distance from Persons
PMP 400 and PTP 200 Series OFDM AP or SM	At least 20 cm (approx 8 in)
Canopy Module (for comparison)	At least 20 cm (approx 8 in)

Section 6.3.1 and Table 9 give details and discussion of the associated calculations.

6.3.1   Details of Exposure Separation Distances Calculations and Power Compliance Margins

Limits and guidelines for RF exposure come from:

- US FCC limits for the general population. See the FCC web site at http://www.fcc.gov, and the policies, guidelines, and requirements in Part 1 of Title 47 of the Code of Federal Regulations, as well as the guidelines and suggestions for evaluating compliance in FCC OET Bulletin 65.
- Health Canada limits for the general population. See Safety Code 6 on the Health Canada web site at http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/99ehd-dhm237/index_e.html.

- ICNIRP (International Commission on Non-Ionizing Radiation Protection) guidelines for the general public. See the ICNIRP web site at http://www.icnirp.de/ and Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields.

The applicable power density exposure limits from the documents referenced above are

- 10 W/m^2 for RF energy in the 5.4-GHz frequency bands.

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

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

where
S = power density in W/m^2
P = RMS transmit power capability of the radio, in W
G = total Tx gain as a factor, converted from dB
d = distance from point source, in m

Rearranging terms to solve for distance yields

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

Table 9 shows calculated minimum separation distances d, recommended distances and resulting power compliance margins for each frequency band and antenna combination.

Table 9: Calculated Exposure Distances and Power Compliance Margins

Frequency Band	Antenna	Variable			d (calcu-lated)	Recom-mended Separation Distance	Power Compliance Margin
		P	G	S			
5.4 GHz	Integrated, 17 dBi	0.05 W (10 dBm)	5.0 (17 dB)	10 W/m^2	6 cm	20 cm (8 in)	10
	Connectori zed, 17 dBi	0.05 W (10 dBm)	316 (17 dB)	10 W/m^2	6 cm	20 cm (8 in)	10

The "Recommended Distances" are chosen to give significant compliance margin in all cases. They are also chosen so that an OFDM module has the same exposure distance as a Canopy module, to simplify communicating and heeding exposure distances in the field.

These are conservative distances:

- They are along the beam direction (the direction of greatest energy). Exposure to the sides and back of the module will be significantly less.
- They meet sustained exposure limits for the general population (not just short term occupational exposure limits), with considerable margin.
- The calculated compliance distance d is overestimated because the far-field equation models the antenna as a point source and neglects the physical dimension of the antenna.

6.4   LEGAL NOTICES

6.4.1   Software License Terms and Conditions

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6.4.2   Hardware Warranty in US

Motorola US offers a warranty covering a period of 1 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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