

MD4000 Product Family

Hardware Installation Instructions



Root and Relay Nodes

Mesh Networks provide long range connectivity by relaying packets from one mesh node to another, like a bucket brigade. The end of the bucket brigade terminates at the root – which connects to the Ethernet. (above) Relays connect to the root or other relay nodes to form a wirelessly linked chain.

Upstream & Downstream

Upstream implies closer to the Ethernet. The root is upstream of relay 1.

Wireless Uplinks and Downlinks. The Ethernet link is the uplink (upstream link) connection for the root. The root has a wired uplink. Its “backhaul” is the wired network.

Relays have wireless uplinks through a upstream downlink radio. Downlink radios act like Access Points (AP) : they send out a beacon. Uplink radios act like clients – they do not send out a beacon.

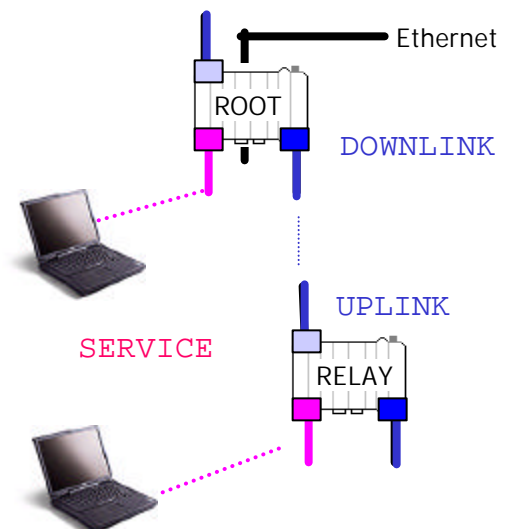
A wireless radio card in the laptop can inform you of the presence of downlinks but not of uplinks. Downlinks beacon, Uplinks do not.

The uplink and downlink radios form a [wireless backhaul path](#).





AP radios operate in the 2.4GHZ band to service 11b/g clients. 802.11a wireless devices may be serviced by the 5.8G downlink.

Thus, both 802.11a and 802.11b/g client access is supported.

Backhaul radios operate in 5.8GHZ band to avoid interference with the 11b/g 2.4GHZ AP radio (shown pink, right). **Note: Do not use any other modules not approved with this device other than the ones that were tested which are MD2 FCC ID: UZU-MD2 and MD5 FCC ID: UZU-MD5**



To summarize, there are 4 types of “links” to Structured Mesh™ products:

-  A wired uplink to provide Ethernet connectivity. This connects the Root node to the wired network.
-  A [wireless downlink](#) to provide wireless connectivity. Acts like an AP for the uplink. Typically 5.8G.
-  A [wireless uplink](#) to connect to upstream mesh nodes. This is a “client” to the downlink. Typically 5.8G.
-  A **AP** radio for clients. Typically 2.4G with support for both b and g clients.

In our standard offering, the 11a uplink, the 11a downlink and 11b/g service are 3 separate radios (Fig 2.2).



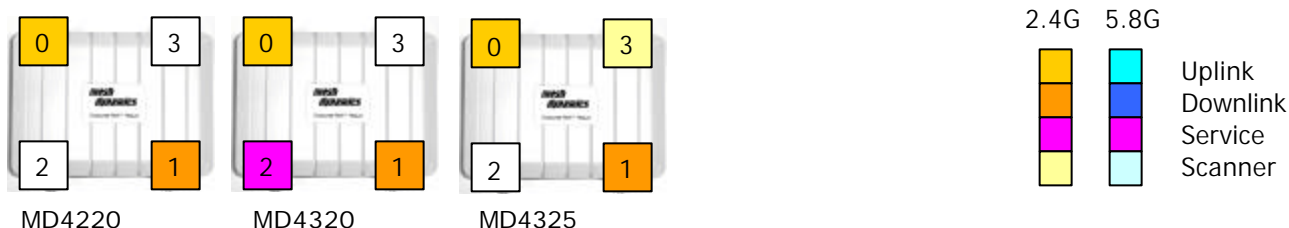
The MD4000 Modular Mesh™ products support up to 4 radios in a single enclosure. Slots 0, 1 house one uplink and one downlink radio operating on non-interfering channels but in the same frequency band. They are both 2.4G or both 5.8G. radios. **Note: Do not use any other modules not approved with this device other then the ones that were tested which are MD2 FCC ID: UZU-MD2 and MD5 FCC ID: UZU-MD5**

Note: This two radio backhaul differs from competing mesh products. The differences are explained at: www.meshdynamics.com/WhyStructuredMesh.html

Slot 2 houses a 2.4G AP radio for client connectivity. 2.4G radios can be set to b, b and g or g only modes. Slot 3 can house a 2nd downlink, 2nd AP or a scanning radio for mobile mesh module - that form part of the meshed backhaul in dynamic infrastructure mesh networks.

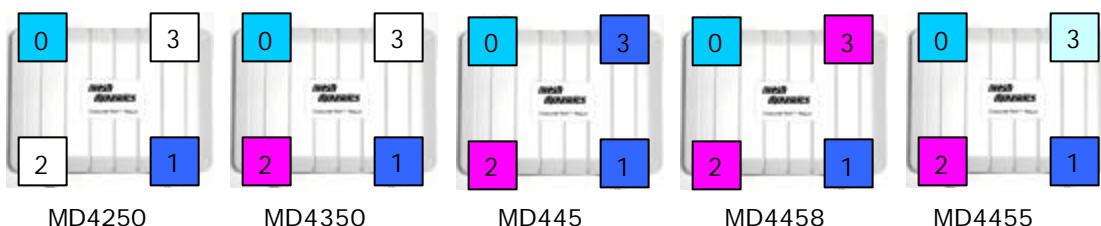
The 2 Ethernet ports on each module may be used to interface to cameras for high resolution video over mesh. A 2nd (slave) module attaches via Ethernet to provide a total of 8 radios. Operating temperature range is -40 to +85 Celsius. The die cast weather proof enclosure is NEMA 67 rated.

2.4G Backhaul Products (Standard Configurations)



1. MD4220-BBxx: 2-Radio module 2.4G uplink and downlink Backhaul (BH).
2. MD4320-BBBx: 3-Radio module 2.4G sector BH slots 0,1 and 2.4G AP radio in slot 2.
3. MD4325-BBxB: 3-Radio module 2.4G BH, Downlink also acts as AP. A 2.4G Mobility Scanner in slot 3.

5.8G Backhaul Products (Standard Configurations)



1. MD4250-AAxx: 2-Radio module 5.8G BH uplink and downlink Backhaul (BH).
2. MD4350-AABx: 3-Radio module 5.8G BH and 2.4G AP radio in slot 2. AP modes may be b, g, or b & g.
3. MD4452-AABA: 4-Radio module 5.8G BH and 2.4G AP radio. Second sector 5.8G downlink in slot 3.
4. MD4458-AABB: 4-Radio module 5.8G BH and 2.4G AP radios (two) in slots 2, 3 for sector service.
5. MD4455-AABA: 4-Radio module 5.8G BH and 2.4G AP radio in slot 2. 5.8G Scanner in slot 3

Notes:

1. All 2.4G Downlinks and APs may be configured to support b only, g only, or b & g client connectivity
2. All 5.8G Downlinks may be configured to provide 802.11a client connectivity
3. All radios interfaces may be configured to provide IEEE 802.11e differentiated Class of Service

How Far Apart Should Backhaul Radios be Placed?



For a “good signal”, the fraction of the energy from the transmitter that reaches the receiver should exceed the receiver radio’s receive sensitivity. If not, the ACK will not be sent and re-transmission occurs. Throughput then declines. The rate control software on the mesh module is sampling the link quality between its uplink and the parent downlink. If the throughput declines, it lowers the transmit rate, since transmit power and receive sensitivity improve at lower transmit rates. The throughput is thus adjusted based on signal quality.

Degradation of signal quality over distance is expressed by the free space path loss relationship:

$$Path_Loss = 20 * \log(Freq) + Decay * 10 * \log(Dist) - K \text{ where}$$

Path_loss: Path Loss in dBm
Freq: Frequency in MHZ
Decay : Varies based on RF environment, line of sight etc.
Dist: Distance between the two mesh nodes (in meters)
K: Constant.

Transmit power from the radio and antenna gains offsets this path loss. The adjusted value must then exceed the receiving radio receive sensitivity for transmissions to be “heard”. Table A1 shows backhaul distances for a 5.8G radio transmitting with 20 dBm transmit power radio and over two 8 db omni-directional antennas. Acceptable receive sensitivity is set at – 65 dBm. Decay is varied from 2.0 (rural, open space) to 2.4 (more urban settings, non line of sight, occlusions, interference). Notice how range is dramatically affected by changes in Decay.

Table A1

Case	RS (dBm)	TR (dBm)	Decay	Ant 01	Ant 02	Freq (MHZ)	Dst (m)	Dst (Ft)
01	65	20	2.0	8	8	5800	461	1512
02	65	20	2.2	8	8	5800	264	866
03	65	20	2.4	8	8	5800	166	544

Increasing antenna gain from 8 dBm to a 14 dBm panel on the downlink reduces this path loss (Table A2).

Table A2

Case	RS (dBm)	TR (dBm)	Decay	Ant 01	Ant 02	Freq (MHZ)	Dst (m)	Dst (Ft)
01	65	20	2.0	14	8	5800	921	3017
02	65	20	2.2	14	8	5800	495	1622
03	65	20	2.4	14	8	5800	295	967

Panels have a less dispersed beam pattern than omni-directional antennas. Their restricted field of view also makes them less sensitive to noise in the vicinity. In very noisy settings, more radio transmit power may be needed. Two downlinks doubles transmit radio power from 20 dBm to 23 dBm. (Table A3).

Table A3

Case	RS (dBm)	TR (dBm)	Decay	Ant 01	Ant 02	Freq (MHZ)	Dst (m)	Dst (Ft)
01	65	23	2.4	14	8	5800	394	1290

Range is also effectively doubled by changing from 5.8G to a 2.4G backhaul. Compare Table A4 with Table A1.

Table A4

Case	RS (dBm)	TR (dBm)	Decay	Ant 01	Ant 02	Freq (MHZ)	Dst (m)	Dst (Ft)
01	65	20	2.0	8	8	2400	1115	3655
02	65	20	2.2	8	8	2400	589	1931
03	65	20	2.4	8	8	2400	346	1135

Unfortunately, the 2.4G RF space is “polluted” with multiple AP and client devices. 2.4G Backhails are best limited to rural areas with low subscriber density and low 2.4G RF interference. If 2.4G Backhails are critical, reduce 2.4G RF interference on the backhaul with a panel antenna and its more focused beam. The [4320](#) 3-radio 2.4G backhaul product is intended to be used with panels on the backhaul and an omni for the 3rd 2.4G AP radio .

Suggestions

In rural areas or low client density situations, use 2.4G backhails preferably with panels to reduce RF interference from other 2.4G devices. In all other scenarios use 5.8G Backhails. Start with [two 8 dBm 5.8G omni-directional 250m apart, with clear line of sight and no metal obstructions with 1.5m of the antennas](#). Increase node spacing till throughput begins to decline – look at the heart beats shown on the NMS. For noisy 5.8G environments, reduce path loss with panels and/or double the transmit power with dual downlinks ([4452](#)) .

How Far Apart Should AP Radios be Placed?

Table B1

Case	RS (dBm)	TR (dBm)	Decay	Ant 01	Ant 02	Freq (MHZ)	Dst (m)	Dst (Ft)
01	65	20	2.0	8	8	5800	461	1512
02	65	20	2.2	8	8	5800	264	866
03	65	20	2.4	8	8	5800	166	544

Table B2

Case	RS (dBm)	TR (dBm)	Decay	Ant 01	Ant 02	Freq (MHZ)	Dst (m)	Dst (Ft)
01	65	20	2.0	8	8	2400	1115	3655
02	65	20	2.2	8	8	2400	589	1931
03	65	20	2.4	8	8	2400	346	1135

Table B1 and B2 indicate that the range of the 2.4G radios backhaul will always exceed that of the 5.8G backhaul. The theory does not take into consideration two salient real-world differences between backhauls and AP radios:

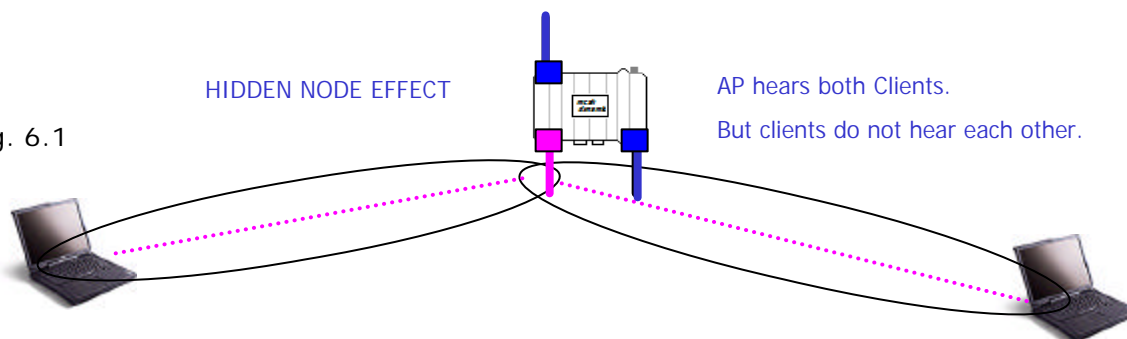
1. Antennas are generally mounted on roof tops. The backhaul antennas generally have free space line of sight connectivity. However the antennas of the AP, also mounted on roof tops, must connect with clients on the ground. The path from AP antennas to the 2.4G client radios is often not clear line of sight. Additionally, there is significant 2.4G RF interference in urban areas. With higher decay the range is significantly reduced (Table B3).

Table B3

Case	RS (dBm)	TR (dBm)	Decay	Ant 01	Ant 02	Freq (MHZ)	Dst (m)	Dst (Ft)
01	65	20	2.6	8	8	2400	221	724
02	65	20	2.8	8	8	2400	150	492
03	65	20	3.0	8	8	2400	108	352

2. Clients on the same AP also can also create RF interference due to **Hidden-Node effects**. The AP has big ears (high receive sensitivity). Even though clients radios are much lower power, the AP can hear them. It also has a loud voice (high transmit power) so clients can hear it. But clients may not be able to hear each other such as when clients are on opposite ends from each other. The clients are thus "hidden".

Fig. 6.1



Radio is a shared medium: only one device should be active at any time. If clients are "hidden" from each other, then they could be talking at the same time, causing RF interference and loss of signal quality. Table B4 indicates that clients hear each other only within 100 meters. In noisy or occluded settings it could be as low as 50 meters.

Table B4

Case	RS (dBm)	TR (dBm)	Decay	Ant 01	Ant 02	Freq (MHZ)	D (m)	D (Ft)
01	65	15	2.0	0	0	2400	99	326
02	65	15	2.2	0	0	2400	65	214
03	65	15	2.4	0	0	2400	46	151

Suggestions

If omni-directional antennas are being used, select ones with down tilt. This focuses the beam downwards – where the clients. This also reduces the AP range so clients are less spread apart. The hidden node effect is thus curtailed. For noisy /occluded environments, reduce path loss with panels and/or double transmit power with dual AP radios.

Note: Range Calculation Sheet location: www.meshdynamics.com/DOWNLOADS/MDRangeCalculations.xls

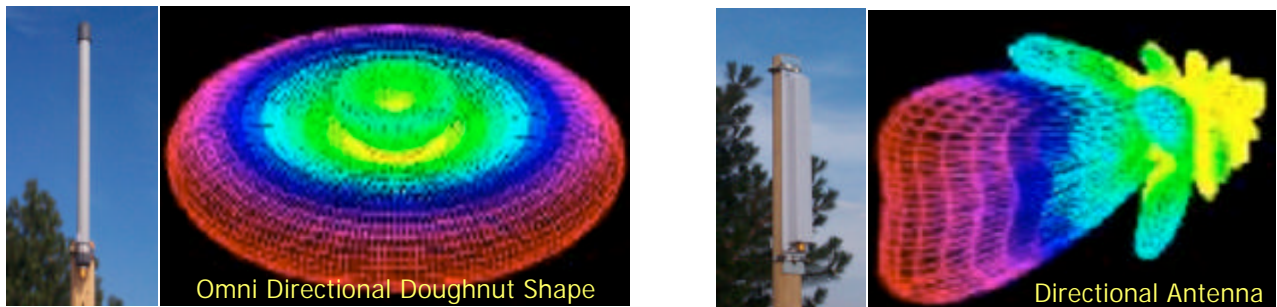


Figure 6.1

Omni-directional antennas provide an even distribution of RF energy (above, left). Directional antennas, in contrast, focus RF energy towards a receiver in their line of sight. Omni-directional antennas are less efficient than directional antennas as distance between the relay increases. In the event the RF signal is weak, over long ranges, Sector or Panel antennas should be considered.

When ordering omni-directional antennas for the up/down links, look at the **down tilt** and **vertical beam width** specifications. If the relays are at different heights, or differing angles then the RF beams may not “connect”.

The service radio antenna, if omni-directional, should have a large down tilt, if mesh nodes are mounted up high. In that case the beam has to travel downwards to reach client devices (e.g. laptops) on the ground.

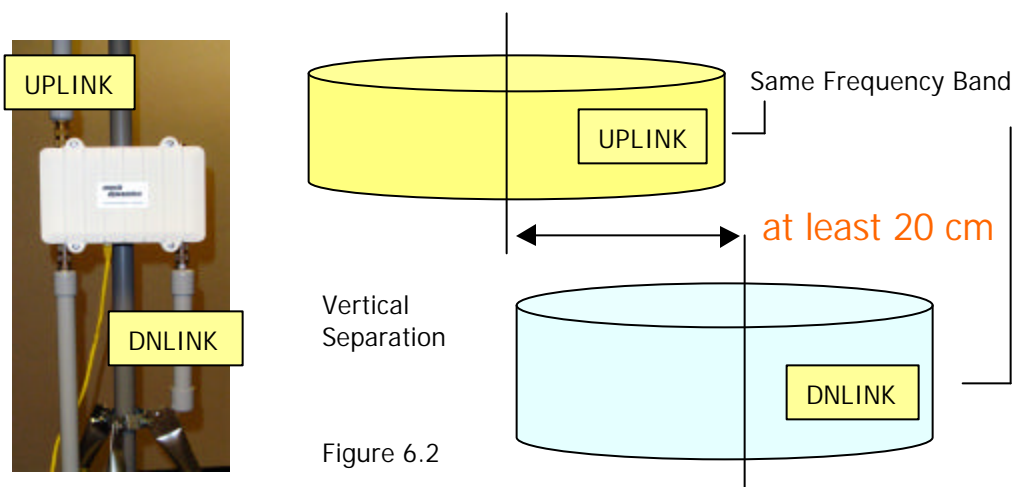


Figure 6.2

The up-link and down-link antennas operate on the same frequency band – they are either BOTH 11a or 11b/g.

For all antennas, avoid placements where the open end of is near metal poles or near power transformers. Also omni-directional antennas, should be mounted as vertical as possible and at similar heights for best results. Note at the down tilt and beam width affects permissible height variations, based on the tangent of the angle times the distance.

NOTE: ANTENNA PLACEMENTS MUST BE ATLEAST 20 CMS APART. SEE PAGE 15, TERMS OF USE

Understanding the beam pattern of omni-directional antennas and the “vertical window of connectivity” that is available at any given distance is important in the alignment of the antennas for the mesh backhaul. It is especially important when the terrain for the mesh deployment varies in elevation, and/or the objects on which the mesh nodes will be mounted vary in height.

An omni-directional antenna has a radiation pattern that looks like a horizontal disc emanating from the antenna. The disc gradually gets thicker as you move farther from the antenna, and the angle that describes how fast it gets thicker is called the “vertical beam angle”.

Given that the antennas are mounted perfectly vertical (please use a level to ensure this), there will be a vertical window at any given distance from a first backhaul antenna within which a second backhaul antenna will be able to receive signals transmitted with the full rated gain of the first antenna.

In the diagram below, the 18 degree vertical beam angle shown corresponds to a preferred 8dBi, 5GHz omni antenna. One can think of this vertical pattern as two right triangles back-to-back where each has a 9 degree angle - one triangle facing up and one facing down relative to a horizontal line.

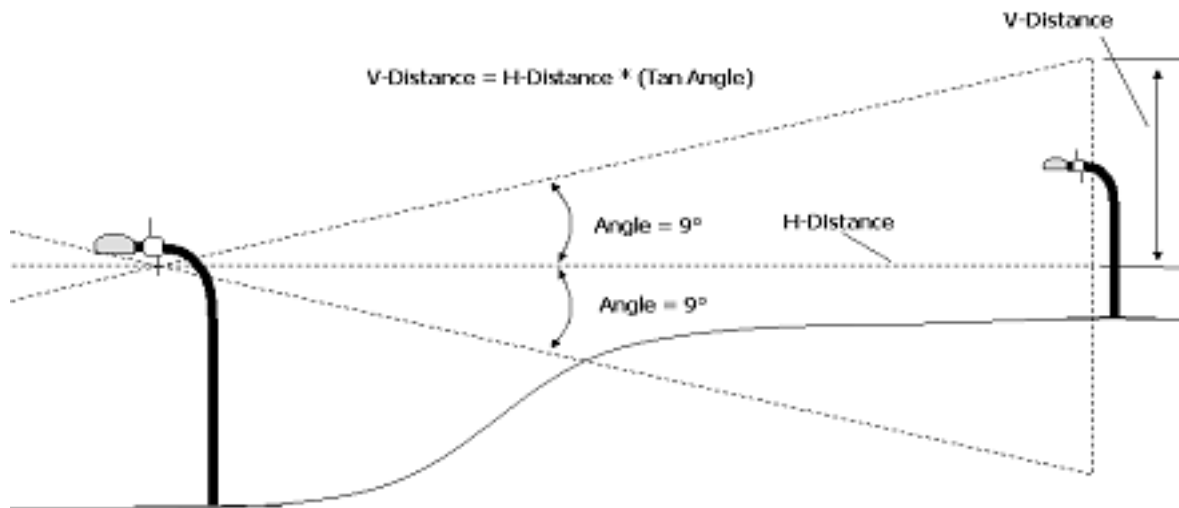


Figure 7.1

Here is how the trigonometry works for omni-directional antennas.

The side of each triangle opposite the 9 deg angle (V-Distance) represents the height above and below horizontal that the antenna's radiation pattern will cover given that you are some distance away, for instance 800 ft. The tangent of 9 degrees is 0.158, so at an 800 ft distance, the pattern will cover a height of $(800 * 0.158 = 126 \text{ feet})$ above, as well as 126 feet below horizontal for a total vertical window of 252 feet. If however, the antenna on the first node is tilted only 3 degrees from vertical and tilted in the wrong direction relative to a second node, the vertical connection window available at the second node is now reduced to that resulting from a 6 degree angle giving a height of $(800 * 0.105 = 84 \text{ feet})$ from horizontal in the direction of interest instead of 126 feet.

As the distance between the mesh nodes grows, the vertical window enlarges. As the distance between mesh nodes is shortened, the vertical window shrinks. For instance, if for some reason the nodes were placed 300 ft apart, the connectivity window would be $(300 * 0.158 = 47)$ feet above and 47 feet below. Basically, the further apart the nodes are, the less sensitive they are to the relative height of the nodes.



Figure 8.1

A. Windows 98 or better laptop with PCMCIA card and Ethernet Port Access.

Temporarily disable firewalls on the laptop if you intend to configure the nodes with the NMS

B. 802.11 a/b/g card. Model Shown: SMC 2336 W-ACG. Needed for any remote diagnostics.

C. N-Male to N-Male Barrel Adaptors. Needed to temporarily mount Antennas on Structured Mesh™ Module

D. N-Male to N-Male low loss Cabling. Connects Antennas (E, F) to N-Female Connectors on Module

E. Downlink and Uplink Antennas. Two required. For Backhaul. Typically 11a (5.8G), Full range.

5.8Ghz Omni-directional www.Superpass.com/SPDJ6O.html , www.Superpass.com/SPDJ6OP.html

F. Service 8dBi Antenna for connecting to client devices (e.g. laptops). Typically 11b/g (2.4G).

2.4Ghz Omni-directional: www.Superpass.com/SPDG16O.html , www.Superpass.com/SPDG16OP.html

G. Power Over Ethernet (POE) injector.

Input Voltage 110V, Output 24VDC on Pins 4,5 of Ethernet RJ45 Connector.

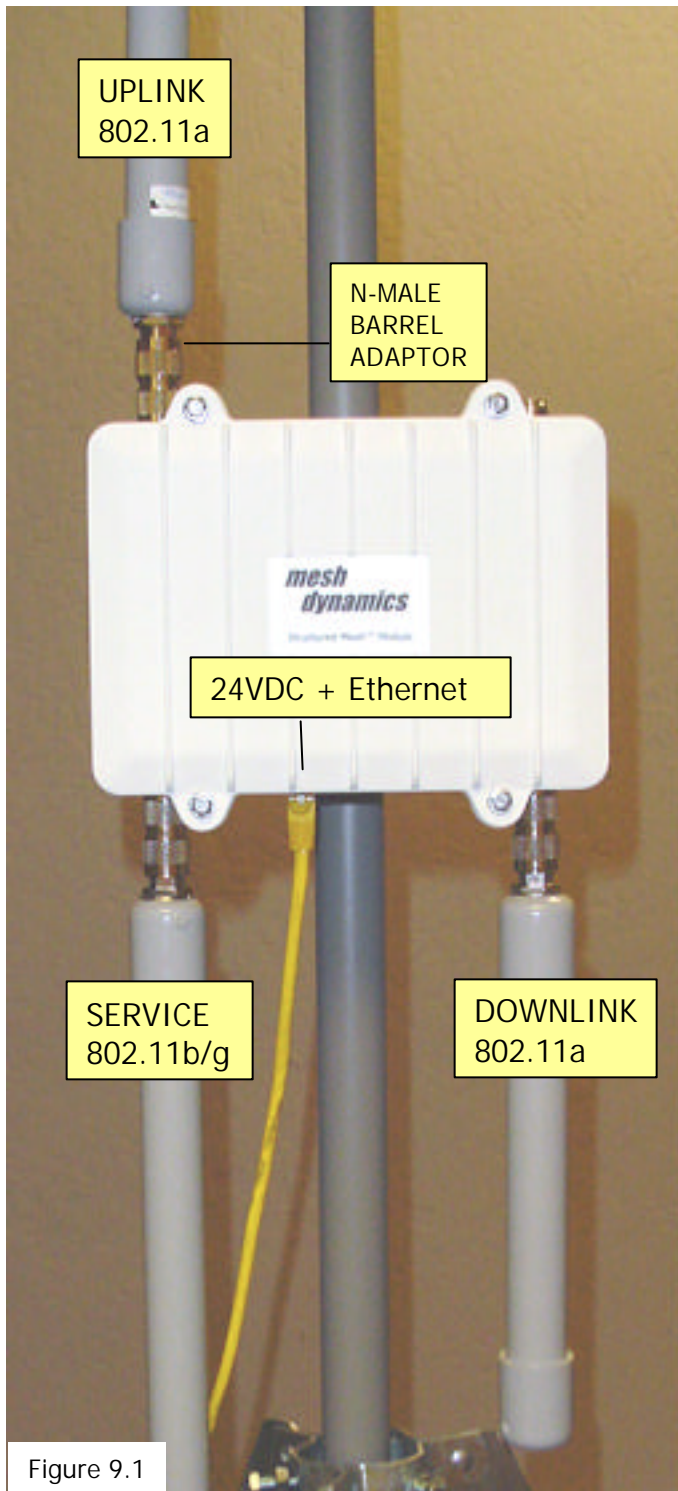
Not included with modules but may be purchased separately from Meshdynamics.

H. RJ45 Ethernet Cables. Two needed. One connects to the wired network, the other to the node.

Notes:

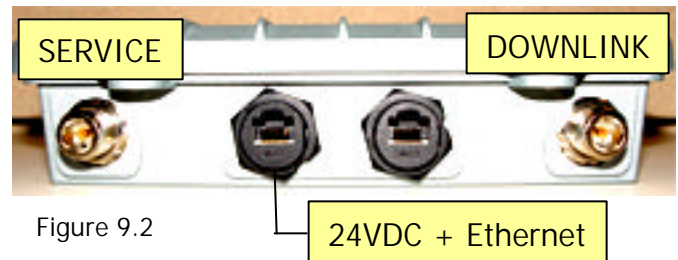
1. Items E.F relates to a typical 3-Radio Mesh Module: 11a uplink/downlink and 11b/g service.
If the uplink and downlink or service radio types/settings change, please change antennas accordingly

Connecting the Downlink Antennas to the Module

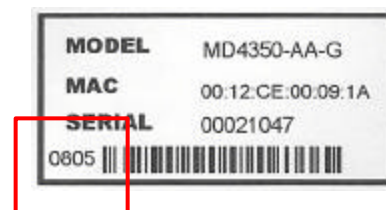


Antenna Mounting Shown for illustration Purposes Only.

NOTE: **ANTENNAS MUST BE ATLEAST 20 CMS APART. SEE PAGE 15, TERMS OF USE**



Note: Units built after August 2005 have connections on the module is shown in Figures 9.1, 9.2



Example: 0805 is the MMY date of manufacture.

If there is no number on your sticker, then uplink and downlink connections are reversed. But switching them also requires opening the module and placing the radios in different mini-PCI slots, as described later

Switching to the current convention is advised, but does not affect performance of the unit. Reversing the uplink and downlink antennas may require antenna alignments.

Bringing up a ROOT Node

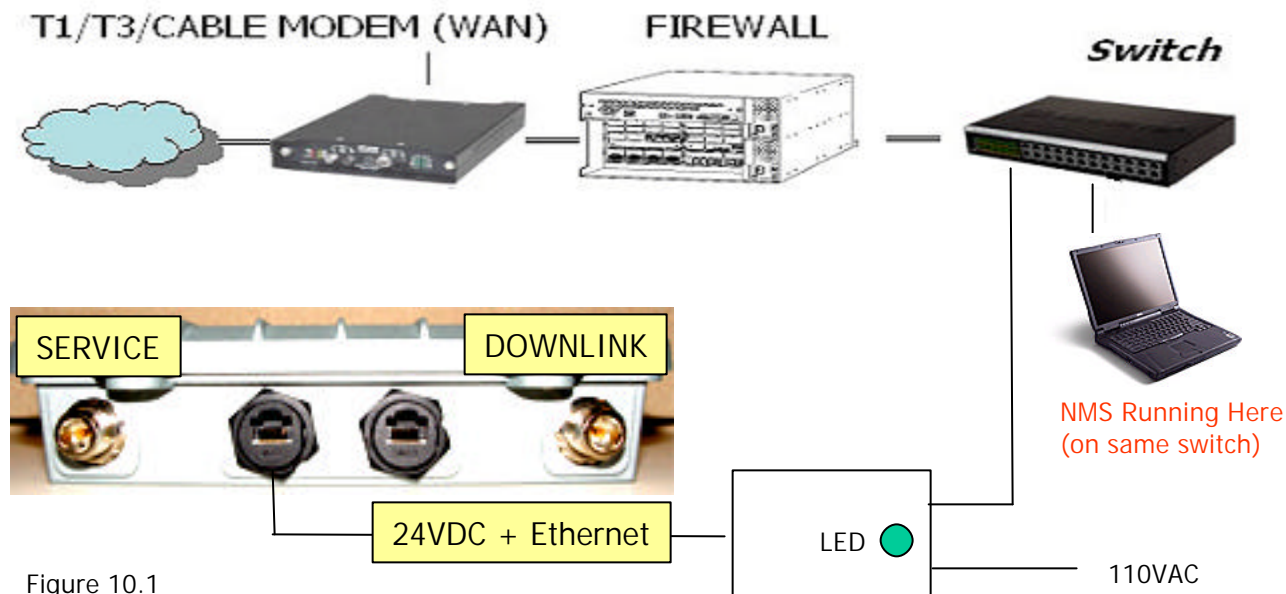


Figure 10.1

1. Mount the Antennas as shown on the previous page.
2. Connect a cable from the switch to the POE injector (above).
3. Verify internet connectivity on the cable to be plugged into the unit.
4. Power up the POE Injector. The LED on the POE will light up.
5. **Now** connect the Ethernet cable (with power) to the Module.
6. The internal fan should start and is audible, if you put your ear to the box.
7. Insert the 11a/b/g radio card and bring up the Wireless Card utility.
8. **Firewalls should be disabled if you wish see the Heartbeats on the NMS.**



9. The wireless card utility will show two APs named MESH_INIT and the last numbers of the MAC ID of the radio, for identification purposes. These are the downlink radio and service radio AP of the root node.

Note: On power up the node first senses if there is an Ethernet link on the first Ethernet port. If it senses one, it configures itself as a root node. **If no Ethernet link is sensed, the node assumes it is a relay.** It's uplink radio then searches for other mesh node downlinks to connect to. It first searches for a root node, failing which it searches for a relay node that has established a chained link back to a root node. If there are multiple relay node candidates, it will connect to the relay that provides the best service, based on test packet transmissions.

10. If the Ethernet cables are "good" then the Ethernet will be sensed and the MESH_INIT_XX will change to StructuredMesh (below). **If it does not, check the Ethernet cables and connectivity back to the switch.**

Fig. 10.2

Network	SSID	Type	WEP	Signal	Channel	BSSID
	StructuredMesh	A		78%	165	00:12:CE
	StructuredMesh	B		83%	1	00:12:CE

In the image above, one "AP" is on the 5.8GHZ backhaul frequency band (802.11a). This is the root downlink radio. The other radio is the 2.4GHZ AP client service on 802.11b/g. Connect the 11a/b/g radio card to both radios to verify wireless connectivity on both 802.11a and 802.11b/g

Bringing up a RELAY Node

1. Mount the Antennas as shown on Figure 10.1. Power up the POE Injector. The LED will light up. Power up the Module. The fan should start and be audible. 4. Bring up the 11a/b/g Wireless Card utility on the laptop.
2. The wireless card utility will show two APs named MESH_INIT and the numbers of the MAC ID of the radio. These are the downlink radio and service radio AP. In general, the downlink radios searches for other mesh nodes to connect to. The Service AP also radio scans to select the best non-interfering channels.

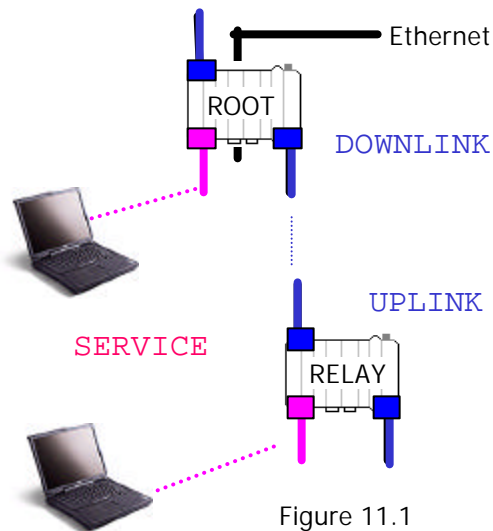
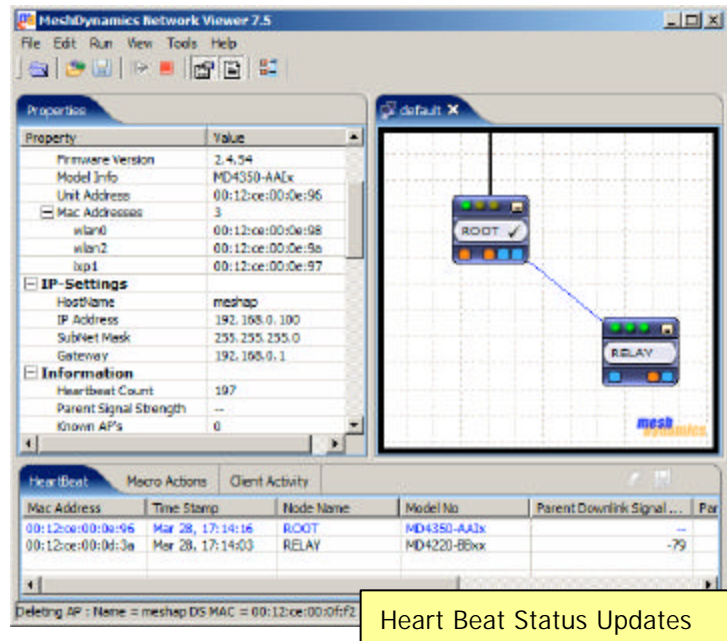


Figure 11.1



Heart Beat Status Updates

3. The relay node "scans" until it finds another node (root or upstream relay) to form a backhaul path. If successful, the MESH_INIT SSID changes to StructuredMesh in 1-2 minutes. If the NMS is running (see NMS User Guide for details), then the ROOT and RELAY nodes should show up based on heart beats sent by nodes.
4. If the radio does not change from MESH_INIT then check to see if the a/b/g wireless radio card can "see" a potential parent downlink to connect to. The radio card utility must show at least one 11a downlink (below)

Network	SSID	Type	WEP	Signal	Channel	BSSID
	StructuredMesh			78%	165	00:12:CE
	StructuredMesh			63%		
	StructuredMesh			88%		

Figure 11.2

Laptop Radio Card should show ROOT Downlink near Relay Node Uplink Antenna location

If the relay uplink antenna cannot "see" a parent downlink, it cannot "connect" to it! Check if:

- The antenna placement for the uplink and downlink on all nodes are as shown in Fig 9.1
- The node uplink antenna is of the right type for the backhaul frequency band
- The parent downlink antenna is of the right type for the backhaul frequency band
- The antennas connections for uplink, downlink and service are as described earlier
- The relay uplink and parent downlink antennas are approximately at the same height
- The relay uplink and parent downlink antennas are both aligned to the vertical
- There are no obstructions between the two antennas (clear line of sight)
- There are no high voltage or other RF interference sources near the relay
- The antennas are not within 1 meter (3 feet) of any metal structures
- If unit was field upgraded: check if pigtailed are firmly connected to the radios.
- If unit was field upgraded: check if pigtailed are not damaged, using an ohm meter.

These frequently asked questions were compiled by our Tech Support.
Please contact your applications engineer if you have questions not addressed here.

Q. Can the NMS be running in the field over a wireless connection?

A. Yes, connect your radio card to the SSID of either the downlink or service radios to receive node heartbeats

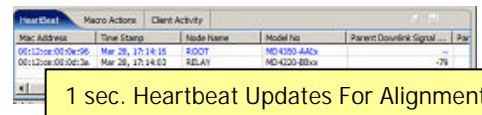
Q. The Root Node does not show on the NMS.

A. There could be many reasons for this: First the "Root" did not detect the Ethernet connection from the switch and therefore configured itself as a relay, in search of a root. Replace the Ethernet cables and reboot the node. The second possibility is that the root node is indeed "up" (as seen by a radio card, Fig 11.2) but the heart beats to the NMS are being blocked by a firewall on the computer.

Q. The Relay Node does not show on the NMS.

A. The Relay node uplink radio has to "hear" the Root node downlink radio. The beams from the antennas have to intersect each other. The heartbeats show signal strength and transmit rate from parent to child node. Set the heartbeat rate for the relay to 1 sec. Align the relay antenna based on the changes to the signal strength shown by the heartbeats Repeat the steps above with the Root Node – setting its heart beat to 1 second also.

Note: Rotate omni directional antennas during alignment.
Sometimes the "wire" is not well aligned inside the tubing.



Mac Address	Time Stamp	Node Name	Model No	Parent Downlink Signal	Rate
00:12:00:00:00:00	Mar 28, 17:14:35	ROOT	MD4200-4A0x	-	-
00:12:00:00:00:00	Mar 28, 17:14:33	RELAY	MD4200-8B0x	-78	-

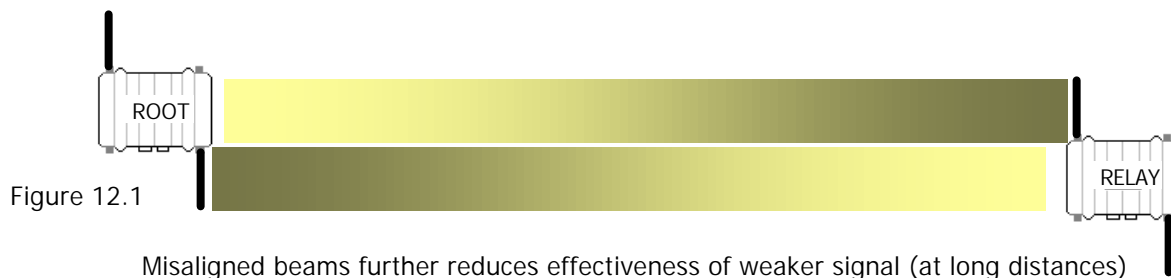
1 sec. Heartbeat Updates For Alignment

Q. The laptop connects to the node but the signal strength is weak.

A. Recall that the factory default SSID setting for both 802.11a downlinks and 802.11b service radios is the same: StructuredMesh. Your computer may not be connecting to the nearest radio. Change the SSID on the radios: e.g. Relay80211A, Relay802.11b, connect to the radio of interest and then check signal strength.

Q. The laptop connects to the node but range is less than expected.

A. The 2.4Ghz service radio supports 3 modes: 802.11b only, b and g, g only. 802.11g provide more bandwidth, than 802.11b but at the cost of range. Change the settings from the NMS to b only, if more range is needed. Also the radio power settings slider bar should be at 100%.



Q. The Root and Relay work well at short distances but not as the distance is increased.

A. The most common cause is poor antenna alignment. The signal is weaker at longer distances and the effect of misalignment more pronounced (above). Check cables, radio pigtails also, in case of field upgrades.

Q. The overall throughput is poor, despite a good signal strength between backhaul radios.

A. Bandwidth reduces with retries. Retries occur when packets are not correctly received. This could be due to external RF interferences. Move the antennas to another location or change the channels manually to see if that helps. For long range (beyond IEEE 802.11 default settings) change ACK timing for both downlink and uplink.

If your question is not addressed above please do email us at techsupport@meshdynamics.com

Under normal circumstances, there should be no reason to open the module. This page addresses cases where lower power radios are being replaced with higher power units or a 4th radio is added (see C,D below).

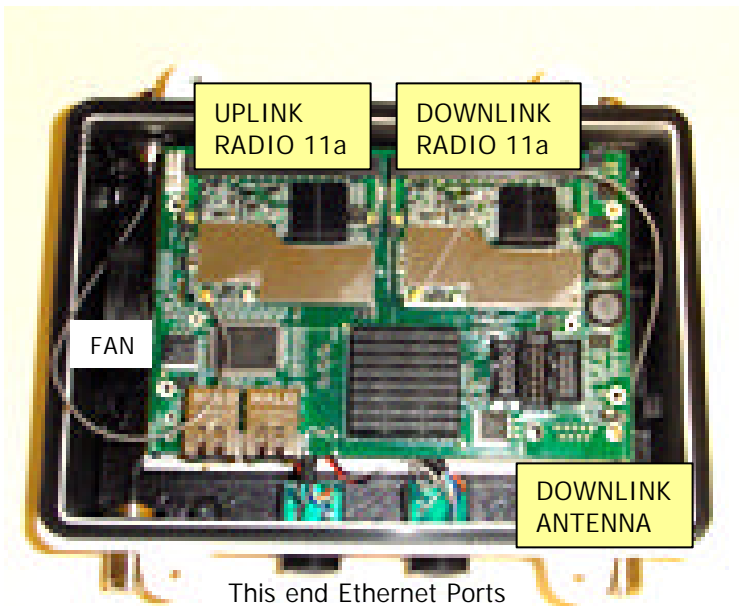


Figure 13.1

Radios are replaced when radio output power has to be increased (for more range) or when a 4th radio is added for mesh node mobility- the scanning radio.

A. Replacing Uplink and Downlink Radios

1. Remove all power and wait for 10 seconds.
2. Release any static before opening the box
3. Remove the upper lid from the box
4. Disconnect the pigtails by applying low pressure
5. Replace radios. Locations shown on left.
6. Snap in pigtail connections
7. Attempt to pull off the pigtail, it should be secure.
8. Re-fasten the upper lid.

B. Replacing the Service Radio

1. Remove all power and wait for 10 seconds.
2. Release any static before opening the box
3. Remove the upper lid from the box
4. Remove pigtails for the uplink and downlinks
5. Remove the 4 screws holding down the board
6. Turn the board over, (as shown left)

Verify that Ethernet ports are on the Bottom Right.

7. Disconnect the pigtails by applying low pressure
8. Replace radios. Locations shown on left
9. Snap in pigtail connections
10. Attempt to pull off the pigtail, it should be secure.
11. Screw the board back..
12. Snap back the pigtails for the backhaul radios.
13. Re-fasten the upper lid

C. Adding a 4th Radio for Mesh Mobility

Refer to Section B above and Figure on left.

D. Adding a 4th Radio for 2 Downlinks

Refer to Section B above and Figure on left.
Assumes sectored Antennas being used.

Note: Do not use any other modules not approved with this device other then the ones that were tested which are MD2 FCC ID: UZU-MD2 and MD5 FCC ID: UZU-MD5

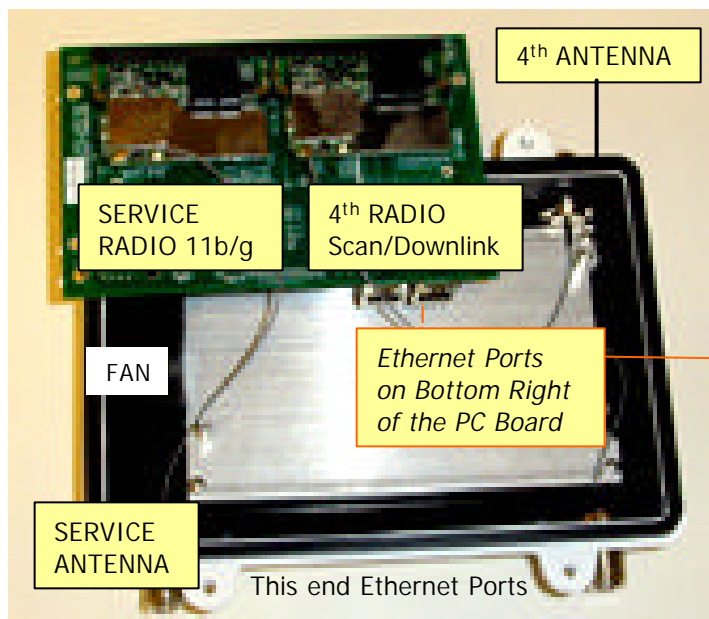


Figure 13.2

Adding Diversity Antennas

In situations where the uplink-downlink wireless connectivity is weak, adding a diversity antenna may help.

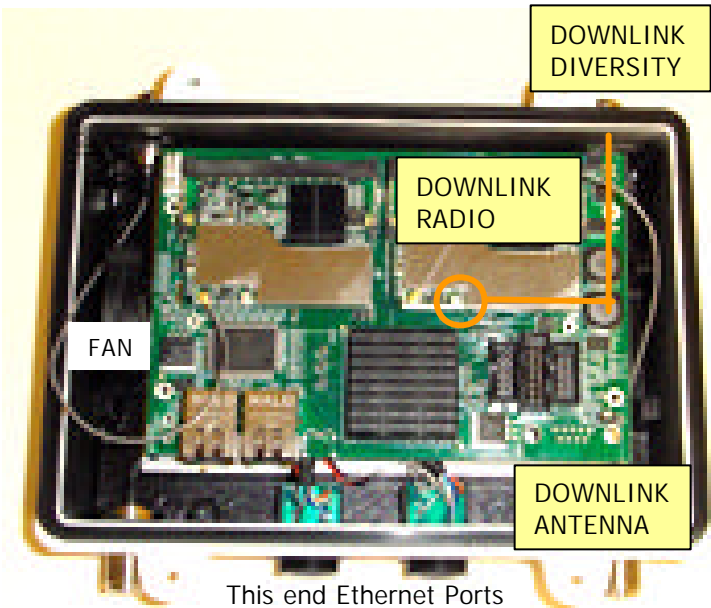


Figure 14.1

Adding Diversity Downlink for Root Nodes

For **root** nodes, adding a diversity downlink antennas improves the backhaul link to relay nodes. The 4rth N-Female connector, if unused, may be used to this purpose (left).

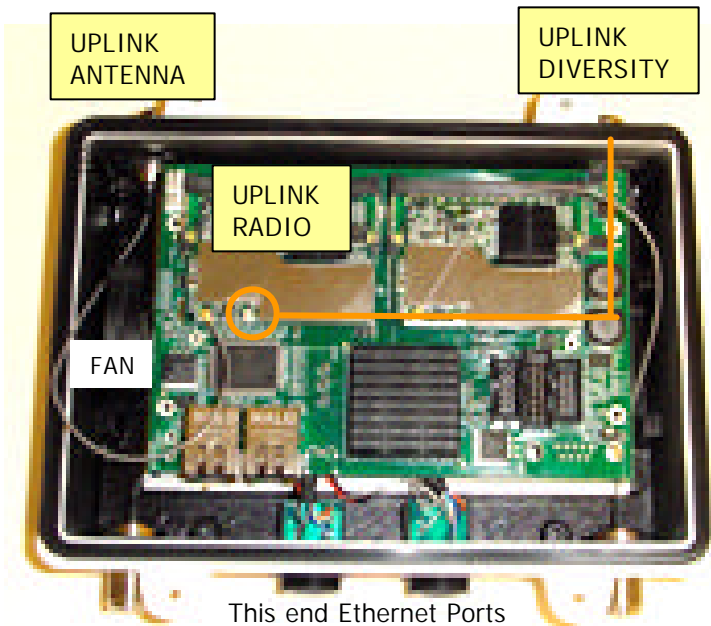


Figure 14.2

Adding a Diversity Uplink for Relay Nodes

For **relay** nodes, adding a diversity uplink antenna improves backhaul link to upstream nodes. The 4rth N-Female connector, if unused, may be used to this purpose (left).

WARNING: While this device is in operation, a separation distance of at least 22.8 cm (8.97 inches) must be maintained between the radiating antenna and the bodies of all persons exposed to the transmitter in order to meet the FCC RF exposure guidelines. Making changes to the antenna or the device is not permitted.

Doing so may result in the installed system exceeding RF exposure requirements. Using higher gain antennas and types of antennas not certified for use with this product is not allowed. The device shall not be co-located with any another transmitters.

This device complies with Part 15 of the FCC rules. 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 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 the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment.

Non-Modification Statement

Unauthorized changes or modifications to the device are not permitted. Use only the antennas recommended. Modifications to the device will void the warranty and may violate FCC regulations. Please refer to this installation manual for the recommended antennas.

Maximum Antenna Gain

This device has been designed to operate with an antenna having a maximum gain of 8dBi. Antennas not included in this manual (Page 8) or having a gain greater than 8dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

High Power Radars

High power radars are allocated as primary users (meaning they have priority) in the 5250MHz to 5350MHz and 5650MHz to 5850MHz bands. These radars could cause interference and/or damage to LELAN devices used in Canada.

RF Emissions from power cables

The MD4000 products have been certified for use with power cables to the POE up to 3 meters in length.

Industry Canada Notice and Marking

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

The term "IC:" before the radio certification number only signifies that Industry Canada technical specifications were met. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.