FM 4500 FIBER

# User manual

Manual version 0.3.1.

Firmware Version 8.x

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**WARNING**

ONLY QUALIFIED PERSONNEL SHOULD INSTALL THIS UNIT. THE INSTALLATION SHOULD CONFORM TO ALL LOCAL CODES. IN SOME COUNTRIES, A CERTIFIED ELECTRICIAN MAY BE REQUIRED.

**CAUTION**

When open, the unit should not be dripping or splashing. No object filled with liquid shall be placed on the unit.
Radios should be installed in restricted access locations only.

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# 1 Manual Overview

This manual describes how to install and operate the Fluidmesh 4500 FIBER product. More specifically, this manual contains a general overview of the Fluidmesh 4500 FIBER in Section 3.1. This user's manual also includes a complete overview of the network architectures that can be created using Fluidmesh technology, and is discussed in Section 4. The Fluidmesh network addressing is described in Section 5. The use of Fluidmesh software plug-ins, their features, and their

installation procedures in a network follows in Section 6. The FMQuadro is then described in Section 7. Please note that, unless otherwise explicitly specified, the FMQuadro presentation refers to the Fluidmesh 4500 FIBER. Screenshots shown in this manual are explanatory examples and may be different from the ones that appear when you run the FMQuadro.

**Fig. 1.1 - FM4500 FIBER**

# 2 Precautions

## 2.1 Fluidmesh Networks Products Are For Professional Use Only

Fluidmesh Networks products have been designed with safety in mind. However, if not used properly, they can cause fires that may lead to serious bodily injuries. To avoid such accidents, make sure that you are properly qualified to install these products.

## 2.2 In Case of Breakdown

In case of system breakdown, discontinue use and immediately contact your authorized Fluidmesh Networks dealer or Fluidmesh Networks LLC directly.

## 2.3 In Case of Abnormal Operations

If the unit emits smoke or an unusual smell, if water or other foreign matter enters the enclosure, or if your drop the unit or damage the enclosure, power off the unit immediately and contact your authorized Fluidmesh Networks dealer or Fluidmesh Networks LLC directly.

# 3 Installation and System Set-Up

This section describes how to install and set up Fluidmesh products.
*Please refer to physical installation instructions manual for proper wiring and installation procedures*.

## 3.1 Fluidmesh 4500 FIBER

The Fluidmesh 4500 FIBER (part number FM4500M-HW, for simplicity referred to as FM4500) is designed for connecting moving vehicles. The hardware is enclosed in an IP66-rated metal enclosure.

**Fig. 3.1 - FM 4500 FIBER**

The FM4500 FIBER can operate both as a **point-to-point wireless bridge** or as a single radio **mesh unit**. The former operating mode is described in Section 4.1 whereas the latter is discussed in Section 4.2.

### 3.1.1 Proper Installation Procedures

Metal hose-clamps are supplied to install the unit on a pole (*please refer to installation instructions).* FM4500 FIBER is specifically designed for rail application and is equipped with a 8-pins M12 Ethernet port, a 5-pins M12 DC-IN power supply port and an SFP module port. Please refer to the installation instructions for the specific wiring of the 8pins and 5 pins M12 ports respectively.

**Fig. 3.2 - FM4500 FIBER - panel**

### 3.1.2 Status and Link LEDs

A panel on the front of the FM4500 FIBER, shown in Fig. 3.3, provides six (6) LEDs which can be used to check the unit and the link quality status. From the left-hand side, the first 2 green LEDs indicate the unit power, the Ethernet port activity, respectively. The remaining 4 colored LEDs indicate the level of the link signal and can be used for antenna alignment purposes. During the unit boot-up process, the LEDs indicate the boot status and can be used for problem detection. Specifically, the 4 colored LEDs light up in sequence from the leftmost one (red) to rightmost one (bright green). If the LEDs lighting up sequence does not complete, then an error has been detected during the booting process. Please refer to Table 3.1 for details.

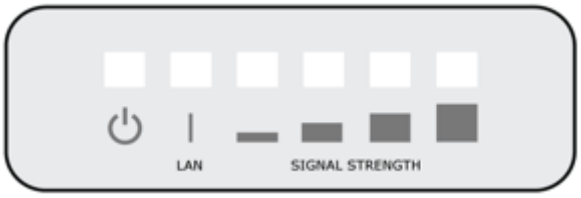



**Fig. 3.3 - From Left To Right Status LEDs, Link/Boot LEDs**

| LED # (Color) | Boot Status | Link Quality |
|---|---|---|
| 1 (Red) | Booting core system | Poor/link absent |
| 2 (Orange) | Booting wireless system | Fair |
| 3 (Green) | Booting routing engine | Good |
| 4 (Green) | Booting unit configuration | Very good |

**Table 3.1 - FM4500 FIBER Boot/Link Status LEDs Color Scheme**

**Powering the unit**
FM4500 could be powered using a standard IEEE802.3at switch through the LAN1/PoE 8-pins M12 ports, or with a 48Vdc-in (not included) using the 5 pins M12 slot.
Please refer to the installation instructions for the specific port wiring.
To minimize power losses, it is recommended to install the PoE injector as close as possible to the FM radio. The maximum suggested distance is 330ft/ 100m.

## 3.2 Use Shielded Cables

Please note that only professional outdoor-rated **shielded** cables must be used in conjunction with the FM radios.
In order to secure proper grounding for the radio and to get reliable connectivity, it is strongly recommended to use shielded CAT5/6 cables and connectors.

*Please refer to installation instructions for proper wiring and installation procedures*

## 3.3 Factory Default Hardware Reset

The FM radios can be reset to factory default using the proper RESET button present at the bottom of the unit. To reset the radio to factory default settings, power up the unit and wait approximately 40 seconds for the unit to boot up. Once the unit is up and running, press the reset button for 7 seconds. The radio will restore the factory default settings and automatically reboot. The LEDs will blink when the unit receives the reset to factory default signal. After the reset, the default IP address of 192.168.0.10/255.255.255.0 is restored and the administrator password is set to *admin*. The RESET button can also be used to reboot the unit when pressed for 1 second.

# 4 Fluidmesh Architecture Overview

The FM4500 series can be used to create any kind of network architecture such as point-to-point links and mesh networks. More-over, thanks to the innovative FluidMAX™ patent pending technology, point-to-multipoint links can be created. This also gives to the user the ability to create mixed networks architectures (shown in Fig. 4.1) leading to higher performance and flexibility in the deployment. In the following section we describe how to build point-to-point, point-to-multipoint, and mesh networks with the Fluidmesh products.

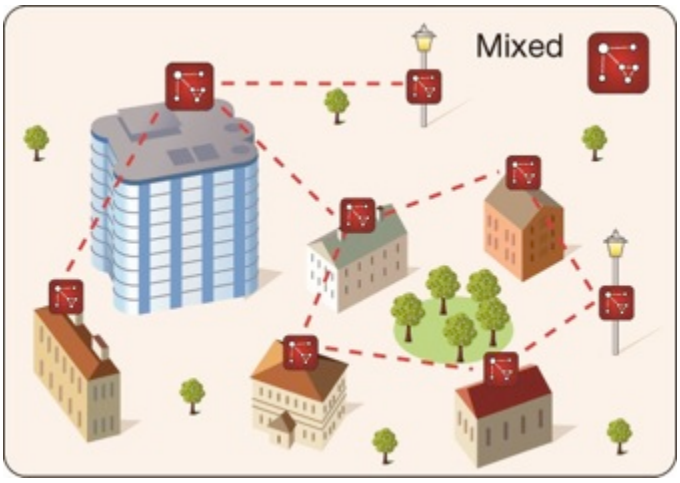



**Fig. 4.1 - General Network Architecture That Can Be Built**

**Using a combination of FM Units**

## 4.1 Point-to-Point Wireless Bridge

A wireless bridge enables two local networks (i.e., network segments) to communicate with each other as depicted in Fig. 4.2.

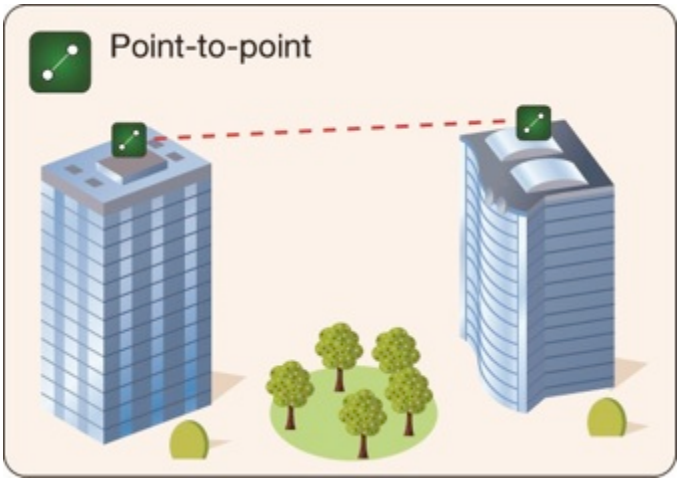



**Fig. 4.2 - Point-To-Point Network Architecture**

The wireless bridge is defined as “transparent” because its activity is transparent to the network hosts. In other words, the wireless bridge forwards packets from one network segment to the other according to a “forwarding table” which is built by learning the network topology from the analysis of the incoming traffic. In this configuration, no explicit interaction between the wireless bridge and the network hosts takes place. The two network segments, connected to both sides of the wireless bridge, will share the same IP addressing class. Thus, each network host must use a unique IP address, i.e., it is not allowed to have two devices sharing the same IP address.

## 4.2 Mesh Network Architecture

This section describes the Fluidmesh mesh networking architecture and the basic functionalities of the FM4500 series. For the sake of clarity, we will refer to a generic FM unit whenever the discussion applies to the FM4500.

Fluidmesh Networks develops wireless networking solutions based on the innovative mesh networking architecture which presents unmatched advantages in terms of reliability and flexibility compared to any traditional wireless solution. Using Fluidmesh technology for your network allows you to take advantage of this powerful architecture. An example of wireless mesh network is shown in Fig. 4.3. In a wireless mesh network, every FM unit transmits the data packets coming from the devices directly attached to it and also acts as an “intelligent router” able to forward packets coming from other FM units through the optimal path.

In a redundant and reliable mesh network, every stream of data packets has multiple available paths to reach the base station, and the network forwards the packets through the optimal path at any point in time. The absence of any single point of failure increases its reliability compared to any other transmission technology, either wireless or wired.

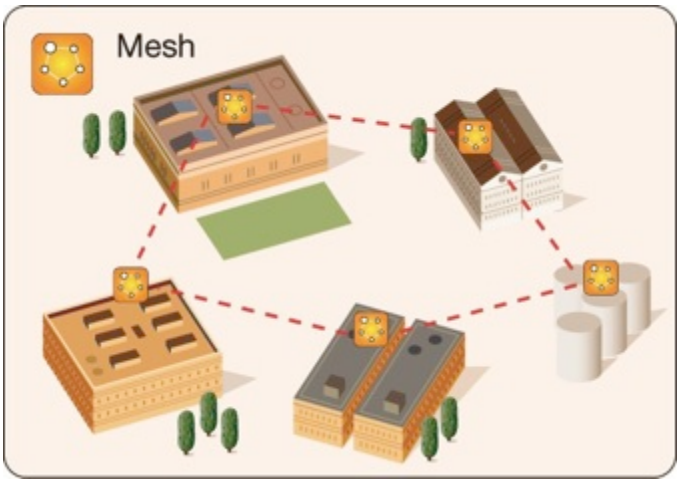



**Fig. 4.3 - Fluidmesh Mesh Networking Architecture**

## 4.3 Point-to-Multipoint Architecture: FluidMAX™

Developing FluidMAX[1], Fluidmesh embraced the Point-to-Multipoint architecture (see Fig. 4.4) improving its features and capabilities to meet the needs of system integrators in the security and industrial automation industry. The FluidMAX technology is based on a centralized Medium Access Control (MAC) protocol and allows Fluidmesh customers to create point-to-multipoint networks using the FM units.
With the FluidMAX technology, an FM unit can thus be used at the center of the star topology in a

[1] Patent pending.

point-to-multipoint fashion using sector antennas or antenna splitters with multiple directional antennas. The unit operating at the center of the star topology plays the role of *Master* and is in charge of coordinating communications to and from the other units that thus act as *Slaves*. As a result, the hidden and exposed terminal problems are eliminated by the centralized FluidMAX MAC protocol that supports up to 500 Mb/s maximum throughput[2]. By reducing the number of slaves, the supported rate per slave can be increased provided that the **sum** of the throughput requirements of the slaves is lower than or equal to 150 Mb/s.

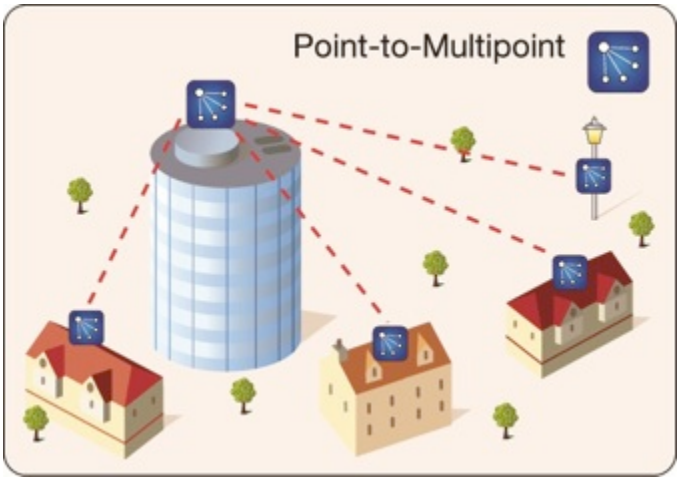



**Fig. 4.4 - Point-To-Multipoint Network Architecture**

FluidMAX is fully automatic and integrated within the mesh architecture. By continuously monitoring the network topology, FM units are able to automatically select whether to operate the FluidMAX MAC protocol or remain in the initial mesh operating mode. Consequently, no additional configuration is needed to enable the FluidMAX features because the communication protocol is automatically chosen by the FluidMAX protocol based on the detected network topology.

## 4.4 FLUIDITY LAYOUT

## 4.5 Prodigy

Firmware versions 6.5 or above feature the innovative Prodigy 2.0 MPLS-based protocol. The protocol is a quantum leap in terms of performance with respect to its predecessor Prodigy 1.0. Prodigy 2.0 features include Fluidity (through software plug-in), traffic engineering and advanced QoS. **Prodigy 2.0 is NOT compatible with Prodigy 1.0.** The protocol selection can be done, for back-compatibility, using the Web GUI in the Local Configuration page (see Section 7.6 for more details). No mixed operation of Prodigy 1.0 and Prodigy 2.0 are allowed. In case of expansion of current network deployments two options are available:

1. Setting the newly added units with Firmware 6.5 or above to operate in Prodigy 1.0.
2. Upgrading the previously deployed units with a Firmware 6.5 or above and set them to operate in Prodigy 2.0.

We recommend option 1 if there is no specific issue in the network.

[2] We assume the default channel width of 80 MHz

# 5 Fluidmesh Network Addressing

## 5.1 Bridge IP Addressing

The FM unit can be operated in bridge mode to create a single point-to-point connection between two network segments as described in Section 4.1.

Each FM unit is provided with a default IP address for its wired Ethernet port(s), which is: 192.168.0.10

No IP address is associated to the wireless interface.

When you set up a wireless bridge using two FM units for the first time, both units will have the same default IP address equal to 192.168.0.10. It is recommended to change the IP address of one of the two units in order to unambiguously address and configure the system with no confusion (see Fig. 5.1).

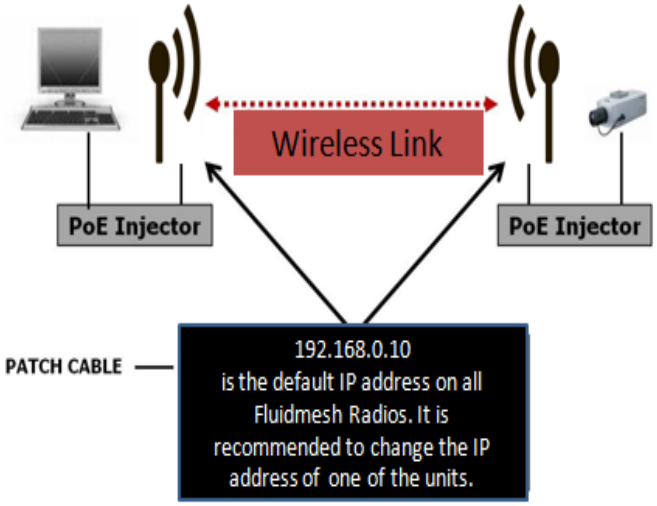



**Fig. 5.1 - Wireless Network Architecture And Initial Bridge Configuration**

### 5.1.1 Connecting and Configuring IP Devices and Cameras

The FM4500 FIBER features two M12 ports.

The camera or the device attached to the FM unit should use an IP address belonging to the same class of the devices on the other network segment of the wireless bridge.

The default IP subnet is 192.168.0.0/255.255.255.0 and the default IP address of the radio is 192.168.0.10 / 255.255.255.0

## 5.2 Mesh Addressing

The FM units have two modes of operation which are used to develop mesh network architectures:

- Mesh Point Mode
- Mesh End Mode

**Mesh Point Mode:** it is the default mode for the FM unit. Each unit in the field that is **not** connected to the wired LAN backbone must be set in **Mesh Point** Mode.

**Mesh End Mode:** in the Fluidmesh network, an FM unit that is connected to the main wired LAN must be set in **Mesh End** Mode. The **Mesh End** unit is the junction point between the wireless network and any IP-based wired network.

Regardless of its configuration, any FM unit comes from the factory with a unique unit ID with the following format:

**5.a.b.c**

where the triplet (a,b,c) unambiguously identifies the unit and cannot be changed. The unit ID is used to identify the units throughout the Web-based Graphical User Interface (GUI).

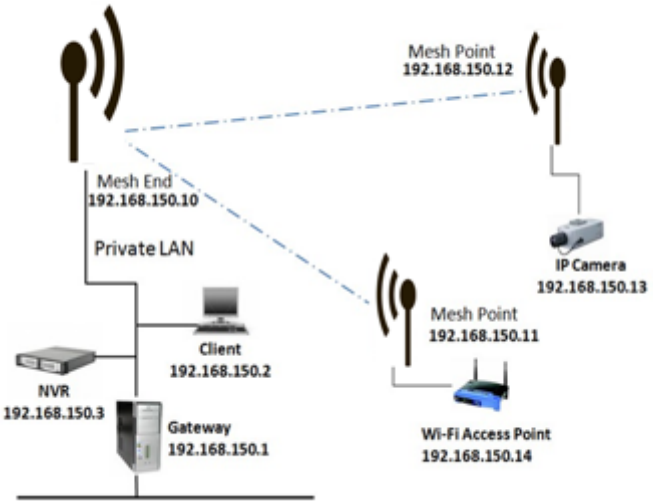



**Fig. 5.2 - Fluidmesh Network Addressing**

### 5.2.1 Network Addressing

The Fluidmesh layer 2 addressing allows configuring each FM unit and each device connected to the FM units according to the IP address class used within the private LAN to which the **Mesh End** unit is connected. A sample network configuration is shown in Fig. 5.2.

The Fluidmesh network logically becomes part of the private LAN where (usually) the control room resides. Therefore, both the FM units and any other edge device should be provided with a private LAN IP address and will be accessed through that specified IP address.

Consider the layout in Fig. 5.2 where the private LAN IP address class is 192.168.150.0 with netmask 255.255.255.0. Each device is configured with an IP address belonging to this class.

Please note that each IP address must be univocal within the entire network to avoid address conflicts. The **default IP address** of each FM unit is 192.168.0.10 with netmask 255.255.255.0. Finally, please note that the default factory-set 5.a.b.c unit IDs are still valid and used to unambiguously identify each FM unit.

Multiple FM units can be connected together through a network switch to form clusters of radios if needed. The Fluidmesh proprietary routing proto-col will be run automatically on the cabled segment of the network. Please note that the units must be operated in **Mesh Point** mode only to activate the cluster feature.

### 5.2.2 Connecting and Configuring an Ethernet Edge-Device

The FM unit Ethernet ports can be used to connect all kinds of Ethernet edge devices (e.g. IP Cameras, Video-Servers, Wi-Fi Access Points, etc.). Any Ethernet device can be configured either manually or automatically through a DHCP server residing on the LAN network. The Fluidmesh network is totally transparent so DHCP requests and responses are forwarded transparently across the network.

A manual IP setting is recommended in any video-surveillance system where the cameras need to have a fixed custom IP address to be accessed by the video-recording software.

### 5.2.3 VLAN Tagging (Software Plug-In Required)

Virtual LAN (VLAN) tagging (or IEEE 802.1q) is a networking standard allowing multiple switched networks to transparently share the same physical hardware without the leakage of information between networks. For example, consider a company with several departments. With VLAN tagging, a separate private logical network is made available for each department while using only one physical corporate network. Each VLAN is identified by a specific number called VLAN ID (VID) which is also used for tagging packets belonging to the same VLAN. Because VLANs are based on logical instead of physical connections, several types of VLANs exist based on the criteria adopted to logically separate networks. The traditional VLAN scheme is port-based where each physical Ethernet port is configured specifying membership in a VLAN. However, if there are requirements that individuals or devices must be segregated regardless of their physical location, the MAC-based VLANs can be used. In this case, the network is configured with an access list mapping individual MAC addresses to VLAN membership. Other, less common, types of VLANs exist like the protocol based VLANs, where the protocol type is used to separate networks. VLAN tagging is usually supported by network switches with advanced capabilities. The wireless networks can be viewed as a large distributed switch with VLAN support. Two different types of VLAN tagging mechanisms are supported: port-based and mac-based VLANs. Fig 5.3 reports a network configuration example where two VLANs are set up, i.e. using VID #2 and VID #3. Each VLAN uses a separate IP address class and the devices belonging to the VLANs must be configured accordingly.

The Fluidmesh VLAN implementation is compatible with the specification of the IEEE 802.1q standard and, thus, the Fluidmesh network can interoperate with other VLAN-aware network devices. VLAN trunking between the Fluidmesh network and the Ethernet switches is also supported to enable carrying VLAN membership information throughout the wireless and wired network segments.

The VLAN tagging can be enabled and configured through the Web interface as described in Section 7.11.1.

### 5.2.4 Multicast Streaming

To enable multicast video-streams from IP cameras or video-encoders, no multicast group setting is required. Every multicast packet will be forwarded by the **Mesh Point** unit towards the closest

**Mesh End** unit. Please refer to Section 7.15 for additional details.

# 6 Software Plug-Ins

The Fluidmesh 4500 FIBER (part number FM4500F-HW) feature the innovative FluidThrottle™ technology which provides a variable software-upgradable capacity of the Ethernet port based on the user's needs.
Please refer to a Fluidmesh representative for the full upgrade list.

| Part Number | Description | FM4500 |
|---|---|---|
| FM-AES | AES Encryption | ✓ |
| FM-VLAN | VLAN Plug In | ✓ |

**Table 6.1 - Software Plug-In Upgrades**

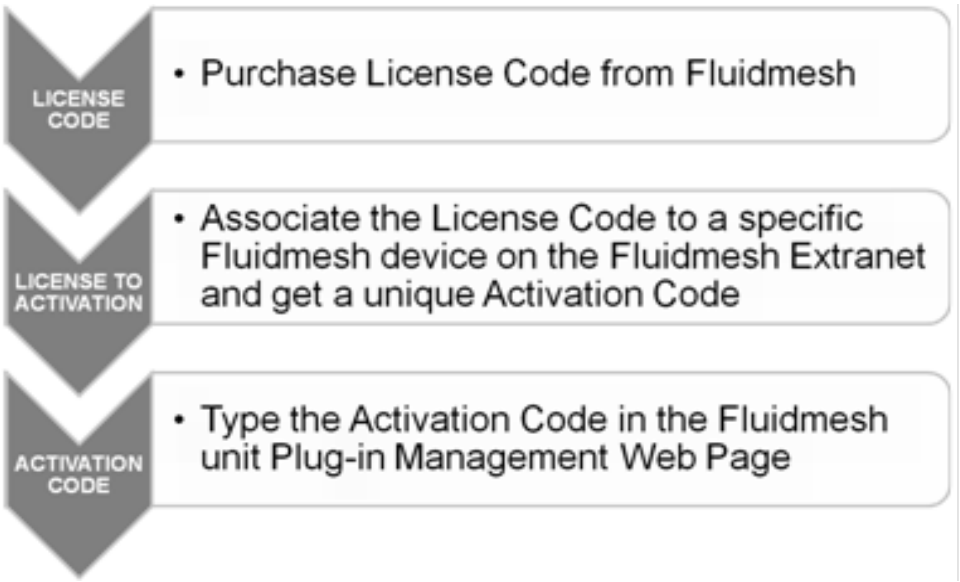



**Fig. 6.1 - Plug-In Installation Procedure**

Additionally, the FM3200, the FM1200 and the FM4500 can be upgraded to support the AES industry-grade data encryption, the 4.9 GHz U.S. public safety band[3], Fluidity, the L2TP tunneling, the Virtual Gigabit. Fluidity, Virtual Gigabit are described in specific user guides. A summary of the available Plug-ins for the FM units is reported in Table 6.1.

[3] Not available in Brazil and Canada.

## 6.1 Plug-In Activation/Deactivation Procedure

The Plug-in management procedure has been standardized for maximum flexibility as follows. When a customer purchases a Fluidmesh Plug-in, a generic 16-digit License Code is provided. Because the License Code is generic and not associated with any device, it needs to be activated before it can be used on a Fluidmesh device. In order to activate a License Code, the user can access the Fluidmesh website[4] (www.fluidmesh.com) and bind the License Code to the specific Fluidmesh Unit ID or Fluidmesh Product Serial Number to which the Plug-in should be applied. By doing so, the Fluidmesh website will provide the user with a specific eight digit Activation Code that can be applied to the specific device to activate the Plug-in functionalities. The overall process is depicted in Fig. 6.1.

Fig. 6.2 depicts the Fluidmesh Web extranet interface to generate Activation Codes available at www.fluidmesh.com. As indicated, the purchased License Code must be bound to the unit's unique ID (both the unit ID and the Serial Number are accepted) in order to get the Activation Code. Please refer to Section 7.13 to input the Activation Code into the unit Web interface.

To provide the maximum flexibility in the Plug-in management, Fluidmesh allows the deactivation of any installed Plug-in in order to transfer it to another Fluidmesh unit. Specifically, each Plug-in can be deactivated via the Web interface of the unit according to the procedure described in Section 7.13. A Deactivation Code is provided by the unit which can be input in the Fluidmesh Plug-in Management Web Page on Fluidmesh Extranet to generate a fresh License Code as depicted in Fig. 6.3. The latter can then be used to generate a new Activation Code to activate the Plug-in for a different unit.

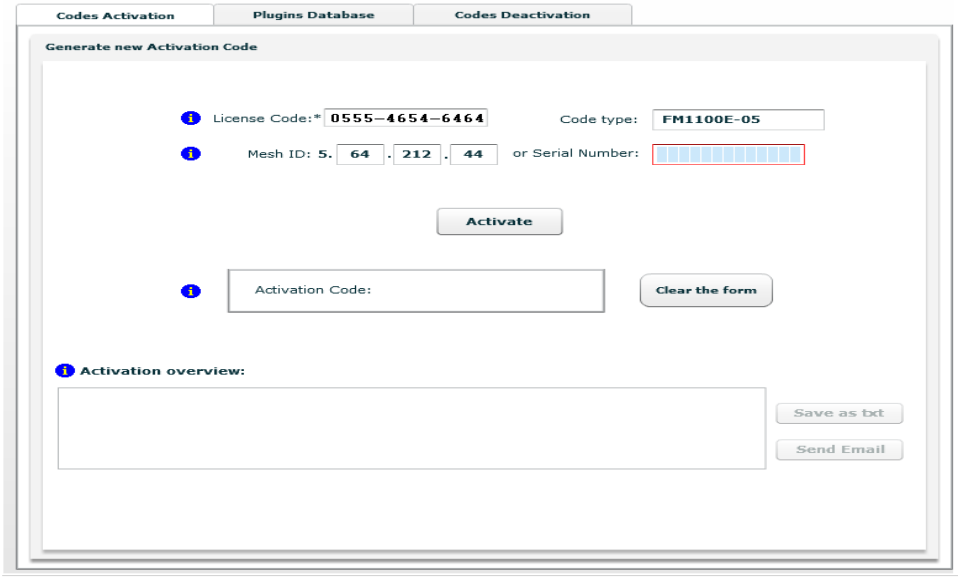



**Fig. 6.2 - Plug-in Activation**

[4] In order to access the Fluidmesh extranet, users need to register on the Fluidmesh website at www.fluidmesh.com. Registration is free of charge.

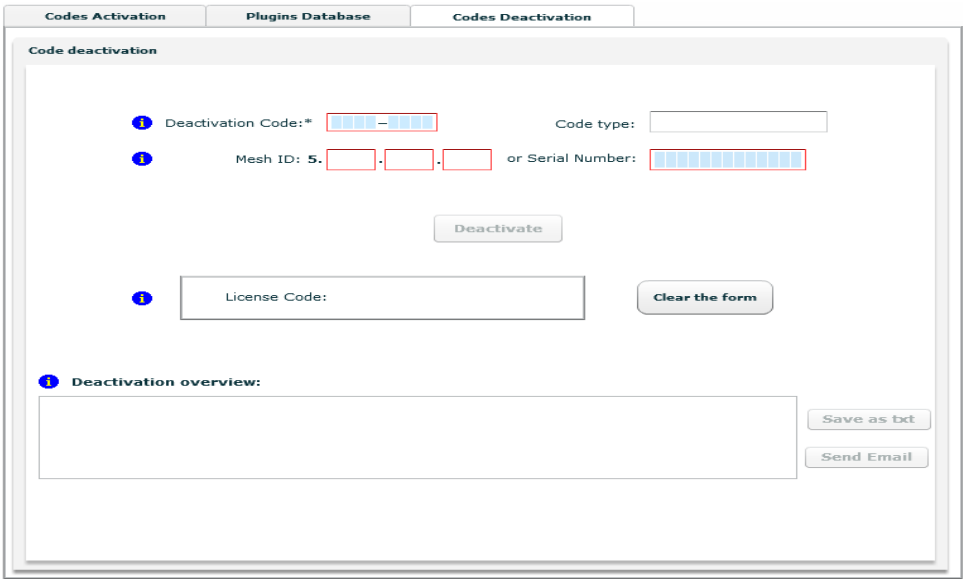



**Fig. 6.3 - Plug-in Deactivation**

**Activation/Deactivation Code**

Generation Web interface available at www.fluidmesh.com.

# 7 FMQuadro™ Web Based Interface and Configuration

Every FM unit can be configured and managed using a Web-based Graphical User Interface (GUI). By default, each FM unit is configured in **Bridge** Mode with the Bridge IP address 192.168.0.10 and netmask 255.255.255.0.

To change the settings on the units, you need to log-in to the Web- based interface.

## 7.1 Software and Hardware Requirements

To log-in to the Web GUI, you need a PC with a Web-browser, an Ethernet port, and an Ethernet cable.

Requirements List:

- Cat5 / 6 Ethernet cable with RJ45 connectors.
- PC with the following characteristics:
  - Windows XP or Windows 2000. In this manual, we assume use of Windows XP and every instruction or screenshot is based on this assumption. The device can also be configured using other operating systems, such as Linux, MAC OS, or older versions of Windows.
  - Chrome. In this manual, we suggest theuse of Chrome. A Fluidmesh device can also be configured using other browsers such as older versions of Internet Explorer, Firefox or Safari but the configuration using these browsers has not been thoroughly tested.
  - Wired Ethernet Network Card.
  - Hardware Requirements. Typical PC hardware allowing for proper operations of Windows XP and Microsoft Internet Explorer 6.

## 7.2 Logging Into The Web-Based Interface

Power up the device and wait for about one minute for the initialization to be completed. Connect an Ethernet cable with RJ45 connectors between a computer and the Fluidmesh device that you want to configure.

Configure the wired Ethernet port of **your** computer according to the de-fault class "C" IP address of the device, e.g., IP: 192.168.0.30, Netmask: 255.255.255.0.

If you do not know how to configure your Windows PC, please refer to Section 8 where the manual IP configuration process is described. Disable the **Access the Internet using a proxy server** function. To disable this function, go to **Control Panel** > **Internet Options** > **Connections** > **LAN Settings** and uncheck the Enable box. Disable the wireless Wi-Fi card of your PC if present to avoid routing issues between the two network interfaces of your computer. Open a Web browser such as Internet Explorer and type the following URL:

*http://192.168.0.10*

Please use http:// for FM3200 / FM1100 radios and https:// for FM1200 A log-in form asking for a username and a password should appear as shown in Fig. 7.1.

To preserve the security of your system, make sure you change the default password once the entire installation is completed. In case the log-in form does not appear, please refer to Section 8.

The default username and password are:

**Username**: admin
**Password**: admin

**Fig. 7.1 - Log-In Window**

## 7.3 End-User License Agreement and Region of Operation

The first time you log-in, you will be asked to accept the terms of the end-user license agreement and select the country where you will be operating the unit (Fig. 7.2 is an example for an FM4500 unit). You must accept the terms of the license agreement in order to activate the device. If you do

not wish to accept the terms of the license agreement, please turn off the unit and contact Fluidmesh Networks. Choosing a wrong country/regulatory domain setting may lead to an illegal wireless configuration.

Once the license is accepted, the unit can be configured. Two configuration methods are available as shown in Fig. 7.3(a): MeshWizard™ and Classic. The former consists of a simple four step wizard to configure the basic settings of the unit (see Section 7.4), whereas the latter is the classic Fluidmesh FMQuadro for advanced configuration (see Section 7.5).

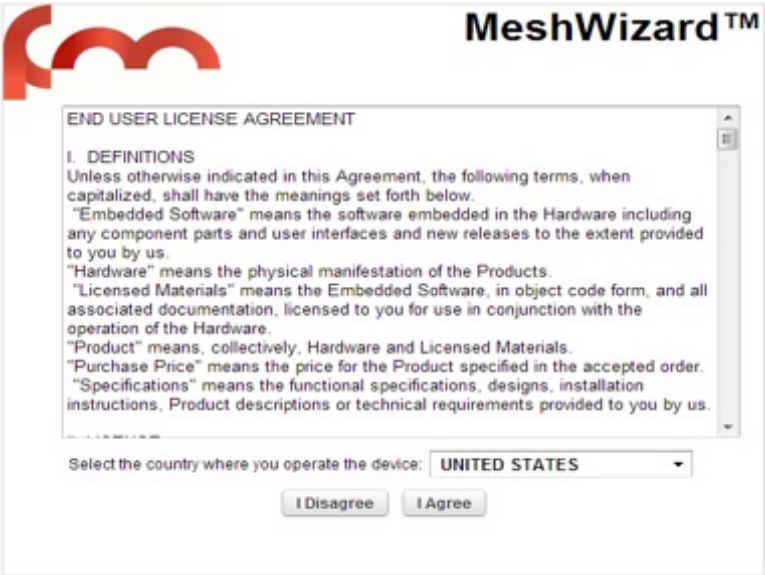



**Fig. 7.2 - End-User License Agreement**

## 7.4 MeshWizard™

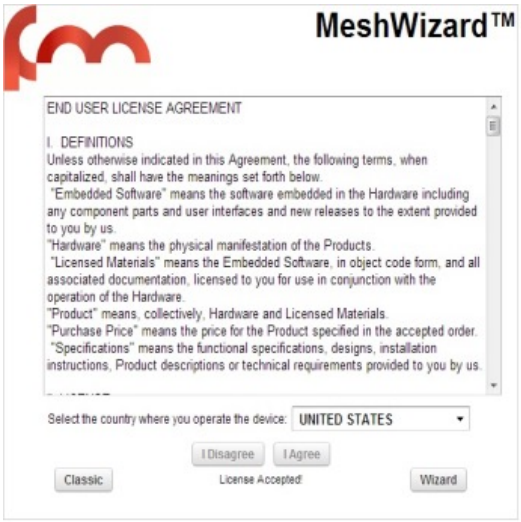
MeshWizard is a simple yet effective tool to configure the basic settings of an FM unit based on the following four steps:

Step 1, Figure 7.3(a): click on the "Wizard" button to start configuring the unit;

Step 2, Figure 7.3(b): unit IP configuration;

Step 3, Figure 7.3(c): wireless radio frequencies configuration;

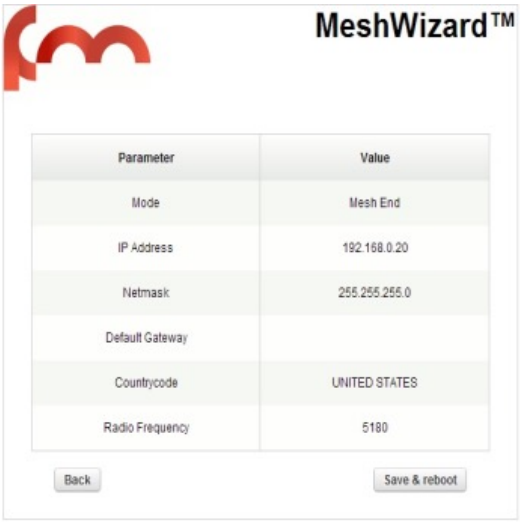
Step 4, Figure 7.3(d): settings summary and configuration save.




(a) Step 1

(b) Step 2

(c) Step 3




(d) Step 4

**Fig. 7.3 - MeshWizard™ FM Unit Configuration Steps**

## 7.5 Web-Based Interface Menus

Once logged in successfully, the ***general mode*** page will appear as shown in Fig. 7.4. Through this page you can change the mode of operation of the FM unit. The item list menu on the left can be used to set/ modify the configuration of the unit.

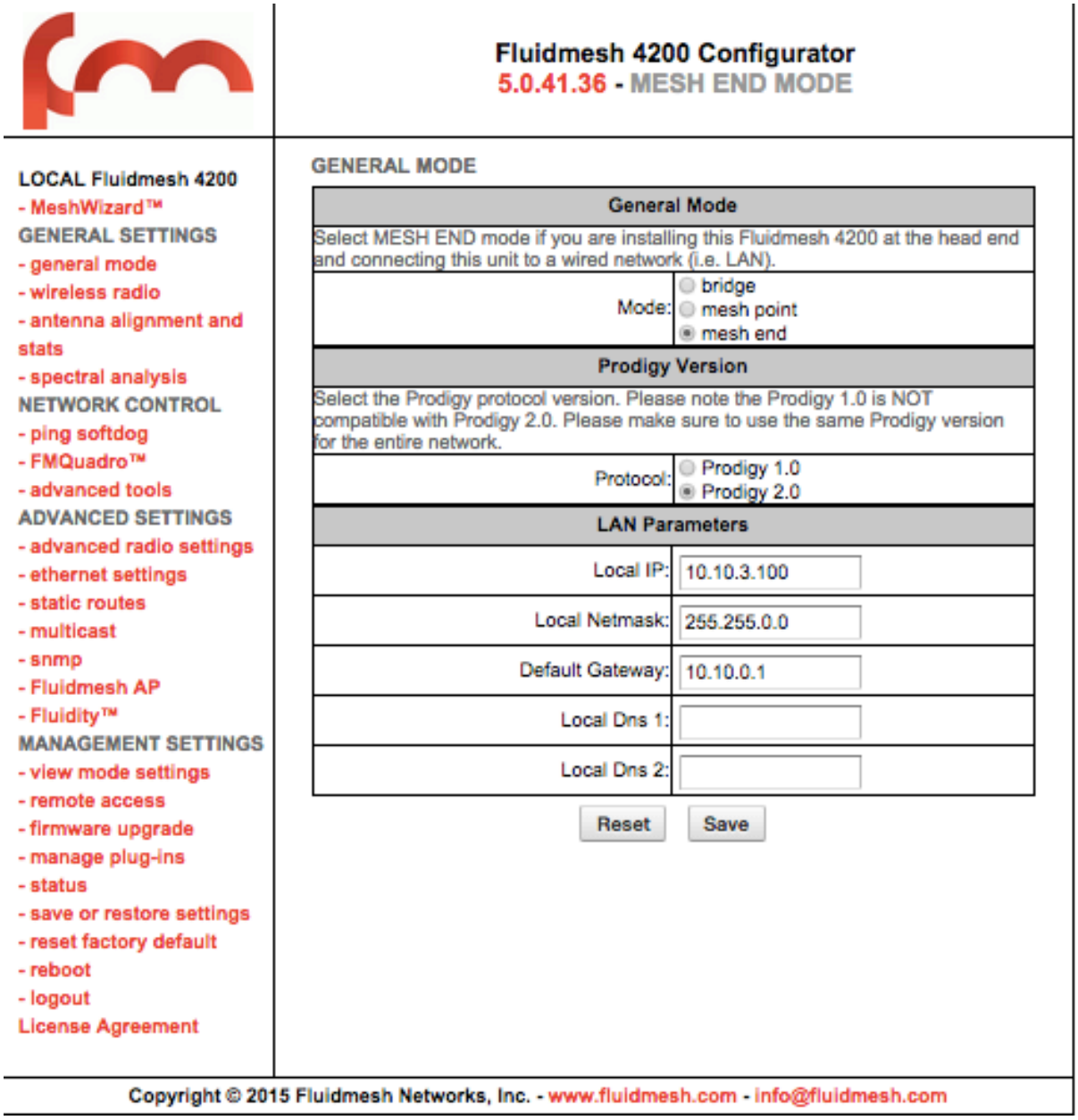



**Fig. 7.4 - FM Unit General Configuration Window**

## 7.6 General Mode

Firmware version 6.5 supports both Prodigy 1.0 and Prodigy 2.0. **Prodigy 2.0 is NOT compatible with Prodigy 1.0.** The protocol selection can be done, for back-compatibility, using the FMQuadro General Mode Configuration page. **Please make sure that all the units within the same**

**network use the same protocol version. No mixed operation of Prodigy 1.0 and Prodigy 2.0 are allowed**. In case of expansion of current network deployments two options are available:

1. Setting the newly added units with Firmware 6.5 or above to operate in Prodigy 1.0.
2. Upgrading the previously deployed units with a Firmware 6.5 or above and set them to operate in Prodigy 2.0.

We recommend option 1.if there is no specific issue in the network.

Every FM unit has three possible modes of operations:

- Bridge Mode
- Mesh Point Mode
- Mesh End Mode

The FM unit factory default mode is **Bridge**. The **Mesh Point** mode must be used for any unit deployed in the field. On the other hand, the FM unit must be set in **Mesh End** whenever it is connected to the main cabled network where the control room (usually) resides. You will need to input the settings of the wired network (LAN) to the FM unit that will be connected. The default IP address of the FM unit is 192.168.0.10 and the default Netmask is 255.255.255.0. If you do not know the LAN settings, contact the local network administrator before changing the settings of the gateway.

Please remember that a Mesh End unit is always necessary for the correct mesh network operations, even for small networks (e.g., 2 FM units).

## 7.7 Wireless Settings

The wireless settings menu is used to configure the radio present in the FM unit and can be accessed by clicking on ***wireless radio***. The wireless settings menu is available in either *Basic* (Fig. 7.5) or *Advanced* mode (Fig. 7.6). The former provides the basic radio configuration options whereas the latter can be enabled by expert users for tuning the radio channel width or using non-standard carriers. The following wireless parameters are available:

**Shared Passphrase:** The shared passphrase is a shared secret that must be set in every FM unit forming a wireless network. Any Fluidmesh device that does not have the correct passphrase will not be able to be part of the network. Different passphrases can also be used to create separate Fluidmesh networks in the same area and sharing the same frequencies. Passphrase secret is also used for setting the Fluidmesh proprietary encryption secret.

**Country:** You need to specify the **country** where you will operate the unit. Different countries have different telecommunications regulations. Setting the country properly allows you to operate in compliance with national regulations. The available frequencies and other settings related to the RF operation will vary based on the selected country. Choosing the wrong country/ regulatory domain may lead to an illegal operation of the unit.

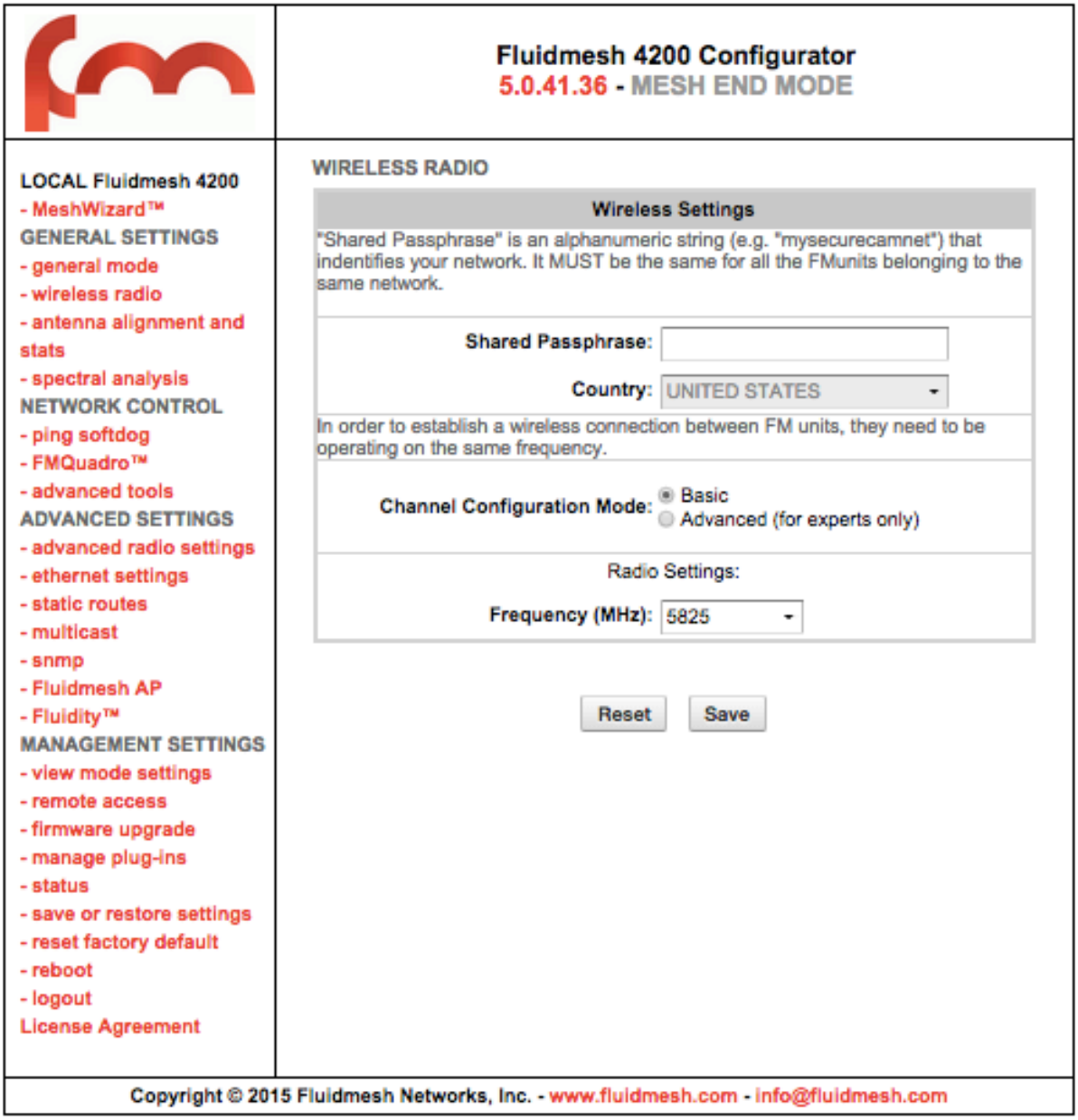



**Fig. 7.5 - Wireless Parameters Configuration-Basic Mode**

Please make sure the country has been properly specified before changing the frequency of the system.

**Frequency Selectors:** All Fluidmesh units are equipped with multi-band radios capable of operating on the 4.9-6 GHz bands[5]. You can change the frequency of each radio in order to minimize interference with other wireless networks operating in the same area. The frequencies listed on the Frequency Selector are the carrier frequencies. Please note that when the unit is forced to be "SLAVE" of a point-to-multipoint topology, the frequency is NOT selectable. In fact, the SLAVE will scan for the relative "MASTER" according to the configuration of the "MESH Cluster ID" described in Section 7.8. The frequency selector in Mesh Point configured as slave will be available by unchecking the autoscan box in advance radio settings page.

To avoid network co-location interference it is advised to have the frequencies as far apart as possible.

[5] 4.9 GHz must be enabled through the proper software plug-in. Please refer to Section 7.13 for details. Not available in Brazil and Canada.

Before deploying your network, you need to plan frequency allocation on each link. A good rule of thumb is to use the narrowest possible channel that can support the amount of throughput needed and separate the channels as much as possible. Although two radios are not on the same channel, they can still interfere with one another because of the side lobes. It is also good practice to space the radios vertically as far apart as possible one from the other with a minimum of 3ft., ideally 5ft. Mounting radios back to back or side by side is not a good practice as it may lead to co-location interferences and will strongly affect the performance of your network.

In Advanced mode, the following selectors are also available:

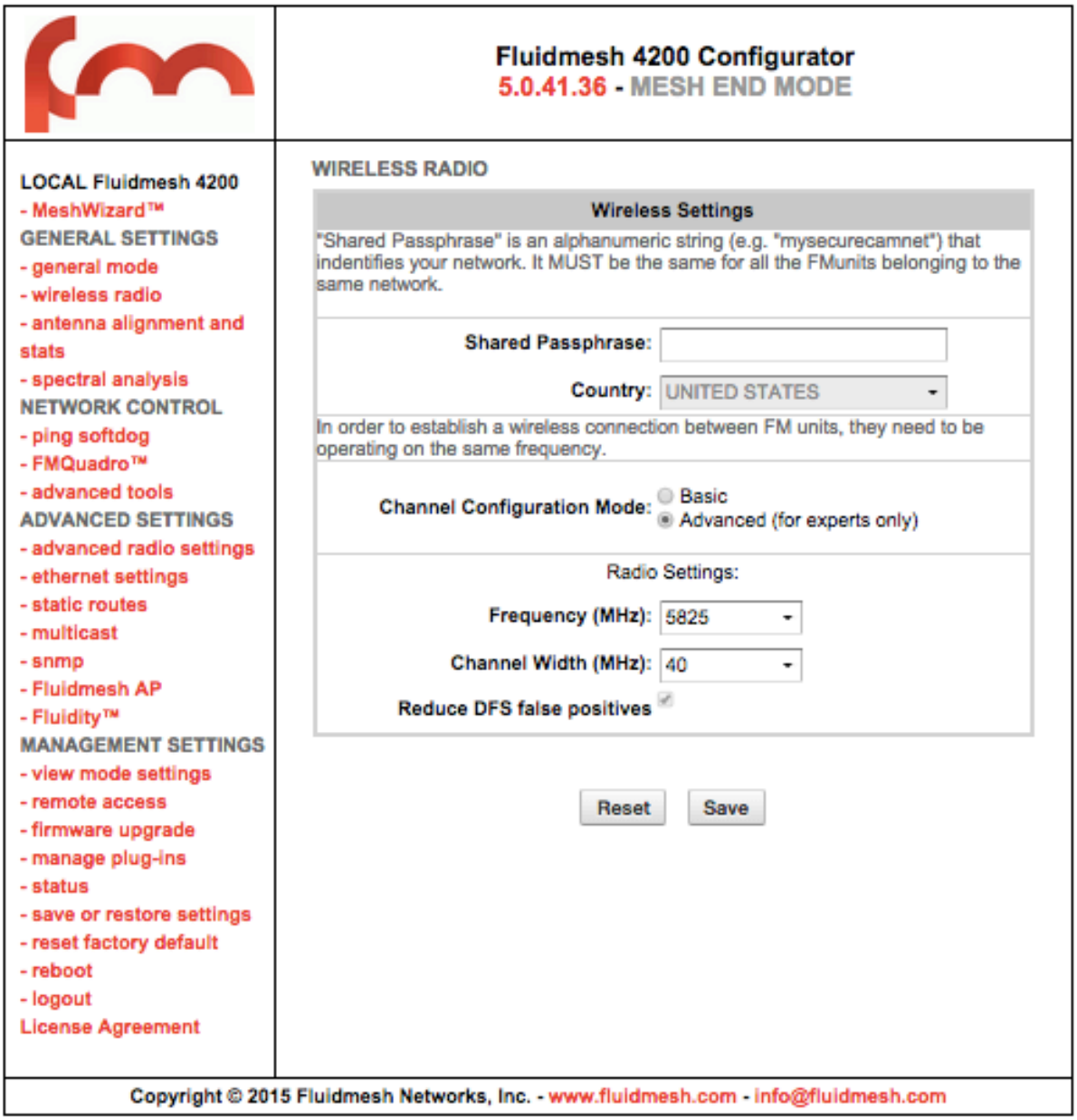



**Fig. 7.6 - Wireless Parameters Configuration. Advanced Mode**

| Width | Modulation Speed | Throughput |
|---|---|---|
| 5 MHz | 37 Mb/s | 8 Mb/s* |
| 10 MHz | 75 Mb/s | 16 Mb/s* |
| 20 MHz | 150 Mb/s | 90 Mb/s* |
| 40 MHz | 300 Mb/s | 90 Mb/s* |
| 40 MHz ** | 300 Mb/s | 150 Mb/s |
| 80 MHz | | |

**Table 7.1 - Available Radio Channel Widths**

* Throughput mentioned above is in ideal conditions. Actual throughput may vary depending on environmental conditions.
** With Virtual Gig Plug-in enabled.

Channel Width: **The width of the operating radio channel can be set through this selector. The available options are described in**

Table 7.1 where the theoretic data rate and the achievable throughput are also indicated for each channel width.

Whenever possible, setting the radio to operate on a narrower channel can be useful to reduce the interference in the network and to increase the number of available channels. Please remember to set the **same** channel width on both sides of the wireless link. A channel width mismatch will prevent the FM units from communicating properly. Please note that changing the channel width may violate the local telecommunication authority's guide-lines and lead to illegal wireless operations.

**IN NO EVENT SHALL FLUIDMESH NETWORKS, INC. BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES, WHETHER BASED ON TORT, CONTRACT, OR OTHERWISE, ARISING OUT OF OR IN CONNECTION WITH IMPROPER USE OR OPERATION OF THE CHANNEL WIDTH FUNCTIONALITIES.**

**DFS Management:** Each device implements a proprietary distributed channel switching algorithm which is used when radar is detected to comply with the Dynamic Frequency Selection (DFS) international regulations. Upon radar detection, two communicating Fluidmesh units agree to switch to the next radar-free channel so that they can continue to communicate on that channel. The DFS is automatically enabled in the following frequency ranges: 5.250 GHz – 5.350 GHz and 5.470 GHz – 5.725 GHz. The DFS management can be manually disabled. The number of detected radars is reported as well. Outside these mandatory frequency bands, the DFS is not required and it is disabled by default. Please note the DFS is required by law in many countries and by disabling it you might incur fines and criminal charges by the local telecommunication authorities.

**IN NO EVENT SHALL FLUIDMESH NETWORKS, INC. BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES, WHETHER BASED ON TORT, CONTRACT, OR OTHERWISE, ARISING OUT OF OR IN CONNECTION WITH IMPROPER USE OR OPERATION OF THE DFS FUNCTIONALITIES.**

| Option | Specification |
|---|---|
| AUTO | The FluidMAX engine is enabled and the unit role is set automatically. |
| MASTER | The FluidMAX engine is enabled and the unit role is set to MASTER. This is used to force the FluidMAX role of the Fluidmesh unit at the center of the star topology to be a MASTER. |
| SLAVE | The FluidMAX engine is enabled and the unit role is set to SLAVE. This is used to force the FluidMAX role of the unit which is NOT the center of the star topology to be a SLAVE. |
| OFF | The FluidMAX engine is disabled. |

**Table 7.2 - FluidMAX Management Options**

## 7.8 Advanced Wireless Settings

The advanced wireless settings menu (Fig. 7.7) can be used to configure the following advanced wireless parameters:

**FluidMAX Management:** Although the FluidMAX engine automatically selects the most appropriate MAC protocol to be used according to the detected network topology, convenient selectors are included in the FMQuadro to force the FluidMAX operations and control the FluidMAX role of the unit. Please refer to Table 7.2 for the available options and their specification. When the units are set to be Master or Slave, an additional setting must be specified: "Mesh Cluster ID". The Mesh Cluster ID is used to associate the specific slave with a Master. Once the Mesh Cluster ID is set, the slaves will scan the frequencies searching for the correspondent Master unit. This feature can be extremely useful during network planning and testing in dense point-to-multipoint networks. In fact, the network administrator will only have to change the frequency of the Master unit to force all the slaves to scan the air and reconnect to the Master with the same Mesh Cluster ID. Please make sure that different point-to-multipoint cluster have different Mesh Cluster IDs or they will be conflicting on the slave perspective leading to unpredictable network topologies.

**Transmission Rate Selection:** Each FM unit implements a proprietary data-rate selection algorithm which is able to adapt to the specific radio channel conditions. Through this setting, it is possible to force the rate selection algorithm to limit the modulation speed at a specific rate. This option might be useful with unstable channel conditions.

**Maximum TX Power:** This setting controls the output power of the radio. By decreasing the output power of a radio, you can decrease the overall E.I.R.P. By default, the radio transmission power is controlled automatically by the innovative Fluidmesh Transmission Power Control (TPC) algorithm. The Fluidmesh TPC algorithm tries to obtain an optimal link signal strength (about -55 dBm) on both sides of the link while not exceeding the maximum TX power which can be set by the user through the selector. Note that the maximum transmission power may vary depending on the operating frequency channel of the radio.

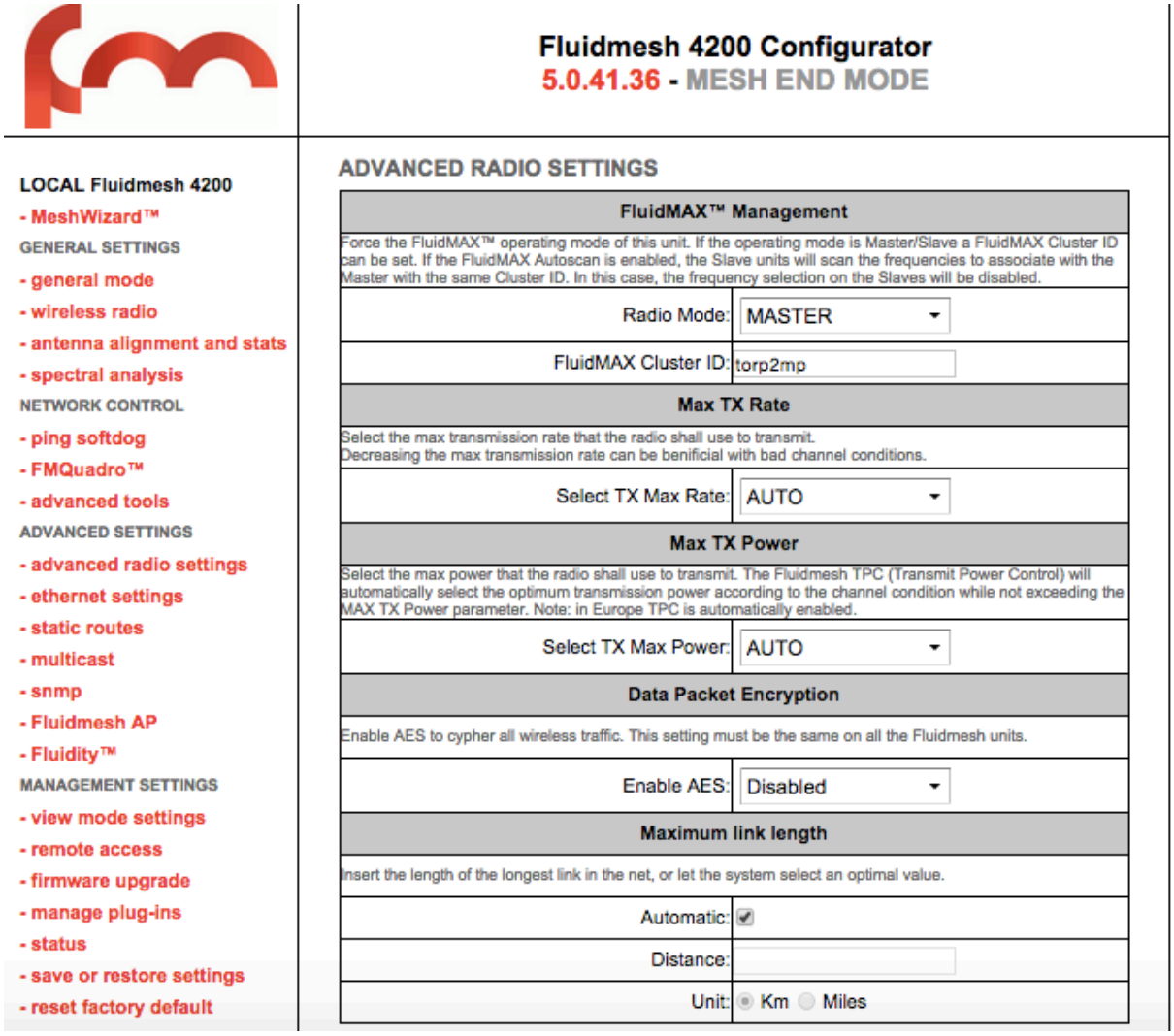



**Fig. 7.7 - Advanced Wireless Parameters Configuration**

**Data Packet Encryption (Software Plug-in Required):** Advanced Encryption Standard (AES) 128 bit encryption can be enabled at the link- level for wireless data transmission. This feature is available in addition to the default Fluidmesh proprietary encoding algorithm for maximum industry-grade network security. A software Plug-in is required to activate this option. Please contact your Fluidmesh Networks' representative for details.

## 7.9 Antenna Alignment Tools and Physical Statistics

The **antenna alignment and stats** page provides a powerful tool which can be used to check the current link status during the normal unit operation and the physical installation of the antennas. Specifically, the web page shows the list of links detected by the local unit and the relative signal strengths (in dBm) on each radio as shown in Fig. 7.8.

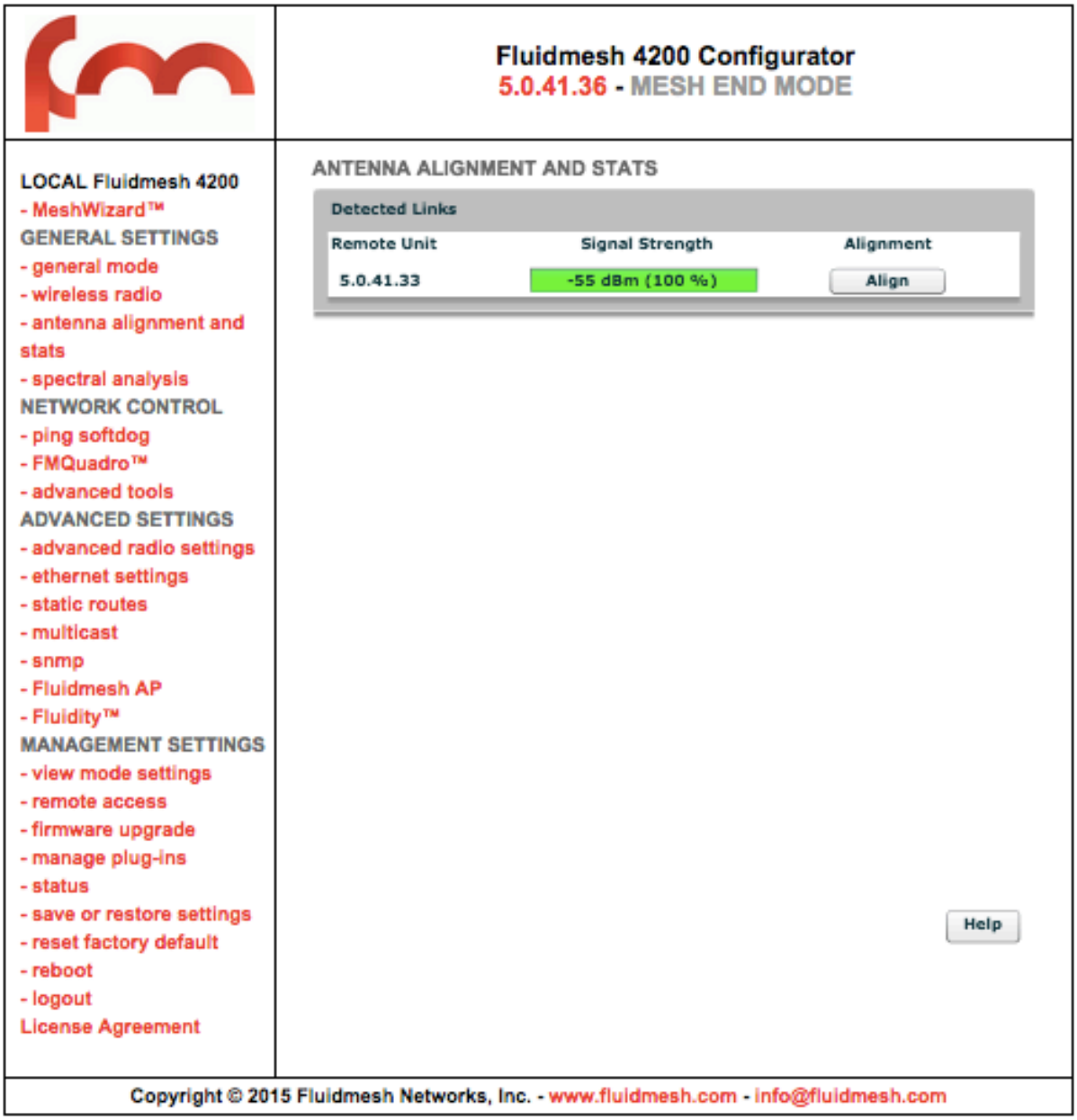



**Fig. 7.8 - Link selection**

To perform an accurate antenna alignment for a specific link, click on the "Align" button to open the antenna alignment tool as depicted in Fig. 7.9.

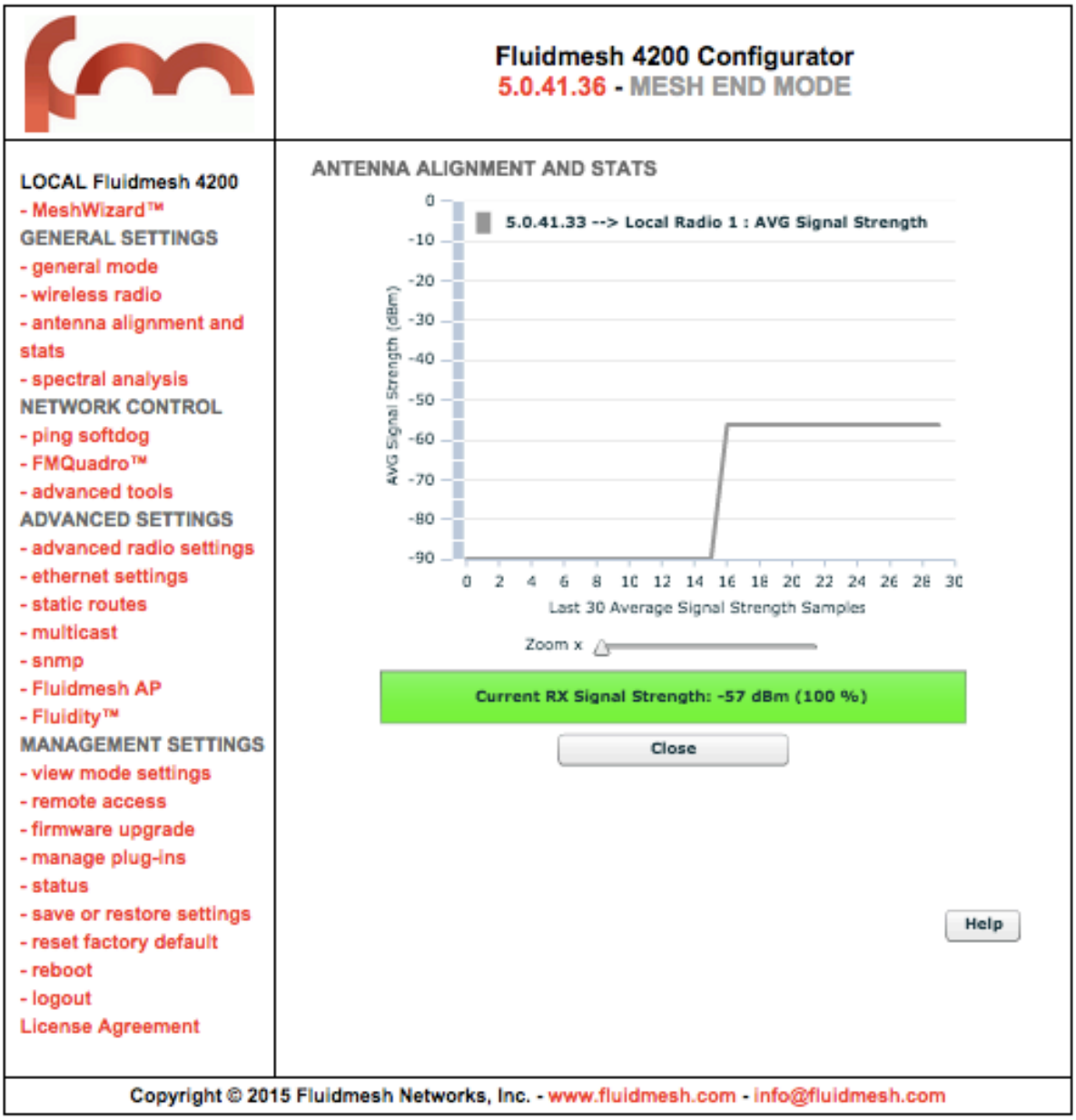



**Fig. 7.9 - Alignment**

The user is warned that the proprietary Fluidmesh TPC algorithm (see Section 7.8) will be disabled during the alignment process so as to avoid unwanted interactions with the tools. The antenna alignment tool consists of a real-time graph and a bar which report the *average signal strength* and the *current signal strength* detected at the local unit receiver, respectively. During the physical antenna alignment process, the graph and the bar can be monitored to obtain optimal link quality.

## 7.10 Frequency Scan Tool

The **Scan Tool** page provides a powerful tool for analyzing the status of the radio interference in the available channels. The channel scan can be started on each radio separately by means of the buttons at the top of the page (see Fig. 7.10). As soon as the scanning is complete, a bar chart will appear indicating the current interference level and the overall quality of each channel.

As shown in Fig. 7.10, each bar in the chart consists of two sections. The black section represents the amount of interference detected in the channel, whereas the colored one gives a qualitative idea of

the status of the channel according to the following table:

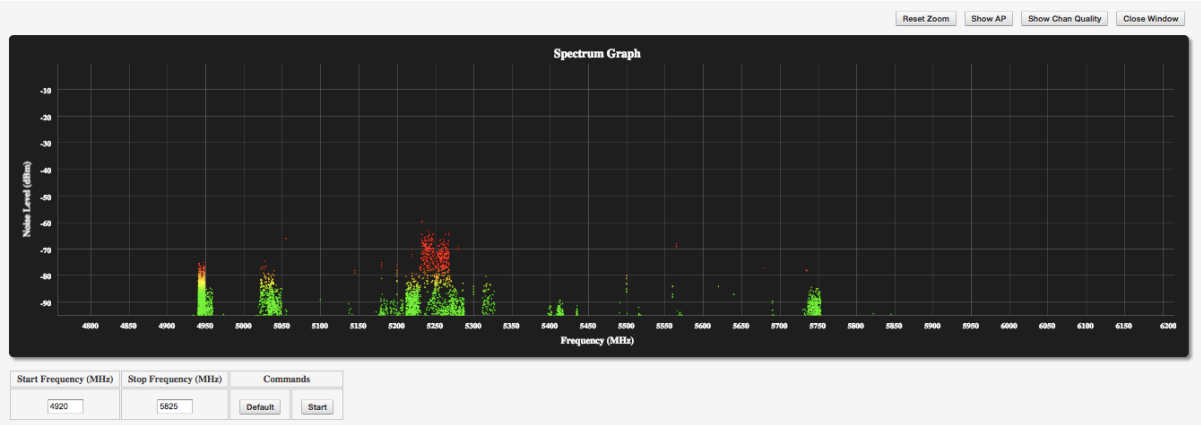



**Fig. 7.10 - Frequency Scan Tool Results**

| Color | Channel Quality |
|---|---|
| GREEN | GOOD |
| YELLOW | FAIR |
| RED | BAD |

**Table 7.3 - Frequency Scan Status**

Additional information such as number of Fluidmesh units and access points detected is available by bringing the cursor of the mouse over the frequency channel bars. Please note that in a network with overlapping channels, the number of Fluidmesh units detected by the scan tool might be higher than the actual number of units deployed.

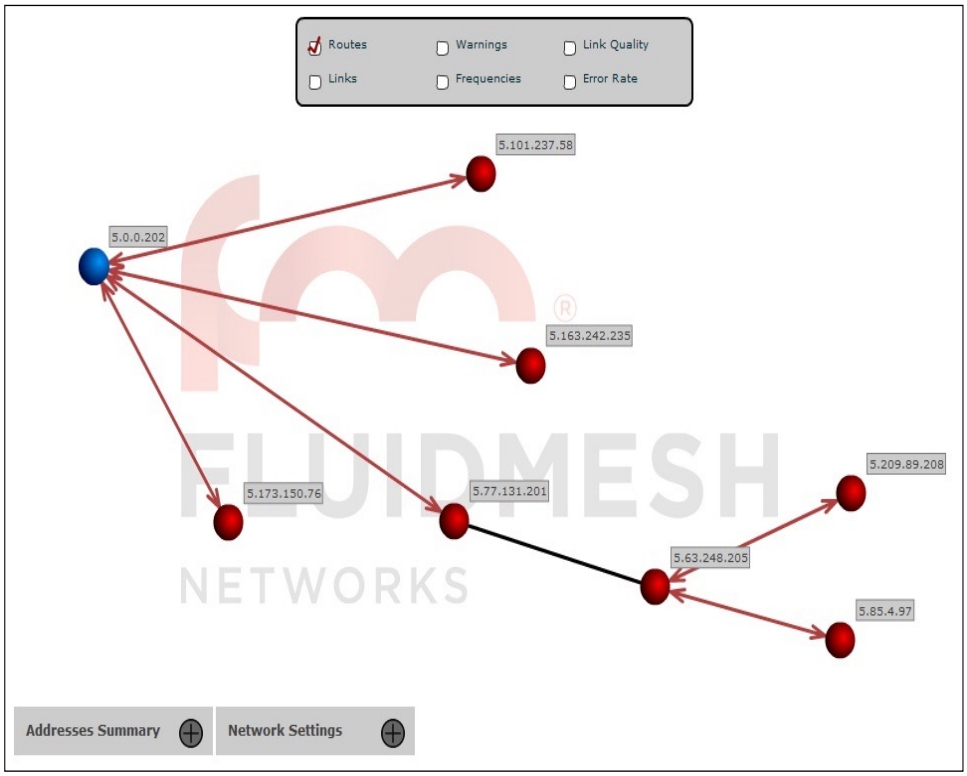



**Fig. 7.11 - FMQuadro™ (Mesh End Only)**

This feature is available only in FM units configured in Mesh End mode. The innovative FMQuadro engine provides an interactive graph representation of the Fluidmesh network where vertices and edges represent FM units and wireless links, respectively, as shown in Fig. 7.11. The links which are currently in use by every packet generated/ relayed by a Fluidmesh device to reach a possible destination in the network (i.e., the routing table) are depicted as continuous lines.

Backup links are depicted as dashed lines, and they are not shown by de-fault. Backup links can be viewed by selecting the appropriate field in the top panel of the FMQuadro window.

This panel also includes other fields which can be selected to display additional always-on link information such as the link frequency, the link error rate, and the link quality.

In the graph, **blue** is the color of a mesh end whereas mesh points are depicted in **red**. The unit color becomes **yellow** if any anomalous condition is detected on the unit.

Each element displayed in FMQuadro is interactive, and can be dragged and/or clicked to get additional real-time information based on the context.

**Fig. 7.12 - FMQuadro, Unit Information**

For example, by clicking on a specific unit, information about the remote unit selected is displayed in a callout as shown in Fig. 7.12. This information includes the Layer 2 IP address, current FluidMAX status of the unit, the radio frequencies currently in use, and the details of the data traffic flows generated by the edge devices connected to the unit.

The list of currently active Plug-ins is visible. Furthermore, any Plug-in Activation Code can be conveniently added to the specific remote unit using the form available in the callout. Finally, current throughput and maximum capacity of the Ethernet port is reported in order to monitor the Ethernet ports utilization and detect whether the Ethernet port is over utilized with respect to the installed FluidThrottle Plug-in.

Similarly, the status of a wireless link connecting any two units can be monitored by clicking on the related line, as reported in Fig. 7.13. Several real-time parameters are displayed including the current signal strength, the packet error rate, and the link utilization of both link directions (i.e. the link from a unit to the other and vice-versa). Additionally, the current congestion level of the link is monitored. A detailed description of the available parameters is reported in Table 7.4.

Visual alarms and warnings are triggered whenever anomalous conditions are detected, as described in Table 7.4. Warnings are of two types: *link* and *unit*. When unit warnings are triggered, the unit color becomes yellow. The warning details are available by clicking on the unit element. The link warnings notification can be disabled by removing the "Warning" flag in the FMQuadro top panel.

| Metric | Description |
|---|---|
| Current TX Rate | Current link transmission rate in Mb/s. |
| Packet Error Rate | Percentage of packet dropped due to excessive transmission errors. |
| Link Error Rate | Percentage of packet retransmissions due to transmission errors. |
| Signal Strength | Current received signal level in dBm. |
| Link Utilization | Percentage of the current link utilization for data transmission in a pie chart format. |

**Table 7.4 - Link Metrics Description**

| Warning | Type | Cause |
|---|---|---|
| Low Signal Strength | Link | Link Signal Strength < 60%. |
| High Error Rate | Link | Packet Error Rate > 5%. |
| High Link Congestion | Link | Link Utilization > 80%. |
| Ethernet Capacity Overflow | Unit | Plug-in capacity exceeded. |
| Hidden Terminal Detected | Unit | Hidden terminal detected by the FluidMAX engine. |

**Table 7.5 - FMQuadro Warning Description**

Through the link status callout, the user can also check the level of interference of the selected link by clicking on the "Check for Interference" button. The link interference is analyzed on both sides of the link by the FMQuadro engine and the interface suggests, in case of detected problems, a set of preferred channel frequencies that the radio link is recommended to be set to.

All the link metrics are continuously monitored by the FMQuadro engine and statistics are logged and can be displayed by clicking on any link metric button, as shown in Fig. 7.14. By default, the last 48 hour's statistics are recorded with a metrics' sampling interval of 5 minutes. The statistics recording time can be increased up to 24 days at the cost of increasing the metrics' sample interval proportionally.

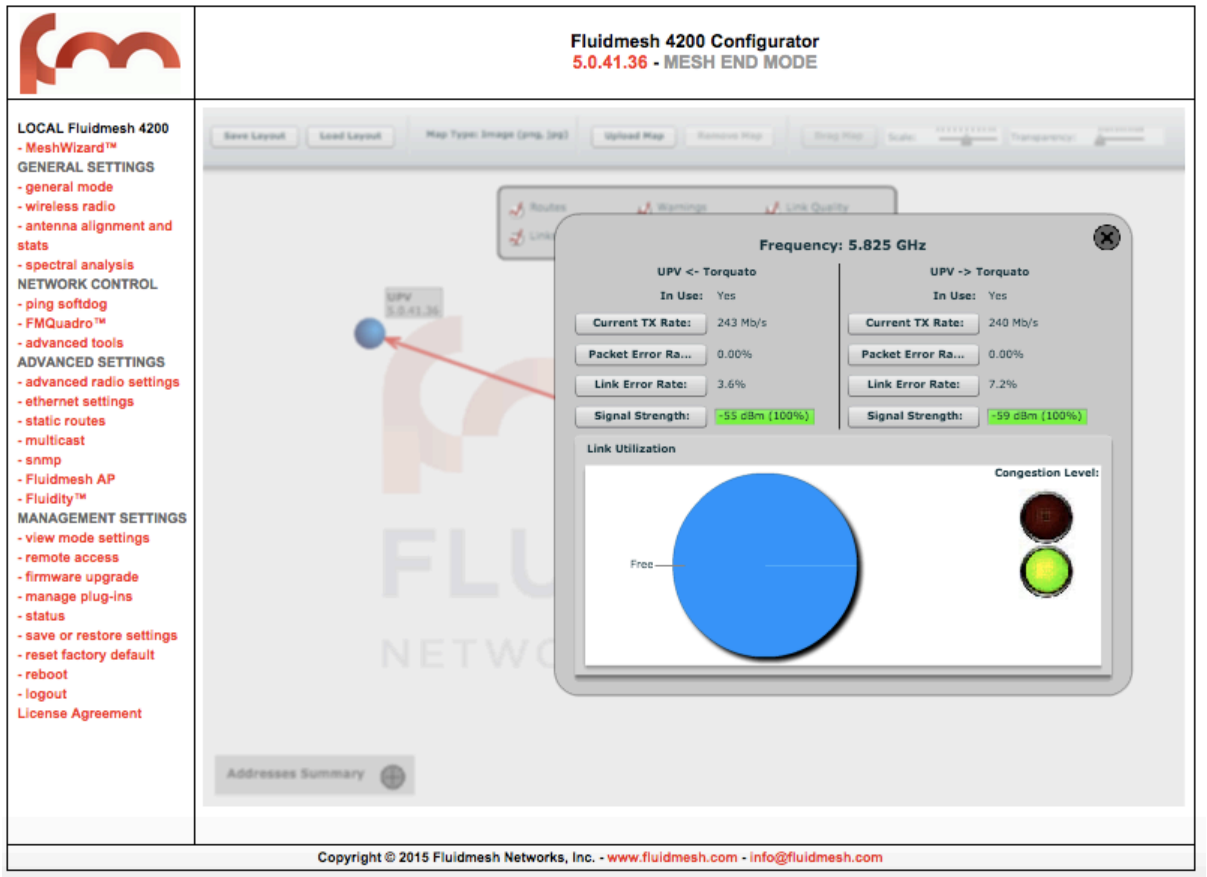



**Fig. 7.13 - FMQuadro, Link Information**

A table, placed at the bottom of the window, reports the network units address summary and can be viewed by clicking on the proper button as reported in Fig. 7.15. It is possible to assign a name to each of the Fluidmesh units. This may be especially convenient with a large mesh network.

Furthermore, through the "Network Settings" table, placed at the bottom of the window, you can check whether the DFS settings are consistent the network, e.g., the DFS is enabled in the all the units. The Network Settings table allows for harmonizing the DFS settings in the whole network with a single mouse click.

FMQuadro is an accurate representation of the network, so it can be useful to add a map of the area in which the Fluidmesh system is deployed[6]. Map images can be uploaded to the Mesh End unit using the proper button placed in the FMQuadro top toolbar. Image format supported is jpg. The file has to be less than 100 KB in size and can be uploaded using IE only. The top toolbar provides several intuitive buttons to drag & drop the background map and control its transparency and

[6] Aerial images can be downloaded using Google Earth (http://earth.google.com/).

scale. Once the map is set up, the FM units can be dragged to their actual installation places. Finally, the modified layout can be saved and used again in the future.

The overall network status and individual device status can be monitored real-time through the FMQuadro interface on Mesh End unit.

**Fig. 7.14 - FMQuadro, Last 48 Hours Link information**

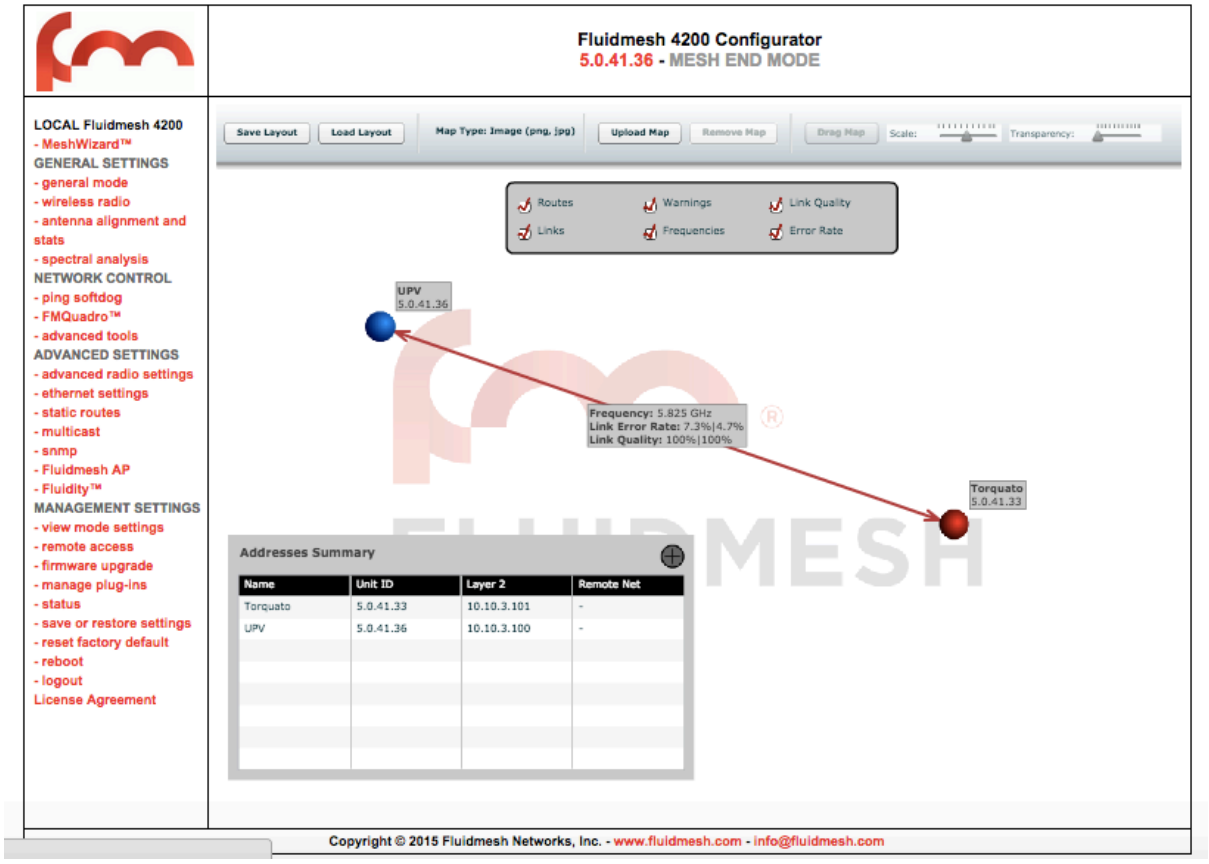



**Fig. 7.15 - FMQuadro, Addresses Summary Table**

## 7.11 Fluidmesh Wi-Fi Access Point

Firmware 6.5 and above feature an embedded Wi-Fi access point (AP) that works together with the standard Fluidmesh mesh interface. The purpose of the embedded Wi-Fi AP is mainly site maintenance and service. By enabling the Wi-Fi AP, it will be possible to connect to the Fluidmesh radios with a standard PC or laptop equipped with a Wi-Fi NIC card. To avoid impacting the performance of the mesh interface, the Wi-Fi access point bandwidth is limited to 5 Mb/s. This can be enough for maintenance, browsing the network and, in this case, for pulling one camera video. Fig. 7.16 reports the configuration page for the Wi-Fi AP. The AP can be enable/disable by clicking on the relative box. By selecting the parameter “Disable SSID Broadcasting”, the user can hide the visibility of the AP by preventing the AP from broadcasting the specified SSID. “AP Security” indicates the encryption mechanism used by the AP to encrypt the communication to and from the clients using the encryption secret “AP Passphrase”. Finally, DHCP parameters must be specified so that the client could be assigned with a proper IP address automatically during the association phase. Please note that for each Fluidmesh radio in the network, the Wi-Fi AP, if enabled, should be configured using a different DHCP IP class so as to avoid IP conflicts between associated clients to different Wi-Fi APs.

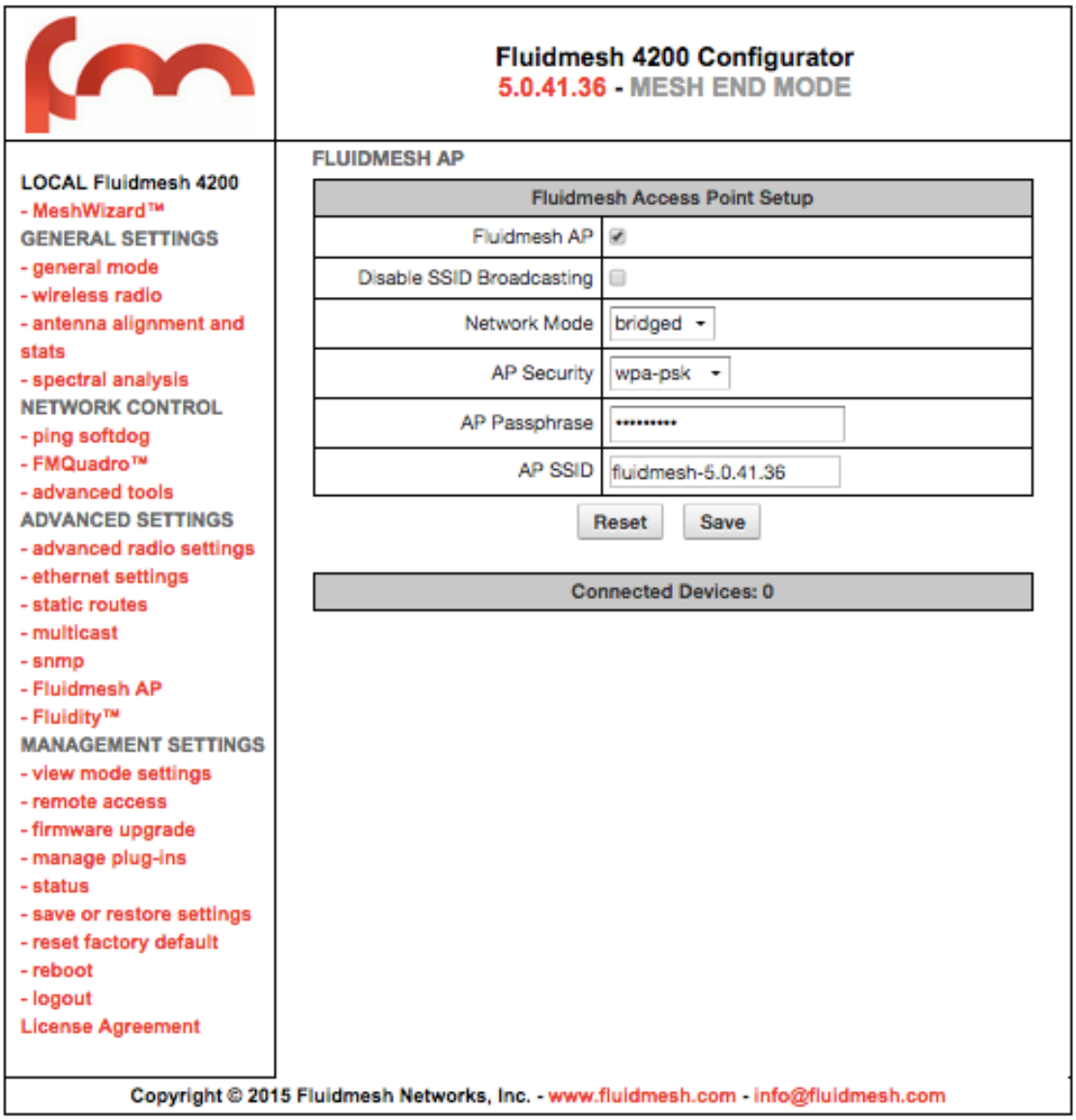



**Fig. 7.16 - Wi-Fi Access Point Configuration Page**

## 7.12 Static Routes

The static routes page can be used to set static routing rules in the radio unit. This option is especially useful with the Wi-Fi AP enabled to allow the connected clients, i) to access other Fluidmesh radios / client devices in the network and, ii) to reach gateways (i.e. Internet gateways).

## 7.13 SNMP

The SNMP page can be used to configure the SNMPv2c service to run on the unit. Both walkthrough and traps operations are supported. In case you are enabling traps on the unit, the SNMP will periodically send out monitoring information to the specified server IP address (NMS hostname) at a specified time interval. Please refer to the Fluidmesh MIB for more details about the SNMP information available for the Fluidmesh units.

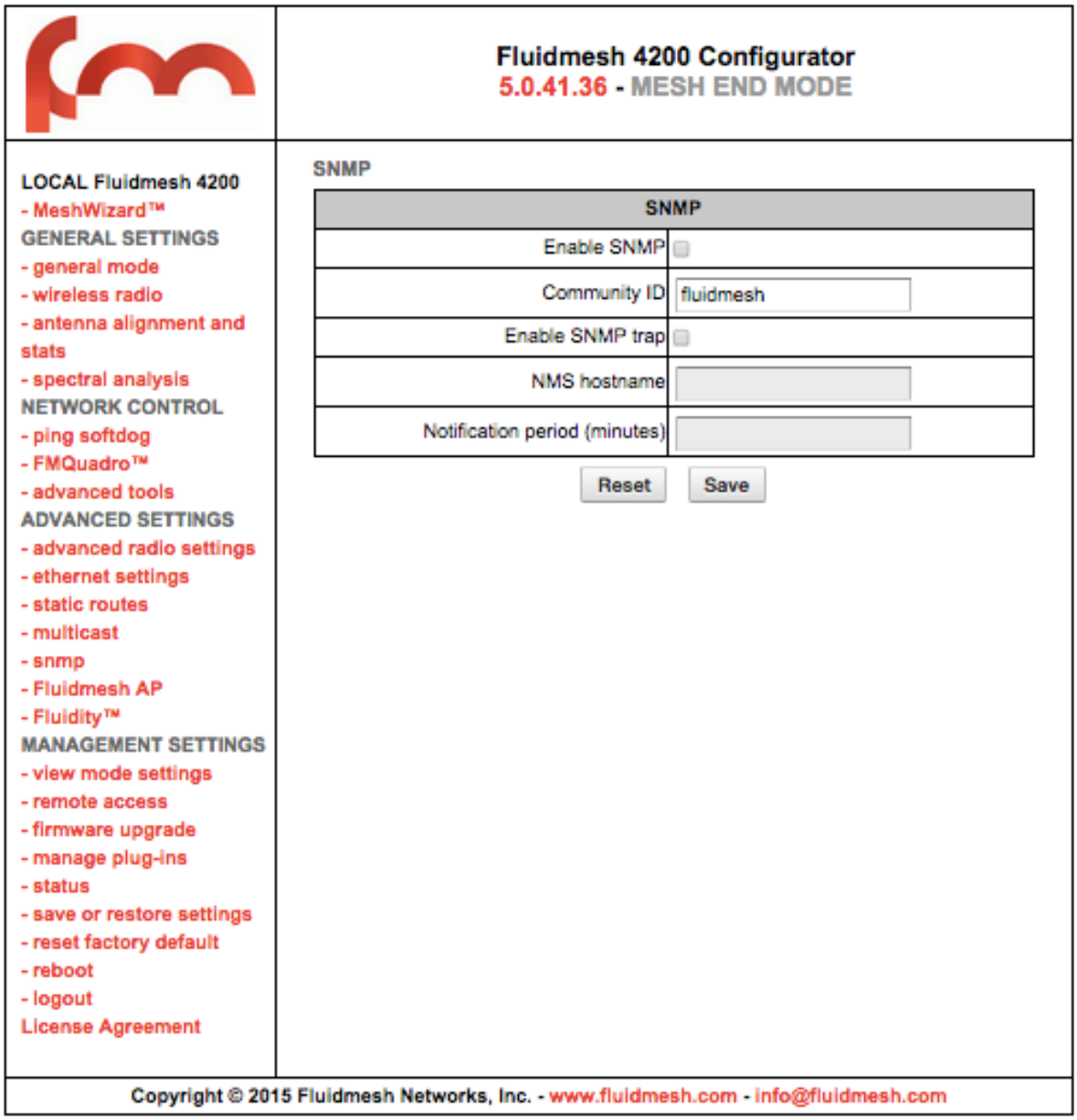



**Fig. 7.17 - SNMP Configuration Page**

## 7.14 Firmware Upgrade

Through the ***firmware upgrade*** page (Fig. 7.18), it is possible to upgrade the Firmware of the devices to the latest version available. To do so, download the latest Firmware upgrade file to your PC from the Fluidmesh Networks Website at www.fluidmesh.com[7]. Select the correct file on your hard disk, and upload it. This operation might take several minutes. The unit will automatically reboot at the end of the upgrade process.

[7] An approved Fluidmesh extranet account is required. Please register for an online account and contact Fluidmesh for approval.

Upgrading a working system is always a delicate and somewhat risky operation. Fluidmesh discourages anybody from upgrading a functional system except if there is an issue to fix.

Recommended upgrading procedure for running systems:

1. Download the latest firmware release available for your hardware/firmware family;
2. Power off the whole network;
3. Power on one device at a time;
4. Connect directly to the Fluidmesh unit to be upgraded directly through an Ethernet cable;
5. Write down the unit configuration (at least network settings and wire- less settings);
6. Upgrade the device with the chosen firmware;
7. Once the upgrade is completed, wait for the system to reboot.

**WARNING: DO NOT RESTART OR POWER OFF THE UNIT WHILE UPGRADING THE FIRMWARE. RESTARTING OR POWERING OFF THE UNIT BEFORE THE UPGRADE IS COMPLETED MIGHT DAMAGE THE UNIT.**

When the upgrade is completed, check the **firmware upgrade** page in order to make sure that the new firmware version has been correctly up-dated. If the firmware version has not been changed, the upgrade process has failed. Therefore, please repeat the upgrade procedure.

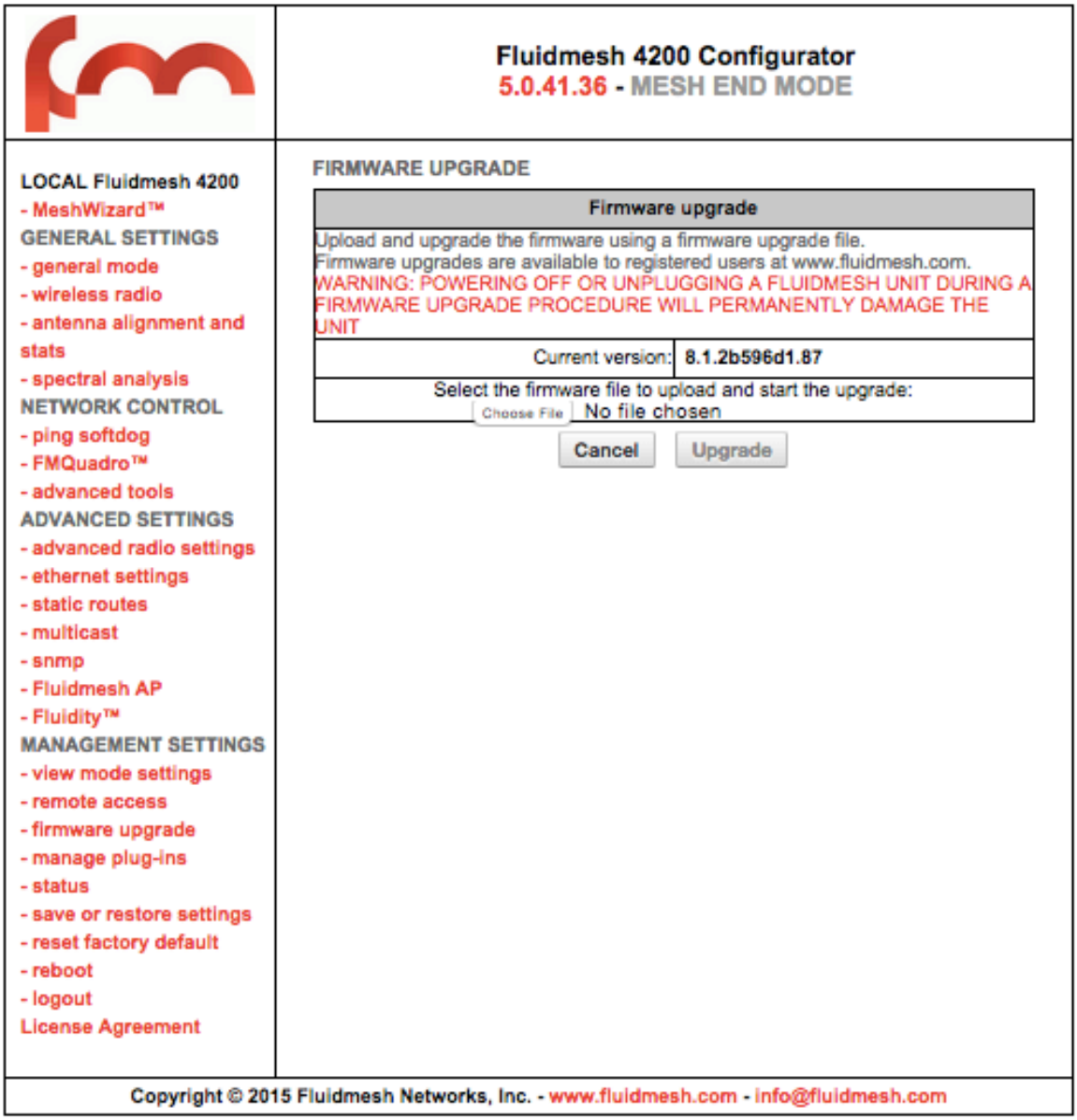



**Fig. 7.18 - Firmware Upgrade Web Page**

## 7.15 Plug-In Management

The **manage plug-ins** page (Fig. 7.18) shows the installed Plug-ins and allows the user to add Plug-in Activation Codes. Additionally, a Plug-in can be deactivated to, for example, transfer it from one unit to another. Once the Plug-in has been deactivated, you will be provided with a Deactivation Code displayed at the bottom of the page. In order to get a fresh Activation Code to use it in another device, you **must** complete the unit deactivation procedure at the Fluidmesh Networks website (www.fluidmesh.com). Please refer to Section 6 for details on the software Plug-in activation/deactivation procedures.

Please check the license code activation video by clicking on the link below. Please note, you need to be a registered member of the website to access this link and to generate activation codes:
http://www.fluidmesh.com/en/support/how-to-videos/viewvideo/13/tech-support/how-to-activate-a-

license-code.html.

An 8 hour Plug-in trial is available by clicking on the "Demo Mode" button at the bottom of the page. The Plug-in demo mode includes the 4.9 GHz[8], the AES and the Unlimited Plug-in trials all at once. The unit will reboot on the 8 hours plug-in trial expiration.

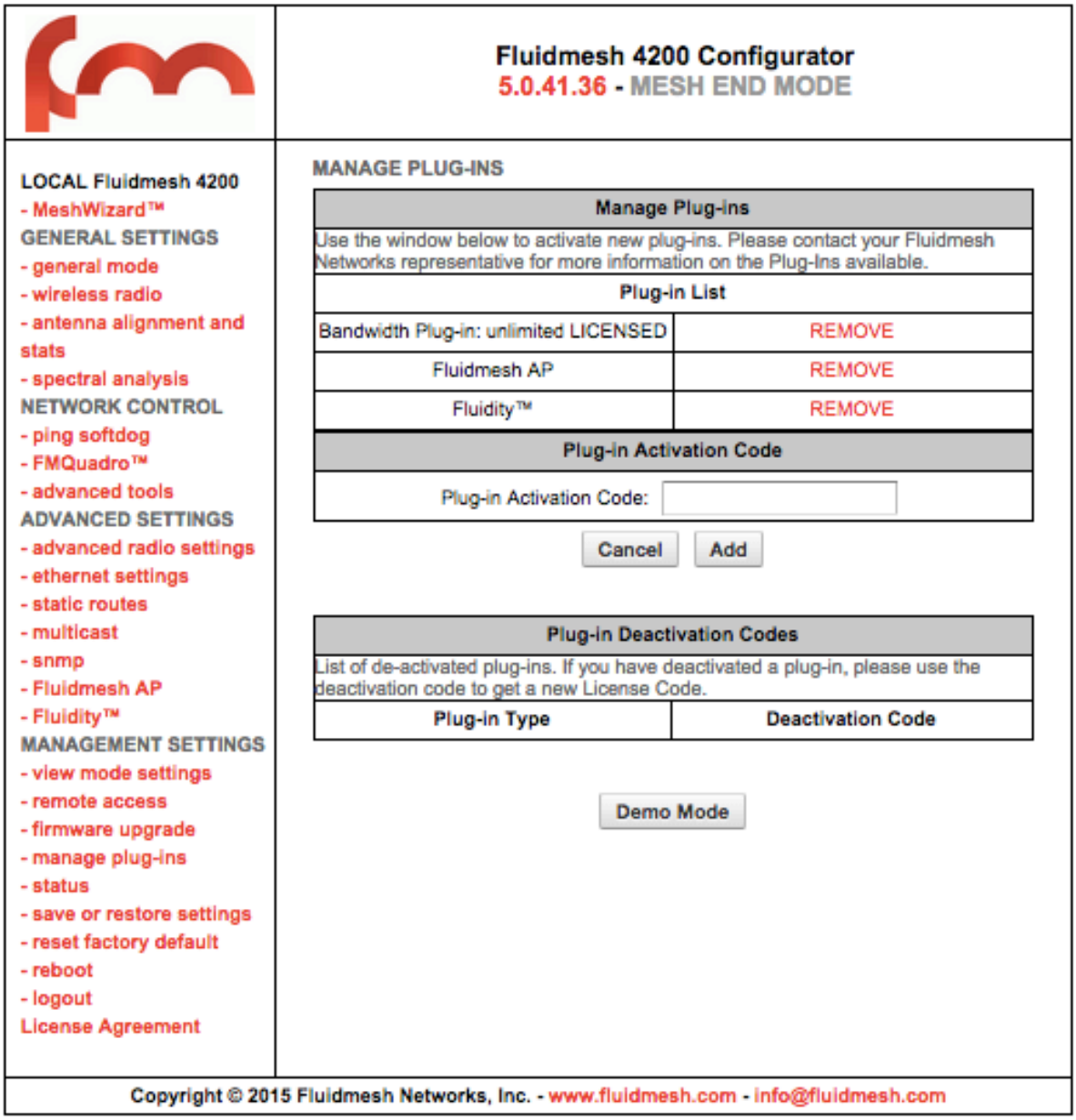



**Fig. 7.19 - Plug-Ins Management Web Page**

## 7.16 Advanced Tools

Through the advanced tools page, it is possible to run tests to verify network connectivity and the achievable throughput on a network path. As shown in Fig. 7.19, network connectivity can be tested by issuing a "Ping Test" towards a specific destination. Additionally, the "Bandwidth Test"

[8] Not available in Brazil and Canada.

tool generates a stream of packets at a specified rate to test the available network path throughput.[9]

In order to run a Ping or a Bandwidth Test, write the destination IP in the proper window and click run. Bandwidth Test is performed using 4 Mb/s UDP traffic. Both tests can be run on top of a loaded network to test operational performances, or on top of an unloaded network to test installed capacity.

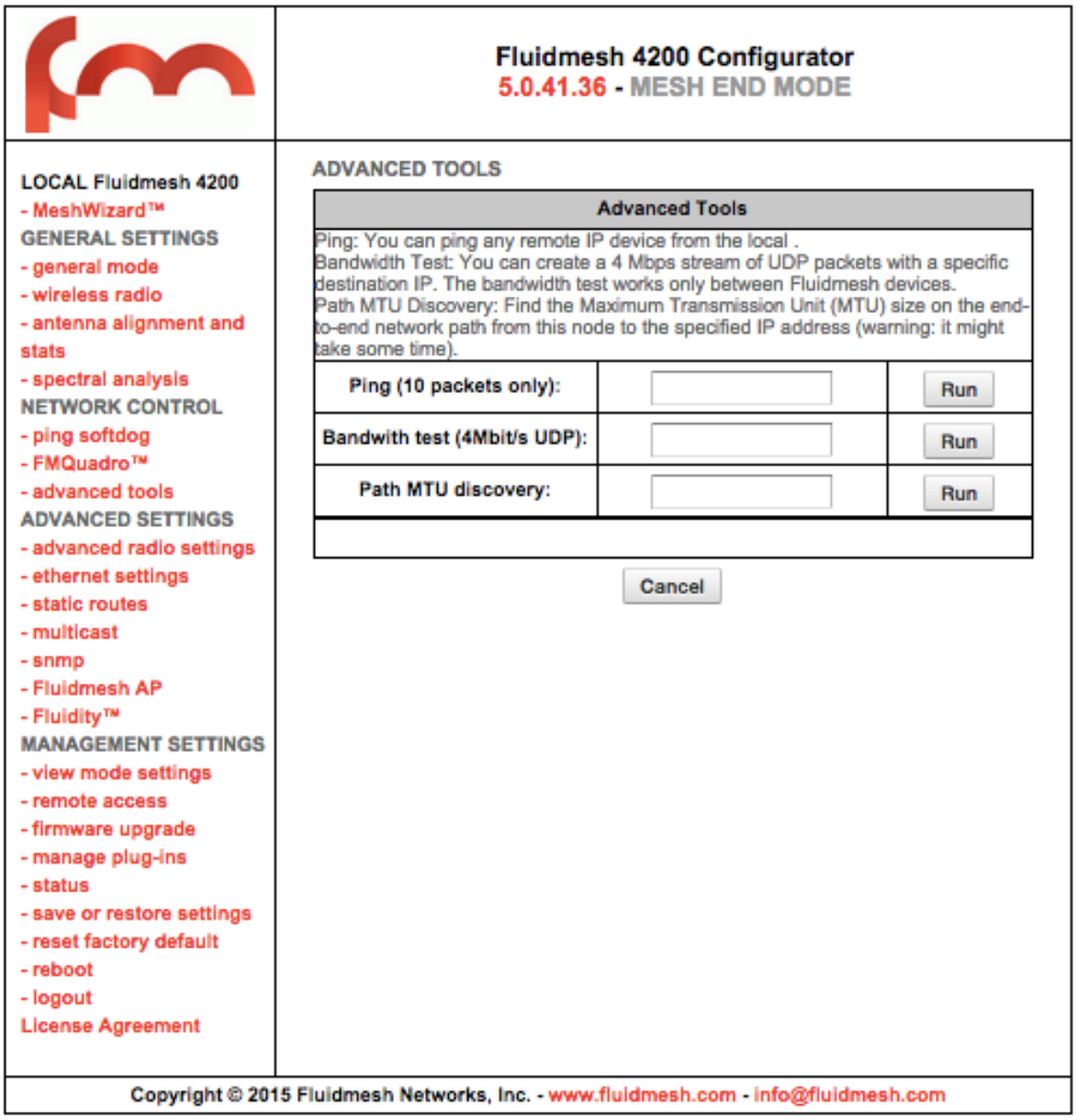



**Fig. 7.20 - Advanced Tools Web Page**

## 7.17 Multicast

By default, FM units operating in **Mesh Point** mode forward all the multicast traffic generated by the cameras to their closest **Mesh End** unit. However, in some network configurations, it may be convenient to forward the multi-cast traffic from a **Mesh Point** to others, e.g., to remotely record the

[9] Please note that the achievable rate computation is CPU-intensive and only indicative. Results may be not accurate. Usually the bandwidth tests tend to underestimate the real throughput of the link.

video flow.

By default, the unit operating in **Mesh End** mode does NOT forward any multicast traffic[10] to the wireless networks. To redirect a traffic flow to a **Mesh Point**, you must specify all the multicast flows redirection information within the **Mesh End** multicast page as shown in Fig. 7.20.

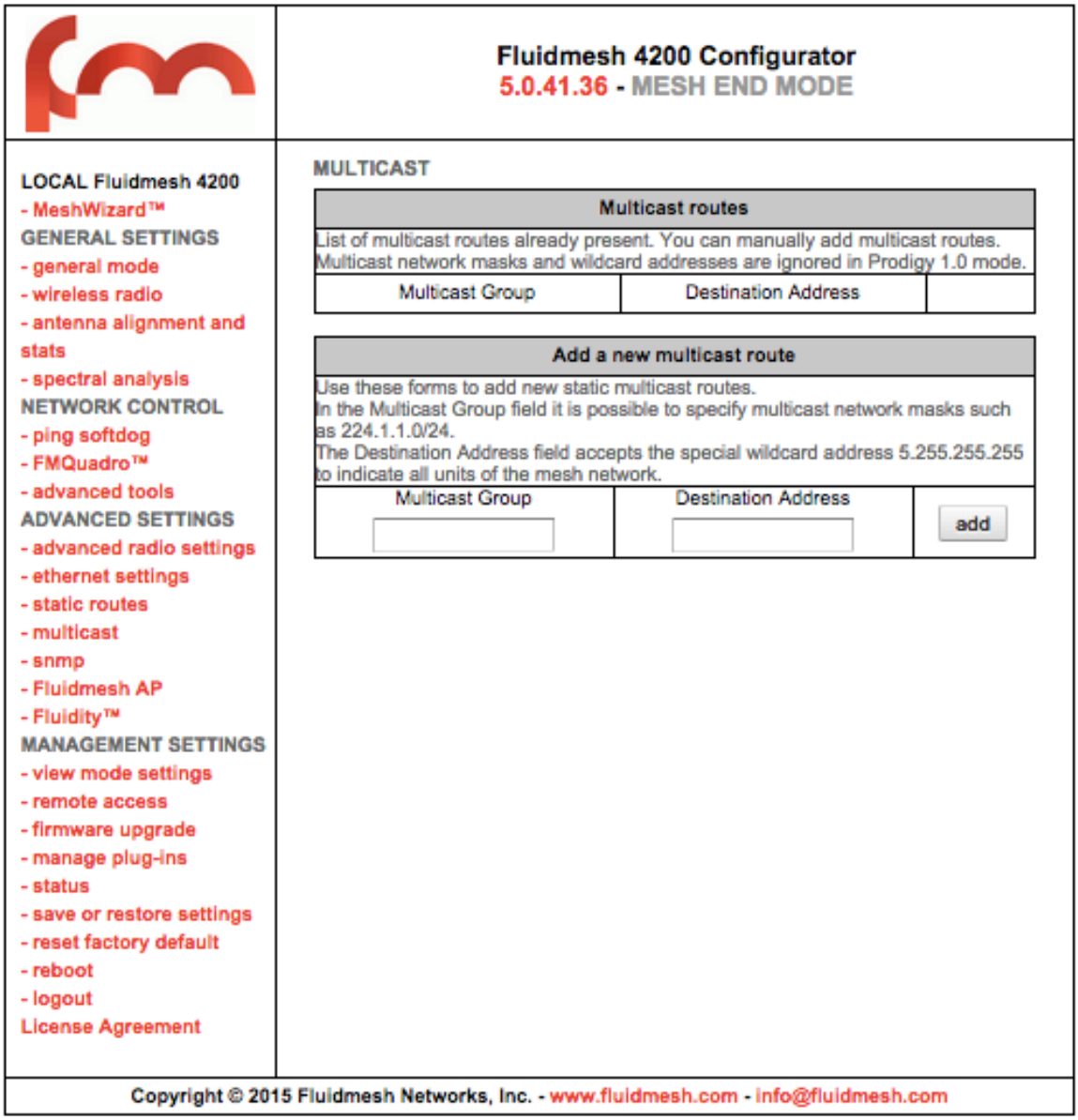



**Fig. 7.21 - Add/Remove Multicast Routes Towards Mesh Points**

## 7.18 Change Password

Use this page to change the password to access the unit Web GUI.

[10] With the exception of UPnP and IGMP traffic.

## 7.19 Status

This page reports a summary of the status of the unit. The MAC address of the radio is published on the status page as well. In case of system malfunctions, the unit's diagnostic file dump can be downloaded through this page and emailed to the Fluidmesh technical support to facilitate the problem diagnosis. Additionally, the unit log can be viewed. The information of the log is relative to possible flapping of the Ethernet port and provides information about possible duplicate IPs present in the LAN. Please refer to Table 7.6 for a detailed description of the log messages.

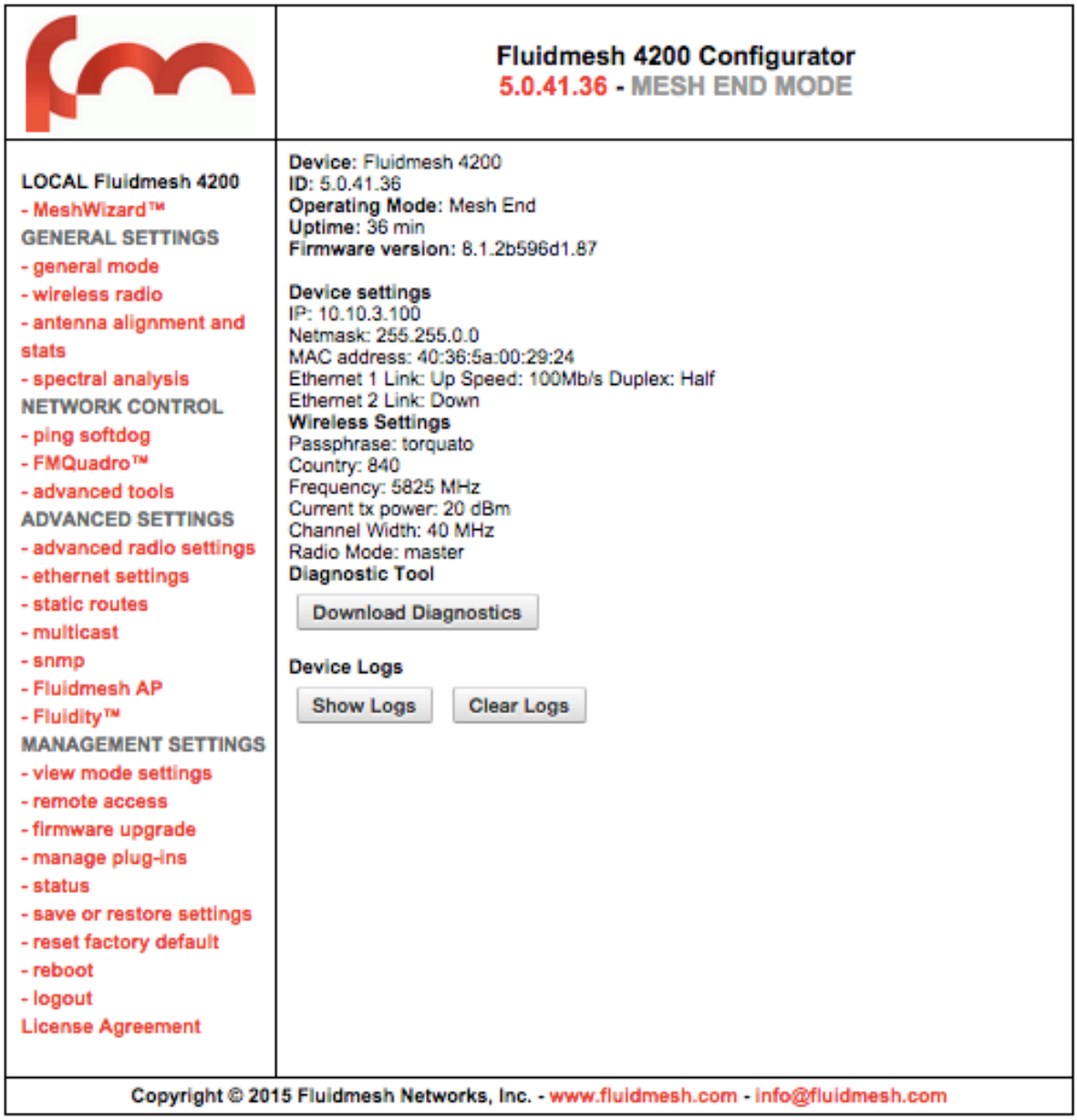



**Fig. 7.22 - Status Report**

| Log Message | Description |
|---|---|
| ethX phy:X is up/down | The Ethernet port X goes up/down. |
| chatter: VBR: duplicate IP X? MACX --> MAXY at timestamp | Possible duplicate IP X has migrated from MAC address X to Y. |

**Table 7.6 - Status Description**

## 7.20 Ping Softdog

This page can be used to set up constant pings toward multiple destinations. If the Fluidmesh unit detects that connectivity is lost, the users can specify whether the Fluidmesh unit must reboot or not. This can be done by checking or unchecking the reboot checkbox. The purpose of the constant ping is thus twofold. On one hand, it can be used to reboot the unit in case of malfunctions. On the other hand, it can be used as a keep-alive message to multiple devices like IP phones.

## 7.21 Save and Restore Settings

This is a handy tool for saving and restoring Fluidmesh radio configuration. The typical scenario of use is the substitution of a damaged unit in the field. The new unit can be configured restoring the previously saved configuration of the damaged unit. This greatly speeds up the maintenance process and prevents configuration errors from happening.

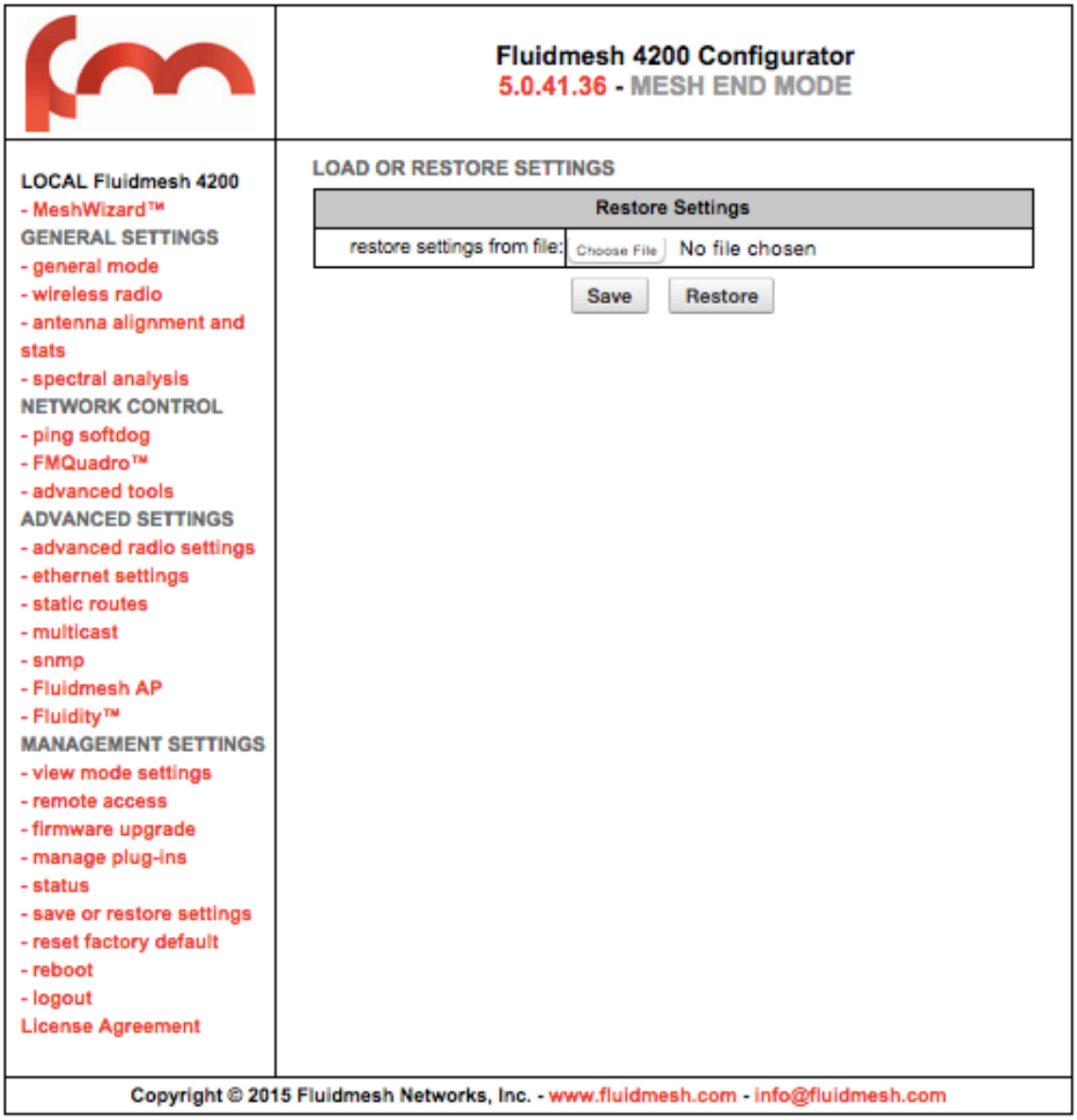



**Fig. 7.23 - Save and Restore Settings**

## 7.22 Reboot and Reset to Factory Default

Use the **Reboot** page to restart the unit. Use the **Reset to Factory Default** page to restore the unit default factory settings.

## 7.23 On-Line Help

The electronic version of this manual is available by accessing the **Help** web page. Additionally, specific manual sections can be consulted by clicking on the question mark present at the upper right corner of every page of the Web GUI.

# 8 Troubleshooting

The troubleshooting section will allow you to solve the most common problems encountered when configuring and installing Fluidmesh products.

## 8.1 I Am Unable To Get The Log-In Screen

If you are unable to get the log-in form on your computer screen, you should check the following:

*Is your computer set to a valid IP address?* You should manually set the correct network settings as follows:

1. In Windows Explorer, right-click "My Network Places" and select Properties;

2. Right-click Local Area Network and select Properties;

3. Right-click Internet Protocol (TCP/IP) and select Properties;

4. Set the IP address to 192.168.0.30 (or any other IP address belonging to the subnet 192.168.0.0/255.255.255.0), Netmask to 255.255.255.0;

5. Click OK, then OK again.

*Have you disabled the "Access the Internet using a proxy server" function?* To disable the **Access the Internet using a proxy server** function, go to **Control Panel** > **Internet Options** > **Connections** > **LAN Settings** and uncheck the enable box.

## 8.2 I Am Unable To Log-In To The Web-Based Interface

If you are unable to log-in to the Web-based interface, check your user name and password settings.

The user name cannot be changed by the user and corresponds to:

**admin**

The password can be changed, so make sure you are using the right password. The default password is:

**admin**

If you forgot the password, check Section 8.3 to fix the problem.

## 8.3 I Forgot The Administrator Password

If you forgot the password and need to access the Web-based interface, you must physically access the unit, open the enclosure in a weather-safe situation and reset to the factory default settings. Please refer to the instructions of Section 3.1.4 for FM1100, Section 3.3.4 for FM1200 and Section 3.2.4 for FM3200 units.

## 8.4 I Get No Link in Bridge Mode

To improve your link strength in Bridge Mode if you get no link or the link LED is always red or you are getting a weak wireless link (below 60% signal strength), please check the following:

1. **Antenna Alignment:** the two antennas must be aligned toward each other.
2. **Line of Sight:** you must have clear line of sight between the two antennas.
3. **Power:** check if the FM unit is properly powered-on with the provided PoE injector.
4. **Channel:** both FM unit units must be operating on the same channel.

# APPENDIX A

## Federal Communication Commission Interference Statement

This equipment has been assembled with components that comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial environment. 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. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expenses.

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and 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.

**FCC Caution:** to assure continued compliance, use only shielded interface cables when connecting to computer or peripheral devices. Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

# FCC Radiation Exposure Statement

This equipment has been assembled using components that comply with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 21 cm between the radiator and your body.

This device has been assembled using components that comply with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

# Industry Canada

This Class B digital apparatus has been assembled using components that comply with Canadian ICES-003.

Cet appareil nume´rique de la classe B est conforme a´la norme NMB-003 du Canada.

The use of this device in a system operating either partially or completely outdoors may require the user to obtain a license for the system according to the Canadian regulations.

**Industry Canada Statement**
This device complies with RSS-247 of Industry Canada.
Operation is subject to the following two conditions: (1) this device may not cause interference, and (2)

this device must
accept any interference, including interference that may cause undesired operation of the device.

**Avis d'industrie Canada**
Le present appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.
L'exploitation est autorisee aux deux conditions suivantes:
(1) l'appareil ne doit pas produire de brouillage, et, and (2) l'utilisateur de l'appareil doit accepter tout brouillage
radioelectrique subi, meme si le brouillage est susceptible d'en compromettre le fonctionnement.

**IC RF Radiation Exposure Statement:**
This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 21cm between the radiator & your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

**Déclaration d'exposition aux radiations:**
Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 21 cm de distance entre la source de rayonnement et votre corps.

# EC Declaration of Conformity

Fluidmesh Networks, Inc. declares under its sole responsibility that Fluidmesh 4500 series are compliant with the following Directives; and have been designed and manufactured to the following Specifications:

| | |
|---|---|
| EMC | EN 61000-6-1; EN 61000-6-2; EN 61000-6-3; EN 61000-6-4;<br>EN 489-17 |
| R&TTE | EN 300 328-1 V. 1.3.1; EN 300 328-2 V. 1.2.1; EN<br>301 893-1 V. 1.2.1; EN 300 440-2 V. 1.3.1 |
| Safety | EN 60950-1:2001 |

Caution: This equipment is intended to be use in all EU and EFTA countries. Contact local Authority for procedure to follow.

**Note:**
Class A ITE is a category of all other ITE which satisfies the class A ITE but not the class B ITE limits. Such equipment should not be restricted in its sale but the following warning shall be included in the instruction for use:
WARNING: this is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

For more details on legal combinations of power levels and antennas, contact Fluidmesh Networks, Inc.

## Belgique

Dans le cas d'une utilisation privee, a' l'exterieur d'un batiment, au-dessus d'un espace public, aucun enregistrement n'est necessaire pour une distance de moins de 300m. Pour une distance superieure `a 300m un enregistrement aupres de l'IBPT est requise. Pour une utilisation publique `a l'exterieur de batiments, une licence de l'IBPT est requise. Pour les enregistrements et licences, veuillez contacter l'IBPT.

## France

Vous pouvez contacter l'Autorite de Regulation des Telecommunications (http://www.art-telecom.fr) pour de plus amples renseignements.

| | |
|---|---|
| 73/23/EEC | The Low Voltage Directive and its amending directives. |
| 89/336/EEC | The Electromagnetic Compatibility Directive and its amending directives |
| 99/5/EC | The Radio and Telecommunications Terminal Equipment Directive and its amending directives. |

# APPENDIX B

## Contact Information

## Worldwide Headquarters

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