Dust Networks

SmartMesh® IA-510
D2511 Manager Guide

WirelessHART®

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Contents

About This Guide

Thank you for purchasing the SmartMesh® IA-510 D2511 manager. This guide provides an overview of the hardware and software resources of the D2511 manager in addition to detailed specifications.

Related Documents

This guide is a part of a documentation suite for the IA-510 family of products. The following documents contain important information for software and firmware development with an IA-510 manager:

- *SmartMesh Manager Serial API Guide*—provides information about manager's packet-based API and instructions on configuring the serial port application function.
- *SmartMesh Manager XML API Guide*—provides information about manager's hierarchical tag-based XML API.
- *SmartMesh CLI Commands Guide*—describes manager's CLI commands, used for debugging and troubleshooting.

Conventions Used

The following conventions are used in this guide:

- `Computer type` indicates information that you enter, such as specifying a URL.
- **Bold type** indicates buttons, fields, and menu commands.
- *Italic type* is used to introduce a new term.

Note: Notes provide more detailed information about concepts.

Caution: Cautions advise you about actions that might result in a loss of data.

Warning! Warnings advise you about actions that may cause physical harm to the hardware or your person.

Revision History

Revision	Date	Description
040-0078 rev 1	7/30/2009	Final (product release).
040-0078 rev 2	9/28/2009	
040-0078 rev 3	11/18/2009	
040-0078 rev 4	8/10/2010	

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Introduction

The SmartMesh IA-510 D2511 network manager combines Dust Networks' robust, Intelligent Networking Platform and industry-leading low power radio technology to achieve the carrier class data reliability, lower latency, and deterministic power management required for the industrial automation market. The D2511 acts as both a gateway and network manager for up to 250 SmartMesh IA-510 motes (DN2510 or M2510), creating a self-configuring, reliable wireless mesh network.

What is a SmartMesh Network?

SmartMesh networks are reliable, ultra low-power, wireless mesh networks that can be used for a wide variety of monitoring applications, including building automation, industrial monitoring, and remote site security. A SmartMesh network consists of a network manager and up to 250 motes—low-power wireless transceivers that have connections for analog, digital, and serial sensors and actuators.

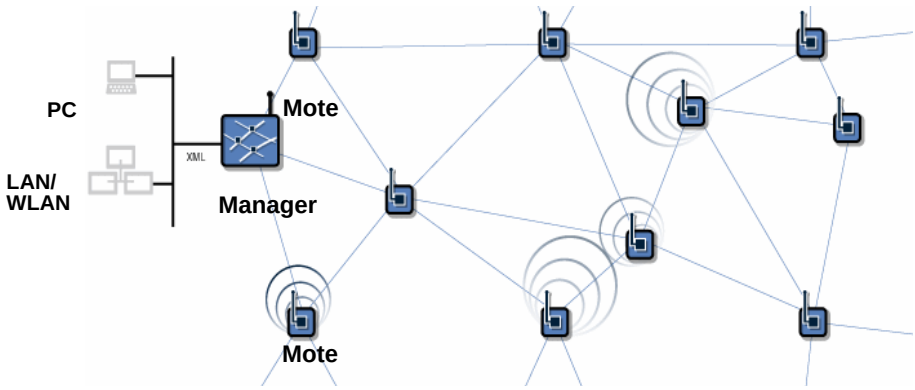


Figure 1 A SmartMesh Network

- **SmartMesh manager** is a line powered network node that controls and monitors network performance. The manager coordinates routing, aggregates mote packets, collects network statistics, and publishes data to a wired network. The manager can publish data in XML format over the Ethernet port, or in serial format over the serial port.
- **Motes** are ultra low-power wireless transceivers that receive serial data from attached sensors and use an onboard radio to send the packets to neighboring motes. These motes pass the packet on to other motes—and, in a series of "hops" deliver the data to the SmartMesh manager. Motes run SmartMesh software and are designed as a simple-to-integrate wireless modules.

SmartMesh Network Features

SmartMesh networks provide a simple, reliable way to monitor and control processes and equipment. Using redundant, multi-hop networking and ultra low-power hardware, SmartMesh networks offer unprecedented access to information about the physical world.

SmartMesh networks are:

- **Easy to Install**—They are self-configuring, battery-powered networks that require no site survey or wireless expertise to install.

  Benefit: You can deploy a SmartMesh Network within hours, not days.

- **Reliable—**They provide redundant, self-healing routing that approaches the reliability of a wired network.

  Benefit: You have the reliability of a wired network with the flexibility of wireless.

- **Manageable**—They provide network-wide quality-of-service metrics and control commands that simplify network management.

  Benefit: You can manage multiple networks from a single PC. No device-level coding or management is needed.

SmartMesh Manager's Role

The D2511 manager provides configuration, management, and gateway functionality for a network of SmartMesh IA-510 motes. At its core, the D2511 manager utilizes the SmartMesh IA-510 embedded manager (PM2511), which includes a wireless transceiver, processor and memory, embedded networking software, and multiple interfaces to host systems, including PPP and Ethernet.

SmartMesh IA-510 managers host well defined application interfaces (via both XML API and serial API) that allow programmatic access to network control commands, performance statistics, and connectivity details. In addition, the D2511 manager offers administrative interfaces via its Web-based Admin Toolset utility and text-based command line interface (CLI).

Manager Packing List

The components shipped with the D2511 manager are listed in Table 1.

Table 1 Packing List for the D2511 Manager

Component	Amount	Description
D2511 manager	1	Controls and monitors the network.
Power cable	1	Connects the manager to an AC outlet.
International adapter kit	1	The kit includes power adapters for most countries.

Manager Overview

The D2511 manager provides a 10/100Base-T Ethernet interface and three serial interfaces, a power supply connector, and status LEDs, as shown in Figure 2. The data interfaces are described in detail in the following sections. For power supply specifications, refer to Chapter 2.

The status LEDs provide the following information:

- **Power (Green)**—The Power LED is on when the 12 V power supply provided with the D2511 is connected and functioning properly.
- **Subscription (Yellow)**—Indicates that a client program is subscribed to the manager via Ethernet or the Serial 1 interface.
- **Radio (Yellow)**—Blinks when there is data activity over the radio.

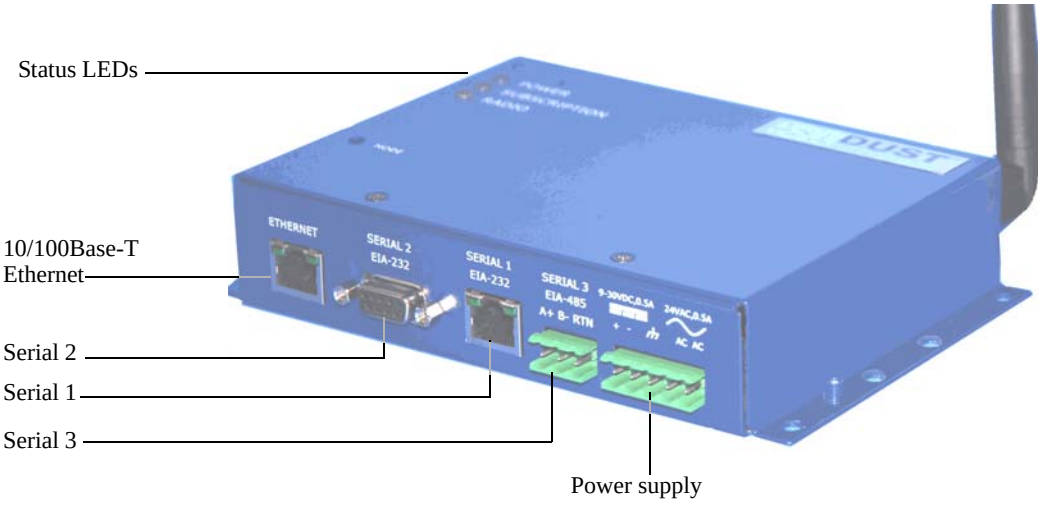


Figure 2 Manager Features

10/100Base-T Ethernet Interface

The 10/100Base-T Ethernet interface is a standard RJ45 connector which provides users with access to manager's XML-RPC API and the Admin Toolset utility.

Table 2 Ethernet Port Hardware Specifications

Port	Description	Signaling
Ethernet	10/100Base-T Ethernet	IEEE 802.3 10/100Base-T

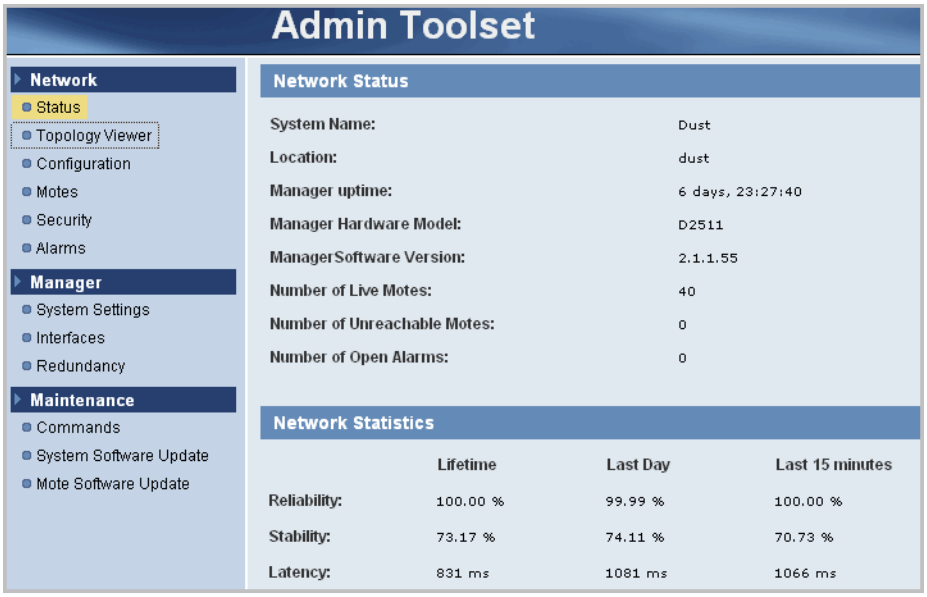
XML-RPC API

The XML-RPC API is an open Extensible Markup Language (XML) interface that lets a client application send Remote Procedure Call (RPC) requests to the manager and receive responses and other data from the manager via XML-RPC. The API consists of a Control Channel and a Notification Channel. The Control Channel is used to establish connection and exchange commands and information about the SmartMesh Network. The Notification Channel is used to stream data and network events to the client program. The API is fully documented in the *SmartMesh IA-510 Manager XML API Guide*.

Admin Toolset

The D2511 manager provides a Web-based administrative tool, called Admin Toolset (see Figure 3), which can be used to view network statistics and mote and alarm information, configure serial and Ethernet port settings, configure the Real Time Clock or enable the Network Time Protocol (NTP) server, set the network security mode, and execute selective commands. You can also use Admin Toolset to upgrade the manager software as well as perform remote software updates on motes in the wireless network. The Admin Toolset utility is described in detail in the *SmartMesh IA-510 Admin Toolset Guide*.

Figure 3 Admin Toolset



Serial 1 Interface

The Serial 1 interface (RJ45 connector) provides programmatic access for configuration, management, and data access to the manager. The interface can be used for one of two functions:

- To access the manager using Point-to-Point Protocol (PPP)
- To access the serial API associated with the manager

The following sections describe the Serial 1 functions in greater detail. Instructions for configuring the Serial 1 are provided Appendix A.

Note: An adapter is required for the Serial 1 interface if you are connecting to a PC or other control device that uses a 9-pin D-SUB RS232 port. See Appendix B for information on assembling an RJ45 to 9-pin D-SUB adapter.

Table 3 Serial 1 Interface Hardware Specifications

Port	Description	Signaling
Serial 1	UART 5-pin	RS232 levels

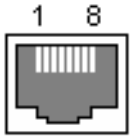


Figure 4 RJ45 Connector

Table 4 RJ45 Connector Pinout

Pin	Signal Description
1	TX out of manager
2	RTS out of manager
3	RX into manager
4	GND
5	GND
6	CTS into manager
7	Not connected
8	GND

PPP

The manager allows IP connection through the Serial 1 port using Point-to-Point Protocol (PPP). This connection provides access to the same interfaces that are available through the Ethernet interface, such as the XML API and the Admin Toolset utility. The manager acts as a PPP server. Note that the client is responsible for periodically pinging the manager and re-establishing PPP connection if necessary. Table 5 provides specifications for the PPP interface.

Table 5 PPP Interface Specifications

Parameter	Value
Serial port data rate	115 kbps, 8 bits, no parity, 1 stop bit
Authentication required	None
Header compression	PPP header compression
Data compression supported	PPP deflate compression (preferred), BSD compression
IP addresses	Settable during connection
Default D2511 (server)	192.168.101.10
Default client	192.168.101.11

Serial API

The manager provides a packet-based serial API that allows communications over its asynchronous Serial 1 interface. For more information about the Serial API, refer to the *SmartMesh IA-510 Manager Serial API Guide*. See Appendix A for instructions on configuring the Serial 1 port for Serial API.

Serial 2 Interface

The Serial 2 interface (9-pin D-SUB female connector) allows access to manager's command line interface (CLI) through RS232. The CLI can be used to set the configuration of the Serial 1 interface and for troubleshooting with the assistance of Dust Networks support. Appendix A provides instructions on using the CLI to set the Serial 1 configuration.

Table 6 Serial 2 Port Hardware Specifications

Port	Description	Signaling
Serial 2	UART 9-pin	RS232 levels

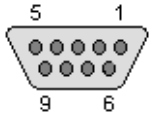


Figure 5 9-pin D-SUB Female Connector

Serial 3 Interface

The Serial 3 interface is reserved for future use.

Specifications

2

This chapter provides specifications, mechanical drawings, and certification information for the D2511 managers.

Detailed Radio Specifications

Table 7 D2511 Radio Specifications

Parameter	Min	Typ	Max	Units	Comments
Operating frequency	2.4000		2.4835	GHz	
Number of channels		15			
Channel separation		5		MHz	
Occupied channel bandwidth		2.7		MHz	At –20 dBc
Frequency accuracy	–40		+40	ppm	
Modulation					IEEE 802.15.4 DSSS
Raw data rate		250		Kbps	
Receiver operating input level		0		dBm	
Receiver sensitivity		–92.5 –90		dBm dBm	At 50% PER, 25 °C At 1% PER, 25 °C, (inferred from 50% PER measurement)
Output power, EIRP PA* enabled PA* disabled		 +10 0		 dBm dBm	See “Antenna Specifications”
Range**					
PA* enabled					25 °C, 50% RH, +2 dBi omni-directional antenna
Indoor†		100		m	
Outdoor†		300		m	
Free space		1200		m	
PA* disabled					
Indoor†		25		m	
Outdoor†		200		m	
Free space		350		m	

*PA = power amplifier.

**Actual RF range performance is subject to a number of installation-specific variables including, but not restricted to ambient temperature, relative humidity, presence of active interference sources, line-of-sight obstacles, near-presence of objects (for example, trees, walls, signs) that may induce multipath fading. As a result, actual performance varies for each instance.

†1 meter above ground.

Antenna Specifications

The antenna provided on the D2511 manager meets the specifications in Table 8. For optimum performance, position the antenna vertically when manager is installed.

Table 8 D2511 Antenna Specifications

Parameter	Value
Frequency range	2.4-2.4835 GHz
Impedance	50 Ω
Gain	+2 dBi maximum
Pattern	Omni-directional

Power Supply

A universal power supply is included with each packaged manager. The output of the transformer is 12 V at 1.1 Amps DC, and it is connected to + (positive) and – (ground) terminals of the connector. However, any DC supply with an output of 9–30 V at 0.5 Amps can be connected. A 24 VAC supply can be connected to the two right-most terminals of the connector (see Figure 6). The power supply connector uses a Phoenix PN 1757048 or equivalent mating connector.

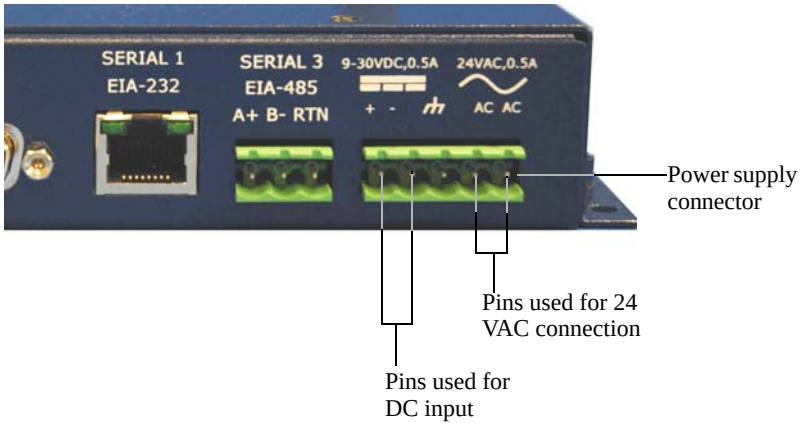


Figure 6 Power Supply Connector

Mechanical Drawings

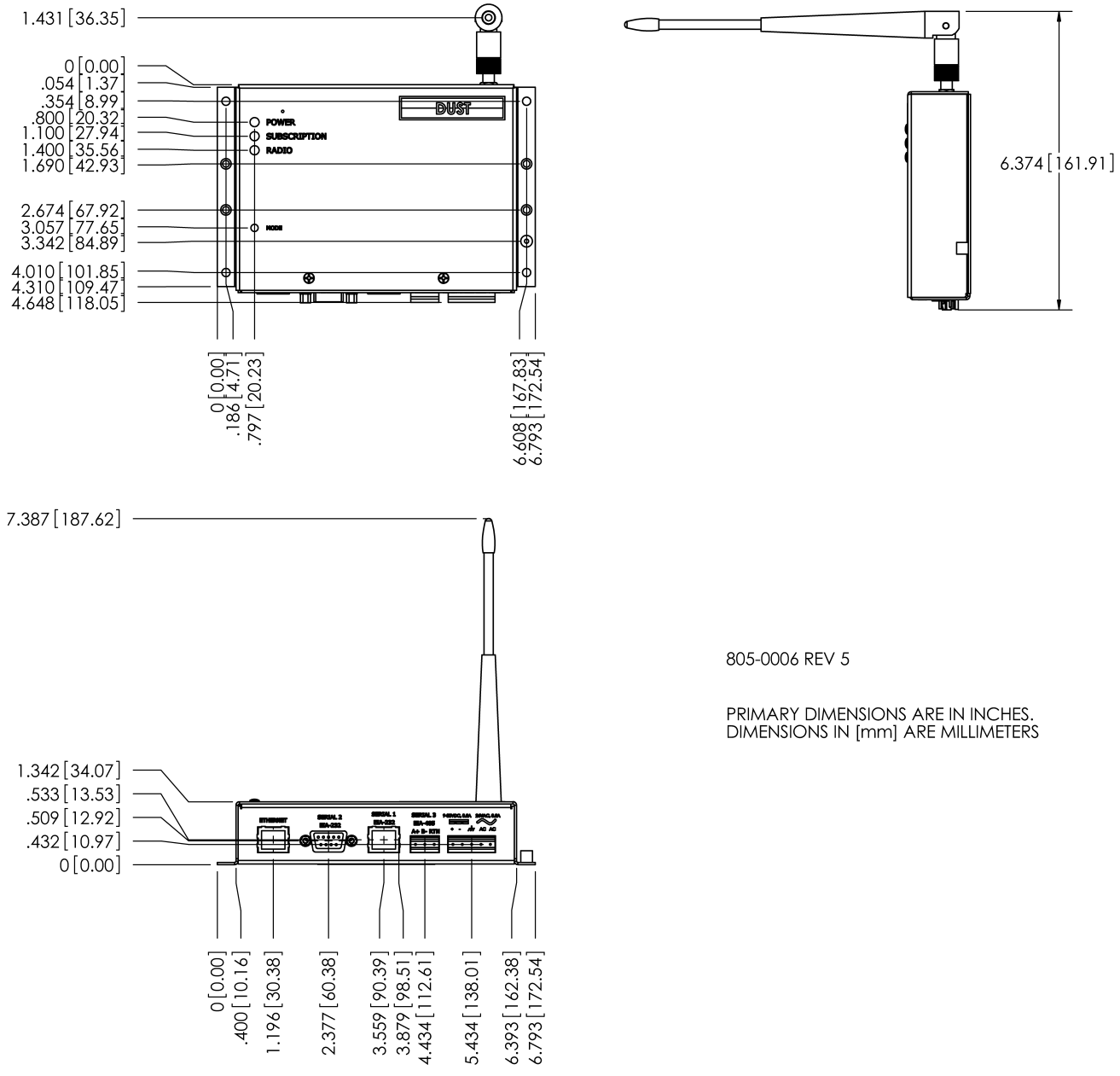


Figure 7 Dimensions of D2511 Manager

Regulatory and Standards Compliance

Installation and Operation

The antenna used for the D2511 transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operated in conjunction with any other antenna or transmitter. Installers and end-users must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

FCC Compliance

FCC Testing

The D2511 complies with Part 15.247 modular (Intentional Radiator) of the FCC rules and regulations. The D2511 complies with FCC rules and regulations, CFR Title 47, Part 15, Subpart B.

IC Compliance

IC Testing

The D2511 is certified for modular Industry Canada (IC) RSS-210 approval. The D2511 complies with IC ICES-003 and FCC Part 15, Sub. B - Unintentional Radiators.

CE Compliance

Declaration of Conformity

We, Dust Networks, of 30695 Huntwood Ave, Hayward CA 94544, USA, declare under our sole responsibility that our products, SmartMesh IA-510 D2511, and in combination with our accessories, to which this declaration relates is in conformity with the appropriate standards ETSI EN 300 328, ETSI EN 301 489-17, EN 60950, EN 55022 Class A, EN55024, EN61000-4-3, following the provisions of Radio Equipment and Telecommunication Terminal Equipment Directive 99/5/EC with requirements covering EMC Directive 2004/108/EC, and Low Voltage Directive 2006/95/EC.

Restrictions

Norway prohibits operation in the 2.4000 GHz to 2.4835 GHz spectrum within 20 km of Ny-Alesund in Svalbard. The D2511 should not be operated in this region.

Encryption Cipher

The D2511's 128-bit Advanced Encryption Standard (AES) cipher has been certified compliant to the United States National Institute of Standards and Technology (NIST) FIPS-197 (NIST certificate numbers, AES: 1437 and AES: 1439). To view the FIPS-197 validation list, go to: http://csrc.nist.gov/groups/STM/cavp/documents/aes/aesval.html.

Normal Operating Conditions

Table 9 D2511 Normal Operating Conditions

Parameter	Min	Typ	Max	Units	Comments
Operating temperature range	0		+70	°C	

3 Installing the D2511 Manager

The D2511 manager can be connected directly to a computer or installed on your local area network (LAN). The computer must have the following:

- Windows Internet Explorer 7 (or later) or Firefox 2.0 (or later)
- Java Runtime Environment (JRE) version 6 (or later)

Note that the manager is preconfigured with network ID 1229. If you are already running another manager in the same area with the default network ID of 1229, you need to change the network ID of the existing network before installing the new manager. For information on changing the network ID and using the manager with a SmartMesh Evaluation Kit, refer to the *IA-510 Evaluation Kit Guide*.

Ports Used by the D2511 Manager

The transmission control protocol (TCP) ports listed in Table 10 must be open to allow the Admin Toolset utilities to connect to the D2511 manager. These ports are restricted by the default in Windows XP firewall and some operating systems. If you have difficulties connecting to the manager, consider temporarily disabling your Windows XP firewall in the Windows Control Panel.

Table 10 Ports Used by Data Console and Admin Toolset

Port #	Type	Description
4445	TCP	XML-RPC control channel.
24112	TCP	XML-RPC notification channel.
80	TCP	Used for http services. (Optional) A script redirects all traffic to the https port (443).
443	TCP	Used for https (secure http for a Web server).

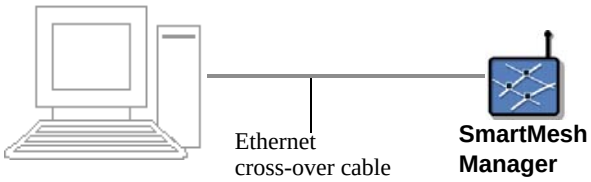
Warning: The D2511 is not recommended for outdoor use because the enclosure is not weatherproof. Exposing the manager to moisture may cause permanent damage.

Connecting the Manager Directly to a Computer

The D2511 manager is preconfigured with the static IP address `192.168.99.100` for connection directly to a computer. You will temporarily set the computer IP address to a static IP address that enables the computer to communicate with the manager. The computer needs to have Windows Internet Explorer 7 (or later) or Firefox 2.0 (or later) installed.

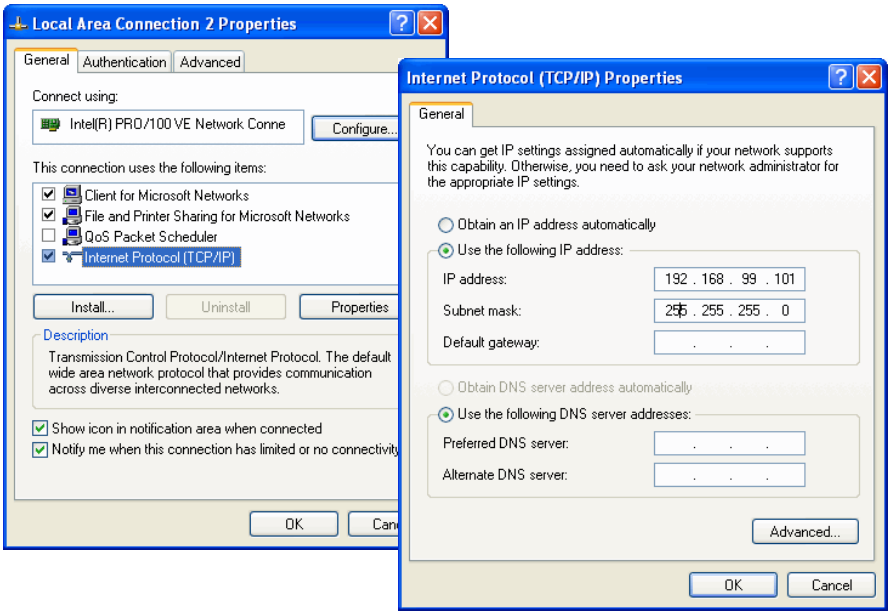
To connect the manager directly to a computer:

1. Use the Ethernet cross-over cable to connect the manager to your computer.



2. Connect the power cord to the manager and an AC outlet.
   The Power light on the manager turns on after a 20-second delay.
3. Set the computer IP address to a static address that will enable connection to the manager:
   a. On the **Start** menu, click **Control Panel**.
   b. Double-click **Network Connections**.
   c. Right-click **Local Area Connection**, and then click **Properties**.
   d. Click **Internet Protocol (TCP/IP)**, and then click **Properties**.
   e. Click **Use the following IP address**, and enter the following information:
      - **IP Address:** `192.168.99.101`
      - **Subnet Mask:** `255.255.255.0`

f. Click **OK** to close the dialog boxes.



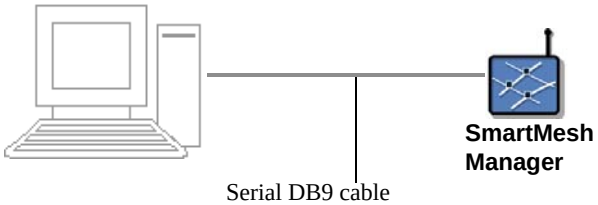
Note: When you are finished using the manager, you can switch your computer IP address back by selecting "Obtain an IP address automatically" on the General tab in the Internet Protocol (TCP/IP) Properties window.

Installing the Manager on the LAN

To install the manager on the LAN, you need to change the manager's default static IP address to a LAN IP address. You can either configure the manager to use DHCP to obtain a LAN-assigned IP address, or assign a static LAN IP address to the manager. If you want to use a static LAN IP address, you will need to obtain this address from the LAN administrator.

To connect to the manager over the LAN:

❶ Use the serial DB9 cable to connect the manager to your computer.



❷ Connect the power cord to the manager and an AC outlet.
The Power light on the manager turns on after a 20-second delay.

3. Establish a HyperTerminal connection to the manager using the following settings:
   - **Bits per second:** `115200`
   - **Data bits:** `8`
   - **Parity:** `None`
   - **Stop bits:** `1`
   - **Flow control:** `None`
4. At the manager login, enter: `dust`
5. At the manager password, enter: `dust`
6. Connect the manager to the LAN using the Ethernet straight-through cable.
7. Configure the manager to use DHCP or assign a static LAN IP address:
   - **DHCP**—To configure the manager to use DHCP, enter:

     `sudo ifswitch-to-dhcp`

     Important: The manager must be connected to the LAN (step 6) before the `sudo ifswitch-to-dhcp` command is issued or an IP address will not be assigned to the manager by the DHCP server.
   - **Static LAN IP address**—To configure the manager to use a static LAN IP address provided by your LAN administrator, enter:

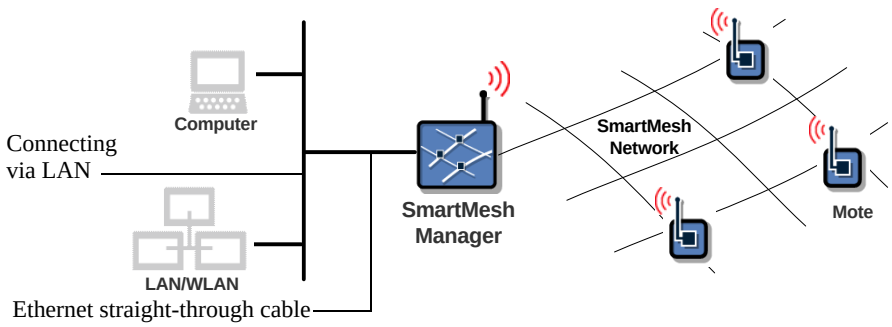
     `sudo ifswitch-to-static` *<New Static IP Address>*
8. Verify that the manager's IP address has been changed by entering:

   `ifconfig`

   Then manager's new IP address should display.
9. Enter `logout` to close the HyperTerminal window.
10. Disconnect the manager from your computer and from AC power. Then reconnect the manager to AC power.

    The new IP address takes effect when the manager powers on again.

Important: If the manager is configured to use DHCP, it must always have an Ethernet connection to the LAN when it is powered on or reset or it will not receive a LAN IP address from the DHCP server. If you power on or reset the manager before connecting it to the LAN, you will need to establish a HyperTerminal connection to the manager and issue the `sudo ifswitch-to-dhcp` command to prompt the DHCP server to assign the manager a LAN IP address.



A

Configuring Serial 1 Operation

The Serial 1 interface on manager can be used for a PPP, manager serial API, manager CLI, or Linux shell connection. Refer to the *SmartMesh IA-510 Manager Serial API Guide* for information on how to log in to these processes.

This appendix provides instructions for configuring the Serial 1 interface using the Admin Toolset utility on manager or Linux commands.

Configuring the Serial 1 Interface

To connect the Serial 1 interface to a PC or control device that uses a 9-pin D-SUB RS232 port, an RJ45 to 9-pin D-SUB adapter is required. Appendix B provides instructions for assembling the adapter.

Important: The Serial 1 interface is intended for local serial connections only. Because no authentication is performed, use it only in a trusted environment.

Using Admin Toolset to Configure Serial 1

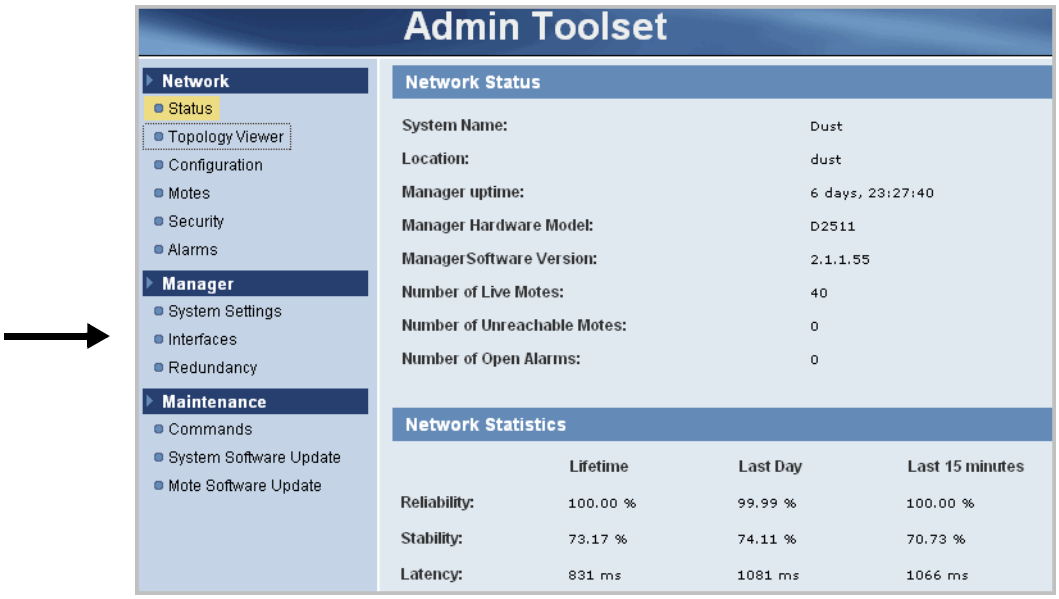
To configure Serial 1 for PPP:

1. Connect your computer to the manager:
   - If the manager is installed on the LAN, connect your computer to the LAN.
   - If the manager is not installed on the LAN, connect your computer directly to the manager using an Ethernet cross-over cable. The manager default IP address is 192.168.99.100. You can change your computer IP address to 192.168.99.101 to be compatible. For more information, see “Connecting the Manager Directly to a Computer” in Chapter 3.
2. Open Internet Explorer. In the URL address field, type in the IP address of the manager.

3. If a security alert displays indicating that there may be a problem with the site security certificate, take the action required to proceed to the website (the site is

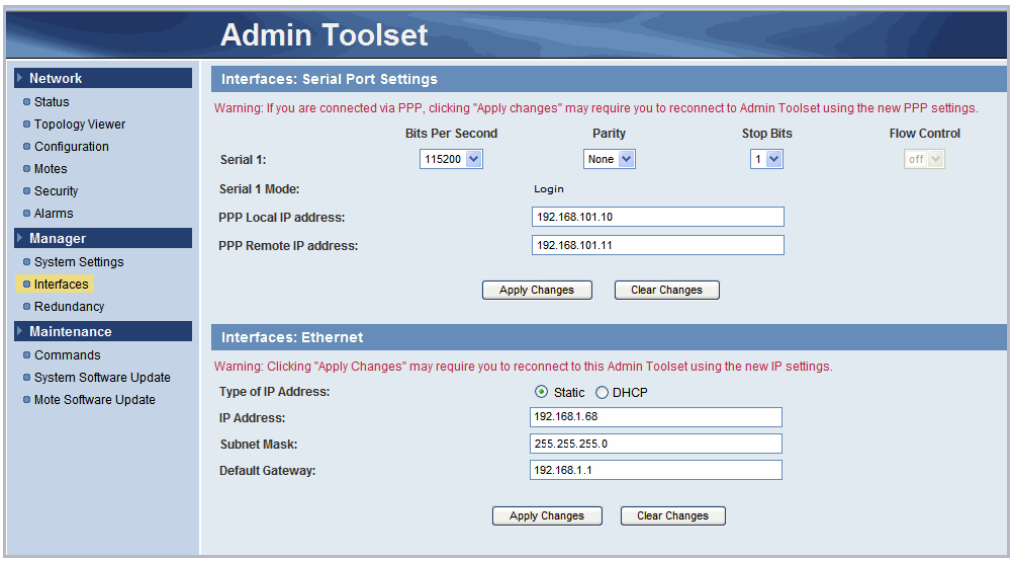
secure).

4. Enter "`system`" as the username and the password.
5. Click the **Interfaces** link.



6. In the **Interfaces: Serial Port Settings** area, change the serial port settings (if necessary). If you are setting up a PPP connection, enter the local and remote PPP IP addresses.

   Note: By default, the IP address of the manager over the PPP connection is 192.168.101.10 (local IP address), and the client PC's PPP IP address is 192.168.101.11 (remote IP address).



7. Click **Apply Changes**.

Using Linux Commands to Configure Serial 1

To configure Serial 1 for PPP using Linux:

1. Connect your computer serial port to the serial 2 port on the manager.

   Or

   Connect your computer to the LAN if the manager is installed on the LAN.
2. Open a Secure Shell connection to manager.
3. At the login prompt, enter `dust` as the username and password.
4. To view the current serial port settings, enter:

   `cat/etc/ttyS1.conf`
5. Use the following commands to change the port settings (if necessary):

   `sudo set-serial { -d <device> [-b <speed>] [-p <parity>] [-s <stopbits>] [-f <flow-control>] }`

   The command options are as follows:

   device: `ttyS1`

   speed: `4800, 9600, 19200, 38400, 57600, 115200, or 230400`

   parity: `none, even, or odd`

   stopbits: `1 or 2`

   flow-control: `on or off`

   The following are sample commands:

   ```
   sudo set-serial -d ttyS1 -b 38400
   sudo set-serial -d ttyS1 -b 115200
   sudo set-serial -d ttyS1 -b 38400 -f off
   ```
6. If you are setting up a PPP connection, you can use the following command to change the local and remote PPP addresses:

   ```
   sudo /usr/sbin/config-ppp -l <localAddress> -r <remoteAddress>
   ```

   The following example changes the local PPP IP address to `192.168.101.14` and the remote PPP address to `192.168.101.15`:

   ```
   sudo /usr/sbin/config-ppp -l 192.168.101.14 -r 192.168.101.15
   ```

   Note: By default, the IP address of the manager over the PPP connection is 192.168.101.10 (local IP address), and the client PC's PPP IP address is 192.168.101.11 (remote IP address).
7. To log out, enter: `logout`

B

Assembling a 9-pin D-SUB Adapter for Serial 1

If you are connecting the Serial 1 interface on manager to a 9-pin D-SUB RS232 port on a PC or control device, you need to use an RJ45 to 9-pin D-SUB RS232 adapter (see Figure 8).

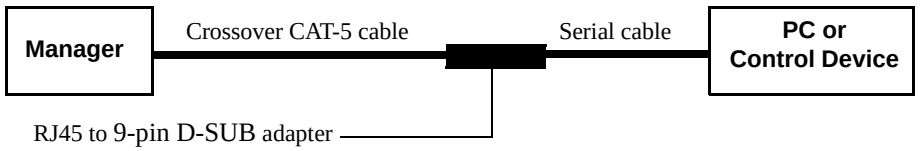


Figure 8 RJ45 to 9-pin D-SUB Adapter

A crossover Ethernet cable is used to connect the Serial 1 interface to the adapter. The adapter in the following example is a female RJ45 to female 9-pin D-SUB. The arrows indicate how to match up the RJ45 and 9-pin D-SUB connector pins described in Table 11.

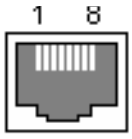


Figure 9 Female RJ45 Connector

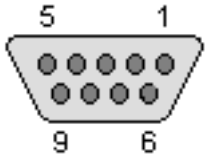


Figure 10 9-pin D-SUB Connector

Table 11 Matching Up RJ45 and 9-pin D-SUB Connector Pins

RJ45 Pinout		9-pin D-SUB Pinout	
Pin	**Signal Description**	**Pin**	**Signal Description**
1	TX out of manager	1	Not connected
2	RTS out of manager	2	RXC
3	RX into manager	3	TXD
4	GND	4	Not connected
5	GND	5	GND
6	CTS into manager	6	Data Set Ready
7	Not connected	7	RTS
8	GND	8	CTS
		9	Not connected

C

Restoring Manager Factory Default Settings

Use the following procedure if you need to restore the factory default settings to the manager.

The following factory default settings are restored:

- IP address
- PPP settings
- Serial port settings
- User name and password
- Wireless network and mote configuration settings
- Wireless network ID and common join key
- Access control list (cleared)
- Log files (cleared)
- Mote list (cleared)

To restore the manager's factory default settings:

1. Insert a jumbo paper clip into the **Mode** hole and gently press and hold down while you press and release the **Power** button. Continue holding the paper clip down for another 20 seconds, and then release.

   The manager's factory default settings are restored.

   Important: If the manager is configured for redundancy, you need to repeat step 1 after the manager restarts in order to fully restore the default settings.

❷ To view the default settings, follow these steps to log onto the **Admin Toolset** utility on the manager:

a. Open **Internet Explorer** or **Firefox**.

b. In the browser's address box, enter the default manager IP address, `192.168.99.100`.

`https://192.168.99.100`

c. If navigation to the site is blocked due to a certificate error, click to continue on to the Web site (the Web site is safe).

d. In the **Connect** dialog box, enter the following username and password:

- **Username:** `system`
- **Password:** `system`

e. In the Admin Toolset window, click the links in the left panel to view the default settings. For example, to see the PPP and serial port settings use the **Interfaces** link.