# Drop-in Networking

# GETTING STARTED GUIDE

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# OBJECTIVES

Upon completing this Starter Kit, you will be able to:

- Set up a Drop-in Network
- Discover wireless devices in a Drop-in Network
- Assign names to wireless devices in a Drop-in Network
- Retrieve data from a wireless device over an IP network
- Send data to a wireless device over an IP Network
- Know the tools and resources available for extending the Drop-in Network through customized embedded applications

# QUESTIONS?

For technical assistance with your Drop-in Network, call:

## 1-800-903-8430

# Contents


**1. Start the Drop-in Network ..... 7**

Connect and power on the gateway ..... 8

Connect and power on XBee Adapters ..... 10

XBee Sensor Adapter ..... 10

XBee RS-232 Adapter ..... 12

Access the gateway's web interface ..... 14

Find the XBee Adapters in the Drop-in Network ..... 15

Optional: Assign names to Drop-in Network devices ..... 17

Install and run the demo application ..... 20

What the demo application does ..... 22

Display ZigBee nodes ..... 22

Read the temperature from the temperature sensor ..... 22

Display the temperature ..... 23

Refresh the temperature display ..... 23

Exercise the terminal function ..... 24

How did this demo application work? ..... 26

**2. Extend the Drop-in Network with Embedded Development ..... 27**

OBJECTIVES ..... 27

Connect and power on interface boards ..... 28

XBee interface board, AC-powered ..... 28

XBee interface board, battery-powered ..... 29

LEDs on the XBee Interface Boards 30

Configure a Zigbee Module to low-power mode ..... 32

Install the X-CTU software ..... 32

Start X-CTU and establish communication with XBee Interface Board ... 32

Program the XBee Module to low-power sleep mode ..... 34

Verify XBee Interface Board operation ..... 35

Embedded development resources ..... 36

Software ..... 36

Documentation ..... 36

Order additional Drop-in Networking products ..... 37

Examples of embedded development efforts ..... 38

Modify the PC demo application ..... 38

Create new applications ..... 38

Exercise serial connections ..... 38

Experiment with additional sensors ..... 38

**Use Digi Connectware Manager ..... 39**

ZigBee Networks View ..... 40

ZigBee Node Views ..... 41

Digi Connectware Manager product information ..... 42

# 1. Start the Drop-in Network

There are two sets of equipment in the Starter Kit:

## 1. Start the Drop-in Network

These Starter Kit boxes contain the devices to start the Drop-in Network.

- **ConnectPort™ X Gateway**
- **XBee™ Sensor Adapter**
- **XBee RS-232 Adapter**

You will also need:

**A PC, configured to obtain an IP address automatically.**

**Software and Documentation CD**

Digi ConnectPort X gateways are available in multiple configurations: ZigBee®-to-Ethernet, ZigBee-to-WiFi, and ZigBee-to-Cellular. The latter two configurations enable end-to-end wireless device connectivity.

## 2. Extend the Drop-in Network with Embedded Development

These boxes contain equipment and accessories for developing embedded applications.

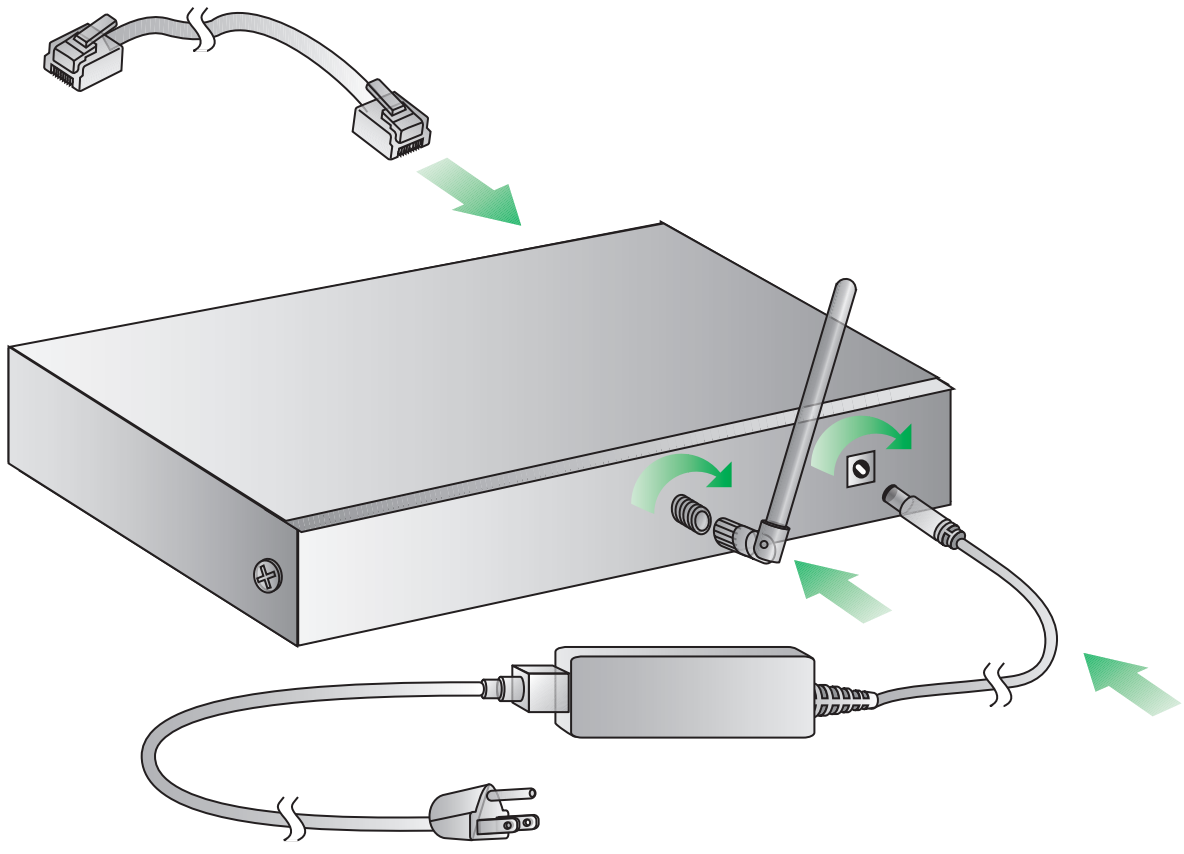
- **XBee Interface Board (AC)**
- **XBee Interface Board (Batt)**
- **Accessories**

## Connect and power on the gateway

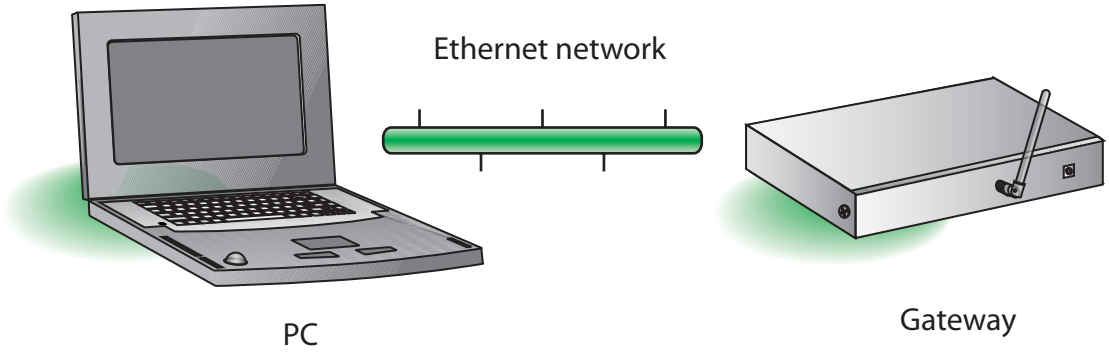
1. Open and unpack the box labeled **ConnectPort X Gateway.**
2. Connect the power supply to the ConnectPort X8 gateway and turn the connector clockwise to lock.

   **Note (International version only):** Connect the power supply to the power cord, and the power cord to the outlet.

   The green **Power** light on the front of the gateway indicates that the device is on.
3. Connect the crossover Ethernet cable to the **Ethernet** port of the gateway, and the other end to the Ethernet port of the PC.
4. Connect the antenna to the **ZigBee** connector on the gateway. Turn the connector clockwise to lock.



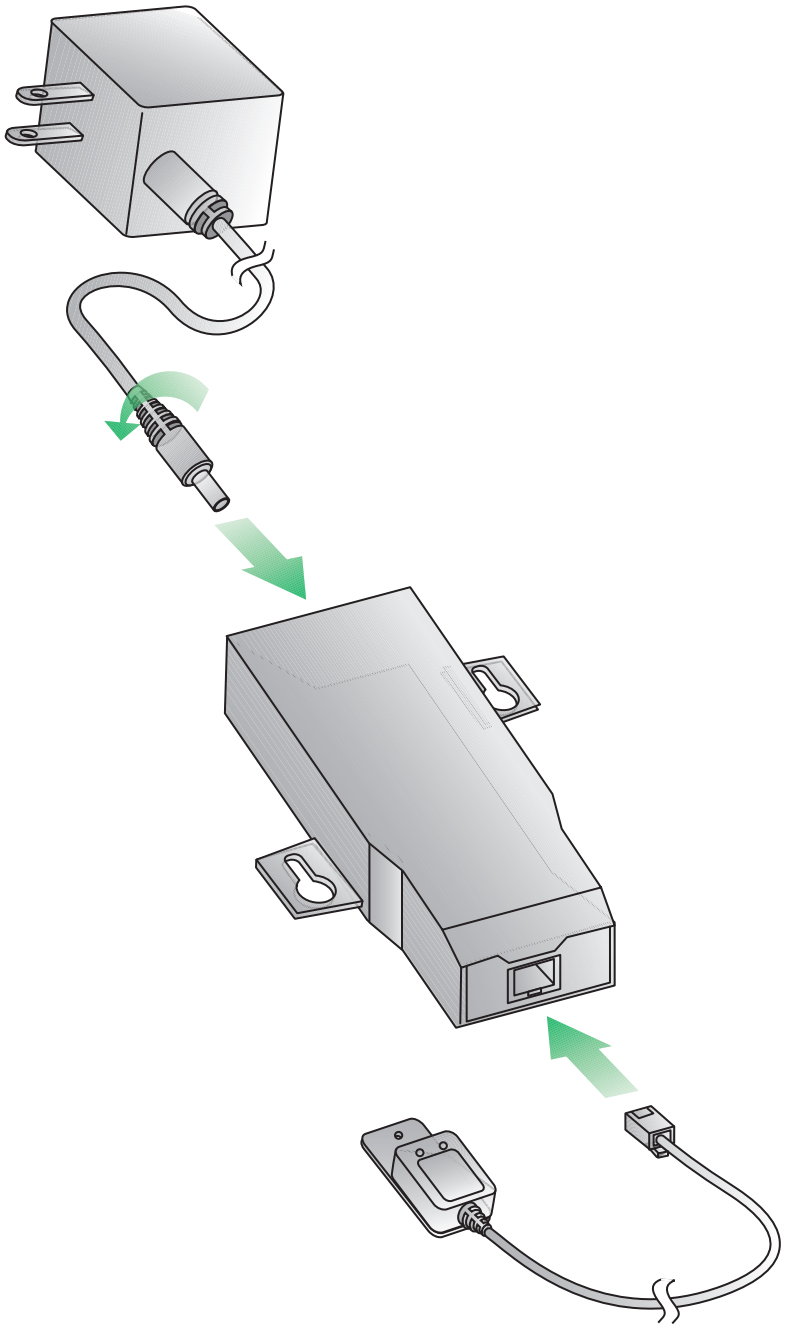
Now your network looks like this:



## Connect and power on XBee Adapters

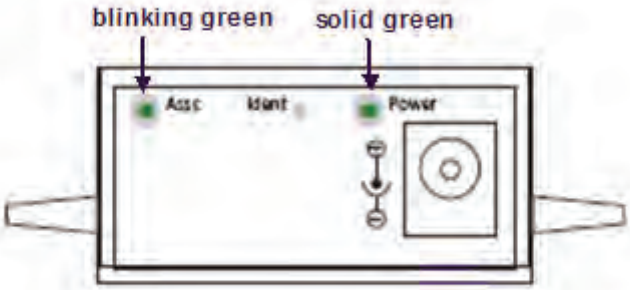
### XBee Sensor Adapter

1. Open and unpack the box labeled **XBee Sensor Adapter**.
2. Connect the Watchport®/T temperature sensor to the **SENSOR** port of the XBee Sensor Adapter.
3. Connect the power supply to the XBee Sensor Adapter. Turn the connector clockwise to lock.



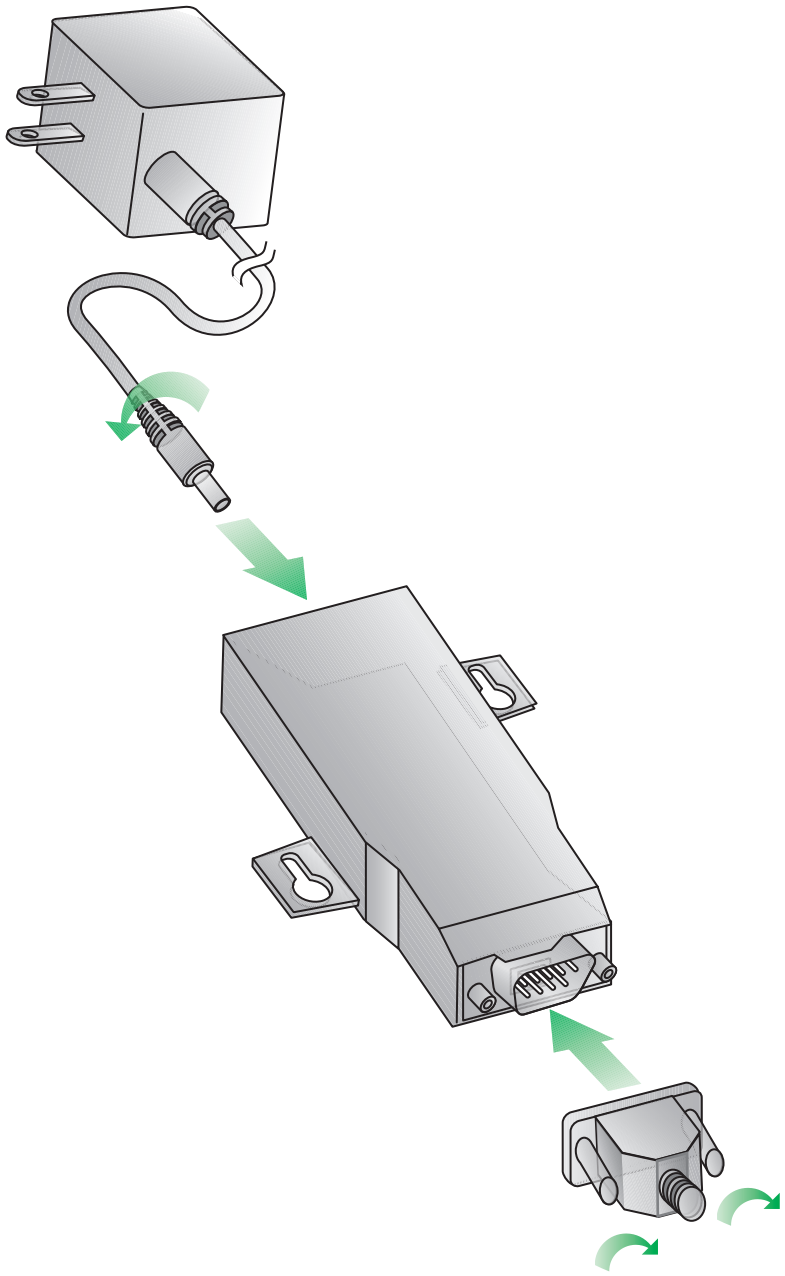
The **Power** light on the power-connector end of the XBee Sensor Adapter indicates that the power is on.

The **Assc** (associate) light indicates whether the XBee Sensor Adapter has joined a ZigBee network. If it is solid green, it has not yet joined a ZigBee network. If it is blinking green, it has successfully joined a ZigBee network.



## XBee RS-232 Adapter

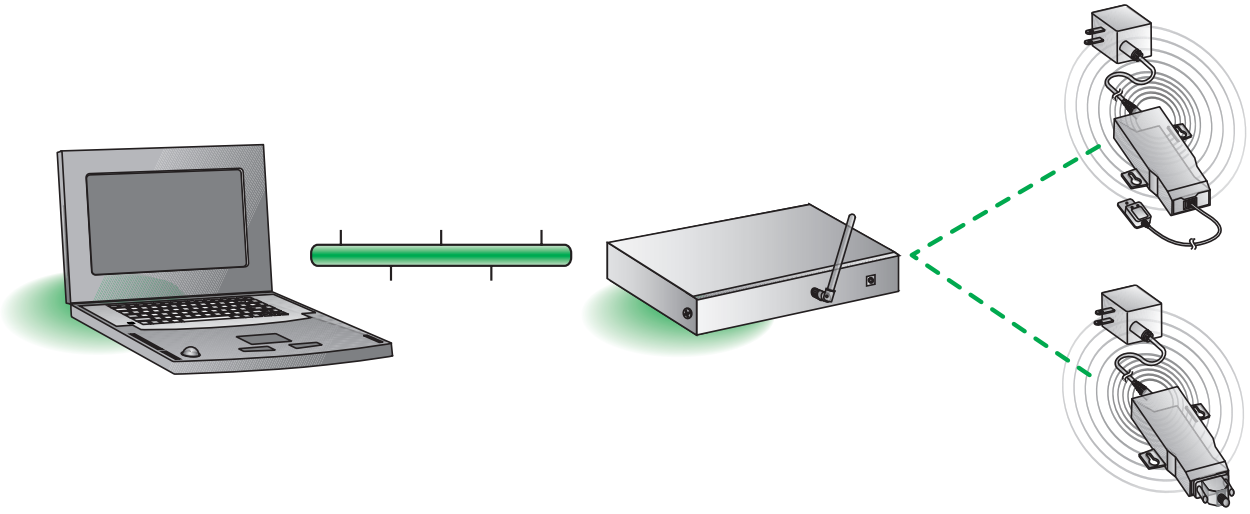
1. Open the box labeled **XBee RS-232 Adapter**.
2. Connect the loopback plug to the serial port of the XBee RS-232 Adapter.
3. Connect the power supply to the adapter. Turn the connector clockwise to lock.



The **Power** light on the power-connector end of the XBee RS-232 Adapter indicates that the power is on.

If the **Assc** (associate) light is solid green, the adapter has not yet joined a ZigBee network. If it is blinking green, it has successfully joined a ZigBee network.

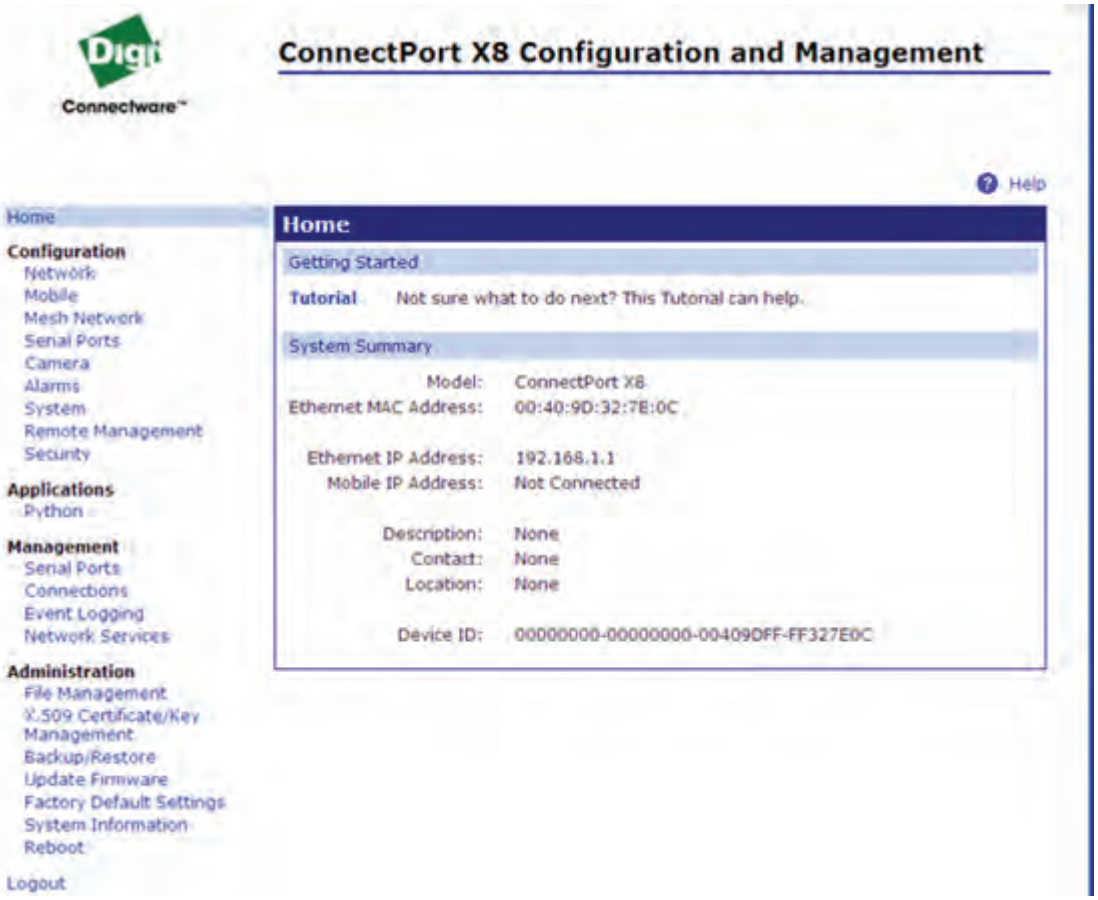
Now, your network looks like this:



## Access the gateway's web interface

Once the core Drop-in Network components are connected and powered on, open the web interface of the ConnectPort X gateway.

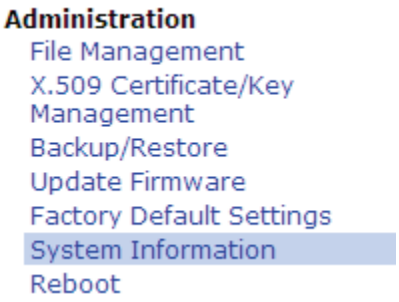
1. On the PC, open a web browser such as Internet Explorer.
2. In the browser's address bar, enter **192.168.1.1** which is the default IP address for the gateway.
3. The home page of the gateway's web interface is displayed.



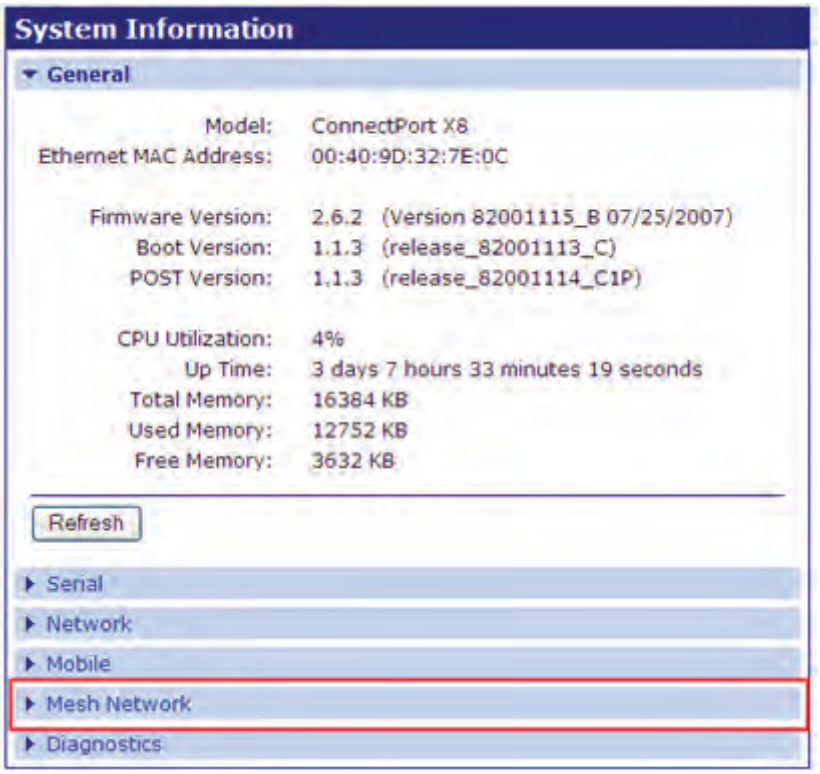
## Find the XBee Adapters in the Drop-in Network

Next, find your XBee Adapters in the Drop-in Network. In this task, you will see a network view of the adapters and the gateway from the gateway's web interface.

1. In the gateway's web interface, select **Administration > System Information** from the menu.

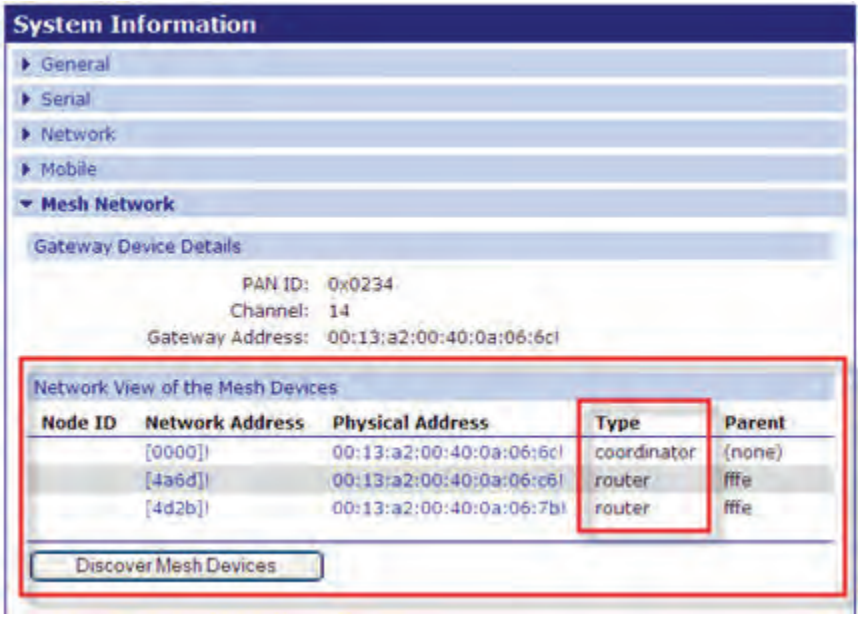



The **System Information** page is displayed.

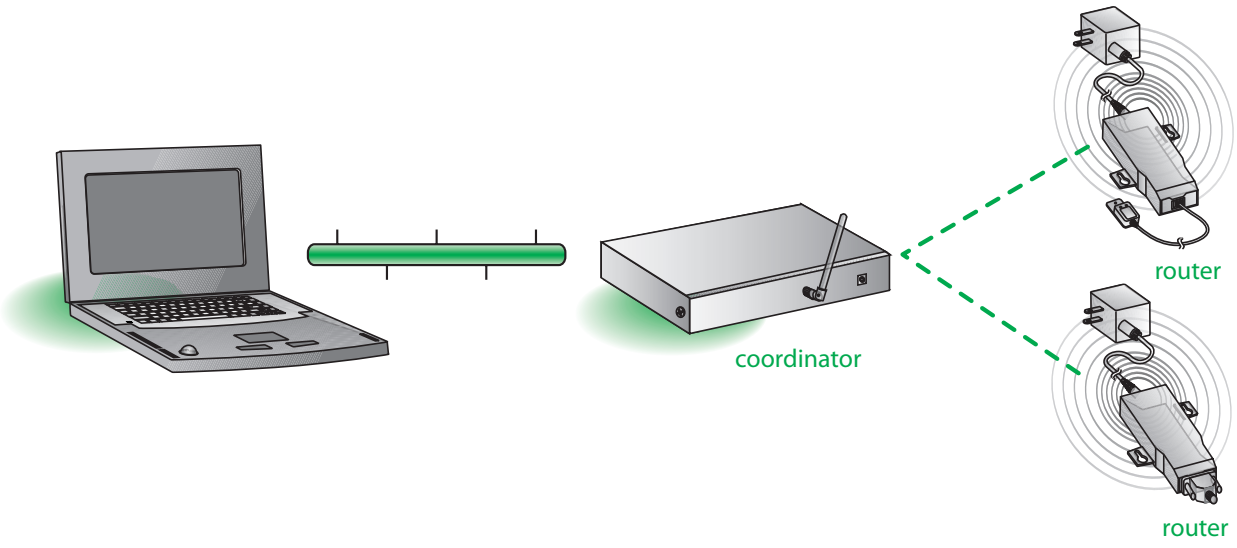


2. From the list of System Information links, click **Mesh Network**.

   The **Mesh Network** page is displayed. It shows several settings for the the gateway, followed by the **Network View of the Mesh Devices**. In the **Type** column, the ZigBee module in the gateway is listed as the **coordinator**, and the two XBee Adapters are listed as **routers**.




   Here is how the values in the **Type** column are assigned in your Drop-in Network.




3. To refresh the view, click the **Discover Mesh Devices button**.

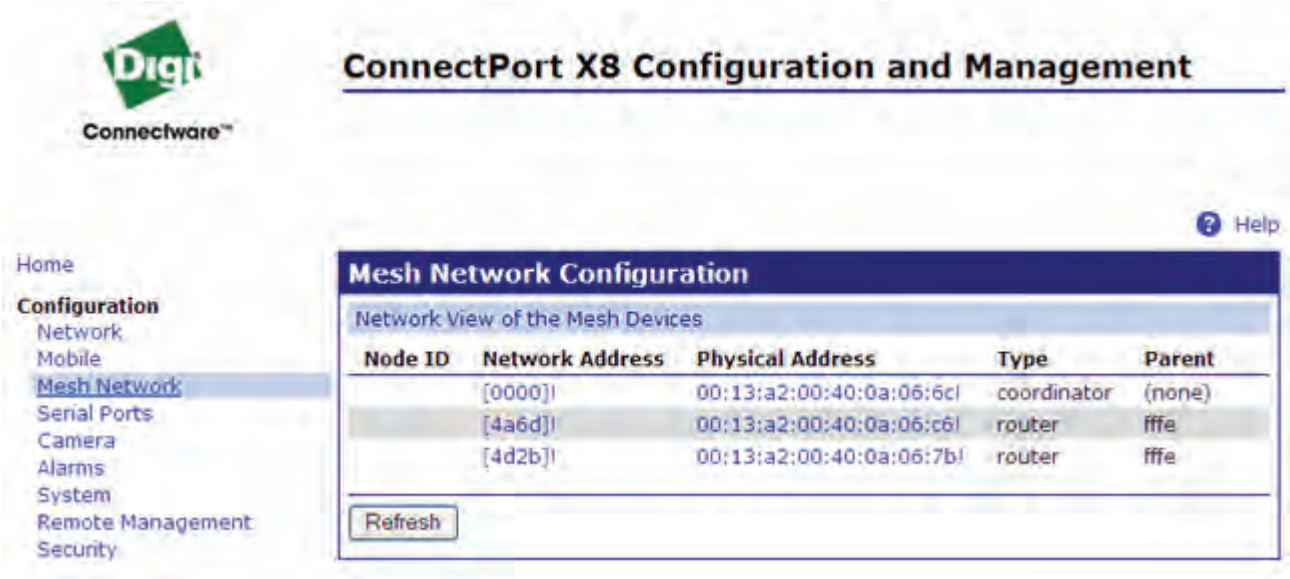
## Optional: Assign names to Drop-in Network devices

Descriptive, user-friendly names can be assigned to each Drop-in Network device, making it possible to reference the units by names rather than their physical addresses.

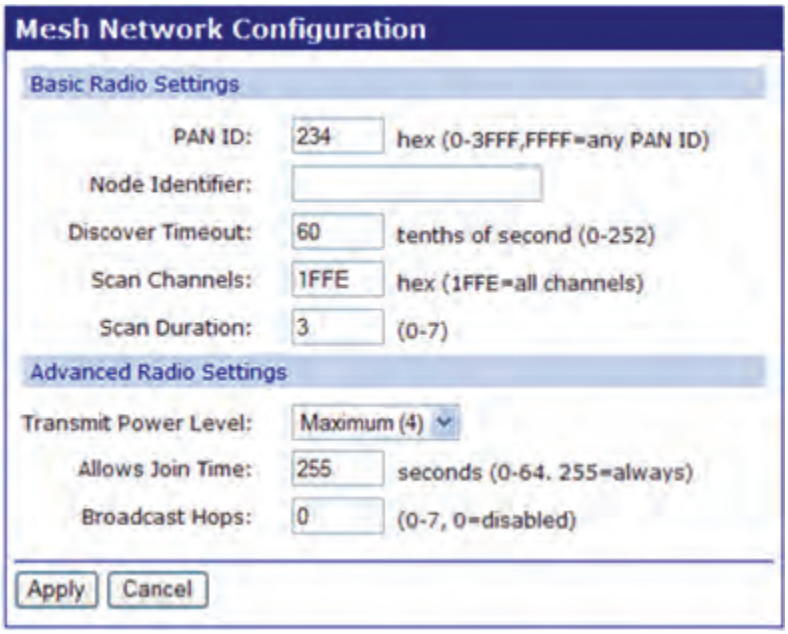
For example, you could name the gateway **gateway**, the XBee Sensor Adapter **sensor**, and the XBee RS-232 Adapter **rs232**, or any other names of your choice.

1. In the web interface, go to **Configuration > Mesh Network**.

   The **Mesh Network Configuration** page is displayed.



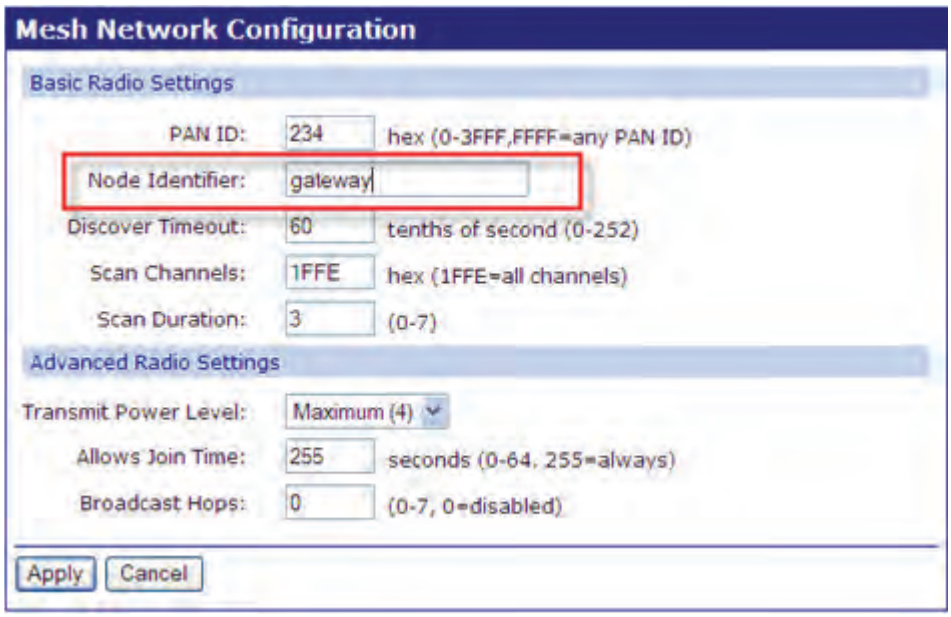

2. From the list under **Network View of the Mesh Devices,** select one of the devices by clicking on its network or physical address. The Mesh Network Configuration page is displayed.



3. Under **Basic Radio Settings**, in the **Node Identifier** setting, enter a name of up to 20 characters.

   For the XBee Adapters, match the physical units with the nodes listed in the Network View of Mesh devices, by locating each adapter's 64-bit address. This address is printed on a label on the bottom of the adapter.

   To assign the node identifier of **gateway** to the XBee module in the gateway, enter:

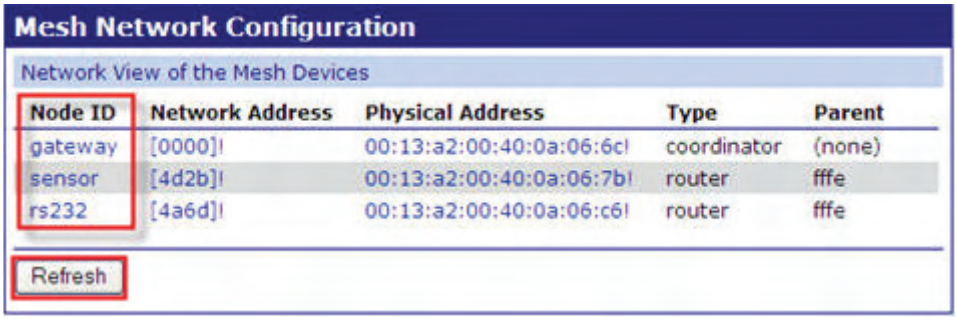



1

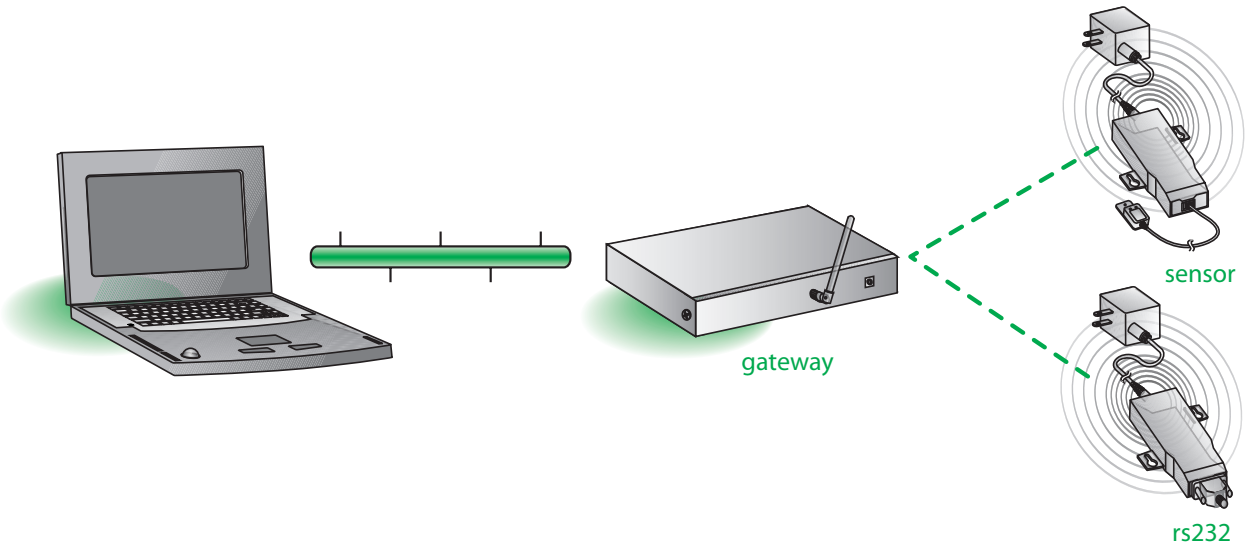
The gateway, adapters, and interface boards in the Drop-in Networking Starter Kit are shipped with the same factory default PAN ID of **234**.

4. For each node, click **Apply**.
5. To name more nodes, go to **Configuration > Mesh Network**, select another node and repeat steps 3 and 4.

6. To view the names you assigned to the network devices, go to **Configuration > Mesh Network** and click **Refresh**. The new names are displayed in the **Node Identifier** column.




The diagram shows your Drop-in Network with the names you assigned.

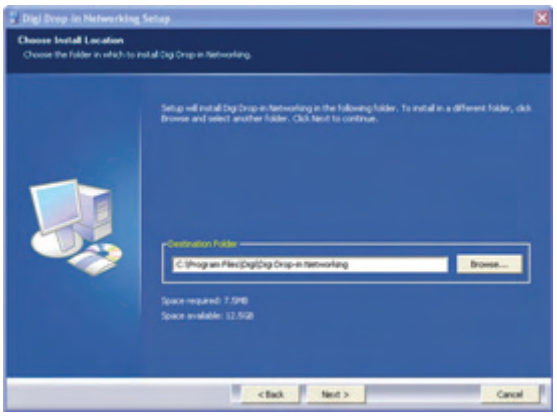


## Install and run the demo application

The Starter Kit includes a demo application to be installed and run on the host PC.

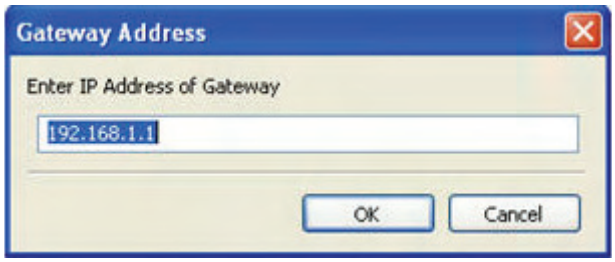
1. Insert the **Software and Documentation CD** in the CD/DVD drive of the PC. The Drop-in Networks Starter Kit splash page is displayed.
2. In the list of options on the right side of the screen, click **Install Demo Application**.

3. The **Digi Drop-in Networking Setup** wizard is launched. Follow the prompts in the wizard, choosing to install the demo application in the default location.

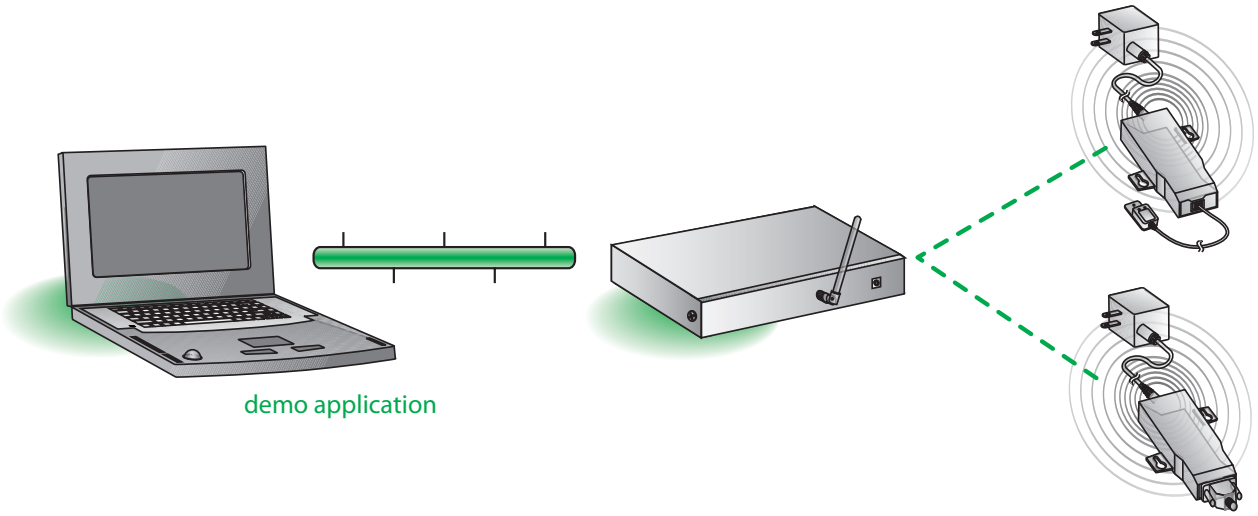


4. Click **Finish** to complete the wizard.

   By default, the sample PC application is launched automatically. When prompted, accept the default IP address of **192.168.1.1** and click OK.




The demo application is now installed on your PC.

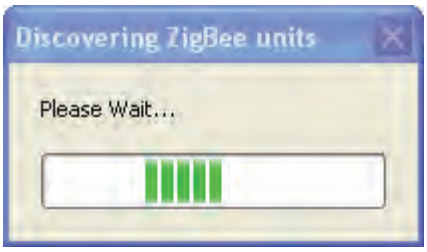


## What the demo application does

The demo application shows how you can send and receive data between your PC, and devices in your Drop-in Network and Ethernet network.

### Display ZigBee nodes

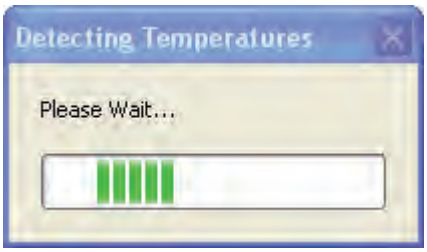
First, the demo application searches for any ZigBee nodes in the range of the gateway. A progress dialog is displayed during this function:




### Read the temperature from the temperature sensor

Any ZigBee nodes found report information back to the demo application on the PC through the gateway. The information read by these ZigBee nodes is displayed in the **Digi Gateway ZigBee Viewer**.

To exercise the temperature-sensing function, the demo application reads the temperature from the Watchport/T temperature sensor connected to the XBee Sensor Adapter. A progress dialog is displayed:

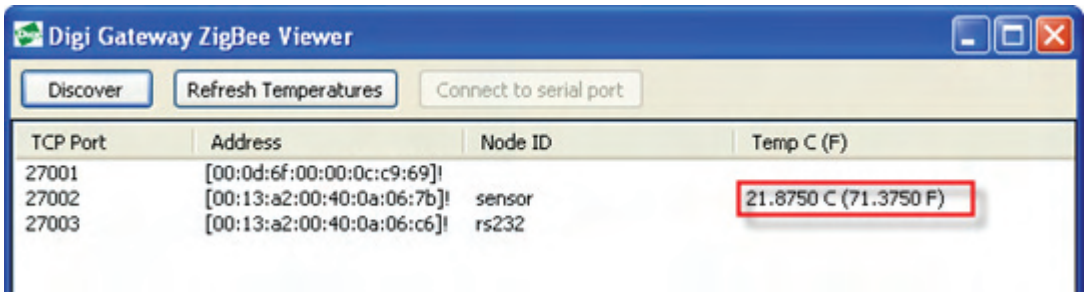



If there were more XBee Sensor Adapters connected to the Drop-in Network, the demo application would display the temperature read by any sensors attached to any XBee Sensor Adapters in the range of the gateway.

Additional XBee Sensor Adapters and Watchport Sensors can be purchased at the digi online store at **www.digi.com**.

### Display the temperature

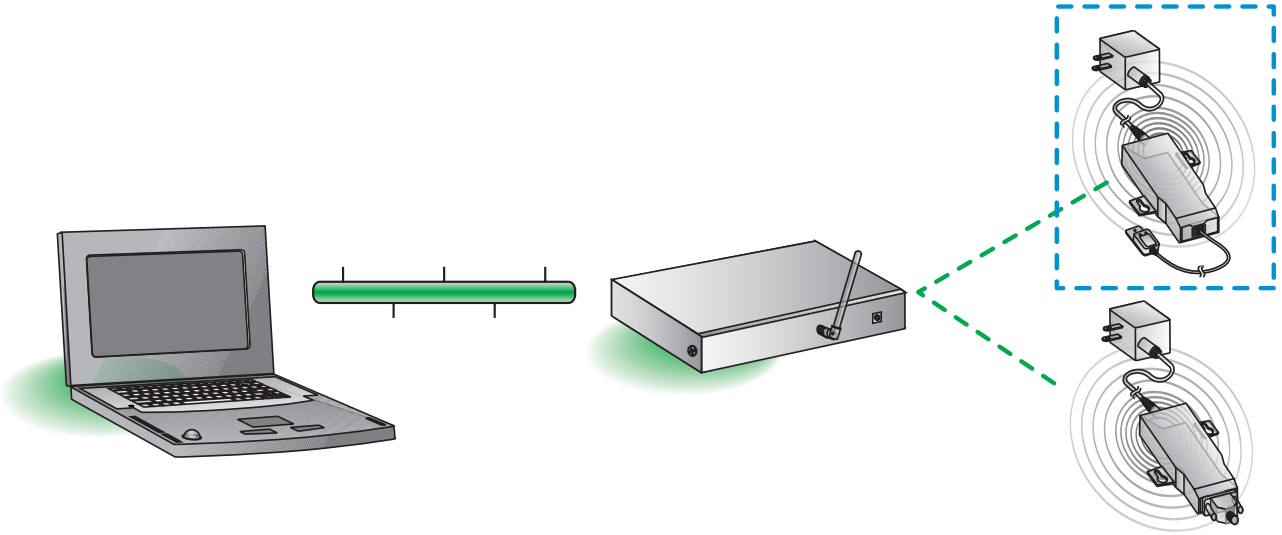
The results are displayed in the **Digi Gateway ZigBee Viewer, in** degrees C and degrees F.




### Refresh the temperature display

To refresh the display of temperatures, click the **Refresh Temperatures** button.

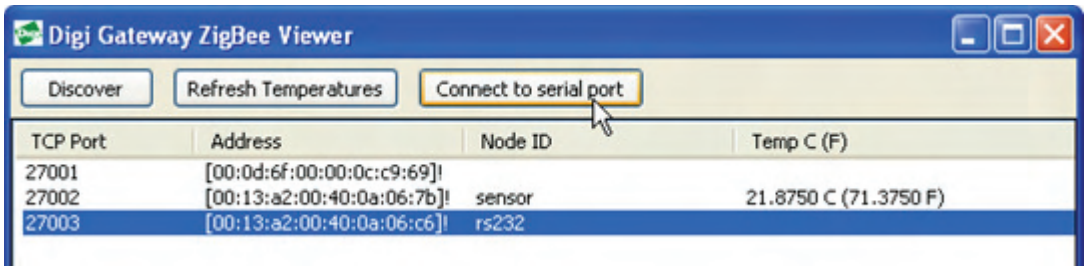
The diagram shows which part of your Drop-in Network is sending information back to your PC.



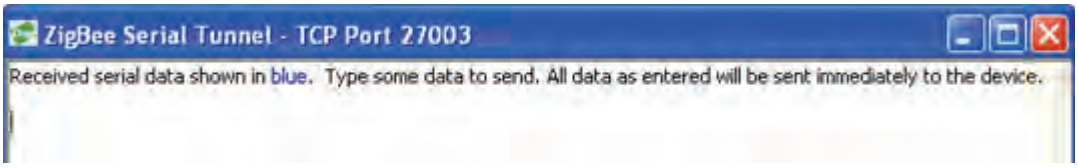
## Exercise the terminal function

Next, exercise the demo application's terminal function. This function shows how data can be sent and received between Ethernet networks and ZigBee networks.

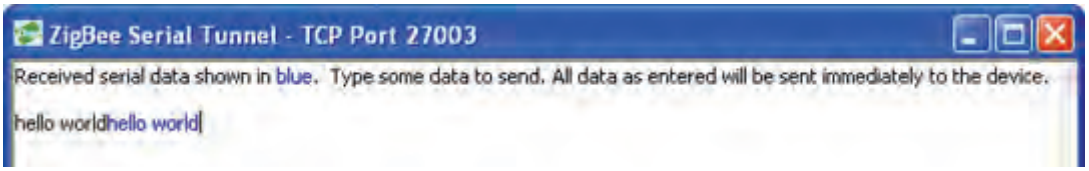
1. In the **Digi Gateway ZigBee Viewer**, select the RS-232 Adapter. and click the **Connect to serial port** button.



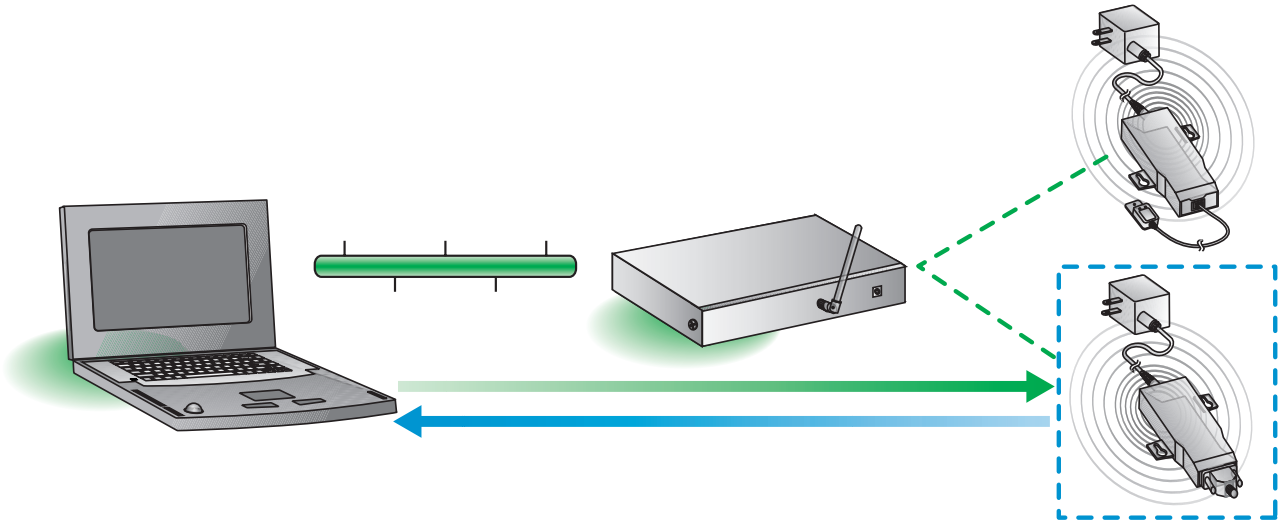

2. A terminal emulator window named **ZigBee Serial Tunnel** is displayed.



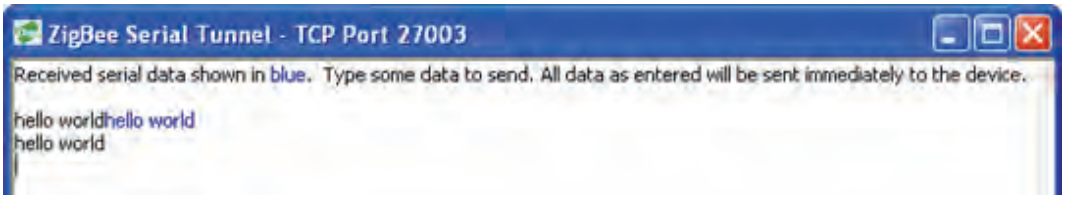

3. In the **ZigBee Serial Tunnel** window, type some text, for example, **hello world**. The text is sent to the XBee RS-232 Adapter with the loopback plug attached, and returned to the host PC. The text transmitted to the adapter is displayed in black. The text returned from the adapter is displayed in blue.



The diagram shows which parts of your network are sending and receiving data.



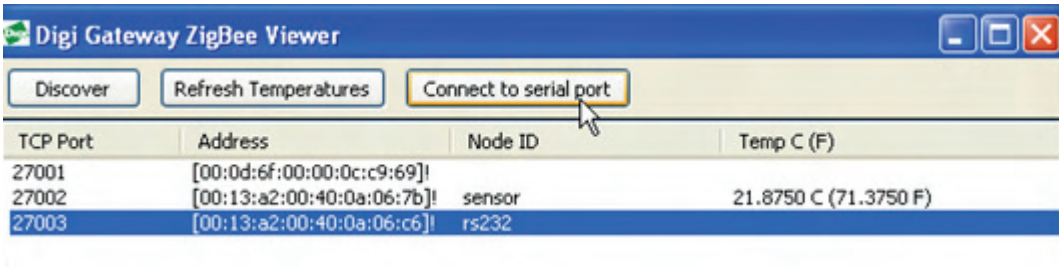
4. Remove the loopback plug from the XBee RS-232 Adapter.
5. In the terminal emulator window, type some text again. Note how only black text is displayed, because no text is being returned from the XBee RS-232 Adapter.




6. Close the ZigBee Serial Tunnel terminal emulator window.

## How did this demo application work?

The demo application that you just ran uses Python programming language functions to discover the XBee Adapters, known as ZigBee nodes in the ZigBee network. It then assigns each ZigBee node a TCP port, which allows the demo application to communicate with the ZigBee nodes over the Ethernet network. Note the numbers assigned to each ZigBee node in the **TCP Port** column of the **Digi Gateway ZigBee Viewer** below. The key link between the ZigBee and Ethernet networks is the assignment of TCP ports to each ZigBee node.




The demo application then uses Python functions to read temperature data from the Watchport/T sensor connected to the XBee Sensor Adapter, and to send and receive data between the PC and the XBee RS-232 Adapter.

You can use the demo application as a base for further application development.

To view the source for the demo application, go to **Start > Digi > Drop-in Networking > Samples**.

To learn more about the Python functions in the demo application, go to **Start > Digi > Drop-in Networking > Documentation > Digi Python Programmers Guide**.

The functions, features, and commands involved in the reading and writing data to and from the XBee Modules in the XBee Adapters are described in the XBee Product Manual for the XBee Module. This manual is included on the Software and Documentation CD for the XBee Product Manual.

To launch the demo application at any other time, select **Start > Programs > Digi > Digi Drop-in Networking > Digi Gateway ZigBee Viewer Sample.**

# Congratulations!

You have successfully installed a Drop-in Network and exercised the functions of the demo application.

To further explore the potential of Drop-in Networking, go the next section.

# 2. Extend the Drop-in Network with Embedded Development

The Drop-in Networking Starter Kit includes XBee interface boards and modules, hardware accessories, software, and documentation to further explore embedding a ZigBee wireless solution into your specific application.

## OBJECTIVES

- Add XBee interface boards to your Drop-in Network
- Configure the XBee module on the battery-powered XBee interface board for low-power operation
- Use tools embedded development tools and documentation

## Connect and power on interface boards

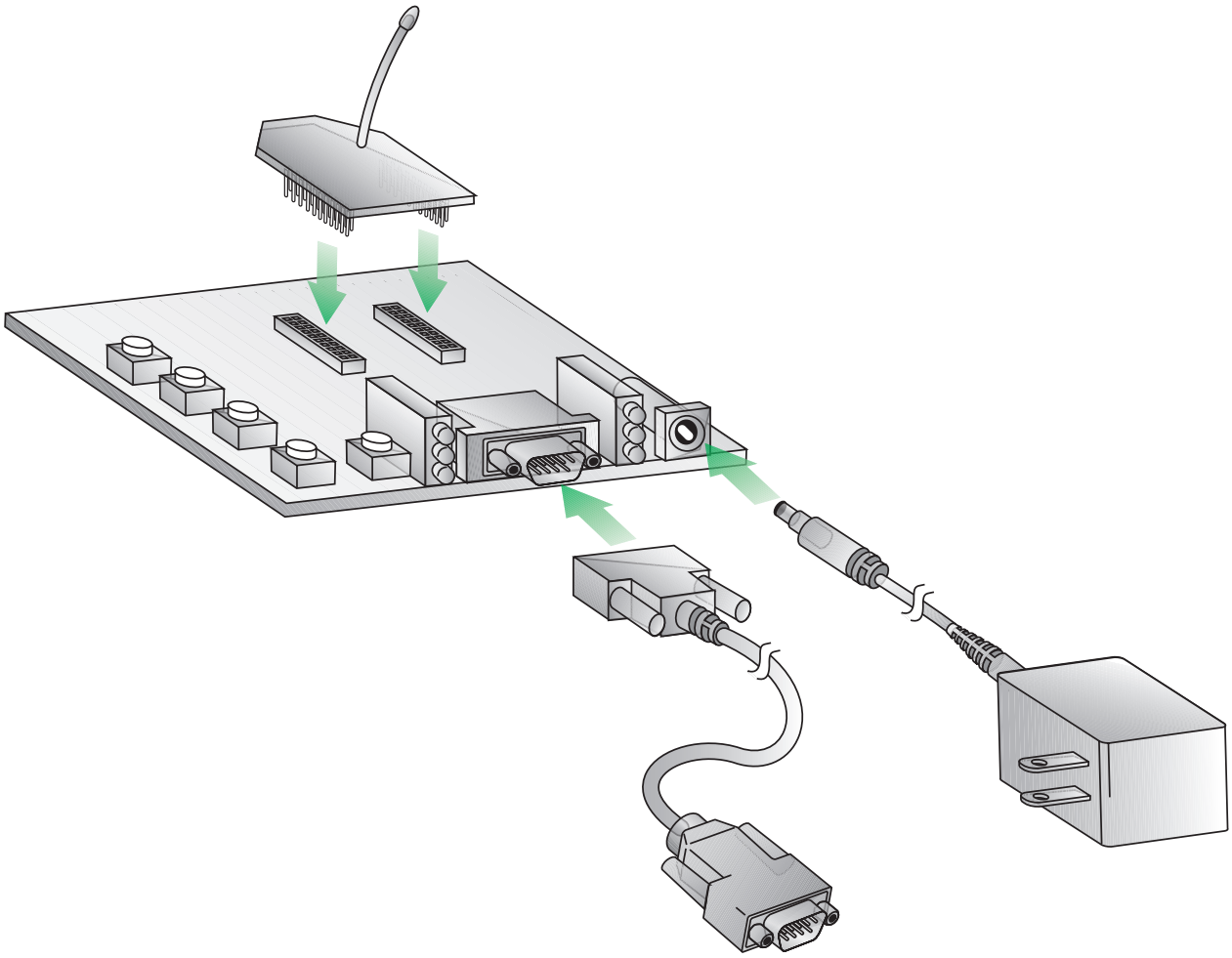
There are two XBee Interface Boards, one powered by batteries and the other through an external AC power supply.

Additional interface boards and XBee Modules are available at:

**http://www.digi.com/din**

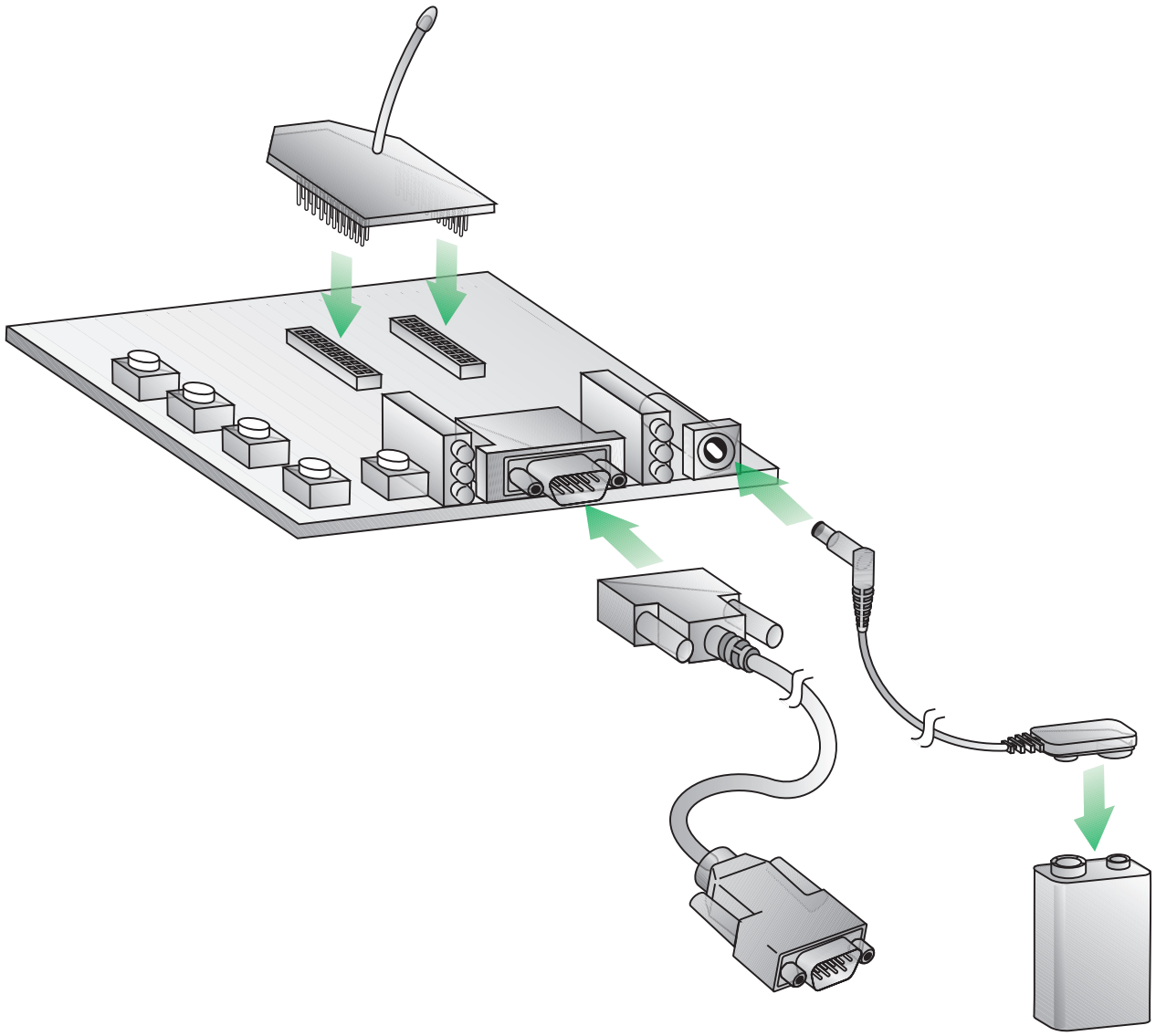
### XBee interface board, AC-powered

1. Open and unpack the box labeled **XBee Interface Board (AC)**.
2. Connect the XBee Module to the connectors on the interface board. Orient the board and connector pins as shown in the diagram.
3. Connect the RS-232 cable to the serial port on the interface board, and to the PC's serial COM port.
4. Connect the power supply to the interface board.



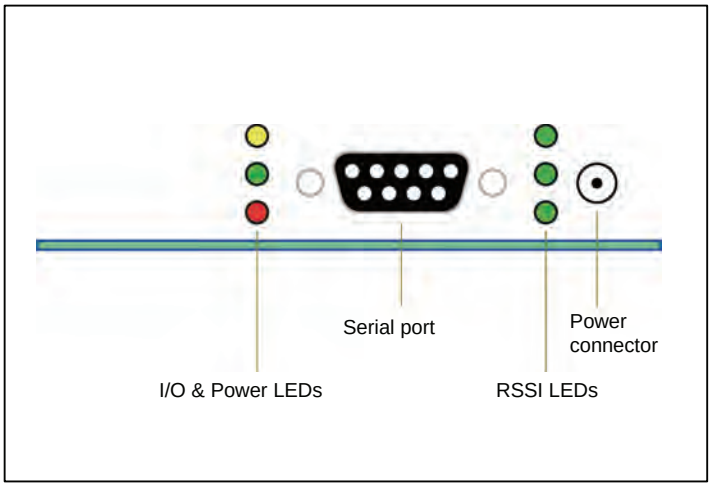
### XBee interface board, battery-powered

1. Open and unpack the box labeled **XBee Interface Board (Batt)**.
2. Connect the XBee Module to the connectors on the interface board.
3. Connect the RS-232 cable to the serial port on the interface board, and to the PC's serial COM port.
4. Connect the battery to the terminals on the battery cable.
5. Connect the battery cable to the power port of the interface board.
6. Because the interface board is battery-powered, the XBee Module must be set to low-power mode. Go to "Configure a Zigbee Module to low-power mode" on page 32 for instructions.



## LEDs on the XBee Interface Boards

The XBee Interface Boards have several LEDs to the right and left of the RS-232 connector that indicate activity.




### I/O and Power LEDs

The LEDs to the left of the RS-232 connector indicate RF module activity:

- **Yellow (top LED)**: Serial Data Out (to host)
- **Green (middle)**: Serial Data In (from host)
- **Red (bottom)**: Power/Association Indicator. This LED indicates both power to the interface board and the network association status for the XBee Module in the interface board.

  **Solid LED** indicates that the XBee Module is powered and is not associated to a ZigBee network.

  **Flashing LED** indicates that the XBee Module has associated to a ZigBee network.

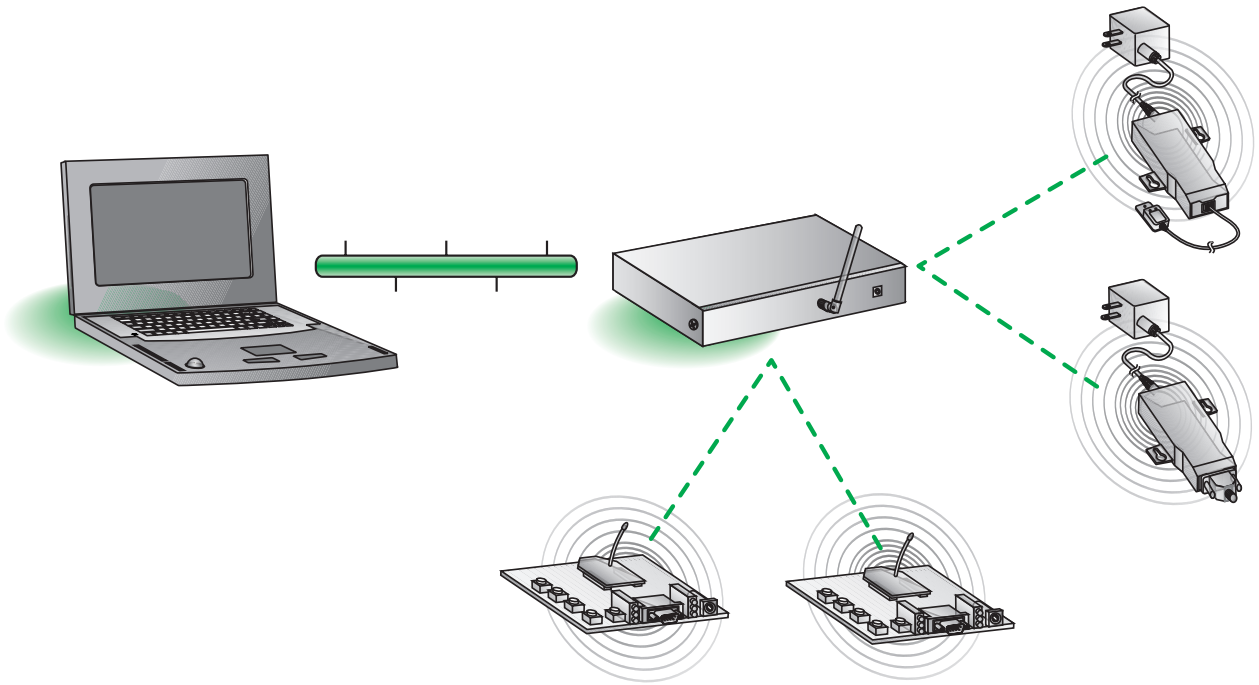
  For more information on this indicator, refer to the description of the D5 (DIO5 Configuration) parameter in the product manual for the XBee Module.

### RSSI LEDs

The RSSI (signal strength) LEDs to the right of the RS-232 connector indicate the amount of fade margin present in an active wireless link. The fade margin is defined as the difference between the incoming signal strength and the module's receiver sensitivity.

- **3 LEDs on**: Very Strong Signal (> 30 dB fade margin)
- **2 LEDs on**: Strong Signal (> 20 dB fade margin)
- **1 LED on**: Moderate Signal (> 10 dB fade margin) 0 LED ON = Weak Signal (< 10 dB fade margin)

Now, your Drop-in Network looks like this:



## Configure a Zigbee Module to low-power mode

By default, all XBee modules are set to Sleep Mode = 0 (No Sleep). With this setting, a typical Alkaline 9-volt battery will power the module for less then a day. The XBee Module on the battery-powered XBee Interface Board must be configured to low-power mode before using the board. This procedure requires installing software called X-CTU on your PC and configuring several settings.

### Install the X-CTU software

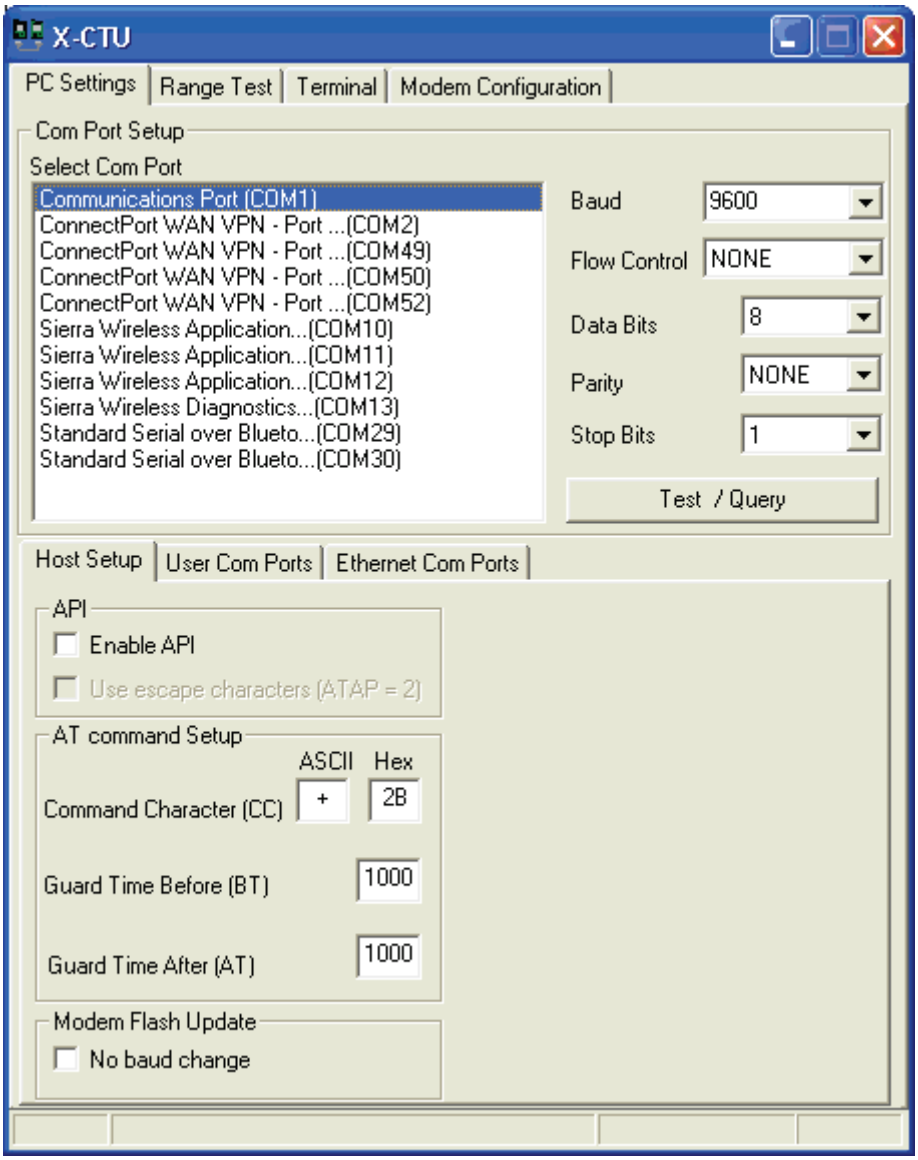
1. Insert the **Software and Documentation CD** in the PC's CD/DVD drive.
2. On the Home page, click **Adapters, Sensors, Modules Documentation/Software**
3. Click **XBee Module** or **XBee Series 2 Module**
4. Click **Install X-CTU**.

### Start X-CTU and establish communication with XBee Interface Board

1. Select **Start > Programs > Digi-Maxstream > X-CTU**.

   The X-CTU Software interface is opened. The interface has several tabs:

   - **PC Settings**: Set up PC serial COM ports to interface with the XBee module.
   - **Range Test**: Test the range of wireless links under varying conditions.
   - **Terminal**: Read/Set parameters on the XBee module and monitor data communications.
   - **Modem Configuration**: Read/Set configuration parameters on the XBee Module.



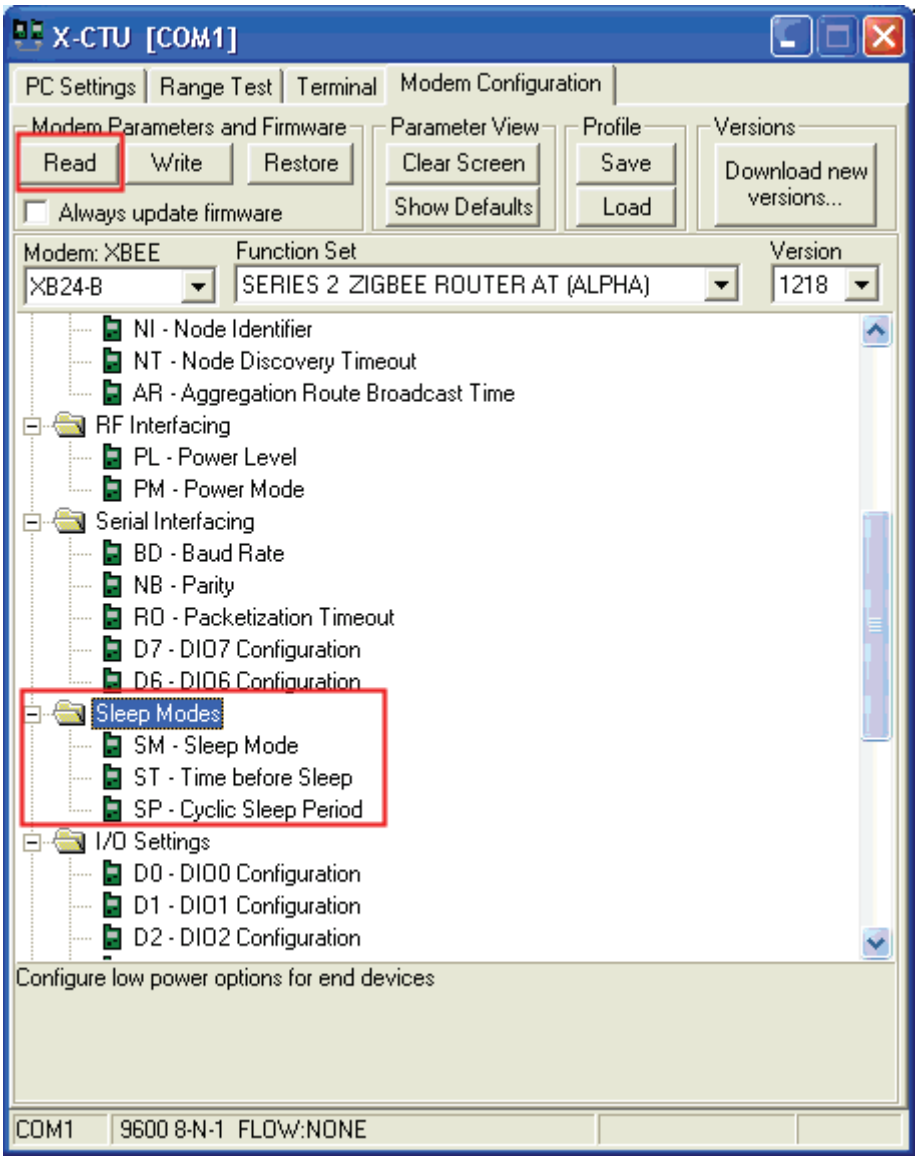

2. On the **PC Settings** tab, establish communications between the PC and interface board:
   - Select **COM 1**.
   - Click the **Test/Query** button.

   **Note:** If the message **Failure to enter AT Command Mode** message is displayed, this failure is most commonly caused by a baud rate mismatch. Make sure the **Baud** setting on the **PC Settings** tab matches the interface data rate of the module. The interface data rate is set by the BD parameter; its default setting is 9600 bps.

### Program the XBee Module to low-power sleep mode

To reconfigure the XBee Module to Low Power mode:

1. In the X-CTU software, go to the **Modem Configuration** tab and click the **Read** button.



2. Set the Sleep Mode settings as follows:
   - **SM - Sleep Mode**: Set to **4 – Cyclic Sleep**.

     With this setting, the module will sleep in a period of time (ST) following the last data transmission, and wake up following the Cyclic Sleep Period (SP).
   - **ST - Time before Sleep**: Set to **1388**.

     1388 (hex) = 5000 (dec) X 1ms = 5000 ms = 5 seconds
   - **SP - Sleep Period**; Set to **7d0**

     7d0 (hex) = 2000 (dec) x 10ms = 20000 ms = 20 seconds
3. To write these settings to the XBee Module, click the **Write** button.

### Verify XBee Interface Board operation

To confirm proper operation of the XBee Interface Board in this application:

1. Select **Start > Programs > Digi > Digi Drop-in Networking > Digi Gateway ZigBee Viewer Sample** to launch the demo application and re-discover the XBee nodes.
2. Open the web interface for the gateway.
3. Go to **Administration > System Information > Mesh Network**. The **Mesh Network** page should display a new device, assigned to a TCP Port.
4. By attaching the red loopback plug in the **Accessories** box to the battery powered XBee Interface Board, you can test the operation of this device as it enters and exits sleep mode.

# Embedded development resources

Several software and documentation resources are available to help you in embedded development efforts, as well as additional Drop-in Networking hardware.

## Software

### Drop-in Networking program group

The Drop-in Networking program group was added during installation of the sample PC application. To view this program group, select **Start > Programs > Digi > Digi Drop-in Networking**.

To run the demo application again, select **Digi Gateway ZigBee Viewer Sample**.

### Demo application source code

The demo application is developed in the Python® programming language and can be used as a example and base for further application development. To view the source code for the demo application, go to **Start > Programs > Digi > Digi Drop-in Networking > Samples.**

## Documentation

There are several places to learn more about Drop-in Networking products and embedded development programming:

- Go to **Digi Drop-in Networking > Documentation** for documents helpful in embedded development that have been loaded on your PC.
- Browse the Software and Documentation CD for additional detailed manuals for Drop-in Networking Starter Kit components.
- See Digi's Drop-in Networking Documentation page at:

  **www.digi.com/din/docs/**

### XBee Module documentation

The **Software and Documentation CD** has product manuals and data sheets for the XBee Modules in the gateway, XBee Adapters, and XBee Interface Boards. Click Adapters, Sensors, Modules Documentation/Software to browse these documents. The product manuals describe module features, modes of operation, and commands for controlling the modules, and reading data to/writing data from them.

### Digi Python Programming Guide

The Drop in Networking Starter Kit includes two demo applications: the PC-based demo application you just ran, and an application on the gateway that discovers the ZigBee nodes.

These applications are written in the Python programming language, and serve as an example for Drop-in Networking application development.

Python is a dynamic, object-oriented language for developing software applications, from simple programs to complex embedded applications. It includes extensive libraries and works well with other languages. A true open-source language, Python runs on a wide range of operating systems.

The *Python Programming Guide* introduces the Python programming language by showing how to create and run a simple Python program. It reviews Python modules, particularly those modules with Digi-specific behavior, and the functions used in the sample PC and gateway applications. It describes how to load and run Python programs onto Digi devices, either through the command-line or web user interfaces, and how to run several sample Python programs.

### ConnectPort X Family User's Guide

The *ConnectPort X User's Guide* provides information about the features and functions the ConnectPort X gateway, including how to configure, monitor, and administer the gateway, primarily from its web user interface.

### XBee Adapter, Sensor, and Router documentation

Additional information on the XBee Adapters, including detailed descriptions of LEDs, buttons, and pinouts, is available in the XBee Adapters, Routers, and Sensors User's Guide. Download this document from:

**www.digi.com/din/docs/**

## Order additional Drop-in Networking products

To learn more about and order other Drop-in Networking products, browse the Software and Documentation CD and go to Digi's Drop-in Networking page at

**www.digi.com/din/**

## Examples of embedded development efforts

Here are descriptions ways you can extend your Drop-in Network through embedded development, from simple programming efforts to larger-scale ones.

### Modify the PC demo application

The PC and gateway demo applications can be modified. See the readme files and source code for both applications for information on how the applications run and the steps involved.

The gateway has a function to upload and manage Python program files on the gateway, and to automatically execute the Python programs at gateway startup. In the gateway web interface, go to **Applications > Python**.

### Create new applications

Custom applications for ZigBee devices can be written and loaded onto the XBee Interface Boards.

The core processors are specific to ZigBee communications; product information is available in MaxStream documents included on the Software and Documentation CD.

### Exercise serial connections

Some ways to further exercise the Drop-in Network's Starter Kit's serial connections include:

- Connect more serial devices and communicate with them.
- Modify the demo applications; for example, change several steps of the application that exercise serial connection.
- Write and run a custom Python application for communicating with serial devices.

### Experiment with additional sensors

The XBee Sensor Adapter can be used with additional sensor types. For example:

- The Watchport/H Humidity / Temperature Sensor is a humidity sensor that measures relative humidity, true humidity and temperature.
- The Watchport/D Distance Sensor is a distance sensor that measures via infrared a distance of 20 cm to 150 cm.
- The Watchport/A Acceleration/Tilt Sensor is a accelerometer that measures position in a x-y, pitch, and roll form.

For additional information and to order these sensors, go to:

**http://www.digi.com/din**

# Use Digi Connectware Manager

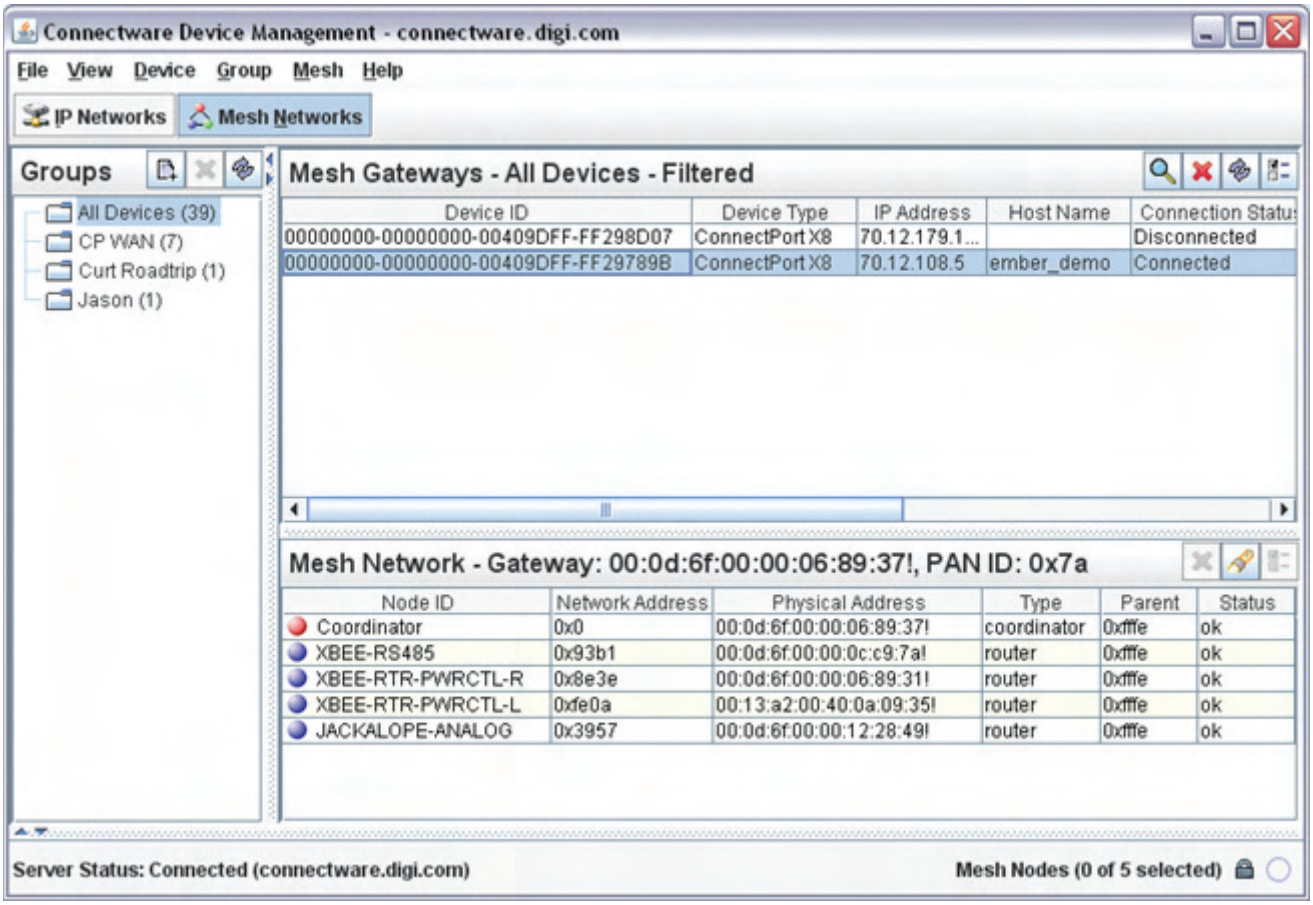
Digi Connectware Manager is a device management platform that provides remote network management of all connected hardware, including devices on the ZigBee network. In contrast to the one-user-to-one device model of other Digi device interfaces, Digi Connectware Manager deploys a one-user-to-many-devices interface model. From Digi Connectware Manager, you can provision and configure network hardware, track device performance, remotely set filters and alarms, monitor connections, reboot devices and reset defaults, and remotely upgrade firmware. ZigBee extensions to Digi Connectware Manager make it a particularly attractive platform for managing ZigBee devices behind the gateway. It displays all nodes on the ZigBee network with the ability to query for node profiles, node descriptors, connected endpoints, radio configuration settings radio statistics, bindings, and more.

The Starter Kit includes a 30-day trial offer for a live demonstration version of Digi Connectware Manager. In addition, the Software and Documentation CD includes a copy of Digi Connectware Manager that can be installed on your PC.

Digi Connectware Manager displays that are particularly useful for viewing and configuring ZigBee networks are the ZigBee Networks View and detailed views of ZigBee network nodes.

## ZigBee Networks View

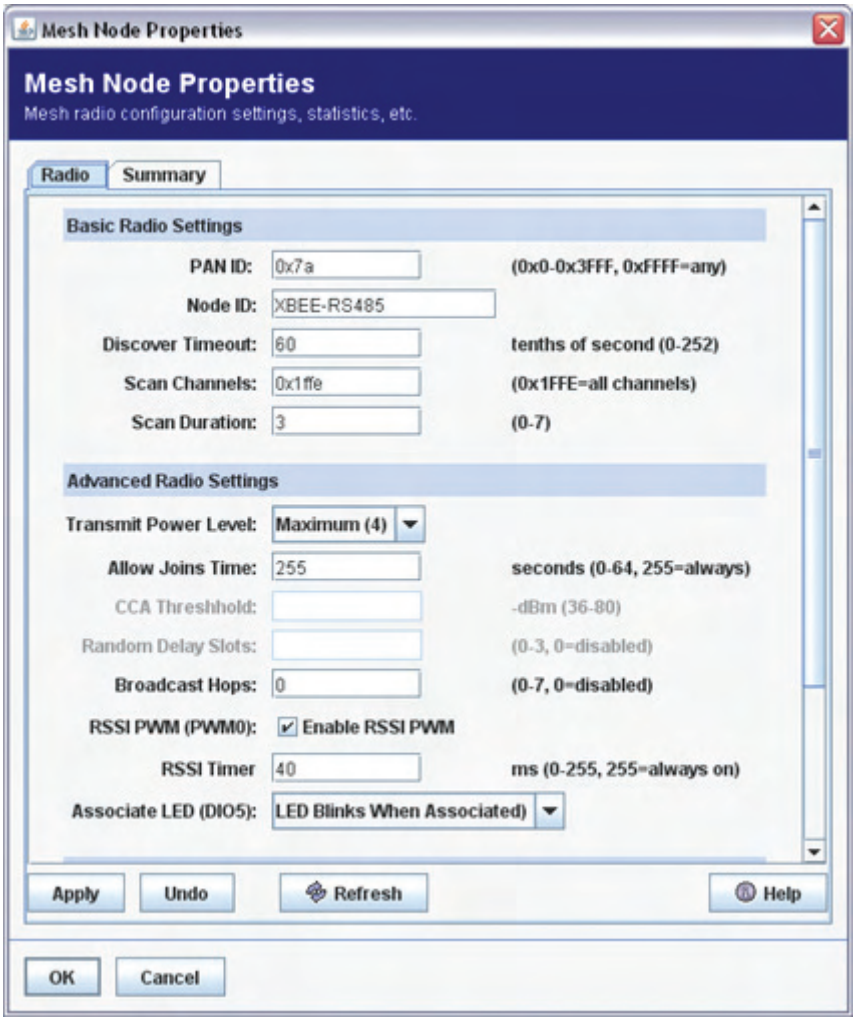
The **Mesh Networks** device management view of Digi Connectware Manager allows for displaying devices in their ZigBee network, including their node ID, the network to which they belong, physical addresses, their role in the ZigBee network (coordinator, router, or end node), and their defined parent in the ZigBee network.



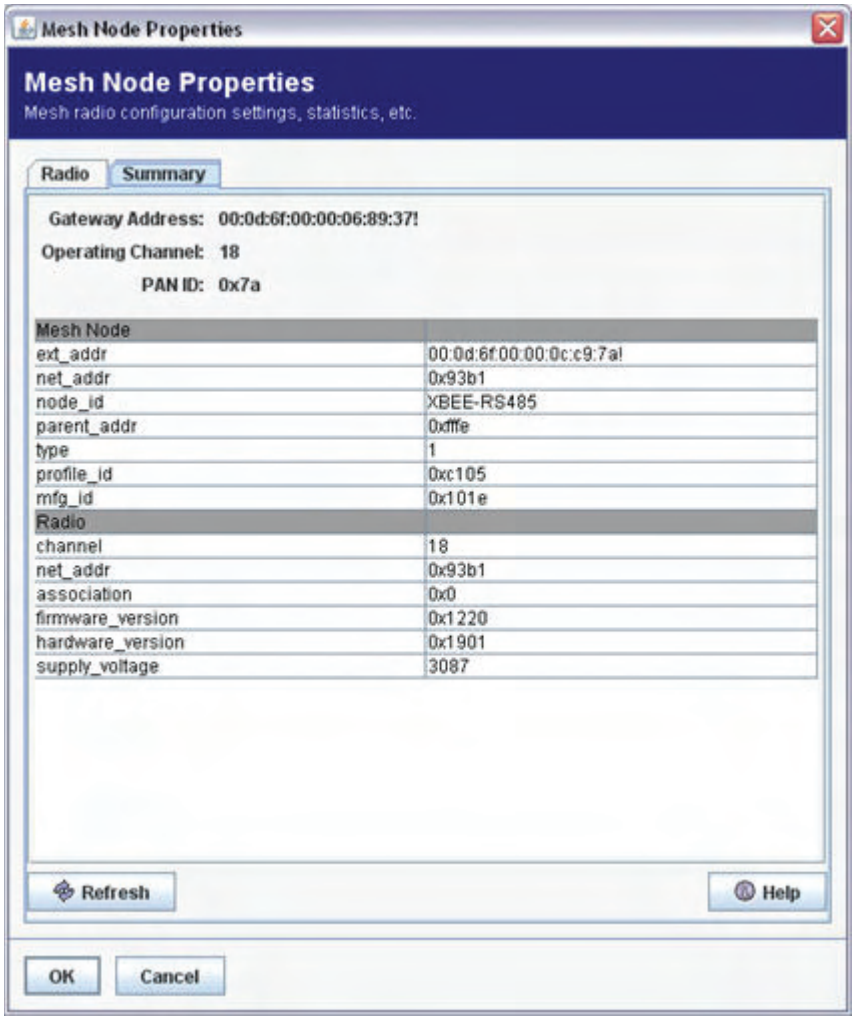
## ZigBee Node Views

From the ZigBee Networks view, more detailed views of devices can be accessed. For example, here are the **Radio** and **Summary** tabs of the **Device Properties** view for a particular ZigBee network node:

**Radio** tab:



**Summary** tab:




## Digi Connectware Manager product information

For more information about Digi Connectware Manager, see the *Connectware Manager Getting Started Guide* on the **Software and Documentation CD**.

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