Jennic

TECHNOLOGY FOR A CHANGING WORLD

JN5139-EK020 802.15.4/JenNet Starter Kit User Guide

JN-UG-3040

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About this Manual

This manual is designed to introduce you to the Jennic JN5139-EK020 IEEE 802.15.4/ JenNet Starter Kit for wireless networks and to help you start using the kit as quickly as possible. We suggest that you work through the manual from beginning to end. Activities will take you from using simple built-in demonstrations to controlling the network using commands from a PC. Finally, the manual provides guidance on choosing the Jennic software to use for your own application development and describes the available resources to help you use this software.

Organisation

This manual consists of 6 chapters and 4 appendices, as follows:

- Chapter 1 introduces the Starter Kit from a hardware point-of-view, provides some essential network information and describes the supplied demonstration applications.
- Chapter 2 describes how to use the ‘out-of-box’ demonstrations.
- Chapter 3 contains a tutorial which involves controlling the network from a PC using AT-Jenie commands.
- Chapter 4 contains tutorials for the advanced demonstrations in which custom AT-Jenie commands are used to control board resources and perform performance tests.
- Chapter 5 provides information that will allow you to choose the Jennic software interface that you will use for your application development.
- Chapter 6 provides guidance on which Jennic resources to use for your application development.
- The Appendices provide procedures for connecting a board to a PC, provide a procedure for downloading the AT-Jenie software to a board, summarise the custom AT-Jenie commands used in the advanced demonstrations and provide a glossary of wireless network terms.

Conventions

Files, folders, functions and parameter types are represented in **bold** type.

Function parameters are represented in *italics* type.

Code fragments are represented in the `Courier New` typeface.

This is a **Tip**. It indicates useful or practical information.

This is a **Note**. It highlights important additional information.

*This is a **Caution**. It warns of situations that may result in equipment malfunction or damage.*

Acronyms and Abbreviations

API	Application Programming Interface
JenNet	Jennic Network
MAC	Media Access Control
PAN	Personal Area Network
UART	Universal Asynchronous Receiver Transmitter

Related Documents

[1] DR1080 Starter Kit Board Reference Manual (JN-RM-2037)

[2] Jenie API User Guide (JN-UG-3042)

[3] Jenie API Reference Manual (JN-RM-2035)

[4] AT-Jenie User Guide (JN-UG-3043)

[5] AT-Jenie Reference Manual (JN-RM-2038)

[6] AT-Jenie Quick Command Reference (JN-RM-2036)

[7] JenNet Stack User Guide (JN-UG-3041)

Feedback Address

If you wish to comment on this manual, or any other Jennic user documentation, please provide your feedback by writing to us (quoting the manual reference number and version) at the following postal address or e-mail address:

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1. Introduction

Welcome to the Jennic JN5139-EK020 IEEE 802.15.4/JenNet Starter Kit, which provides a first experience of wireless networks. The kit allows a small wireless network to be quickly assembled and used with pre-loaded demonstration applications, as well as used to develop new applications.

This chapter introduces you to the Starter Kit by describing:

- the contents of the kit
- the hardware features of the kit and the power supply options
- how to register for technical support
- essential background information on wireless networks
- the built-in demonstration applications

1.1 Kit Contents

In the Starter Kit box, you will find the following components:

1. 3 boards (network nodes) with pre-installed modules featuring the Jennic JN5139 wireless microcontroller and integrated ceramic antenna
2. 2 USB-to-serial cables (for connection to PCs)
3. Pack of 10 AAA batteries (for the boards)
4. CD containing user documentation, demo application binaries, a Flash programming utility and the full Jennic Software Developer's Kit (SDK)

Figure 1: JN5139-EK020 Starter Kit Components

1.2 Kit Hardware

The three boards supplied with the Starter Kit are physically identical and each board is pre-installed with a module containing the Jennic JN5139 wireless microcontroller. This module features an integral ceramic antenna for radio transmission and reception at 2400 MHz.

In addition, each board has the following features:

- 2 LED indicators for user output (D1 and D2)
- 1 LED indicator for power status (D9)
- 4 push-button switches:
    - 2 switches for user input (SW1 and SW2)
    - 2 switches for board reset (RST) and programming (PRG)
- 1 slider switch for power on/off (SW6)
- 2 UART interfaces (UART0 and UART1) for communication and program downloads
- Expansion port for connecting the JN5139 wireless microcontroller to external circuitry, such as sensors

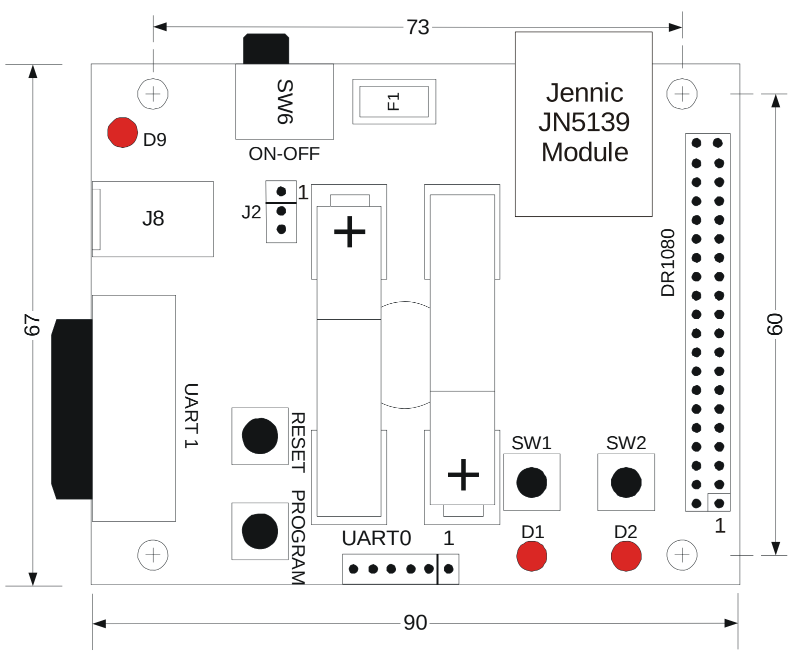


Figure 2: Starter Kit Board

The boards can be powered from batteries or, alternatively, from an external power source. For further details of the possible power sources, refer to Section 1.3.2.

If you require further hardware details on the boards, refer to the *Jennic DR1080 Starter Kit Board Reference Manual (JN-RM-2037)*, available on the Starter Kit CD and from the Support area of the Jennic web site.

1.3 Power Supplies for Boards

The Starter Kit boards can be powered from internal batteries (supplied) or from an external power source. An internal or external power source is selected using the on-board jumper J2 (see Figure 2 for position on board), as shown below:

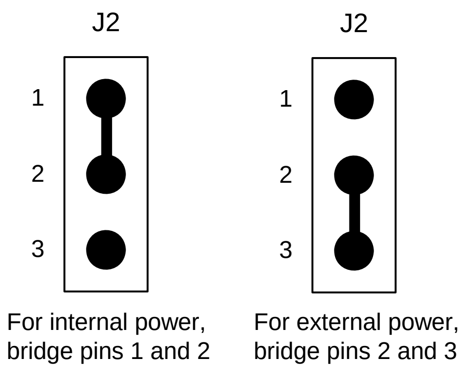


Figure 3: Power Source Selection using Jumper J2

The internal and external power options are presented in the sub-sections below.

1.3.1 Internal Battery Power

Each board can be powered from two 'AAA' batteries from the supplied pack. This may be the most convenient option when you begin using the kit - the boards are configured to use battery power by default.

To prepare a board for use with internal power:

1. Ensure jumper J2 on the board is set for internal power - pins 1 and 2 must be bridged (see Figure 3).
2. Insert two 'AAA' batteries into the board (the required polarities are indicated on the board).

If you wish to save battery life, you should power the boards from external power sources, particularly the Co-ordinator and Router boards (see Caution below).

> ***Caution:** Whilst the End Device board conserves power by periodically sleeping, the Co-ordinator and Router boards are fully powered all of the time. This means that battery life may be relatively short for the non-sleeping boards. Therefore, you should always power off the boards when not using the kit. Alternatively, the boards can be powered from an external source, as described in Section 1.3.2*

1.3.2 External Power Source

Each board can be powered from either of two external power sources:

- **An external PSU (Power Supply Unit):** Connection is via a 2.1-mm jack socket (J8) and the input is protected against reverse polarity. The external PSU voltage supply range is 5-6V DC or 4.5–6V AC.
- **A PC:** Connection is via the supplied USB-to-serial cable connected to the 6-pin serial connector corresponding to UART0 on the board. **Make sure you connect the black wire of the cable to Pin 1 of the on-board connector**.

Note: If the message **Found new hardware wizard for TTL232r-3v3** appears when you make this connection to a PC, you must install the driver for the USB-to-serial cable, as described in Appendix A.1.

To use an external power source, pins 2 and 3 of jumper J2 must be bridged (see Figure 3).

For the positions of the above connectors and jumper, refer to Figure 2 on page 12.

1.4 Registering for Technical Support

To register for technical support, visit **www.jennic.com/support** and follow the **About Technical Support** link. Once registered, you can create technical support requests and receive feedback via the online technical support system. You can also subscribe to the Support newsletter to ensure Jennic keeps you informed of any support updates.

1.5 Wireless Network Essentials

Before setting up a wireless network and running the supplied demonstrations, you are advised to study the background information on wireless networks provided in this section. Only the basic concepts essential to using the Starter Kit are covered here - they are:

- Radio frequency - see Section 1.5.1
- Node types - see Section 1.5.2
- Network topologies - see Section 1.5.3
- Software stack - see Section 1.5.4
- Network parameters - see Section 1.5.5

For a more complete introduction to wireless networks, refer to any one of the Jennic User Guides for Jenie, AT-Jenie or JenNet (see “Related Documents” on page 8).

1.5.1 Radio Frequency

The Starter Kit boards communicate in the 2400-MHz radio frequency (RF) band. This is one of the standard RF bands used by the IEEE 802.15.4 wireless network protocol on which the Starter Kit network is built, and is available for unlicensed use in most geographical areas (check your local radio communication regulations).

The 2400-MHz band spans radio frequencies 2405 to 2480 MHz and is divided into 16 channels, numbered 11 to 26 (the numbers up to 10 are used for other RF bands). The channel of operation for a network can be specified by the application or, alternatively, the network can search for the best channel (the one with least detected activity) at system start-up.

1.5.2 Node Types

In addition to running an application (e.g. temperature measurement), each node of a wireless network has a networking role. A wireless network can contain three types of node, differentiated by their networking roles, as described below:

Node Type	Description
Co-ordinator	Every wireless network must have a Co-ordinator. This node has a role in starting and forming the network, and can also have a routing role (passes messages from one node to another).
Router	This node passes messages from one node to another, although this routing functionality need not be used (in which case the node acts as an End Device). Messages can also originate and/or terminate at a Router.
End Device	This node is simply a place where messages can originate and/or terminate (the node does not have a routing role).

Table 1: Node Types in a Wireless Network

Among the Starter Kit boards:

- One board is programmed to act as an End Device
- The other two boards are each programmed to act as a Router or Co-ordinator (although only one board must be used as a Co-ordinator at any one time)

Note: The board programmed as an End Device is marked with a white dot (in the corner of the board near to LED D9 and switch SW6). The other two boards can each be used as a Router (default) or enabled as a Co-ordinator using the on-board switches. To enable a board as the Co-ordinator, hold down button SW2 while simultaneously powering on the board using the slider switch SW6 (then release SW2).

Note: In order to conserve power, the supplied End Device is able to sleep when not required to be active.

1.5.3 Network Topologies

Different applications may require different configurations of the network. The network topologies that can be achieved with the Starter Kit are illustrated below.

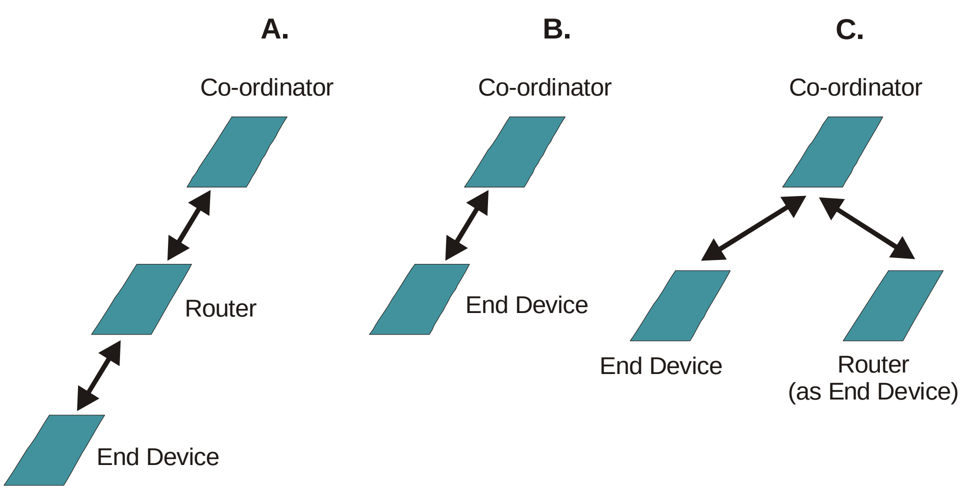


Figure 4: Possible Network Topologies using Starter Kit

- In topology A, the Router has a full routing role between the End Device and Co-ordinator.
- In topology B, the Router is not used.
- In topology C, the routing role of the Router is not used and the Router is effectively employed as an End Device.

These are all examples of a simple tree network. For a more complete description of the possible network topologies, refer to any one of the Jennic User Guides for Jenie, AT-Jenie or JenNet (see “Related Documents” on page 8).

1.5.4 Jenie/JenNet Software Stack

The software which runs on a wireless network node deals with both application-specific tasks (e.g. temperature measurement) and networking tasks (e.g. sending a message to another node). The software is organised as a number of layers, forming a stack, with the user application at the top of the stack. The basic stack architecture is illustrated in the figure below.

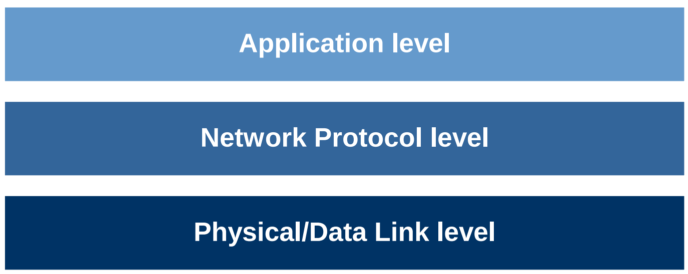


Figure 5: Basic Software Stack Architecture

These basic levels are described below (from top to bottom):

- **Application level:** Contains the user application that gives the device its functionality (mainly concerned with converting input into digital data and/or digital data into output).
- **Network Protocol level:** Provides the networking functionality concerned with network structure, routing and security. In the Starter Kit networks, this level is provided by Jennic’s proprietary JenNet protocol.
- **Physical/Data Link level:** Responsible for message composition/ decomposition and delivery, and provides the interface to the physical transmission medium (radio, in this case). In the Starter Kit networks, this level is provided by the industry-standard IEEE 802.15.4 protocol.

In addition, Jennic provide an easy-to-use software interface, called Jenie, which allows the application to interact with the JenNet network protocol. The resulting Jennic software stack is illustrated in Figure 6 below.

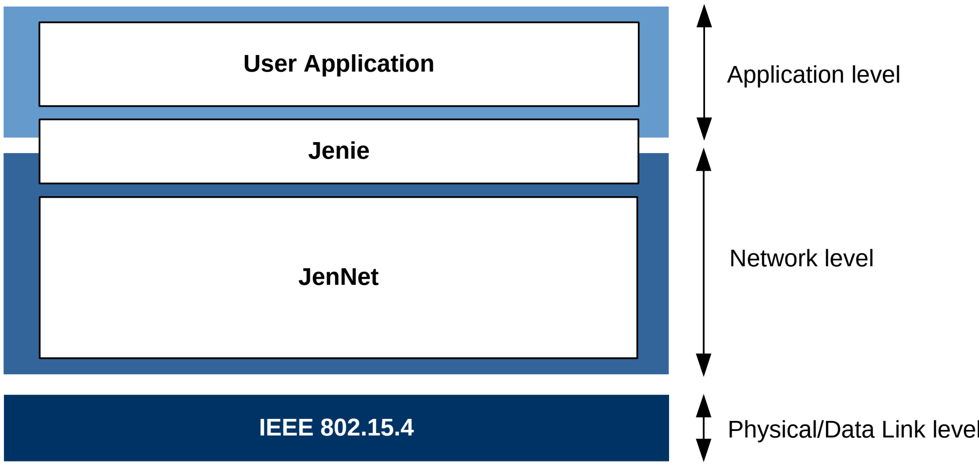


Figure 6: Jenie/JenNet Stack Architecture

The Jenie interface is available as an Application Programming Interface (API), consisting of a library of C functions. The Jenie functions can be used directly in the application code or via a serial command set known as AT-Jenie (refer to Section 3.1 for more details).

1.5.5 Network Parameters

Three fundamental network parameters are set when a wireless network starts up. These are as follows:

Network Parameter	Description
PAN ID	This is a 16-bit value which uniquely identifies the network.
Network Application ID	This is a 32-bit value which uniquely identifies the network - it is specific to Jennic's proprietary Jenie/JenNet system and is the main way of identifying such a network.
Channel	This is the radio channel to be used by the network in the 2400-MHz band - the channels in this band are numbered 11 to 26 with increasing frequency.

Table 2: Fundamental Network Parameters

Caution: *When operating two or more wireless networks in overlapping physical spaces, you should ideally use different radio channels for the networks. If using the same channel, you must ensure that the networks have different Network Application IDs.*

1.6 Demonstration Applications

This section introduces the supplied demonstrations and how to access them.

1.6.1 Demonstration Types

Three categories of demonstration application are built into the Starter Kit boards. These demonstration types are summarised in the table below (full details are provided in the referenced chapters):

Demo Type	Description	Reference
Out-of-box demos	These demos can be run with the minimum of preparation. Two such demos are provided: • **Wireless network:** Illustrates basic wireless network operation based on a light-switch application (pressing a button on one node illuminates or extinguishes an LED on another node) • **Wireless UART:** Allows two PCs to communicate via a wireless link that uses the on-board UARTs You should try these demos before moving on to the other demos (described below).	Chapter 2
AT-Jenie demo	This demo illustrates the use of Jennic's proprietary AT-Jenie command set to interact with a wireless network. AT-Jenie commands are issued from a PC connected to the network.	Chapter 3
Advanced demos	These demos use more advanced features of the Starter Kit boards. They allow you to: • Obtain voltage and temperature measurements from on-chip sensors on the different nodes • Interact with LEDs and buttons on the nodes • Measure the radio signal strength of received packets • Make PER (Packet Error Rate) measurements A customised AT-Jenie command set is used to interact with the network from a PC.	Chapter 4

Table 3: Demonstration Types for Starter Kit

The required demo type is selected using the on-board buttons, as described in Section 1.6.2.

Tip: You are advised to try the out-of-box demos before attempting the other demos. You should also work through the AT-Jenie demo before attempting the advanced demos.

1.6.2 Selecting a Demonstration

To use one of the pre-loaded demonstrations, you should start by referring to its procedure in the relevant chapter of this manual:

- For the out-of-box demos, refer to Chapter 2.
- For the AT-Jenie demo, refer to Chapter 3.
- For the advanced demos, refer to Chapter 4.

This section summarises the use of the on-board buttons SW1/SW2 and LEDs D1/D2 in making this selection. The buttons and LEDs are used as follows:

- Button SW1 moves the board to the next demo type (and is cyclic)
- Button SW2 confirms the demo type selected with SW1
- LEDs D1 and D2 are used to indicate the status of the demo selection

The required button presses and meanings of the LEDs depend on both the required demonstration type and the node type on which the demonstration is being started. They are summarised below for the Co-ordinator board, and for the Router and End Device boards.

Co-ordinator Board

For a board that has been started as the Co-ordinator (see the Note in Section 1.5.2), the buttons and LEDs are used in demo selection as indicated in the table below (work from left to right in the table).

Demo Type Required	SW1 Action(s) *	LEDs D1/D2 (after selection)	SW2 Action	LEDs D1/D2 (after confirm)
Out-of-box	No action needed	ON/ON	**Then** press SW2 to confirm	ON/OFF
AT-Jenie	Press SW1 **once**	ON/OFF		ON/ON
Advanced	Press SW1 **twice**	OFF/ON		OFF/ON

Router and End Device Boards

For a board that has been started as a Router or End Device, the buttons and LEDs are used in demo selection as indicated in the table below (work from left to right in the table).

Demo Type Required	SW1 Action(s) *	LEDs D1/D2 (after selection)	SW2 Action	LEDs D1/D2 (after confirm)
Out-of-box	No action needed	ON/ON	**Then** press SW2 to confirm	ON/OFF
AT-Jenie	Press SW1 **once**	ON/OFF		ON/ON
Advanced	Press SW1 **twice**	OFF/ON		OFF/OFF

* A 10-second timeout applies from the last SW1 button press. If this timeout occurs before you have finished selecting the required demo type, re-start by powering off the board and repeating the necessary steps.

2. Out-of-Box Demonstrations

This chapter describes how to use the 'out-of-box' demonstrations provided with the JN5139-EK020 Starter Kit. These demonstrations are designed to start you using the Starter Kit as quickly as possible. There are two applications in this category:

- **Wireless network:** Illustrates basic wireless network operation based on a light-switch application (pressing a button on one node illuminates or extinguishes an LED on another node) - refer to Section 2.1.
- **Wireless UART:** Allows two PCs to communicate via a wireless link that uses the on-board UARTs - refer to Section 2.2.

Note: Before attempting the demonstrations, you are strongly advised to read through Chapter 1.

Note: The two out-of-box demo applications run on the boards at the same time. Therefore, you do not need to select one of these demos. Simply go to the relevant section of this chapter for operational instructions.

In these demonstrations, the network parameters described in Section 1.5 are automatically set to the following values (so you do not need to set them yourself):

Network Parameter	Value
PAN ID	0xFABB
Network Application ID	0x00000000
Channel	15

Table 4: Network Parameter Values

2.1 Wireless Network Demo

This demonstration requires minimal preparation and equipment. It operates using the three boards of the Starter Kit, with the aim of illustrating basic aspects of wireless networking, including network topologies and self-healing. The demonstration is based on a simple light-switch application, allowing you to control LEDs on one node from buttons on another node.

Note: This demonstration is used in a simplified form on the *JN5139-EK020 Starter Kit Getting Started sheet (JN-UG-3050)*, supplied in the Starter Kit box. Even if you have worked through this sheet, it is important that you attempt the full version of this demonstration below.

This demonstration uses the on-board buttons SW1 and SW2, as well as the on-board LEDs D1 and D2 - for the locations of these board resources, refer to Figure 2 on page 12. The basic use of these resources is as follows:

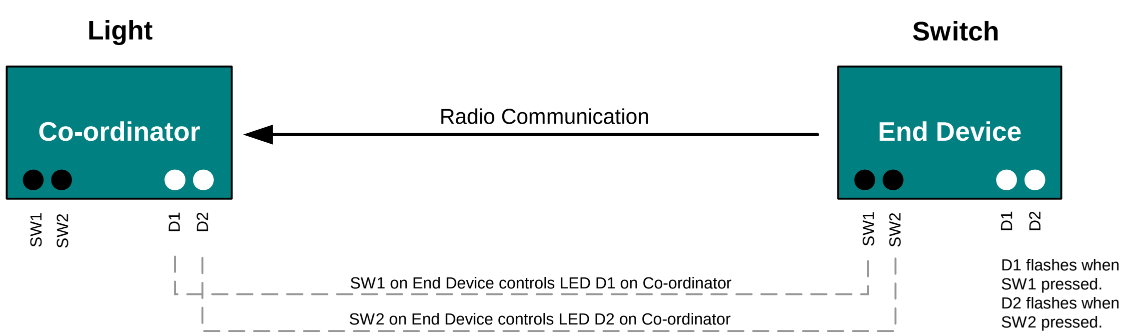
- Pressing SW1 on the End Device or Router board toggles LED D1 on the Co-ordinator board (that is, illuminates or extinguishes the LED).
- Pressing SW2 on the End Device or Router board toggles LED D2 on the Co-ordinator board (that is, illuminates or extinguishes the LED).

In addition, when SW1 or SW2 is pressed, LED D1 or D2 (respectively) flashes on the local board.

Run this demonstration as described in the procedure below.

Stage 1: Create a Simple Wireless Network

In this stage, you will form a simple wireless network consisting of only two nodes - the Co-ordinator board and the End Device board. The Co-ordinator is said to be the parent of the End Device (the child). You will then use the buttons on the End Device to control the LEDs on the Co-ordinator. This network is illustrated in the figure below.



Note that this is the same network as described in the *JN5139-EK020 Starter Kit Getting Started sheet (JN-UG-3050)*.

Step 1 **Prepare the power supplies of the boards**

Ensure that all the boards are powered OFF (using switch SW6) and that the boards are connected to a suitable power supply, as described in Section 1.3.

Step 2 **Start the Co-ordinator**

Select the board to become the Co-ordinator (make sure this not the board labelled with a white dot) and start the board as follows:

a) Hold down button SW2.

b) At the same time, power on the board using slider switch SW6.

c) Now release SW2.

The power status LED D9 as well as LEDs D1 and D2 on the board should illuminate. From this point, you have 10 seconds to start the next step (D1 and D2 are extinguished at the end of this timeout period).

Step 3 **Select the 'out-of-box' demos on the Co-ordinator**

Select the 'out-of-box' demos on the Co-ordinator as follows:

a) Press button SW2 (D2 should now be extinguished).

b) Wait for LED D1 to be extinguished.

The Co-ordinator is now ready to accept requests from other devices to join the network.

Step 4 **Start the End Device**

Power on the End Device board (the board labelled with a white dot) using the slider switch SW6.

The power status LED D9 as well as LEDs D1 and D2 on the board should illuminate. From this point, you have 10 seconds to start the next step (D1 and D2 are extinguished at the end of this timeout period).

Step 5 **Select the 'out-of-box' demos on the End Device**

Select the 'out-of-box' demos on the End Device as follows:

a) Press button SW2 (D2 should now be extinguished).

b) Wait for LED D1 to be extinguished.

The End Device has now joined the network (the Co-ordinator).

Step 6 **Illuminate Co-ordinator LED D1 from the End Device**

Press the button SW1 on the End Device - this has the effect of illuminating LED D1 on the Co-ordinator board (LED D1 on the End Device will also flash when you press the button).

Note: The End Device is programmed to sleep for periods of 1 second (to save energy when the End Device does not need to transmit or receive). However, pressing a button while the End Device is in sleep mode will wake it from sleep in order to transmit a message.

Step 7 **Extinguish Co-ordinator LED D1 from the End Device**

Now press the button SW1 on the End Device again - this has the effect of extinguishing LED D1 on the Co-ordinator board (LED D1 on the End Device will also flash when you press the button).

Step 8 **Illuminate Co-ordinator LED D2 from the End Device**

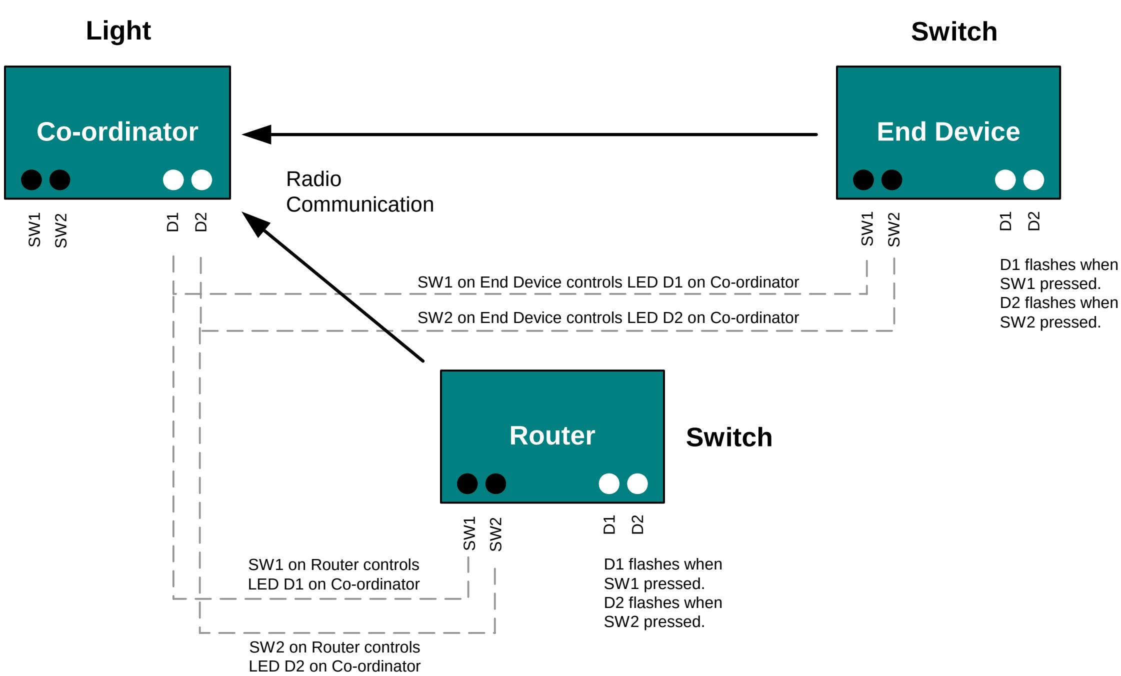
Press the button SW2 on the End Device - this has the effect of illuminating LED D2 on the Co-ordinator board (LED D2 on the End Device will also flash when you press the button).

Step 9 **Extinguish Co-ordinator LED D2 from the End Device**

Now press the button SW2 on the End Device again - this has the effect of extinguishing LED D2 on the Co-ordinator board (LED D2 on the End Device will also flash when you press the button).

Stage 2: Add a Router to the Network

In this stage, you will add a Router in order to create a three-node network. The Router will join the Co-ordinator to form the network illustrated in the figure below. The Co-ordinator will be the parent of both the Router and End Device (the children). In this configuration, the Router will not have a routing role and will effectively act as an End Device. The buttons on the Router will control the LEDs on the Co-ordinator in the same way as the buttons on the End Device.



Step 1 **Start the Router**

Power on the Router board using the slider switch SW6.

The power status LED D9 as well as LEDs D1 and D2 on the board should illuminate. From this point, you have 10 seconds to start the next step (D1 and D2 are extinguished at the end of this timeout period).

Step 2 **Select the 'out-of-box' demos on the Router**

Select the 'out-of-box' demos on the Router as follows:

a) Press button SW2 (D2 should now be extinguished).

b) Wait for LED D1 to be extinguished.

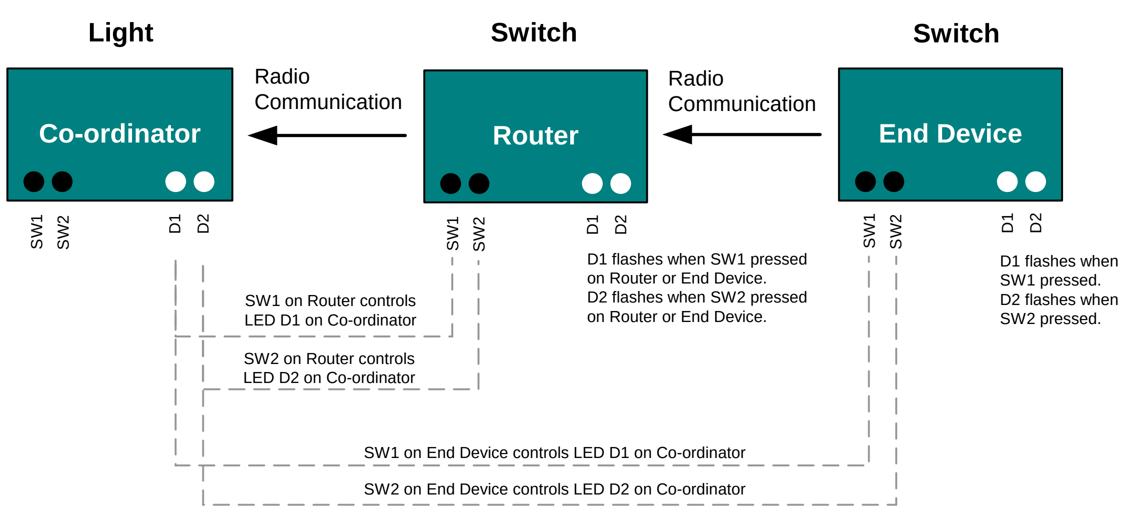
The Router has now joined the network (the Co-ordinator). As the Router joins, both LEDs D1 and D2 on the Co-ordinator will flash (to indicate a change in the network).

Step 3 **Toggle the LEDs on the Co-ordinator**

Use the buttons SW1 and SW2 on the Router and End Device to toggle the LEDs D1 and D2 on the Co-ordinator.

Stage 3: Change the Network Topology

In this stage, you will change the network topology by forcing the End Device to re-join the network via the Router (rather than via the Co-ordinator directly). Thus, in this new configuration, all communications between the End Device and Co-ordinator will go via the Router. The resulting network is as shown in the figure below. Here, the Router is the parent of the End Device and the Co-ordinator is the parent of the Router. The functionality of the network remains unchanged - buttons SW1 and SW2 on both the Router and End Device control LEDs D1 and D2 on the Co-ordinator. Note that the LEDs on the Router flash each time this board routes a message between the End Device and Co-ordinator.



Step 1 **Remove the End Device from the network**

Remove the End Device from the network by powering off the End Device board using the slider switch SW6 and leave the board powered off for at least 10 seconds.

The End Device board dis-associates from the Co-ordinator. As the End Device leaves the network, both LEDs D1 and D2 on the Co-ordinator will flash (to indicate a change in the network). Wait for this flash before continuing to the next step.

Step 2 **Re-introduce the End Device to the network**

Re-start the End Device as follows:

a) Power on the End Device board using the slider switch SW6.

b) Wait for LEDs D1 and D2 to illuminate on the End Device.

c) Within 10 seconds, press button SW2 to select the ‘out-of-box’ demos (D2 should now be extinguished).

d) Wait for LED D1 to be extinguished.

The End Device has now re-joined the network, but this time via the Router. As the End Device re-joins the network, both LEDs D1 and D2 on the Co-ordinator will flash (to indicate a change in the network).

Note: The End Device is forced to join the network via the Router rather than via the Co-ordinator. This is because the demonstration application disabled joinings on the Co-ordinator after the Router joined it in Stage 2: Add a Router to the Network.

Step 3 **Toggle the LEDs on the Co-ordinator**

Use the buttons SW1 and SW2 on the Router and End Device to toggle the LEDs D1 and D2 on the Co-ordinator.

Note that when you press the button SW1 or SW2 on the End Device, the corresponding LED (D1 or D2) on the Router flashes to indicate that the Router has passed a message from the End Device to the Co-ordinator.

Stage 4: Test Self-Healing Capability of Network

In this stage, you will remove the Router from the network, which will leave the End Device with no parent (that is, an orphaned child). The network should, however, self-heal with the End Device automatically seeking a new parent and, as a result, directly joining the Co-ordinator. The resulting network will be similar to the one with which you started in Stage 1: Create a Simple Wireless Network.

Step 1 **Remove the Router from the network**

Remove the Router from the network by powering off the Router board using the slider switch SW6.

The Router board dis-associates from the Co-ordinator. As the Router leaves the network, both LEDs D1 and D2 on the Co-ordinator will flash (to indicate a change in the network).

The End Device will be left without a parent but will still be powered. It will automatically search for a new parent, and should find and join the Co-ordinator.

> **Note:** The End Device is able to re-join the network via the Co-ordinator since the demonstration application re-enabled joinings on the Co-ordinator after the End Device joined the Router in Stage 3: Change the Network Topology.

Step 2 **Wait for the End Device to re-join the network**

When the End Device re-joins the network, both LEDs D1 and D2 on the Co-ordinator will flash (to indicate a change in the network).

Step 3 **Toggle the LEDs on the Co-ordinator**

Use the buttons SW1 and SW2 on the End Device to toggle the LEDs D1 and D2 on the Co-ordinator.

If the LEDs toggle, this confirms that the network has successfully self-healed.

Stage 5: Perform Simple Range Tests

You may now wish to perform experiments to explore the characteristics of this test system in one or more operating environments. Suggested experiments are:

- Deploy the system in an open space (probably outside) and check the range of the radio communications by increasing the distance between the nodes until no communication is possible.
- Deploy the system in an office environment with obstacles (such as furniture and people) between the nodes. Check if radio communication is possible.
- Deploy the nodes of the system in separate rooms of a building (initially neighbouring rooms). Check if radio communication is possible.

To perform these experiments, you will need two people, each with a mobile phone.

2.2 Wireless UART Demo

This demonstration requires the use of two PCs. It allows wireless communications to be sent between the PCs, one character at a time. The wireless link replaces a traditional serial cable connection.

The demonstration uses only the Co-ordinator and Router boards (although no routing functionality is used). Each board is connected to a PC via a UART link (UART0 is used on the boards). This is illustrated in the diagram below.

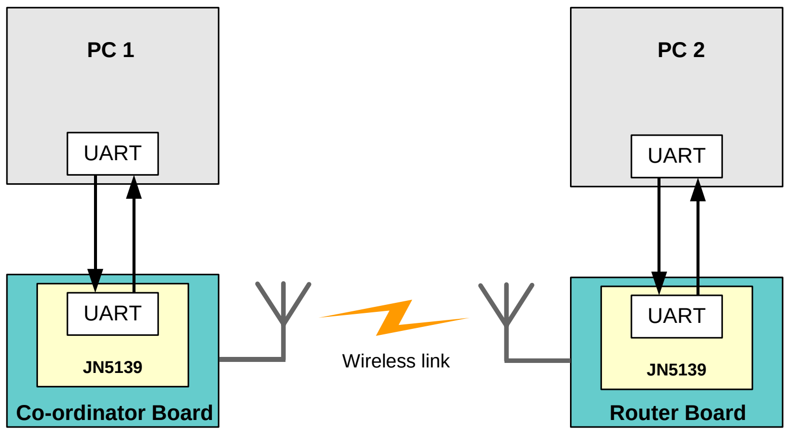


Figure 7: Wireless UART Network

You will use HyperTerminal, or an equivalent terminal emulator, for entering and displaying data on the PCs - that is, data entered in the HyperTerminal window on one PC will be transmitted to and displayed in the HyperTerminal window on the other PC. HyperTerminal is provided with Windows XP but not with Windows Vista. Therefore, Windows Vista users should download an alternative emulator, such as Tera Term Pro (available free-of-charge from http://ttssh2.sourceforge.jp).

Note: Instead of using two PCs, you can use a single PC running two HyperTerminal processes, one for each board. Thus, in this case, the two boards will be connected to separate USB ports of the same PC.

The UARTs on the PCs must be configured (within HyperTerminal) as follows:

- Baud rate: 115200 bits/s
- Data bits: 8
- Parity: none
- Stop bit: 1
- Flow control: hardware

This configuration is covered in the procedure for the demonstration, below.

To set up and perform this demonstration, follow the procedure below:

Stage 1: Make and Configure Cable Connections

Connect each board to a PC and configure the connection as follows:

Note: The Co-ordinator/Router boards must be used in this demonstration. These are the boards that are **not** marked with a white dot.

Step 1 **Connect the board to a PC**

Make the cable connection between the board and PC as follows:

a) Ensure that the board is powered OFF.

b) Connect the USB end of a supplied USB-to-serial cable to a USB port of the PC.

c) Connect the other end of the USB-to-serial cable to the 6-pin serial connector corresponding to UART0 on the board (see Figure 2 on page 12). **Make sure you connect the black wire of the cable to Pin 1 of the on-board connector**.

Note: If the message **Found new hardware wizard for TTL232r-3v3** appears when you make this connection to a PC, you must install the driver for the USB-to-serial cable, as described in Appendix A.1.

Step 2 **Identify PC serial communications port used**

On the PC, identify which of the PC's serial communications ports has been assigned to this connection (e.g. COM3). This is described in Appendix A.2.

Step 3 **Run HyperTerminal on PC and configure communications port**

On the PC, run HyperTerminal and configure the relevant communications port. You can do this in either of two ways:

- Run and configure HyperTerminal automatically by double-clicking on one of the HyperTerminal configuration files (**.ht**) supplied on the Starter Kit CD - use the file for the relevant communications port (e.g. **com3-115k.ht** for COM3).
- Run and configure HyperTerminal manually as described in Appendix A.3. Before completing this manual configuration in HyperTerminal, for this application you should go into the **ASCII Setup** screen (accessed from the **Settings** tab in the **Properties** screen) and enable the following options:
  - **Send line ends with line feed** - this will append a line feed after each carriage return
  - **Echo typed characters locally** - this means that keyboard entries will be echoed to the local HyperTerminal screen

Stage 2: Start the Network

Prepare and start the boards as follows:

Step 1 **Prepare the power supplies of the boards**

Before starting the boards, make suitable power supply arrangements as follows:

a) Ensure that both boards are powered OFF.

b) Ensure that both boards are connected to a suitable power supply, as described in Section 1.3.

Tip: In this demonstration, the boards can easily be powered from the PCs via the USB cables - for this, you must ensure that jumper J2 on the board is configured for an external power source (refer to Section 1.3.2).

Step 2 **Start the Co-ordinator**

Start the Co-ordinator board as follows:

a) Hold down button SW2.

b) At the same time, power on the board using slider switch SW6.

c) Now release SW2.

The power status LED D9 as well as LEDs D1 and D2 on the board should illuminate. At the same time, you should get a message in the HyperTerminal window corresponding to the board, to indicate that the board has started.

From this point, you have 10 seconds to start the next step (D1 and D2 are extinguished at the end of this timeout period).

Step 3 **Select the 'out-of-box' demos on the Co-ordinator**

Select the 'out-of-box' demos on the Co-ordinator as follows:

a) Press button SW2 (D2 should now be extinguished).

b) Wait for LED D1 to be extinguished.

The Co-ordinator is now ready to accept requests from other devices to join the network.

Step 4 **Start the Router**

Power on the Router board using the slider switch SW6 (the board is initialised as a Router by default).

The power status LED D9 as well as LEDs D1 and D2 on the board should illuminate. At the same time, you should get a message in the HyperTerminal window corresponding to the board, to indicate that the board has started.

From this point, you have 10 seconds to start the next step (D1 and D2 are extinguished at the end of this timeout period).

Step 5 **Select the ‘out-of-box’ demos on the Router**

Select the ‘out-of-box’ demos on the Router as follows:

a) Press button SW2 (D2 should now be extinguished).

b) Wait for LED D1 to be extinguished.

The Router has now joined the network (the Co-ordinator).

Stage 3: Transmit Characters Between the PCs

Note: Ensure that the network has formed before continuing with the demonstration - once it has formed (this can take several seconds), LEDs D1 and D2 on both boards will have been extinguished.

On either PC, type a sequence of characters on the keyboard and observe that, as it is typed, each character appears in the HyperTerminal screen of the other PC (as well as being echoed to the local screen).

3. AT-Jenie Demonstration

This chapter describes how to set up and run the AT-Jenie demonstration provided with the JN5139-EK020 Starter Kit. This demonstration is designed to allow you to interact with the network by issuing commands from your PC.

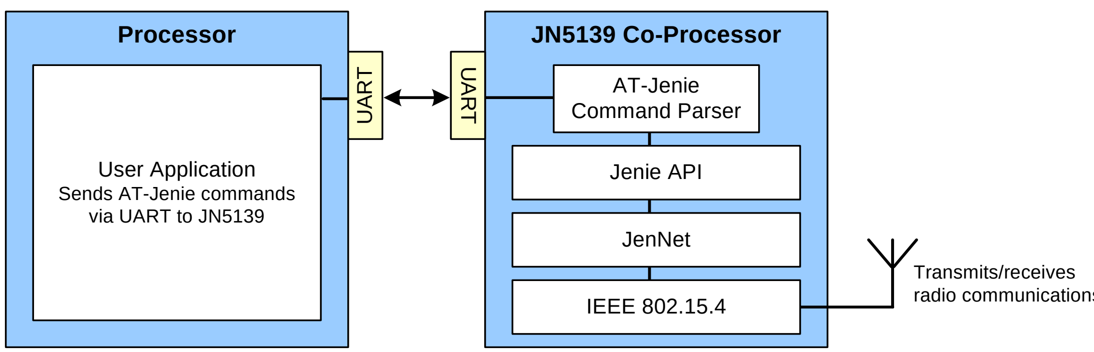
Note: Before attempting this demonstration, you are strongly advised to read through Chapter 1 and to run the 'out-of-box' demonstrations described in Chapter 2.

A further AT-Jenie tutorial is provided in the *AT-Jenie User Guide (JN-UG-3043)*.

3.1 AT-Jenie

AT-Jenie is a serial-based command set, devised by Jennic, which allows easy interaction with a wireless network comprising nodes based on Jennic's JN5139 wireless microcontroller. In particular, AT-Jenie provides an easy-to-use interface to Jennic's proprietary JenNet network protocol (see Section 1.5.4).

The AT-Jenie commands are sent to the JN5139 device via a UART link from an application running on another device. Here, the latter device will be a PC but, in practice, can be a separate processor contained in the same node. Once received by the JN5139 device, a command is interpreted by the AT-Jenie command parser and executed. In the Starter Kit, the AT-Jenie command parser is already programmed into the boards.



The AT-Jenie command parser invokes functions of the Jenie library which runs on top of Jennic's JenNet and the standard IEEE 802.15.4 protocols. For more information on software architecture, refer to the *AT-Jenie User Guide (JN-UG-3043)*.

Figure 8: AT-Jenie Command Parsing

In this demonstration, you will use HyperTerminal on your PC to enter and send AT-Jenie commands to the JN5139 device on the Starter Kit boards.

3.2 AT-Jenie Command Format

Each command is an ASCII string containing a number of fields - a mnemonic instruction with associated parameters, data and control characters - as illustrated and described in the figure below.

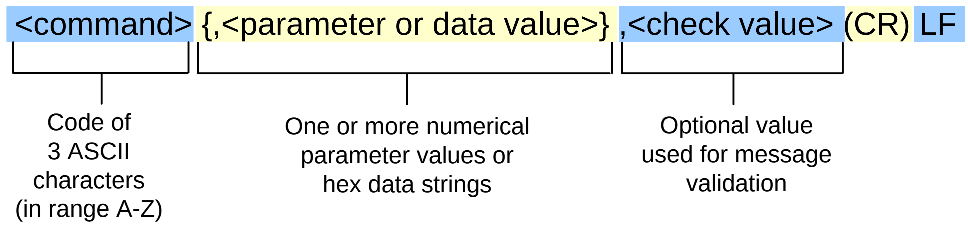


Figure 9: AT-Jenie Command Format

Note the following:

- All parameter and data fields are preceded by a comma (“,”)
- There may be several parameter values, depending on the command
- The parameter values can be encoded in decimal, hexadecimal or binary. The default number system is configured in the command parser, but can be over-ridden in a command by pre-fixing the value with ‘d’ (for decimal), ‘x’ (for hexadecimal) or ‘b’ for binary
- Data strings are encoded in hexadecimal with two hex digits per byte
- The ‘check value’ is optional and will be omitted in all examples in this manual. It is obtained by an XOR operation on all ASCII characters (including commas and spaces) from the preceding fields of the command string
- The command string must be terminated by a LF (Line Feed). In this demonstration, you will configure HyperTerminal to automatically append an LF when the Carriage Return (CR) key is depressed on the keyboard

Communication also takes place in the opposite direction - responses to AT-Jenie commands can be sent to the application, as well as unsolicited messages that indicate when new (received) data is available for the application. AT-Jenie responses have the same format as commands (described above).

Tip: The AT-Jenie commands and responses, as well as their format, are fully detailed in the *AT-Jenie Reference Manual (JN-RM-2038)*. A summary is also provided in the *AT-Jenie Quick Command Reference (JN-RM-2036)*. Both documents are available on the Starter Kit CD, as well as in the Support area of the Jennic web site (**www.jennic.com/support**).

3.3 System Overview

The wireless network in this demonstration consists of just two nodes - a Co-ordinator and a Router. Data is sent from one node to the other (in both directions).

> **Note:** The Router will not use its routing functionality. The Router board is used instead of the End Device board to avoid data polling delays that occur with an End Device that periodically sleeps.

For the purpose of this demonstration:

- The application processor for each node is provided by a PC.
- The application program is provided by HyperTerminal, or an equivalent terminal emulator, which allows AT-Jenie commands to be entered manually on the PC and sent to the node.

HyperTerminal is provided with Windows XP but not with Windows Vista. Therefore, Windows Vista users should download an alternative emulator, such as Tera Term Pro (available free-of-charge from http://ttssh2.sourceforge.jp).

Two PCs may be used - one connected to each board. This is illustrated in Figure 10 below. In practice, you can connect the two boards to a single PC, via separate USB ports of the PC, and use a HyperTerminal window for each board.

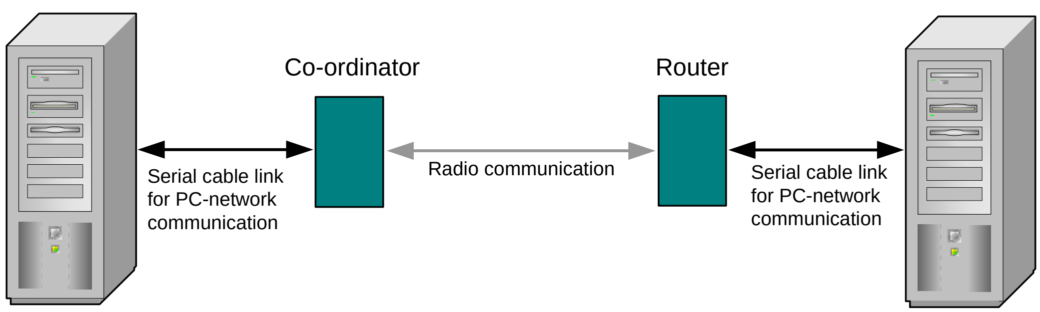


Figure 10: PCs Connected to Network

A PC will be connected to the network by means of the supplied USB-to-serial cable, which will connect a USB port on the PC to the UART0 serial connector on the relevant Starter Kit board (do not make this connection until told to do so in Section 3.4). The UART on the PC must be configured (within HyperTerminal) as follows:

- Baud rate: 115200 bits/s
- Data bits: 8
- Parity: none
- Stop bit: 1
- Flow control: hardware

This configuration is covered in the AT-Jenie demonstration tutorial in Section 3.4.

3.4 AT-Jenie Demo Tutorial

Tip: An additional tutorial which uses the standard set of AT-Jenie commands is provided in the *AT-Jenie User Guide (JN-UG-3043).* You may wish to try this more advanced tutorial at a later stage.

The tutorial comprises the following stages (hypertext links are provided below to the relevant sections):

- Stage 1: Make and Configure Cable Connections from PCs
- Stage 2: Start and Prepare Co-ordinator
- Stage 3: Start and Prepare Router
- Stage 4: Exchange Data Between the Nodes

Stage 1: Make and Configure Cable Connections from PCs

Connect each board to a PC and configure the connection as follows:

Note: The Co-ordinator/Router boards must be used in this demonstration. These are the boards **not** marked with a white dot.

Step 1 **Connect the board to a PC**

Make the cable connection between the board and PC as follows:

a) Ensure that the board is powered OFF.

b) Connect the USB end of a supplied USB-to-serial cable to a USB port of the PC.

c) Connect the other end of the USB-to-serial cable to the 6-pin serial connector corresponding to UART0 on the board (see Figure 2 on page 12). **Make sure you connect the black wire of the cable to Pin 1 of the on-board connector**.

Note: If the message **Found new hardware wizard for TTL232r-3v3** appears when you make this connection to a PC, you must install the driver for the USB-to-serial cable, as described in Appendix A.1.

Step 2 **Identify PC serial communications port used**

On the PC, identify which of the PC's serial communications ports has been assigned to this connection (e.g. COM3). This is described in Appendix A.2.

Step 3 **Run HyperTerminal on PC and configure communications port**

On the PC, run HyperTerminal and configure the relevant communications port. You can do this in either of two ways:

- Run and configure HyperTerminal automatically by double-clicking on one of the HyperTerminal configuration files (**.ht**) supplied on the Starter Kit CD - use the file for the relevant communications port (e.g. **com3-115k.ht** for COM3).
- Run and configure HyperTerminal manually as described in Appendix A.3. Before completing this manual configuration in HyperTerminal, for this application you must go into the **ASCII Setup** screen (accessed from the **Settings** tab in the **Properties** screen) and configure the following options:
  - Tick the **Send line ends with line feed** checkbox (this will append a line feed after each carriage return).
  - Ensure that the checkbox **Echo typed characters locally** is unticked (AT-Jenie echoes typed commands automatically, by default).

Stage 2: Start and Prepare Co-ordinator

Start and prepare the Co-ordinator board as follows:

Step 1 **Prepare the power supply of the board**

Before starting the Co-ordinator board, make suitable power supply arrangements as follows:

a) Ensure that the board is powered OFF.

b) Ensure that the board is connected to a suitable power supply, as described in Section 1.3. Note that in this demonstration, the board can easily be powered from the PC via the USB cable - for this, you must ensure that jumper J2 on the board is configured for an external power source.

Step 2 **Start the Co-ordinator board**

Start the Co-ordinator board as follows:

a) Hold down button SW2.

b) At the same time, power on the board using slider switch SW6.

c) Now release SW2.

The power status LED D9 as well as LEDs D1 and D2 on the board should illuminate. At the same time, you should get a message in the HyperTerminal window corresponding to the board, to indicate that the board has started.

From this point, you have 10 seconds to start the next step (D1 and D2 are extinguished at the end of this timeout period).

Step 3 **Select the AT-Jenie demo on the Co-ordinator board**

Select the AT-Jenie demo on the Co-ordinator as follows:

a) Press button SW1 (D2 should now be extinguished).

b) Press button SW2 (D2 should now illuminate again).

Step 4 **Configure the AT-Jenie command parser on the Co-ordinator board**

In the HyperTerminal window corresponding to the board, enter the following AT-Jenie command to configure the AT-Jenie command parser:

```
CCF,115200,1,0,1,0
```

This configures a baud rate of 115200 bps, hexadecimal numbers, no verification checks, command echoes (to screen) enabled and ASCII command coding.

Step 5 **Configure the board by specifying its network IDs and radio channel**

In HyperTerminal, enter the following AT-Jenie command to configure the node:

```
INI,1234,d18,12345678,0
```

Here, “1234” is the PAN ID, ”d18” selects 2400-MHz band channel 18 (where the “d” indicates a decimal value), “12345678” is the Network Application ID and “0” indicates that automatic context restore is not required.

Step 6 **Start the board as the Co-ordinator**

In HyperTerminal, enter the following AT-Jenie command to start the node as the network Co-ordinator:

```
STR,0
```

Here, “0” sets the node type to be the Co-ordinator.

An NTU response is received to indicate that the network has successfully started.

Stage 3: Start and Prepare Router

Start and prepare the Router board (which will not use its routing functionality and so effectively will act as an End Device) as follows:

Step 1 **Prepare the power supply of the board**

Before starting the Router board, make suitable power supply arrangements as follows:

a) Ensure that the board is powered OFF.

b) Ensure that the board us connected to a suitable power supply, as described in Section 1.3. Note that in this demonstration, the board can easily be powered from the PC via the USB cable - for this, you must ensure that jumper J2 on the board is configured for an external power source.

Step 2 **Start the Router board**

Power on the Router board using the slider switch SW6 (the board is initialised as a Router by default).

The power status LED D9 as well as LEDs D1 and D2 on the board should illuminate. At the same time, you should get a message in the HyperTerminal window corresponding to the board, to indicate that the board has started.

From this point, you have 10 seconds to start the next step (D1 and D2 are extinguished at the end of this timeout period).

Step 3 **Select the AT-Jenie demo on the Router board**

Select the AT-Jenie demo on the Router as follows:

a) Press button SW1 (D2 should now be extinguished).

b) Press button SW2 (D2 should now illuminate again).

Step 4 **Configure the AT-Jenie command parser on the board**

In the HyperTerminal window corresponding to the board, enter the following AT-Jenie command to configure the AT-Jenie command parser:

```
CCF,115200,1,0,1,0
```

This configures a baud rate of 115200 bps, hexadecimal numbers, no verification checks, command echoes (to screen) enabled and ASCII command coding.

Step 5 **Configure the board by specifying the relevant Network Application ID**

In HyperTerminal, enter the following AT-Jenie command to configure the node:

```
INI,0,0,12345678,0
```

Here, the first "0" is unused, the second "0" is unused, "12345678" is the Network Application ID of the required network and "0" indicates that automatic context restore is not required.

Step 6 **Start the board as a Router**

In HyperTerminal, enter the following AT-Jenie command to start the node as a Router:

```
STR,1
```

Here, "1" sets the node type to be a Router.

The response "CHJ,<address>" is received on the parent (Co-ordinator) to indicate that the Router has successfully joined the network - it will therefore be displayed in the HyperTerminal window associated with the Co-ordinator. This response contains the Router's MAC address (as a hexadecimal number).

Step 7 **Write down the MAC address of the Router**

Make a note of the 64-bit MAC address of the Router received in the CHJ response. You will need this in the next stage.

Stage 4: Exchange Data Between the Nodes

Send data between the Router and Co-ordinator (in both directions), as follows:

Step 1 **Send data from the Router to the Co-ordinator**

a) In the HyperTerminal window associated with the Router, enter the following AT-Jenie command to send a data string to the Co-ordinator:

```
SND,0,“Hello Co-ordinator”,d18,1
```

Here, “0” represents the MAC address of the target device (the zero value is always used to indicate the Co-ordinator), “Hello Co-ordinator” is the data string to send, “d18” indicates that there are (decimal) 18 bytes to be sent, and “1” indicates that an acknowledgement is required from the target device (to confirm that the message has been received).

A PKS response is received in the HyperTerminal window associate with the Router to confirm that the message has been sent. This is followed by an ACK (acknowledgement) response from the Co-ordinator once it has received the message.

b) Check the HyperTerminal window associated with the Co-ordinator - you should see a DAT message containing the data from the Router, in the following format:

```
DAT,<address>,0,12,48656C6C6F20436F2D6F7264696E61746F72
```

Here, <address> will be substituted with the 64-bit MAC address of the source device (the Router), “0” is an unused flag, “12” is the hex value of the number of characters of data received, and the rest of the message represents the data string “Hello Co-ordinator” in terms of the ASCII values of its characters.

Step 2 **Send data from the Co-ordinator to the Router**

a) In the HyperTerminal window associated with the Co-ordinator, enter the following AT-Jenie command to send a data string to the Router:

```
SND,<address>,“Hello Router”,d12,1
```

Here, <address> must be substituted with the MAC address of the Router (obtained earlier), “Hello Router” is the data string to send, “d12” indicates that there are (decimal) 12 bytes to be sent, and “1” indicates that an acknowledgement is required from the target device (to confirm that the message has been received).

A PKS response is received in the HyperTerminal window associate with the Co-ordinator to confirm that the message has been sent. This is followed by an ACK (acknowledgement) response from the Router once it has received the message.

b) Check the HyperTerminal window associated with the Router - you should see a DAT message containing the data from the Co-ordinator, in the following format:

```
DAT,<address>,0,C,48656C6C6F20526F75746572
```

Here, <address> will be substituted with the 64-bit MAC address of the source device (the Co-ordinator), “0” is an unused flag, “C” is the hex value of the number of characters of data received and the rest of the message represents the data string “Hello Router” in terms of the ASCII values of its characters.

4. Advanced Demonstrations

This chapter describes how to set up and run the advanced demonstrations provided with the JN5139-EK020 Starter Kit. These demonstrations are designed to:

- further illustrate the use of AT-Jenie by employing custom commands
- interact with a range of features of the Starter Kit boards

Note: Before attempting these demonstrations, you are strongly advised to work through the standard AT-Jenie demonstration described in Chapter 3.

In these demonstrations, the network parameters described in Section 1.5 are automatically set to the following values (so you do not need to set them yourself):

Network Parameter	Value
PAN ID	0xFABB
Network Application ID	0x00000000
Channel	15

Table 5: Network Parameter Values

4.1 Demo Functionality

These demonstrations allow the following tasks to be performed from a PC connected to a wireless network comprising the three Starter Kit boards:

- Obtain the temperature and supply voltage on a specific board (this functionality uses JN5139-based resources)
- Control the LEDs and obtain the states of the buttons on a specific board
- Measure the radio signal strength of a transmission from the Router
- Make PER (Packet Error Rate) measurements for packets from the Router

The AT-Jenie commands used to perform the above tasks are custom commands (in this case, devised by Jennic) that have been added to the standard AT-Jenie command set. These custom commands are summarised in Appendix C.

Note: AT-Jenie allows you to extend its standard command set by adding your own custom commands. This extension is described in the *AT-Jenie User Guide (JN-UG-3043)*.

4.2 System Overview

The wireless network in the advanced demonstrations consists of all three nodes of the Starter Kit - a Co-ordinator, Router and End Device. The Co-ordinator is connected to a PC, from which AT-Jenie commands are issued in HyperTerminal.

The topology of the wireless network can be either of those shown below in Figure 11, depending on whether the End Device joins the Router or joins the Co-ordinator when the system is powered up. The exact topology used does not affect the operation of the demonstrations.

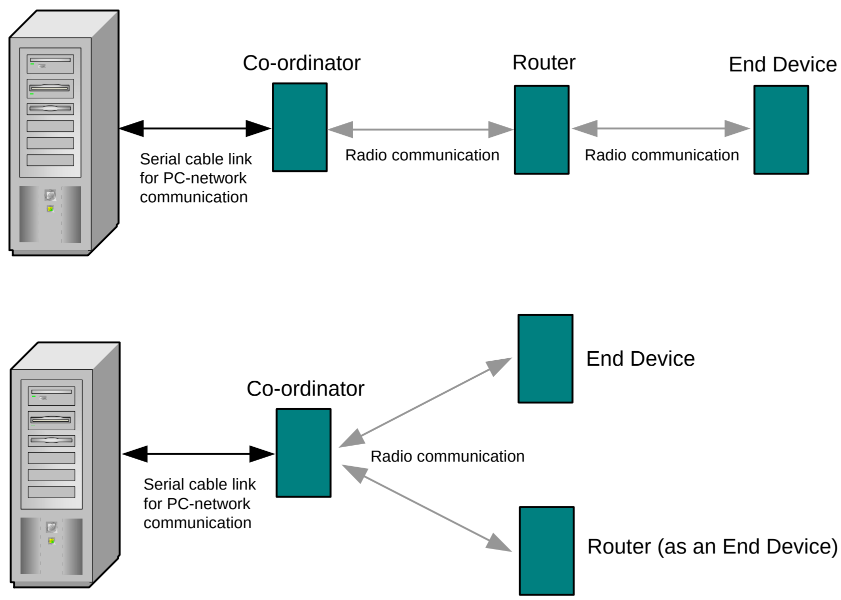


Figure 11: Possible Topologies for Advanced Demos

The PC will be connected to the network by means of the supplied USB-to-serial cable, which will connect a USB port on the PC to the UART0 serial connector on the Co-ordinator board (do not make this connection until told to do so in Section 4.3). The UART on the PC must be configured (within HyperTerminal) as follows:

- Baud rate: 115200 bits/s
- Data bits: 8
- Parity: none
- Stop bit: 1
- Flow control: hardware

This configuration is covered in the tutorial in Section 4.3.

HyperTerminal is provided with Windows XP but not with Windows Vista. Therefore, Windows Vista users should download an alternative emulator, such as Tera Term Pro (available free-of-charge from http://ttssh2.sourceforge.jp).

4.3 Advanced Demos Tutorial (Part 1 - Board Resources)

This section contains the first part of the advanced demos tutorial, which allows you to explore some of the on-board features using custom AT-Jenie commands. The tutorial comprises the following stages (hypertext links are provided below to the relevant sections):

- Stage 1: Make and Configure Cable Connection from PC
- Stage 2: Start the Network
- Stage 3: Obtain Temperature Measurements from Network Nodes
- Stage 4: Obtain Voltage Measurements from Network Nodes
- Stage 5: Obtain Button States from Network Nodes
- Stage 6: Highlight Network Nodes (using LEDs)

Note: For these demonstrations, the network is completely pre-configured, so it is not necessary configure the boards using AT-Jenie commands.

Stage 1: Make and Configure Cable Connection from PC

Connect the Co-ordinator board to a PC and configure the connection as follows:

Note: The board used in this stage must be a Co-ordinator/Router board. This is a board **not** marked with a white dot.

Step 1 **Connect the Co-ordinator board to a PC**

Make the cable connection between the board and PC as follows:

a) Ensure that the Co-ordinator board is powered OFF.

b) Connect the USB end of a supplied USB-to-serial cable to a USB port of the PC.

c) Connect the other end of the USB-to-serial cable to the 6-pin serial connector corresponding to UART0 on the board (see Figure 2 on page 12). **Make sure you connect the black wire of the cable to Pin 1 of the on-board connector**.

Note: If the message **Found new hardware wizard for TTL232r-3v3** appears when you make this connection to a PC, you must install the driver for the USB-to-serial cable, as described in Appendix A.1.

Step 2 **Identify PC serial communications port used**

On the PC, identify which of the PC's serial communications ports has been assigned to this connection (e.g. COM3). This is described in Appendix A.2.

Step 3 **Run HyperTerminal on PC and configure communications port**

On the PC, run HyperTerminal and configure the relevant communications port. You can do this in either of two ways:

- Run and configure HyperTerminal automatically by double-clicking on one of the HyperTerminal configuration files (**.ht**) supplied on the Starter Kit CD - use the file for the relevant communications port (e.g. **com3-115k.ht** for COM3).
- Run and configure HyperTerminal manually as described in Appendix A.3. Before completing this manual configuration in HyperTerminal, for this application you must go into the **ASCII Setup** screen (accessed from the **Settings** tab in the **Properties** screen) and configure the following options:
    - Tick the **Send line ends with line feed** checkbox (this will append a line feed after each carriage return).
    - Ensure that the checkbox **Echo typed characters locally** is unticked (AT-Jenie echoes typed commands automatically, by default).

Stage 2: Start the Network

Start the boards of the network as follows:

Step 1 **Prepare the power supplies of the boards**

Before starting the boards, make suitable power supply arrangements as follows:

a) Ensure that all the boards are powered OFF.

b) Ensure that each board is connected to a suitable power supply, as described in Section 1.3. Note that in this demonstration, the Co-ordinator board can easily be powered from the PC via the USB cable - for this, you must ensure that jumper J2 on the board is configured for an external power source.

Step 2 **Start the Co-ordinator board**

Start the Co-ordinator board as follows:

a) Hold down button SW2.

b) At the same time, power on the board using slider switch SW6.

c) Now release SW2.

The power status LED D9 as well as LEDs D1 and D2 on the board should illuminate. At the same time, you should get a message in the HyperTerminal window corresponding to the board, to indicate that the board has started.

From this point, you have 10 seconds to start the next step (D1 and D2 are extinguished at the end of this timeout period).

Step 3 **Select the advanced demos on the Co-ordinator board**

Select the advanced demos on the Co-ordinator as follows:

a) Press button SW1 **twice** (D1 should now be extinguished)

b) Press button SW2.

c) Wait for LED D2 to be extinguished.

Step 4 **Start the Router board**

Power on the Router board (other board without a white dot) using the slider switch SW6 (the board is initialised as a Router by default).

The power status LED D9 as well as LEDs D1 and D2 on the board should illuminate. From this point, you have 10 seconds to start the next step (D1 and D2 are extinguished at the end of this timeout period).

Step 5 **Select the advanced demos on the Router board**

Select the advanced demos on the Router as follows:

a) Press button SW1 **twice** (D1 should now be extinguished)

b) Press button SW2 (D2 should now be extinguished).

Step 6 **Start the End Device board**

Power on the End Device board (board with a white dot) using the slider switch SW6 (the board is initialised as an End Device by default).

The power status LED D9 as well as LEDs D1 and D2 on the board should illuminate. From this point, you have 10 seconds to start the next step (D1 and D2 are extinguished at the end of this timeout period).

Step 7 **Select the advanced demos on the End Device board**

Select the advanced demos on the End Device as follows:

a) Press button SW1 **twice** (D1 should now be extinguished)

b) Press button SW2 (D2 should now be extinguished).

> **Note:** Ensure that the network has formed before continuing with the demonstration - once it has formed (this can take several seconds), LED D1 on all boards will flash, rapidly on the End Device, slowly on the Router and Co-ordinator.

Step 8 **Change the radio channel (if required)**

Change the 2400-MHz radio channel from the default (channel 15 in these demos), if desired, by entering the following custom AT-Jenie command in HyperTerminal:

```
TCH,<channel>
```

where <channel> is the required radio channel in the (decimal) range 11-26.

This single command changes the radio channel on all nodes of the network.

Stage 3: Obtain Temperature Measurements from Network Nodes

The JN5139 wireless microcontroller on each board is equipped with a temperature sensor. In this stage, you will use a custom AT-Jenie command to obtain a temperature measurement from each node in the network.

The required custom command is

```
NTG,<node>
```

where <node> identifies the target node:

0 for Co-ordinator
1 for Router
2 for End Device

The response received is in the format

```
NTR,<node>,<temp>
```

where <node> identifies the source node (as detailed above) and <temp> is the returned temperature measurement in degrees Celsius.

Step 1 **Obtain a temperature measurement from the Co-ordinator**

In HyperTerminal, enter the following custom command:

```
NTG,0
```

Step 2 **Obtain a temperature measurement from the Router**

In HyperTerminal, enter the following custom command:

```
NTG,1
```

Step 3 **Obtain a temperature measurement from the End Device**

In HyperTerminal, enter the following custom command:

```
NTG,2
```

Stage 4: Obtain Voltage Measurements from Network Nodes

The JN5139 wireless microcontroller on each board is equipped with a voltage sensor which allows the supply voltage to the board (e.g. battery voltage) to be measured. In this stage, you will use a custom AT-Jenie command to obtain a supply voltage measurement from each node in the network.

The required custom command is

```
NVG,<node>
```

where <node> identifies the target node (0, 1 or 2, as detailed previously).

The response received is in the format

```
NVR,<node>,<voltage>
```

where <node> identifies the source node (as detailed above) and <voltage> is the returned supply voltage in millivolts.

Step 1 **Obtain a supply voltage measurement from the Co-ordinator**

In HyperTerminal, enter the following custom command:

```
NVG,0
```

Step 2 **Obtain a supply voltage measurement from the Router**

In HyperTerminal, enter the following custom command:

```
NVG,1
```

Step 3 **Obtain a supply voltage measurement from the End Device**

In HyperTerminal, enter the following custom command:

```
NVG,2
```

Stage 5: Obtain Button States from Network Nodes

The Starter Kit boards are each equipped with two buttons, labelled SW1 and SW2. In this stage, you will use a custom AT-Jenie command to obtain the current states of these buttons on each node in the network.

The required custom command is

```
NBG,<node>
```

where <node> identifies the target node (0, 1 or 2, as detailed previously).

The response received is in the format

```
NBR,<node>,<sw1>,<sw2>
```

where <node> identifies the source node (as detailed above), <sw1> is the returned state of SW1 and <sw2> is the returned state of SW2. The returned state is ‘1’ if the button is pressed and ‘0’ if it is not pressed.

Step 1 **Obtain the states of the buttons on the Co-ordinator**

In HyperTerminal, enter the following custom command:

```
NBG,0
```

Provided you are not pressing a button, the button states should be returned as:

```
NBR,0,0,0
```

Step 2 **Obtain the states of the buttons on the Router**

Hold down SW1 on the Router and, at the same time in HyperTerminal, enter the following custom command:

```
NBG,1
```

The button states should be returned as:

```
NBR,1,1,0
```

Step 3 **Obtain the states of the buttons on the End Device**

Hold down SW2 on the End Device and, at the same time in HyperTerminal, enter the following custom command:

```
NBG,2
```

The button states should be returned as:

```
NBR,2,0,1
```

Stage 6: Highlight Network Nodes (using LEDs)

In this stage, you will highlight each node, in turn, by illuminating its LED D2 using the custom command

```
NHL,<node>,<action>
```

where <node> identifies the target node (0, 1 or 2, as detailed previously) and <action> is the action to be taken on LED D2:

0 to extinguish
1 to illuminate

Step 1 **Illuminate LED D2 on the Co-ordinator**

In HyperTerminal, enter the following custom command:

```
NHL,0,1
```

Step 2 **Illuminate LED D2 on the Router**

In HyperTerminal, enter the following custom command:

```
NHL,1,1
```

Step 3 **Illuminate LED D2 on the End Device**

In HyperTerminal, enter the following custom command:

```
NHL,2,1
```

Step 4 **Extinguish LED D2 on the End Device**

In HyperTerminal, enter the following custom command:

```
NHL,2,0
```

Step 5 **Extinguish LED D2 on the Router**

In HyperTerminal, enter the following custom command:

```
NHL,1,0
```

Step 6 **Extinguish LED D2 on the Co-ordinator**

In HyperTerminal, enter the following custom command:

```
NHL,0,0
```

4.4 Advanced Demos Tutorial (Part 2 - PER/RF Tests)

This section contains the second part of the advanced demos tutorial, which allows you to perform PER (Packet Error Rate) tests and radio signal level tests using custom AT-Jenie commands.

This demonstration uses only two nodes of the network - the Co-ordinator and Router.

> **Note:** This second part of the advanced demos tutorial assumes that you have already worked through the first part in Section 4.3. In particular, you must have set up the connection between the PC and Co-ordinator, including the configuration of the link in HyperTerminal.

Tests

In this demonstration, the following tests are conducted at the same time:

- **PER (Packet Error Rate) test:** This test monitors and reports the rate at which packets (messages) sent from the Router to the Co-ordinator are lost/ corrupted. The PER is reported as the number of packets lost as a percentage of the number of packets sent from the Router. This PER value is updated with every packet sent during the test.
- **Radio signal level test:** This test measures the radio signal strength corresponding to a packet received from the Router. Thus, the reported value is updated with every packet received during the test.

Commands

The custom AT-Jenie command used to start the tests is

```
TCF,<num>,<per>,<len>,<data>
```

where <num> is the number of packets to be sent from the Router during the test, <per> is the period between packets in milliseconds (minimum of 100 ms, maximum of 655350 ms), <len> is the packet length in bytes (maximum of 50 bytes), and <data> is the data to be inserted into the payload of each packet.

A response containing test results is received (in HyperTerminal) for every packet exchanged during the test, in the following format:

```
TPR,<packet ID>,<missed packets>,<PER>,<signal strength>
```

where <packet ID> identifies the latest packet sent, <missed packets> is the number of packets lost/corrupted since the start of the test, <PER> is the percentage PER value and <signal strength> is the measured signal level as an LQI (Link Quality Index) value in the range 0-255.

You can stop the test at any time using the custom command `TST`.

This tutorial comprises the following stages (hypertext links are provided below to the relevant sections):

- Stage 1: Prepare the System and PC
- Stage 2: Conduct a PER Test
- Stage 3: Conduct a Range Test

Stage 1: Prepare the System and PC

Ensure that the network has been set up and that the PC has been configured as described in Stages 1 and 2 of the first part of this tutorial in Section 4.3.

Since the Router must be mobile for the range tests in Stage 3 of this tutorial, if you have powered the Router from an external source then you should now re-start the system with the Router powered from its on-board batteries.

Stage 2: Conduct a PER Test

With the Co-ordinator and Router in positions that allow them to communicate, perform a PER test by entering the following custom command in HyperTerminal:

```
TCF,50,5000,0,30
```

Here, '50' means send 50 packets from the Router during the test, '5000' means send a packet every 5 seconds, '0' means increment the packet length with each packet (length will start at 7 bytes and rise to a maximum of 50 bytes), and '30' is the data value to insert into the payload of each packet.

Therefore, this test will run for 250 seconds (but can be stopped at any time using the TST command).

A TPR response will be received in HyperTerminal for each packet exchanged. For example:

```
TPR,0,0,0,158
TPR,1,0,0,155
TPR,2,0,0,156
TPR,3,0,0,154
TPR,4,0,0,155
TPR,5,0,0,157
TPR,6,1,17,159
```

Missed packets   Percentage PER

The PER value is the third value in the response (as shown above). You can watch this value evolve over the duration of the test. However, to obtain a better estimate of the packet error rate, you should leave the test running over an extended period (e.g. overnight) - for such an extended test, you should power the Router and Co-ordinator from external sources rather than from their on-board batteries.

Stage 3: Conduct a Range Test

With the Co-ordinator in a fixed position and the Router moveable, investigate the maximum range for successful communication between the two nodes. You will start with the Router close to the Co-ordinator and progressively move the Router further away during the test.

Step 1 **Start the PER/RF test**

In HyperTerminal, enter the following custom command:

```
TCF,0,10000,20,0
```

Here, the first ‘0’ means the test should run indefinitely, ‘10000’ means send a packet every 10 seconds, ‘20’ means there will be 20 bytes in each packet, and the second ‘0’ indicates that the payload data values of consecutive packets should automatically increment (from zero).

Step 2 **Increase Separation Once per Minute**

With the test running, move the Router further away from the Co-ordinator approximately once every minute and observe the radio signal strength change.

A TPR response will be received in HyperTerminal for each packet exchanged. For example:

```
TPR,0,0,0,153
TPR,1,0,0,155
TPR,2,0,0,156
TPR,3,0,0,152
TPR,4,0,0,154
TPR,5,0,0,150
TPR,6,0,0,151
TPR,7,0,0,124
TPR,8,0,0,125
TPR,9,0,0,120
```

Signal strength (LQI)

If you notice the PER markedly increase when you move the Router further away, this may suggest that the maximum range is being approached.

Note that the signal strength (LQI) of the Router, as perceived by the Co-ordinator, is also crudely displayed using the LEDs of the Router (the measurement is sent back to the Router for this purpose). The following coding system is used:

- LED D2 is illuminated when any signal is detected (above the receiver sensitivity), corresponding to an LQI value greater than zero.
- LED D1 is illuminated when a signal is detected with strength more than 10 dB above the receiver sensitivity, corresponding to an LQI value greater than 36.

Step 3 **Stop the Test**

Once you have completed your range testing, stop the test by entering the command TST in HyperTerminal.

5. Jenie or AT-Jenie?

Now that you have tried the JN5139-EK020 Starter Kit demonstrations, you should be ready to develop your own wireless network application. The next chapter (Where Next?) directs you to the Jennic resources that you will need in your application development, but first you must think about the type of network you wish to develop and the most appropriate software to use for this development.

5.1 Which Type of Network?

In order to determine which development path to take for your application, you must first consider the type of network you will produce - more specifically, how and from where it will be controlled.

Two general approaches to network control are possible:

- The network can be completely self-contained and self-controlled.
- The network can be controlled from an application running on an external processor, such as a PC.

These two possibilities are expanded on below.

Self-controlled Network

A self-controlled network is completely autonomous, with all control provided by applications within the nodes (except for occasional human intervention that may be provided through input peripherals built into the nodes, such as buttons or a keypad). Therefore, the operation of such a network requires no hardware or software components beyond those provided by the nodes themselves (see Figure 12 below), as in the case of the wireless network demonstration described in Section 2.1.

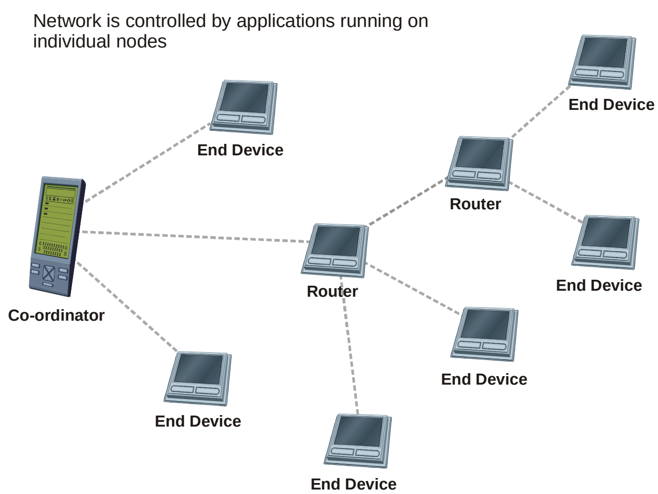


Figure 12: Self-Controlled Network

Externally Controlled Network

In an externally controlled network, the controlling application runs on an external processor, such as a PC, which is connected via a cable link to one of the network nodes. This node passes commands from the application to the other nodes over the airwaves (see Figure 13 below).

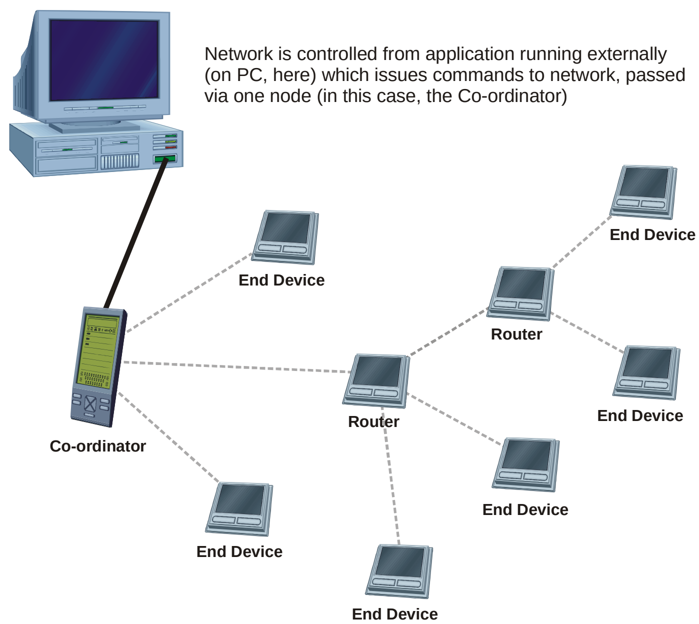


Figure 13: Externally Controlled Network

5.2 Which Software?

The JN5139-EK020 Starter Kit provides a platform on which to start developing applications using either of two easy-to-use programming interfaces provided by Jennic:

- **Jenie API**

  The Jenie Application Programming Interface (API) comprises a set of C functions that can be used directly in your application code to provide high-level control of a network node. The built application runs on the JN5139 device in the node. The development of an application using the Jenie API requires knowledge and experience of the C language.

- **AT-Jenie**

  AT-Jenie comprises a serial command set. These commands are sent to the JN5139 device in a node, where they are interpreted (by the AT-Jenie command parser) and executed. In developing an application using AT-Jenie, you must embed AT-Jenie commands in a program that incorporates all the necessary control logic. This program can be created using the programming language and tool of your choice - a suitable development environment would be Visual Basic.

Each of these interfaces provides simplified interaction with the wireless network protocol stack - specifically with Jennic's proprietary JenNet layer, but also with other stack components such as the software layer that deals with peripherals of the JN5139 device. In general, the use of AT-Jenie is much simpler than direct use of the Jenie API. However, direct use of the Jenie API leads to a more efficient solution than using AT-Jenie.

The decision of which development software to use depends in the first instance on your network type (from those described in Section 5.1):

- For a self-controlled network, you have the choice of using the Jenie API or AT-Jenie - for further information on this choice, refer to Section 5.2.1
- For an externally controlled network, use AT-Jenie - see Section 5.2.2

5.2.1 Software for a Self-Controlled Network

A self-controlled network is completely autonomous and is controlled by applications that run on the network nodes - there may be a different application for each node type (Co-ordinator, Router, End Device). This application runs on a processor within the node, where the processor is either of:

- the JN5139 device - the single-processor solution
- a separate processor which operates alongside the JN5139 device - the two-processor solution

In the single-processor case, the application is developed as a C program using the Jenie API. In the two-processor case, the application is developed as a script using AT-Jenie.

These scenarios are further described below.

Single-processor Solution

In the single-processor solution, both the application and the networking protocol stack run on the JN5139 wireless microcontroller. The application uses Jenie API functions to interact with the JenNet layer of the protocol stack, as illustrated below.

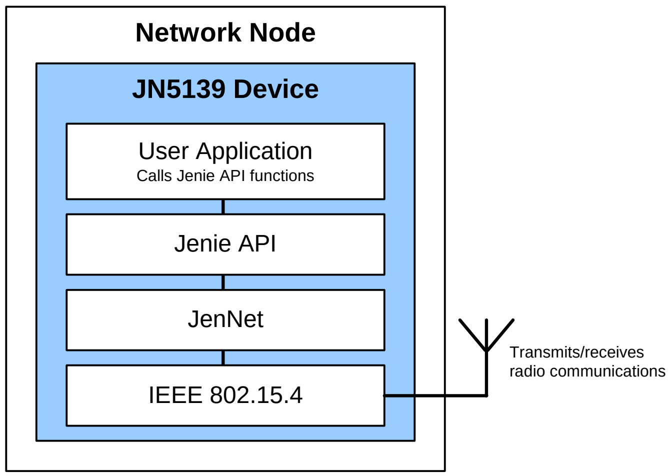


Figure 14: Single-processor Solution (using Jenie API)

Two-processor Solution

In the two-processor solution:

- The networking protocol stack runs on the JN5139 device
- The application runs on a separate processor within the node

The application communicates with the protocol stack by sending AT-Jenie commands to the JN5139 device, via a UART connection. These commands are received by the AT-Jenie command parser and translated into Jenie API function calls, which interact with the JenNet layer of the protocol stack, as illustrated below.

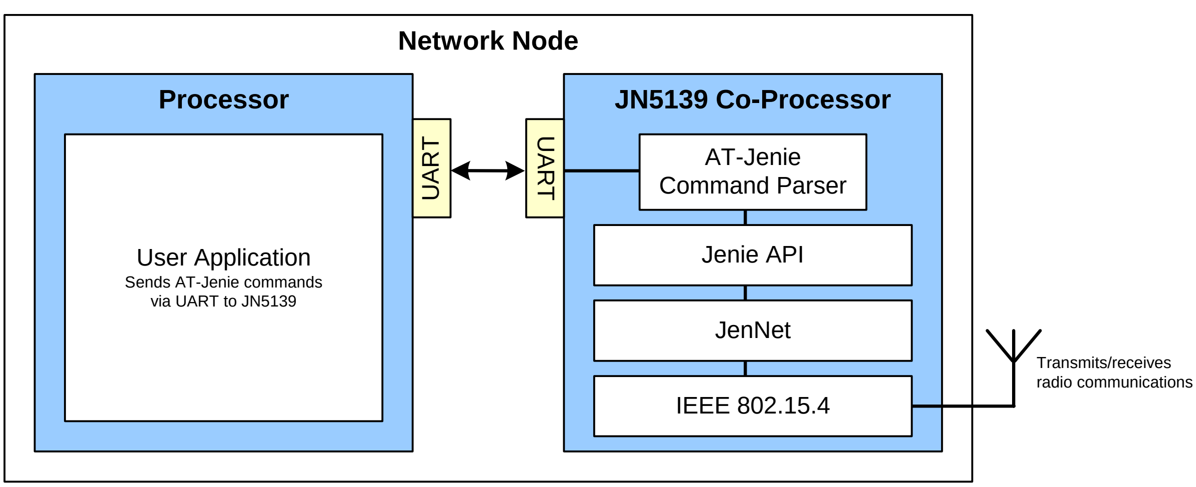


Figure 15: Two-Processor Solution (using AT-Jenie)

5.2.2 Software for an Externally Controlled Network

An externally controlled network is controlled by an application that runs on a processor which is completed external to the network, such as a PC with a cable connection to one of the network nodes. The application is designed using AT-Jenie commands, which are sent to the network nodes. These commands are received by the AT-Jenie command parser on a node and translated into Jenie API function calls, which interact with the JenNet layer of the protocol stack. This is illustrated below for an application that runs on a PC.

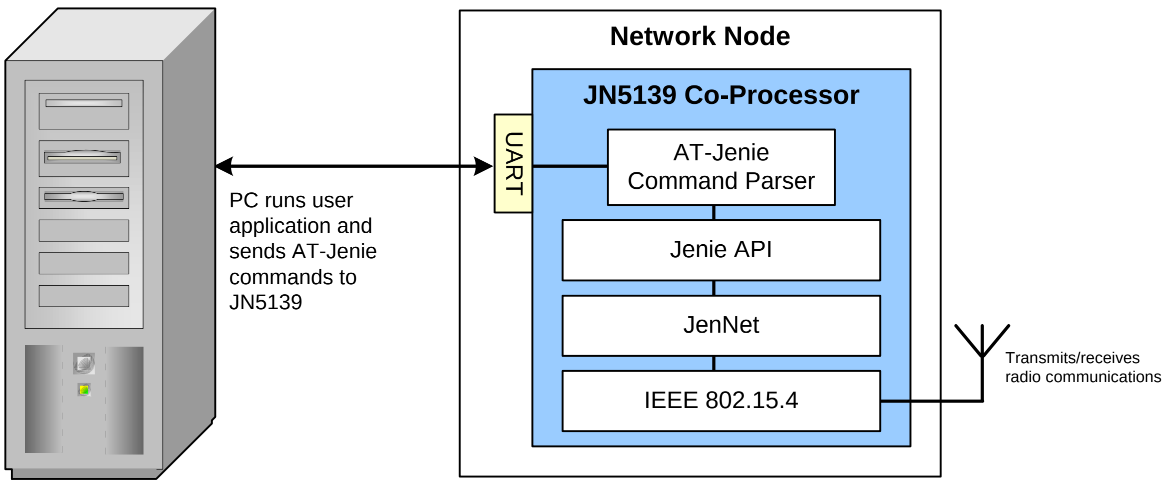


Figure 16: External Control of Network (using AT-Jenie)

Note: In the AT-Jenie demonstrations described in this manual, commands were issued manually from the command line of a terminal emulator, such as HyperTerminal, running on a PC. The terminal emulator was, in effect, the user application.

5.3 Summary

The table below summarises the suitable software for the different possible network types:

Network Control	Processor(s)	Software
Self-controlled	One (JN5139) per node	Jenie API
	Two (JN5139 + other) per node	AT-Jenie
Externally controlled	One (external)	AT-Jenie

6. Where Next?

You should by now have chosen your development software (Jenie API or AT-Jenie, as discussed in Chapter 5) and be ready to move on to developing your own application.

Jennic provide a range of resources to aid application development - these include development libraries and tools, user manuals and application notes. The specific resources that you will need depend on your chosen Jennic development interface - Jenie API or AT-Jenie. This chapter directs you to the resources you will need to develop your application using each of these interfaces:

- For application development using the Jenie API, refer to Section 6.1
- For application development using AT-Jenie, refer to Section 6.2

6.1 Where Next with the Jenie API?

In order to develop your own applications with the Jenie API, you will need to refer to the Jenie API user documentation and you must also install Jennic software. The documentation and software installation are described in the sub-sections below.

6.1.1 Jenie API Documentation

Jennic provide a dedicated documentation set for developing applications with the Jenie API. This documentation is supplied on the Starter Kit CD and is also available from the Support area of the Jennic web site (**www.jennic.com/support**).

Two Jenie API documents are available:

- **Jenie API User Guide (JN-UG-3042):** This manual provides both concept and practical information on developing applications with the Jenie API.
- **Jenie API Reference Manual (JN-RM-2035):** This manual provides full details of the Jenie API functions.

You are advised to read through the *Jenie API User Guide (JN-UG-3042)* before starting your application development. You should then refer to this guide as well as the *Jenie API Reference Manual (JN-RM-2035)* while developing your application.

Tip: In addition to the Jenie API user documentation, Jennic provide a set of Jenie Application Notes, available from the Support are of the Jennic web site (**www.jennic.com/support**). Most of these contain example code to help you develop your own code. They include a Jenie tutorial (JN-AN-1085) and a Jenie application template (JN-AN-1061), which provide excellent starting points for your own application development.

6.1.2 Jenie Software Installation

The Jenie API and associated software are provided as part of the Jennic SDK (Software Developer's Kit), which is supplied on the Starter Kit CD and is available from the Support area of the Jennic web site (**www.jennic.com/support**). You must install the Jennic SDK on your development machine. The SDK is provided as two installers:

- **SDK Toolchain (JN-SW-4031):** Contains all required development tools
- **SDK Libraries (JN-SW-4030):** Contains all required APIs and associated files

For further information on the Jennic SDK and full installation instructions, refer to the *SDK Installation Guide (JN-UG-3035)* supplied on the Starter Kit CD and available from the Support area of the Jennic web site.

6.2 Where Next with AT-Jenie?

In order to develop your own AT-Jenie applications, you will need to refer to the AT-Jenie user documentation and you may also need to install some software. The documentation and software installation are described in the sub-sections below.

6.2.1 AT-Jenie Documentation

Jennic provide a dedicated documentation set for developing AT-Jenie applications. This documentation is supplied on the Starter Kit CD and is also available from the Support area of the Jennic web site (**www.jennic.com/support**).

Three AT-Jenie documents are available:

- **AT-Jenie User Guide (JN-UG-3043):** This manual provides both concept and practical information on AT-Jenie, including a further tutorial.
- **AT-Jenie Reference Manual (JN-RM-2038):** This manual provides full details of the AT-Jenie command set.
- **AT-Jenie Quick Command Reference (JN-RM-2036):** This document lists and briefly describes the AT-Jenie commands. It is useful as a quick reference, but you should refer to the *AT-Jenie Reference Manual (JN-RM-2038)* for full command descriptions.

You are advised to read through the *AT-Jenie User Guide (JN-UG-3043)* before starting your application development. You should then refer to this guide as well as the *AT-Jenie Reference Manual (JN-RM-2038)* while developing your application.

6.2.2 AT-Jenie Software Installation

If you wish to use the standard AT-Jenie commands, as detailed in the *AT-Jenie Reference Manual (JN-RM-2038)*, you will only need the basic AT-Jenie command parser which is already built into Flash memory on the Starter Kit boards.

The AT-Jenie command parser is provided through the AT-Jenie demonstration, which can be accessed on a board by pressing the button SW1 once, after the board has been powered up (as described in Section 1.6.2).

If you require a board to enter AT-Jenie mode by default when powered up, it will be necessary to remove the demonstrations from Flash memory. Since this will also remove the AT-Jenie command parser, it will then be necessary to re-install AT-Jenie on the board. For this, you will need the JN51xx Flash Programmer, provided as an executable on the Starter Kit CD.

The procedure to download AT-Jenie to a board is provided in Appendix B.

Appendices

The appendices provide reference information as follows:

- Useful procedures for connecting a Starter Kit board to a PC - Appendix A.
- A procedure for re-programming the boards with AT-Jenie - Appendix B.
- Summary of custom AT-Jenie commands for advanced demos - Appendix C.
- Glossary of terms used in wireless networks - Appendix D.

A. Procedures for Connecting a Board to a PC

This appendix contains useful procedures that you may need when connecting a Starter Kit board to a PC using the supplied USB-to-serial cable, which allows a PC USB port to be used as a serial communications port.

- Appendix A.1 provides a procedure for installing the driver for the USB-to-serial cable.
- Appendix A.2 provides a procedure for identifying which of your PC's serial communications ports has been allocated to the board connection
- Appendix A.3 provides a procedure for configuring a board connection using HyperTerminal.

***Caution**: When connecting a board to your PC using the supplied USB-to-serial cable, make sure you connect the black wire of the cable to Pin 1 of the 6-pin on-board serial connector (see Figure 2 on page 12).*

A.1 Installing the USB-to-Serial Cable Driver

The USB-to-serial cables supplied with the Starter Kit require an FTDI driver. This driver is provided on the Starter Kit CD and must be installed on your PC the first time you use one of the supplied cables. This installation is described below.

1. When you plug the USB-to-serial cable into a USB port of your PC, check whether **Found new hardware wizard for TTL232r-3v3** is displayed.

   If this appears, you must install the driver by following the rest of this procedure. Otherwise, the driver is already installed.

2. Insert the Starter Kit CD in the CD/DVD drive of your PC.

3. Fill in the screen **Install from a specific location**, as follows:

   a) Select the radio button **Search for the best driver in these locations**.

   b) Tick the checkbox **Include this location in the search**.

   c) Using the **Browse** button, navigate to the directory where the driver is located on the CD. If your CD/DVD drive is **E**, the required path will be:

   E:\Software\Drivers\FTDI_drivers

   d) Click **OK**.

   The wizard will automatically fill in the details in the drop-down search box.

4. In the **Found new hardware wizard** screen, click **Next**.

   Wait for the wizard as it searches for and installs the new driver. On completion, it will display the message “Completing the Found new hardware wizard”. Click **Finish** to complete.

   In some cases, you may need to repeat the procedure from Step 3, depending on your hardware configuration.

   Finally, the **Found new hardware** bubble will indicate that the hardware is installed and ready for use.

> **Tip:** Alternatively, you can obtain the relevant driver for your operating system from the FTDI web page **www.ftdichip.com/FTDrivers.htm**. Download the required driver to your desktop and double-click on its icon to install.

A.2 Identifying PC Communications Port Used

In order to use your PC to communicate with a Starter Kit board via the supplied USB-to-serial cable, you must first use HyperTerminal to configure the communications port on your PC (as described in the relevant tutorials of this manual). Before you do this, you need to find out which port your PC has allocated to the connection with the board - this is described below.

1. In the Windows **Start** menu, follow the menu path:

   Start>Control Panel>System

   This displays the **System Properties** screen.

2. In the **System Properties** screen:

   a) Select the **Hardware** tab.

   b) Click the **Device Manager** button

   This displays the **Device Manager** screen.

3. In the **Device Manager** screen:

   a) Look for the **Ports** folder in the list of devices and unfold it.

   b) Identify the port which is connected to the board (it will be labelled ‘USB Serial Port’) and make a note of it (e.g. COM3).

A.3 Configuring Communications Port in HyperTerminal

Once you have connected your PC to a Starter Kit board, you must configure your PC's USB port used for the connection. This can be done through the HyperTerminal terminal emulator, as described below.

Note: HyperTerminal is provided with Windows XP but not with Windows Vista. Therefore, Windows Vista users should download an alternative emulator, such as Tera Term Pro (available at http://ttssh2.sourceforge.jp).

Caution: *For historical reasons, HyperTerminal assumes that a serial connection will be used for a modem. If presented with modem options, you must dismiss them as described in the procedure below.*

1. Run HyperTerminal by following the Windows Start menu path:

   Start > All Programs > Accessories > Communications > HyperTerminal

2. If a screen for modem options appears, follow the instructions below (otherwise, go straight to Step 3).

   a) Click **Cancel** in the **Local Information** screen, followed by **Yes** to confirm the cancel operation.

   b) In the message box **You must provide location information**, click **OK**.

3. In the **New Connection** screen, enter a name for the connection to be established (e.g. Router_Port for a connection to a Router board) and then click **OK**.

4. If the **Local Information** screen re-appears, again click **Cancel** followed by **Yes** and then **OK** (as in Step 2).

5. In the **Connect To** screen, select your PC's communications port used for the board connection from the dropdown list in the **Connect using** field - for information on obtaining the required port number, refer to Appendix A.2.

6. Now click on the **Configure** button below this field to obtain the **Properties** screen for the selected port.

7. In the **Port Settings** screen, select the following settings:

   - **Bits per second**: 115200 (this is the default for the command parser)
   - **Data bits**: 8
   - **Parity**: None
   - **Stop bits**: 1
   - **Flow control**: Hardware

   Then click **OK**.

8. Depending on your application, you may need to adjust the HyperTerminal settings, as follows:

a) Follow the menu path **File > Properties** to obtain the **Properties** screen.

b) In this screen, select the **Settings** tab and adjust the settings according to your particular application (you may also need to go to **ASCII Setup** from this screen).

c) Click **OK**.

HyperTerminal is now ready to be used with the serial connection to the Starter Kit board. You must repeat the above procedure for each board connected to the PC.

> **Tip:** Once the serial connection is configured, you can disconnect and re-connect using the ‘telephone icons’ on the task bar.

B. Downloading AT-Jenie to Boards

If you require a board to enter AT-Jenie mode by default when powered up, it will be necessary to remove the demonstrations from Flash memory. Since this will also remove the AT-Jenie command parser, it will then be necessary to re-install AT-Jenie on the board. For this, you will need the JN51xx Flash Programmer, provided as an executable on the Starter Kit CD. The following procedure describes how to do this.

Step 1 **Ensure that the board is powered OFF**

If necessary, power off the board using the slider switch SW6.

Step 2 **Connect your PC to the board**

Use the supplied USB-to-serial cable to connect a USB port of your PC to the UART0 connector on the board, **ensuring the black wire of the cable is connected to Pin 1 of the 6-pin UART0 connector** (see Figure 2 on page 12).

> **Note:** If the message **Found new hardware wizard for TTL232r-3v3** appears when you make this connection to a PC, you must install the driver for the USB-to-serial cable, as described in Appendix A.1.

Step 3 **Re-programme the Flash memory on the board**

Use the JN51xx Flash Programmer to re-programme Flash memory on the board with AT-Jenie (the previous installation of AT-Jenie with the demonstrations will be automatically erased), as follows:

a) Power on the board using the slider switch SW6.

b) Put the board into programming mode - hold down the programming button (PRG) while simultaneously pressing and releasing the reset button (RST), and then release the programming button.

c) Run the JN51xx Flash Programmer by copying the **FlashProgrammer1.5.9** folder from the Starter Kit CD to your hard drive and executing **FlashGUI.exe**.

d) Browse the Starter Kit CD to find the appropriate **.bin** file:

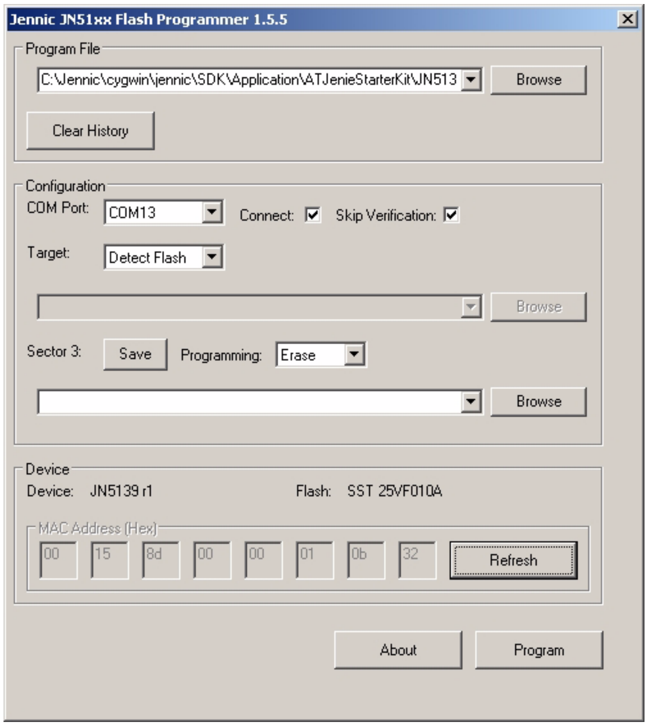
- **ATJenie_App_Coord.bin** for the Co-ordinator
- **ATJenie_App_Router.bin** for the Router
- **ATJenie_App_EndD.bin** for the End Device

> **Note:** After these downloads, one board will always be the Co-ordinator and another board always the Router. You are advised to label these boards accordingly.

e) Select the communications port used for the connection to the board, e.g. COM1. To do this, you can identify the relevant port as described in Appendix A.2.

f) Ensure other fields are as shown in the screenshot below (except MAC address).

g) Click on the **Program** button to start the download and wait until it has finished.



Step 4 **Disconnect the board from the PC**

Once the download has completed, disconnect the USB-to-serial cable at the board end.

Step 5 **Repeat for other boards**

Repeat the procedure for the other boards of the Starter Kit.

C. Custom AT-Jenie Commands for Advanced Demos

This appendix provides a summary of the custom AT-Jenie commands used in the advanced demonstrations described in Chapter 4.

Note: These custom commands are only available in the advanced demonstrations provided with the JN5139-EK020 Starter Kit and are not available in the standard AT-Jenie software.

Note: AT-Jenie allows you to extend its standard command set by adding your own custom commands. This extension is described in the *AT-Jenie User Guide (JN-UG-3043)*.

Command	Parameters/Description	Response (see Table 7)
NBG	**<node>** Obtains the state of the buttons SW1 and SW2 on the target node	NBR ERR
NHL	**<node>,<action>** Illuminates (action=1) or extinguishes (action=0) LED D2 on target node	OK ERR
NTG	**<node>** Obtains a temperature measurement from the target node	NTR ERR
NVG	**<node>** Obtains a supply voltage measurement from the target node	NVR ERR
TCF	**<num>,<per>,<len>,<data>** Starts a PER test between Router and Co-ordinator	TPR ERR
TCH	**<channel>** Sets the channel on all nodes to the specified 2400-MHz channel	OK ERR
TST	Stops the PER test started with **TCF**	OK

Table 6: Custom AT-Jenie Commands

In all cases of <node>, 0=Co-ordinator, 1=Router, 2=End Device

The responses for the custom AT-Jenie commands are detailed in the table below.

Response	Data/Description
ERR	Error - parameter value out-of-range
NBR	**<node>,<sw1>,<sw2>** Reports the states (1=pressed, 0=released) of the buttons SW1 and SW2 on the specified node
NTR	**<node>,<temp>** Reports the temperature, in degrees Celsius, measured by the specified node
NVR	**<node>,<volts>** Reports the supply voltage, in millivolts, measured by the specified node
OK	Success
TPR	**<packet ID>,<missed packets>,<PER>,<signal strength>** Reports the results of a PER test for the latest packet

Table 7: Responses for Custom AT-Jenie Commands

D. Glossary

Term	Description
Address	A numeric value that is used to identify a network node. In Jenie, the 64-bit IEEE/MAC address of the device is used.
API	Application Programming Interface: A set of programming functions that can be incorporated in application code to provide an easy-to-use interface to underlying functionality and resources.
Application	The program that deals with the input/output/processing requirements of the node, as well as high-level interfacing to the network.
AT-Jenie	An ASCII-based serial command set which provides a high-level control interface to the network.
Binding	The process of associating a service on one node with a compatible service on another node so that communication between them can be performed without specifying addresses.
Channel	A narrow frequency range within the designated radio band - for example, the IEEE 802.15.4 2400-MHz band is divided into 16 channels. A wireless network operates in a single channel determined at network initialisation.
Child	A node which is connected directly to a parent node and for which the parent node provides routing functionality. A child can be an End Device or Router. Also see Parent.
Context Data	Data which reflects the current state of the node. The context data must be preserved during sleep mode (of an End Device).
Co-ordinator	The node through which a network is started, initialised and formed - the Co-ordinator acts as the seed from which the network grows, as it is joined by other nodes. The Co-ordinator also usually provides a routing function. All networks must have one and only one Co-ordinator.
End Device	A node which has no networking role (such as routing) and is only concerned with data input/output/processing. As such, an End Device cannot be a parent.
IEEE 802.15.4	A standard network protocol that is used as the lowest level of the Jennic software stack. Among other functionality, it provides the physical interface to the network's transmission medium (radio).
Jenie	Jennic's proprietary easy-to-use interface between the application and the JenNet network level of the Jennic software stack. Available in the form of an API or a serial command set (AT-Jenie).
JenNet	Jennic's proprietary network protocol which sits on IEEE 802.15.4 in the Jennic software stack. An application interacts with JenNet through the Jenie interface.
Joining	The process by which a device becomes a node of a network. The device transmits a joining request. If this is received and accepted by a parent node (Co-ordinator or Router), the device becomes a child of the parent. Note that the parent must have "permit joining" enabled.
Network Application ID	A 32-bit value that identifies the network application (e.g. a product). It is used in JenNet as the main way to identify a network (rather than using the PAN ID).

Term	Description
PAN ID	Personal Area Network Identifier - this is 32-bit value that uniquely identifies the network in that all neighbouring networks must have different PAN IDs.
Parent	A node which allows other nodes (children) to connect to it and provides a routing function for these child nodes. A maximum number of children can be accepted (this limit is user-configurable). A parent can be a Router or the Co-ordinator. Also see Child.
Registering Services	The process by which a node provides a list of its services to the network. A parent node holds its own service list and those of its children.
Requesting Services	The process by which a node specifies the services that it requires from other nodes. The remote nodes send responses detailing which of these services they support.
Router	A node which provides routing functionality (in addition to input/output/processing) if used as a parent node. Also see Routing.
Routing	The ability of a node to pass messages from one node to another, acting as a stepping stone from the source node to the target node. Routing functionality is provided by Routers and the Co-ordinator. Routing is handled by the network level software and is transparent to the application on the node.
Service	A Jenie concept corresponding to a feature, function or capability of a node (e.g. support of LCD display). A node can support up to 32 services.
Service Profile	The list of services supported in a network. It is represented as a 32-bit value in which each bit represents a service - ‘1’ indicating service supported, ‘0’ indicating service not supported.
Sleep Mode	An operating state of a node in which the device consumes minimal power. During sleep, the only activity of the node is to time the sleep duration to determine when to wake up and resume normal operation. The total sleep duration is user-configurable. Only End Devices can sleep.
Stack	The collection of software layers used to operate a system. The high-level user application is at the top of the stack and the low-level interface to the transmission medium is at the bottom of the stack.
UART	Universal Asynchronous Receiver Transmitter - a standard interface used for cabled serial communications between two devices (each device must have a UART).

Revision History

Version	Date	Comments
1.0	29-Feb-2008	First edition for internal company release
1.1	03-Apr-2008	Updated for external release

Important Notice

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