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**ZENA™ Wireless
Network Analyzer
User's Guide**

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ZENA™ WIRELESS NETWORK ANALYZER USER'S GUIDE

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXA”, where “XXXX” is the document number and “A” is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the “ZENA™ Wireless Network Analyzer User's Guide”. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the ZENA Wireless Network Analyzer as a development tool to monitor and analyze wireless network traffic. The manual layout is as follows:

- **Chapter 1. ZENA™ Wireless Network Analyzer Overview** – This chapter introduces the ZENA Wireless Network Analyzer hardware and software, and briefly describes their capabilities.
- **Chapter 2. Getting Started** – This chapter describes how to install the ZENA software.
- **Chapter 3. ZigBee™ Protocol Tools** – This chapter describes how to use the ZigBee protocol tools provided with the ZENA analyzer. Both basic and advance monitoring techniques are shown.
- **Chapter 4. MiWi™ Wireless Networking Protocol Tools** – This chapter describes how to use the MiWi protocol tools provided with the ZENA analyzer. Both basic and advance monitoring techniques are shown.

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- **Chapter 5. MiWi™ P2P Wireless Networking Protocol Tools** - This chapter describes how to use the MiWi P2P protocol tools provided with the ZENA analyzer.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

| Description | Represents | Examples |
|--|---|---|
| Arial font: | | |
| Italic characters | Referenced books | <i>MPLAB® IDE User's Guide</i> |
| | Emphasized text | ...is the <i>only</i> compiler... |
| Initial caps | A window | the Output window |
| | A dialog | the Settings dialog |
| | A menu selection | select Enable Programmer |
| Quotes | A field name in a window or dialog | "Save project before build" |
| Underlined, italic text with right angle bracket | A menu path | <u><i>File>Save</i></u> |
| Bold characters | A dialog button | Click OK |
| | A tab | Click the Power tab |
| N'Rnnnn | A number in verilog format, where N is the total number of digits, R is the radix and n is a digit. | 4'b0010, 2'hF1 |
| Text in angle brackets < > | A key on the keyboard | Press <Enter>, <F1> |
| Courier New font: | | |
| Plain Courier New | Sample source code | #define START |
| | Filenames | autoexec.bat |
| | File paths | c:\mcc18\h |
| | Keywords | _asm, _endasm, static |
| | Command-line options | -Opa+, -Opa- |
| | Bit values | 0, 1 |
| | Constants | 0xFF, 'A' |
| Italic Courier New | A variable argument | <i>file.o</i> , where <i>file</i> can be any valid filename |
| Square brackets [] | Optional arguments | mcc18 [options] <i>file</i> [options] |
| Curly brackets and pipe character: { } | Choice of mutually exclusive arguments; an OR selection | errorlevel {0 1} |
| Ellipses... | Replaces repeated text | var_name [, var_name...] |
| | Represents code supplied by user | void main (void) { ... } |

RECOMMENDED READING

This user's guide describes how to use the ZENA Wireless Network Analyzer. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

Readme for ZENA Wireless Network Analyzer

For the latest information on using the ZENA Wireless Network Analyzer, read the Readme file in the ZENA software installation directory. The Readme file contains update information and known issues that may not be included in this user's guide.

PIC[®] MCU Data Sheets and Family Reference Manuals

See the Microchip web site for complete and updated versions of device data sheets and related device family reference manuals.

Microchip 8-Bit PIC[®] Microcontroller Solutions (DS39630)

This document provides an overview of the features and functionality of the 8-bit PIC microcontroller product family. It highlights its powerful architecture, flexible memory technologies and easy-to-use development tools.

AN1232, Microchip ZigBee-2006 Residential Stack Protocol (DS01232)

This application note assists designers who are interested in adopting the ZigBee protocol in their applications.

AN965, Microchip Stack for the ZigBee[™] Protocol (DS00965)

This application note describes how you can use the Microchip Stack for the ZigBee protocol to quickly build your application. To illustrate the usage of the Stack, working demo applications are included.

ZigBee[™] Protocol Specification

See the ZigBee protocol web site for the complete and most recent revisions of the ZigBee protocol (<http://www.zigbee.org>).

PICDEM[™] Z Demonstration Kit User's Guide (DS51524)

The PICDEM Z Demonstration Kit is designed to allow developers to evaluate and experiment with Microchip solutions for the ZigBee protocol. The PICDEM Z Demonstration Kit provides two ZigBee protocol nodes to create a simple, two-node network.

AN1066, MiWi[™] Wireless Networking Protocol Stack (DS01066)

This application note describes how you can use the Microchip Stack for the MiWi protocol to quickly build your application. To illustrate the usage of the Stack, working demo applications are included.

IEEE 802.15.4[™] Specification

See the IEEE web site for the complete and most recent revisions of the IEEE 802.15.4 specification (<http://www.ieee.org>).

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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To register, access the Microchip web site at www.microchip.com, click on Customer Change Notification and follow the registration instructions.

The Development Systems product group categories are:

- **Compilers** – The latest information on Microchip C compilers and other language tools. These include the MPLAB C18 and MPLAB C30 C compilers; MPASM™ and MPLAB ASM30 assemblers; MPLINK™ and MPLAB LINK30 object linkers; and MPLIB™ and MPLAB LIB30 object librarians.
- **Emulators** – The latest information on Microchip in-circuit emulators. This includes the MPLAB ICE 2000 and MPLAB ICE 4000.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 2.
- **MPLAB® IDE** – The latest information on Microchip MPLAB IDE, the Windows® Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB SIM simulator, MPLAB IDE Project Manager and general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include the MPLAB PM3 and PRO MATE II device programmers and the PICSTART® Plus and PICkit™ 1 development programmers.

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: <http://support.microchip.com>

DOCUMENT REVISION HISTORY

Revision A (April 2006)

- Initial Release of this Document.

Revision B (January 2007)

- Updated existing ZigBee protocol Stack information and added MiWi™ protocol chapter.

Revision C (September 2008)

- Updated APO and ZDO screenshots and information.
- Updated existing ZigBee protocol Stack information.
- Added **Chapter 5. “MiWi™ P2P Wireless Networking Protocol Tools”**.

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Chapter 1. ZENA™ Wireless Network Analyzer Overview

1.1 INTRODUCTION

This chapter introduces the ZENA Wireless Network Analyzer hardware and software, and briefly describes their capabilities. The ZENA analyzer provides three main tools to develop IEEE 802.15.4 solutions quickly and efficiently with the free Microchip Stacks for the ZigBee™ protocol and the MiWi™ protocol. The ZENA analyzer enables developers to quickly modify and adapt the Stacks to suit application requirements. The ZENA analyzer is also an IEEE 802.15.4 packet analyzer, currently supporting the 2.4 GHz spectrum. The ZENA analyzer is capable of decoding ZigBee protocol v1.0 and MiWi protocol packets. The ZENA analyzer also provides network analysis support. The ZENA analyzer draws the network topology of the network as it is formed and allows users to watch packet transactions as they occur, record the packet transactions and play these packets back at variable speeds. These tools, combined, form a powerful tool in wireless development for the IEEE 802.15.4 protocol.

Note: The ZENA Wireless Network Analyzer board does not have to be attached to the computer to use the configuration tool or the playback functionality.

1.2 ZENA™ WIRELESS NETWORK ANALYZER KIT CONTENTS

The ZENA Wireless Network Analyzer kit contains the following items:

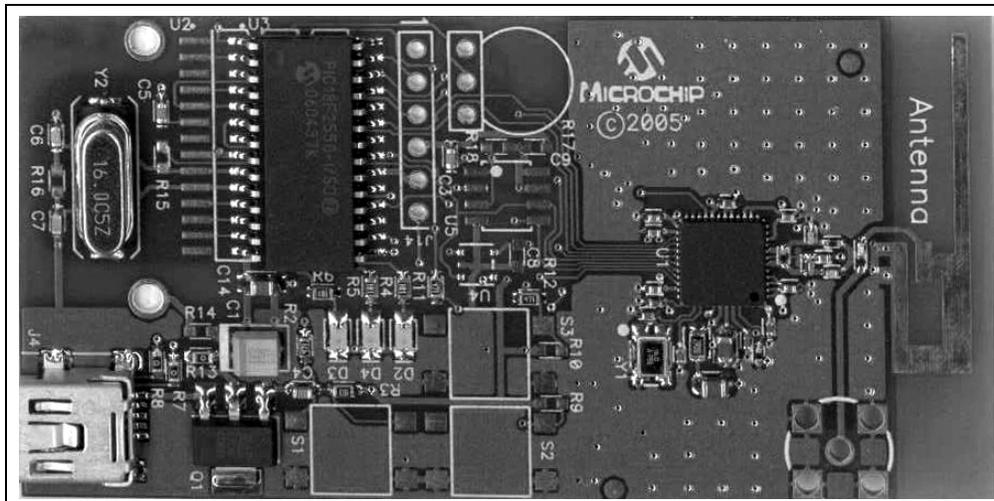
- ZENA Wireless Network Analyzer
- USB mini-B cable
- ZENA Wireless Network Analyzer CD-ROM

1.3 ZENA™ ANALYZER OVERVIEW

The ZENA Wireless Network Analyzer board, seen in Figure 1-1, combines the PIC18LF2550 for full-speed, USB support with an IEEE 802.15.4 transceiver.

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FIGURE 1-1: ZENA™ WIRELESS NETWORK ANALYZER BOARD



The ZENA Wireless Network Analyzer uses a USB mini-B cable to connect to the PC. The ZENA analyzer is powered by the USB bus. A PCB trace antenna receives the packets on the specified channel and sends the information over USB to the PC computer using the HID standard class.

Chapter 2. Getting Started

2.1 INTRODUCTION

This chapter describes how to install the ZENA Wireless Network Analyzer software.

2.2 INSTALLING ZENA™ ANALYZER SOFTWARE

Since the ZENA analyzer software can be used independently of the hardware, it is available from multiple sources, including the ZENA Wireless Network Analyzer CD-ROM, the installation for source files of *AN965*, “Microchip Stack for the ZigBee™ Protocol”, and the installation for source files of *AN1066*, “MiWi™ Wireless Networking Protocol Stack”. The version shipped with the application notes is a demo version, which provides Stack configuration and packet playback capability, but does not allow real-time network monitoring with the ZENA Wireless Network Analyzer hardware. The full version is shipped with the ZENA Wireless Network Analyzer board.

If you are installing the software from the ZENA Wireless Network Analyzer CD-ROM, insert the CD-ROM into your computer's CD-ROM drive. If the installation program does not start automatically, browse to the CD-ROM directory and execute the `ZENA\vn.nn.exe` program, where `vn.nn` is the version number of the ZENA analyzer software. Follow the on-screen directions to install the software.

If you have installed the source code for one of the Microchip supported IEEE 802.15.4 protocols, the demo version of ZENA analyzer software is installed automatically in the root directory of the application source code. The demo version of the software allows access to the Stack configuration and message playback features, but it will not communicate with the ZENA Wireless Network Analyzer hardware.

The ZENA Wireless Network Analyzer license agreement is presented. Read the agreement, then click **I Accept** to continue.

The ZENA Wireless Network Analyzer Readme file contains important information about the most recent release of the ZENA Wireless Network Analyzer, such as new features and known issues. The Readme file will change with each release.

Once the ZENA software is installed, use the Start Menu item to launch the software. The introductory screen appears as follows.

FIGURE 2-1: ZENA™ ANALYZER SOFTWARE MAIN WINDOW



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Chapter 3. ZigBee™ Protocol Tools

3.1 INTRODUCTION

This chapter describes how to use the ZigBee™ protocol tools provided by the ZENA Wireless Network Analyzer. Both basic and advance monitoring techniques are demonstrated.

3.2 MICROCHIP STACK CONFIGURATION TOOL

Microchip provides a freely available Stack as part of application note, *AN965, "Microchip Stack for the ZigBee™ Protocol"*. The application note and source code are available for download from the Microchip web site (www.microchip.com). After you have reviewed the application note and studied the demonstration projects, you will be ready to start your own ZigBee protocol application.

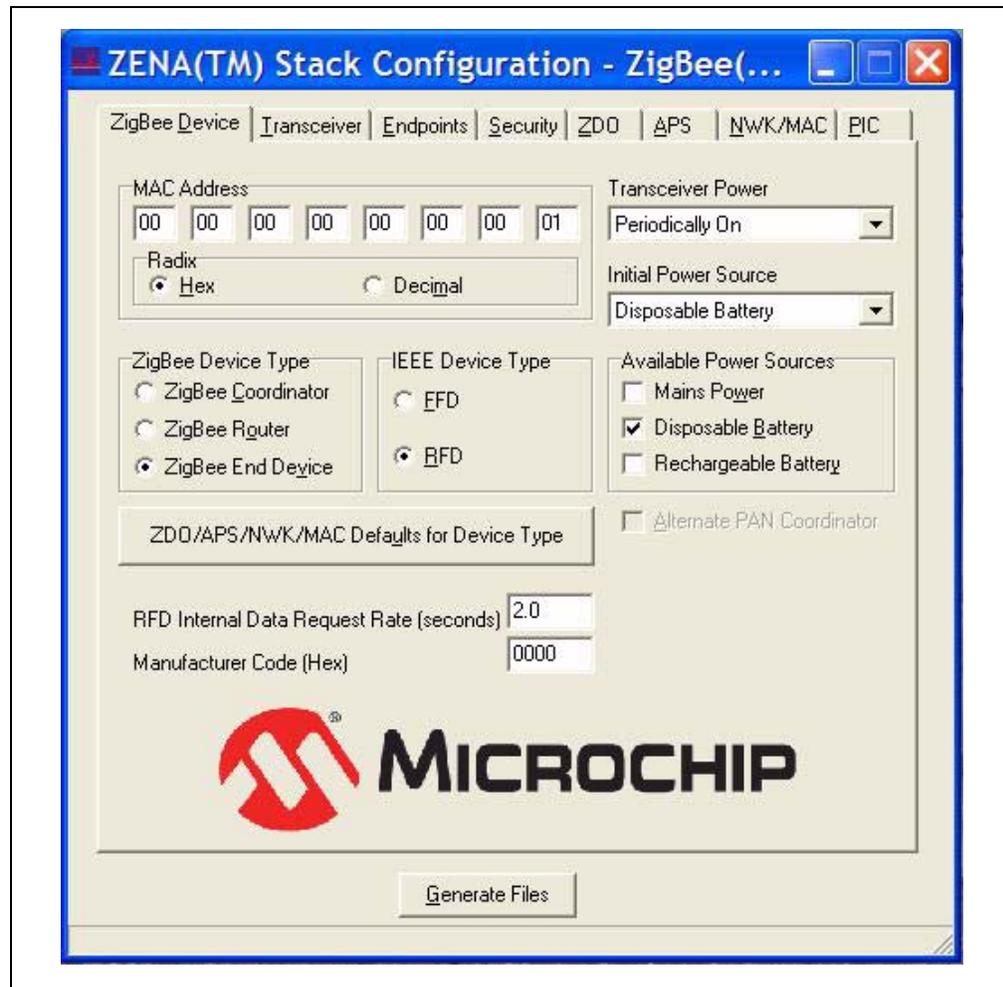
The ZENA analyzer will greatly assist you with configuring the Microchip Stack by automatically generating a portion of the source code for your ZigBee protocol application. Be sure to refer to *AN965, "Microchip Stack for the ZigBee™ Protocol"* for details about each ZigBee protocol configuration option. Select *ZigBee™ Tools>Stack Configuration* from the main ZENA™ Stack Configuration window. The ZENA™ Stack Configuration - ZigBee™ Protocol window will be displayed. Using the tabbed dialog, you can select all of the options required for your ZigBee protocol application. The ZENA software will automatically enable and disable certain options depending on the selections you have made.

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3.2.1 Specifying ZigBee Protocol Device Information

Select the **ZigBee Device** tab.

FIGURE 3-1: ZENA™ STACK CONFIGURATION WINDOW, ZIGBEE DEVICE TAB



Using this window, you can configure the following items:

TABLE 3-1: ZigBee™ PROTOCOL DEVICE CONFIGURATION SELECTION

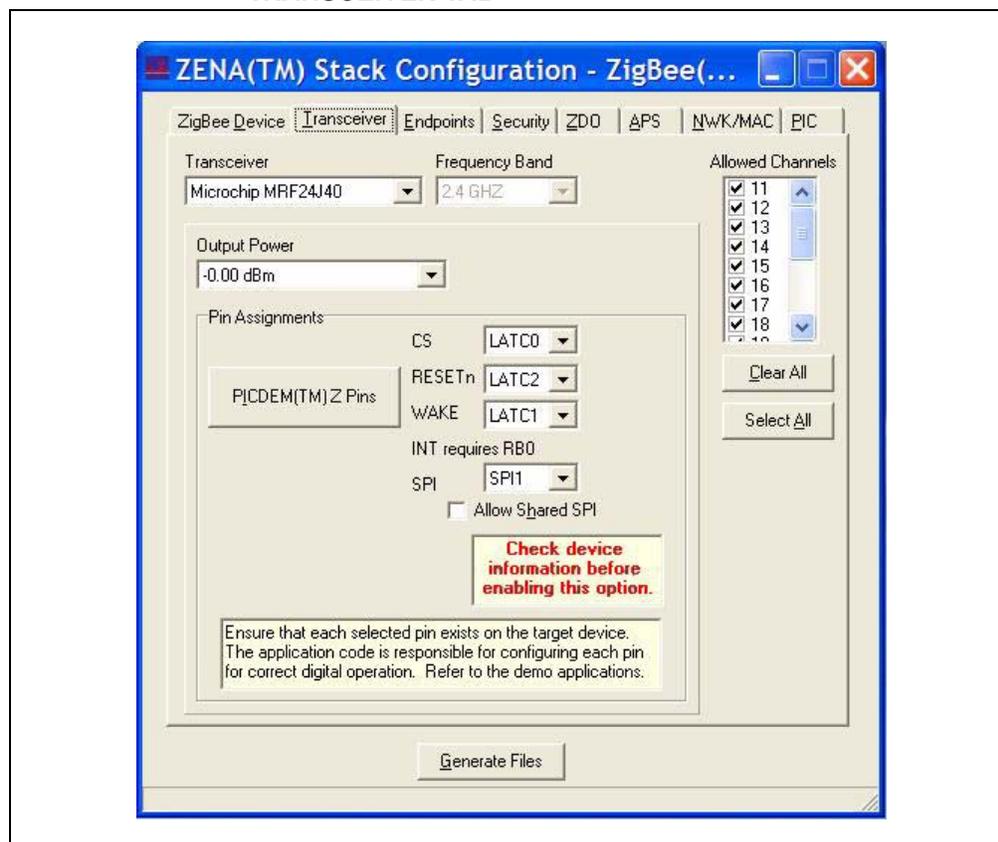
| Configuration | Option Description |
|--|--|
| MAC Address | Each and every ZigBee protocol device must have its own unique MAC address. The Microchip OUI is provided as a default for development purposes only. Please see AN1232, "Microchip ZigBee-2006 Residential Stack Protocol" for additional information. |
| ZigBee Device Type | ZigBee protocol defines three different types of devices. Select the device type of your application. |
| IEEE Device Type | Some ZigBee protocol devices have the option of selecting the IEEE device type. Select the appropriate IEEE device type for your application. |
| ZDO/APS/NWK/MAC Defaults for Device Type | When you change the device type, the ZENA™ analyzer will automatically set many options to their default settings unless you have altered them. Click this button if you have altered them and would like to restore them to their default values. |
| Transceiver Power | Offers transceiver power selection. Selects how the transceiver is powered. |
| Initial Power Source | Offers power source selection. Selects your application's power source. |
| Available Power Sources | Selects the power sources that are available to your application. |
| Alternate PAN Coordinator | This option is currently not supported by the Microchip Stack for ZigBee protocol. |
| Manufacturer Code (Hex) | Each manufacturer of ZigBee protocol devices is assigned a manufacturer code by the ZigBee Alliance. Enter the four digit hex value. |
| RFD Internal Data Request Rate (seconds) | If your device is an RFD, it must explicitly request data to receive messages. Some messages sent internally by the Stack itself will generate a response from the recipient that must be received. Enter the internal poll rate for these messages. Note that this polling is independent from the message polling required by the application. |

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3.2.2 Specifying Transceiver Information

Select the **Transceiver** tab.

FIGURE 3-2: ZENA™ STACK CONFIGURATION WINDOW, TRANSCEIVER TAB



Using this window, you can configure the following items:

TABLE 3-2: ZigBee™ PROTOCOL TRANSCEIVER CONFIGURATION SELECTION

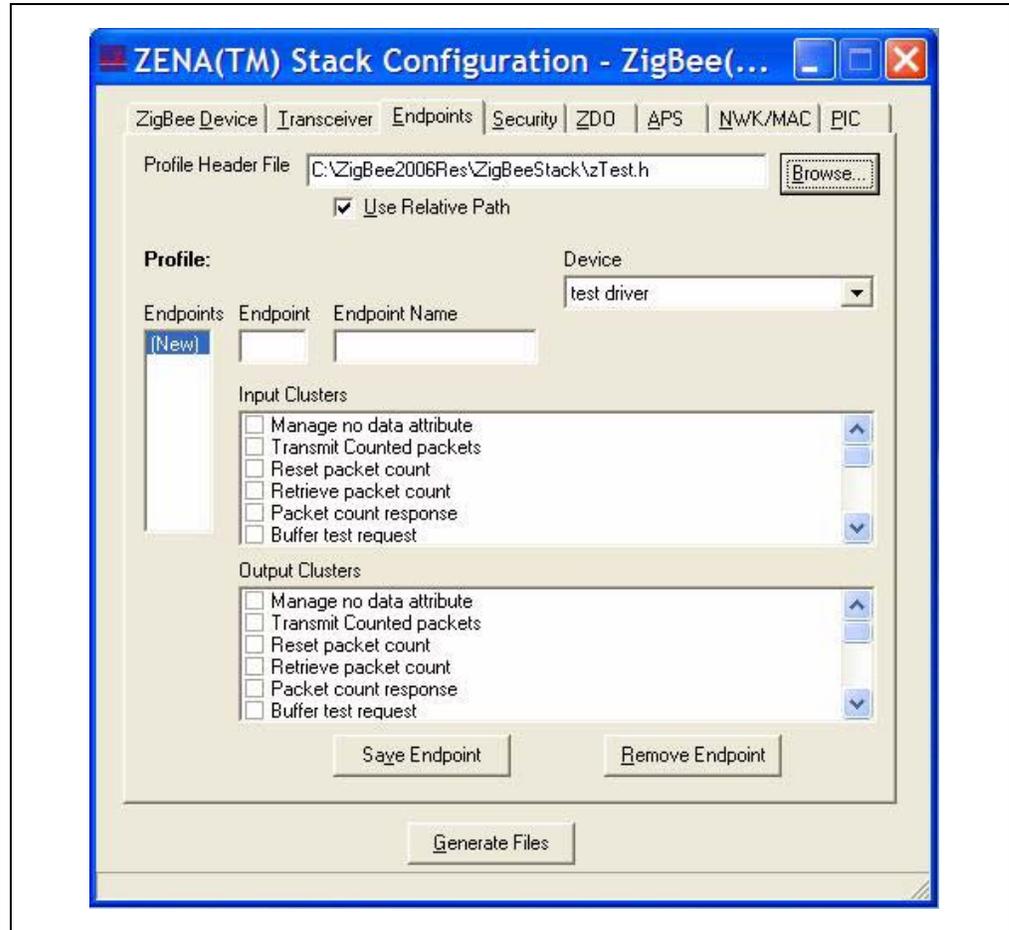
| Configuration | Option Description |
|--------------------------------|--|
| Transceiver | Selects one of the transceivers supported by the Stack. |
| Frequency Band | This combo box shows the various available frequency bands of the selected transceiver. If the transceiver supports only one frequency band, that frequency will be displayed and the combo box will be disabled. |
| Output Power | Selects the initial output power of the transceiver. |
| Pin Assignments ⁽¹⁾ | This panel shows the required pins for the selected transceiver. The Stack allows you to change these pin connections to application-specific port pins. |
| PICDEM™ Z Pins | Click this button to restore the pin assignments to the connections used by the PICDEM Z Demonstration Board. |
| Allowed Channels | This area shows the channels that are supported by the selected frequency band. Selecting channels here will generate a label that can be used to specify the allowed channels for network formation and network discovery. Click Clear All to uncheck all channels and click Select All to check all channels. Each channel can also be checked or unchecked individually by clicking on the checkbox that precedes the channel number. |
| Allow Shared SPI | Some transceivers require a dedicated SPI unless additional hardware is provided. If you are using an SPI serial EEPROM for external nonvolatile storage, and you want the transceiver and EEPROM to use the same SPI peripheral, select this option to allow additional option selection on the PIC® MCU page. |

Note 1: Ensure the pin exists on the target device. The application code is responsible for configuring the pin as a digital input or output as appropriate.

3.2.3 Specifying Profile and Endpoint Information

Select the **Endpoints** tab.

FIGURE 3-3: ZENA™ STACK CONFIGURATION WINDOW, ENDPOINTS TAB



Using this window, you can specify the profile and endpoint structure that your application is using. See Table 3-3 for configuration options.

CAUTION

It is critical for ZigBee protocol interoperability that this section be accurate.

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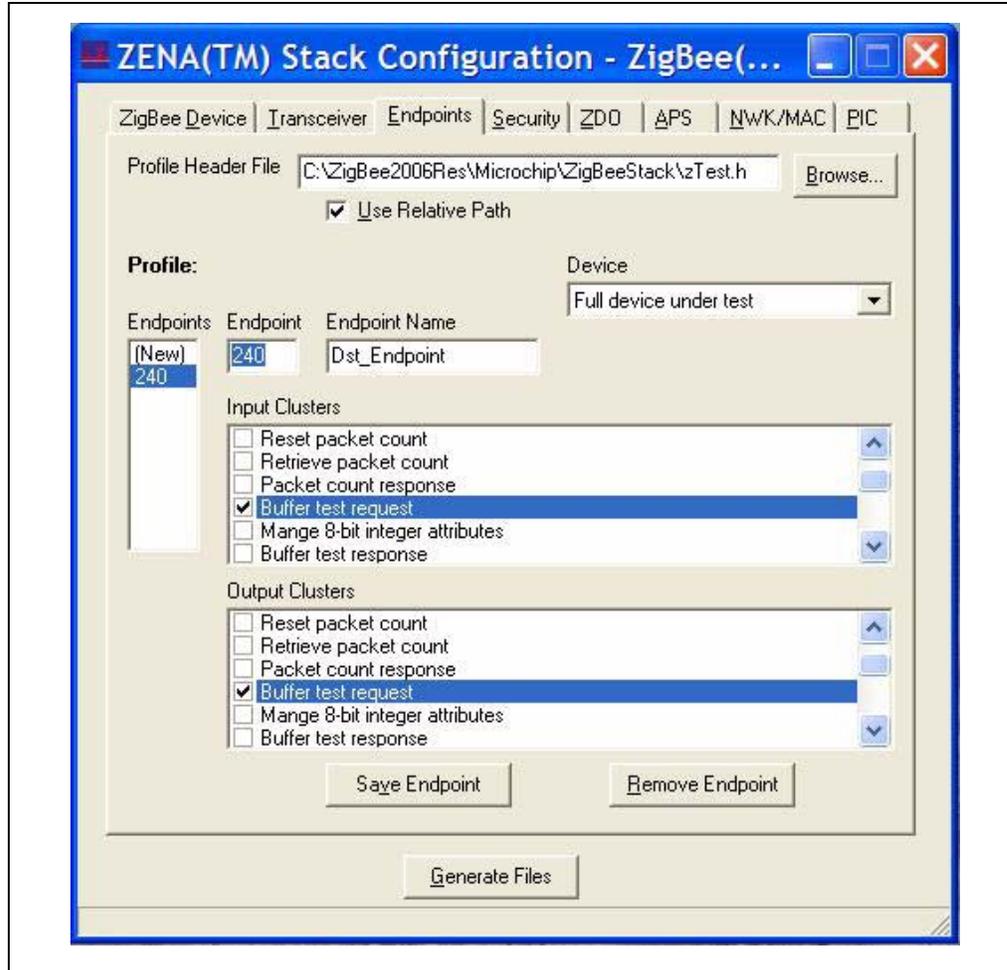
TABLE 3-3: ZigBee™ PROTOCOL PROFILE/ENDPOINTS CONFIGURATION SELECTION

| Configuration | Option Description |
|--------------------------|---|
| Profile Header File | Click Browse to browse to and select the header file for the application's profile. This file has profile information in a specific format which the ZENA™ analyzer uses to configure many items, including: <ul style="list-style-type: none">- Profile name- The list of devices supported by the profile- Allowable input and output clusters- Range checking for various parameters on other tabs |
| Device ⁽¹⁾ | Select the profile device that describes the application. |
| Endpoints ⁽²⁾ | <p>To define an endpoint:</p> <ol style="list-style-type: none">1. Enter the endpoint's numerical value (1-240) in the "Endpoint" edit box.2. In the "Endpoint Name" edit box, enter a valid C language label for that endpoint.3. Select all of the input and output clusters that are supported by that endpoint under "Input Clusters" and "Output Clusters".4. Click Save Endpoint to save the endpoint. The endpoint number will be added to the "Endpoints" list box. <p>To define another endpoint:</p> <ol style="list-style-type: none">1. Click New in the "Endpoints" list box. All of the endpoint information will be cleared.2. Enter the new endpoint's information and click Save Endpoint. <p>To view a previously defined endpoint:</p> <p>Click on the endpoint number in the "Endpoints" list box.</p> <p>To remove a specified endpoint:</p> <p>Click the desired endpoint number in the "Endpoints" list box and click Remove Endpoint.</p> |

Note 1: The ZENA analyzer does not confirm that all mandatory clusters are supported for the selected device.

2: Be sure to click **Save Endpoint** when you are finished defining an endpoint. If the endpoint information has been entered but not saved, the endpoint will not be included in the generated output files.

FIGURE 3-4: ENDPOINT SPECIFICATION

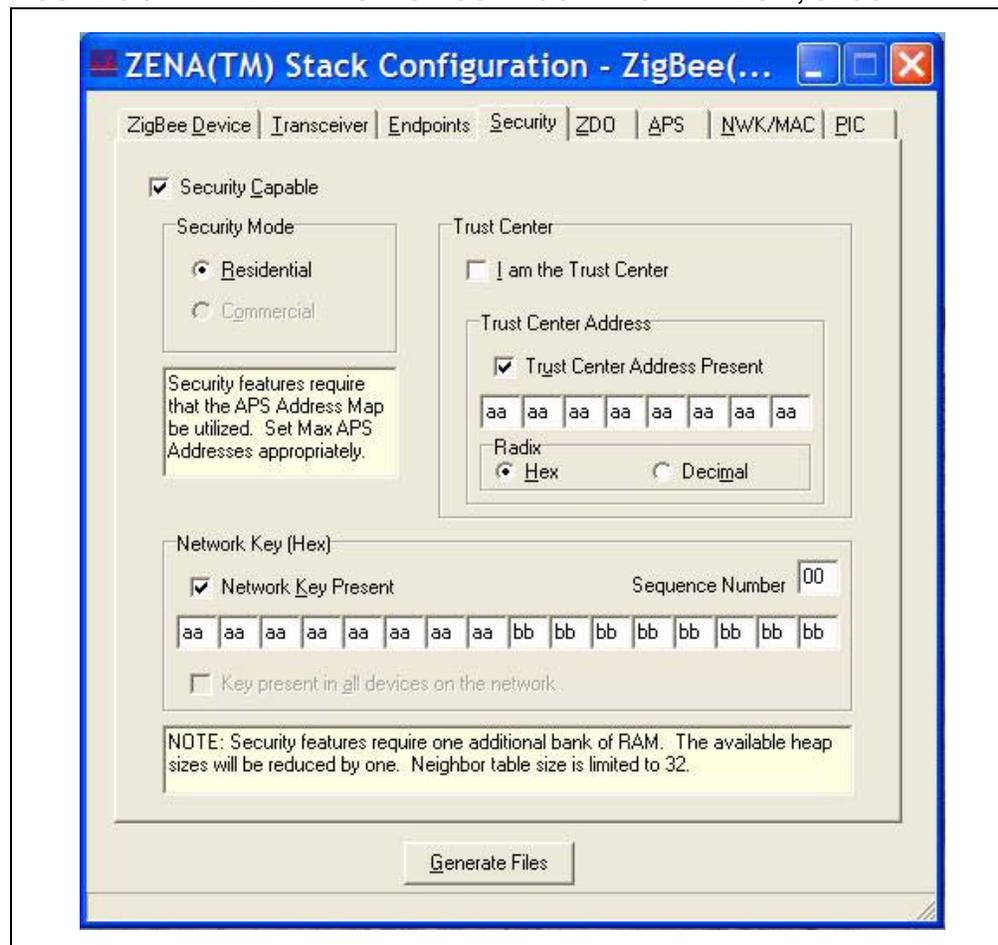


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3.2.4 Specifying Security Information

Select the **Security** tab.

FIGURE 3-5: ZENA™ STACK CONFIGURATION WINDOW, SECURITY TAB



This tab is used to configure the security features of the ZigBee protocol Stack. If your application will utilize security, select the “Security Capable” option. Security imposes the following constraints:

- The Stack requires one additional bank of RAM
- Neighbor table size is limited to 32 (see Table 3-10)
- The APS Address Map must be used (see Max APS Addresses in Table 3-7)

Using this window, you can configure the following items:

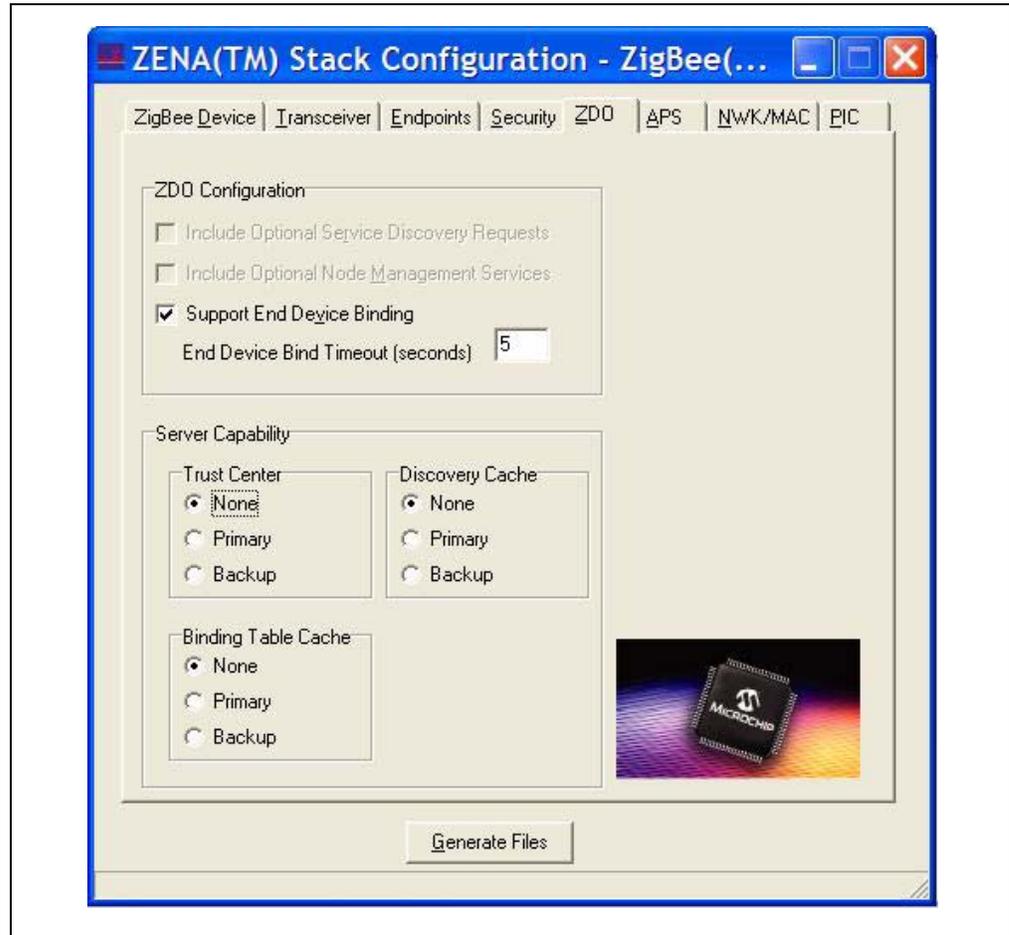
TABLE 3-4: ZigBee™ PROTOCOL DEVICE CONFIGURATION SELECTION

| Configuration | Option Description |
|---|---|
| Security Capable | Select this option if your application will utilize security and send and receive encrypted messages. |
| Security Mode | Only “Residential” mode is currently supported by the Stack. |
| Trust Center | Select this option if this device is the trust center. |
| Trust Center Address | If the address of the trust center is known, enter it here. |
| Network Key Present | If the network key is known, enter it here with the “Sequence Number”. |
| Key present in all devices on the network | Select this option if the device is a ZigBee Coordinator or a ZigBee Router and it contains the network key and all devices on the network contain the network key. |

3.2.5 Specifying ZDO Layer Information

Click on the **ZDO** tab.

FIGURE 3-6: ZENA™ STACK CONFIGURATION WINDOW, ZDO TAB



This tab is used to configure the ZDO (ZigBee Device Object) Layer of the Stack. Many options on this tab are enabled or disabled based on the “ZigBee Device Type” that is selected on the **ZigBee Device** tab.

ZigBee allows some network services to be distributed among different devices in the network. The Server Capability selection (refer to Table 3-6) is used to describe the specific additional services the device capable of providing.

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TABLE 3-5: ZigBee™ PROTOCOL ZDO CONFIGURATION SELECTION

| Configuration | Option Description |
|---|---|
| Include Optional Service Discovery Requests | If selected, the application will support the optional ZDO service discovery requests. <i>This feature is not yet supported by the Microchip Stack.</i> |
| Include Optional Node Management Services | If selected, the application will support the optional ZDO node management services. <i>This feature is not yet supported by the Microchip Stack.</i> |
| Support End Device Binding | This function is available only on ZigBee protocol coordinators. If selected, enter the "End Device Bind Timeout (seconds)" in seconds. |

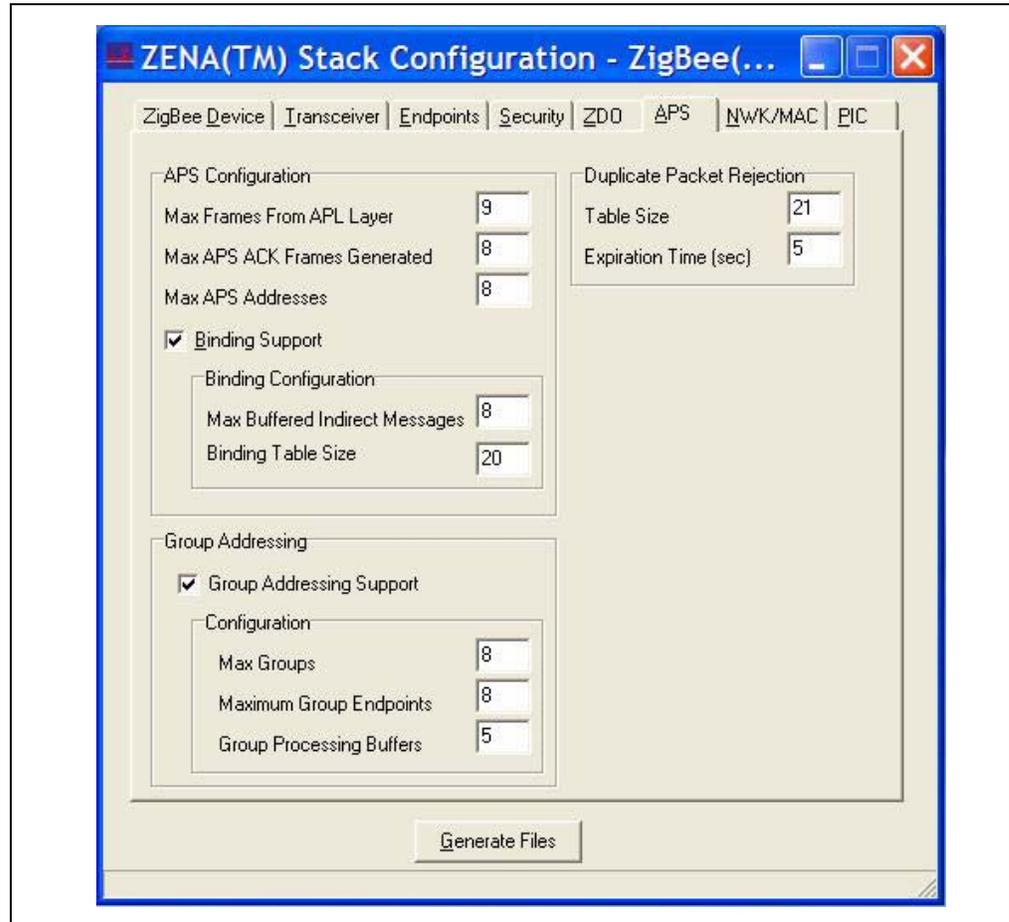
TABLE 3-6: ZIGBEE™ PROTOCOL ZDO SERVER CONFIGURATION SELECTION

| Configuration | Option Description |
|---------------------|---|
| Trust Center | This specifies whether the device is capable of serving as a Trust Center. If yes, then indicate whether it is as a primary or a backup Trust Center. <i>This feature is not yet fully supported by the Microchip Stack. The ZigBee Coordinator is the Trust Center within the Microchip Stack.</i> |
| Binding Table Cache | This specifies whether the device is capable of serving as a Binding Table Cache i.e. a device that can store the Binding Table of other devices. <i>This feature is not yet fully supported by the Microchip Stack. Devices can only store their own binding tables.</i> |
| Discovery Cache | This specifies whether the device is capable of providing information that describes both the identity and services provided by other devices on the network. If yes, then indicate whether the device will operate as the primary or backup device, responding to discovery requests from other devices. <i>This feature is not yet fully supported by the Microchip Stack. The Individual Routers and Coordinator may respond with service information regarding their own child devices, but not for the network as a whole.</i> |

3.2.6 Specifying APS Layer Information

Click on the **APS** tab.

FIGURE 3-7: ZENA™ STACK CONFIGURATION WINDOW, APS TAB



This tab is used to configure the APS (Application Sub Support) Stack layer. Some options on this tab are enabled or disabled based on the “ZigBee Device Type” selected on the **ZigBee Device** tab.

Many of these options affect the amount of RAM and nonvolatile memory that is used by the application. To view the associated memory usage, hover the mouse over the appropriate edit box after the box has been enabled.