PICDEM™ Z DEMONSTRATION KIT 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 "DSXXXXXA", where "XXXXX" 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 PICDEM Z Demo Kit. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use the PICDEM Z Demo Kit as a development tool to evaluate and experiment with Microchip solutions for the ZigBee™ protocol. The manual layout is as follows:

- **Chapter 1: PICDEM Z Demonstration Kit Overview –** Describes the PICDEM Z Demonstration Kit and how it works.
- **Chapter 2: Getting Started with the PICDEM Z Demonstration Kit –** What you need to know to start using the PICDEM Z Demonstration Kit.
- **Chapter 3: Experimenting with the PICDEM Z Demonstration Kit –** How to program and use the PICDEM Z Demonstration Kit.
- **Chapter 4: Troubleshooting –** How to solve common operation problems with the PICDEM Z Demo Kit.
- **Appendix A: PICDEM Z Motherboard Schematics –** Hardware information on the PICDEM Z demonstration board
- **Appendix B: PICDEM Z 2.4 GHz RF Card –** Hardware information on the PICDEM Z RF card

CONVENTIONS USED IN THIS GUIDE

Where applicable, this manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* 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	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
'b*nnnn*	A binary number where *n* is a digit	'b00100, 'b10
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier font:		
Plain Courier	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`
Italic Courier	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
`0x`*`nnnn`*	A hexadecimal number where *`n`* is a hexadecimal digit	`0xFFFF`, `0x007A`
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[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) { ... }`

WARRANTY REGISTRATION

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in the Warranty Registration Card entitles users to receive new product updates. Interim software releases are available at the Microchip web site.

RECOMMENDED READING

This user's guide describes how to use the PICDEM Z Demo Kit. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

Microchip Stack for the ZigBee™ Protocol (AN965)

This application note describes how you can use the Microchip Stack for ZigBee protocol to quickly build your application without the need to acquire detailed knowledge of ZigBee specifications. To illustrate the usage of the stack, two working demo applications are included. These demo applications can be used as a reference or simply modified and adapted to your requirements.

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 (FAQ), 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

DEVELOPMENT SYSTEMS CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

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 C17, 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 and MPLAB SIM30 simulators, 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 programmer.

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support
- Development Systems Information Line

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

In addition, there is a Development Systems Information Line which lists the latest versions of Microchip's development systems software products. This line also provides information on how customers can receive currently available upgrade kits.

The Development Systems Information Line numbers are:

1-800-755-2345 – United States and most of Canada

1-480-792-7302 – Other International Locations

Chapter 1. PICDEM Z Demonstration Kit Overview

1.1 INTRODUCTION

This chapter presents an overview of the features and requirements of the PICDEM Z Demonstration Kit. Topics covered in this chapter include:

- What is the PICDEM Z Demonstration Kit?
- PICDEM Z Demonstration Kit Components
- Overview of the PICDEM Z Demonstration Kit
- PICDEM Z Motherboard
- PICDEM Z RF Card
- PICDEM Z Software CD

1.2 WHAT IS THE PICDEM Z DEMONSTRATION KIT?

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 nodes to create a simple two-node network. If required, additional nodes may be purchased to expand the network. The preprogrammed demo application firmware allows multiple operational configurations without modifying a single line of code. Using the Microchip Stack for ZigBee Protocol source code, available free-of-charge from the Microchip web site, developers can develop their own applications or modify the supplied demo applications.

1.3 PICDEM Z DEMONSTRATION KIT COMPONENTS

Your demonstration kit contains the following items:

1. Two PICDEM Z demonstration motherboards.
2. Two PICDEM Z RF cards (Exact RF transceiver is dependent upon your kit P/N).
3. Two 9V batteries.
4. The *Microchip Software CD for ZigBee* CD-ROM, which contains demo applications and source code for the Microchip Stack.
5. This manual (included on the CD-ROM in Adobe® Acrobat® format).
6. A warranty registration card.

1.4 OVERVIEW OF THE PICDEM Z DEMONSTRATION KIT

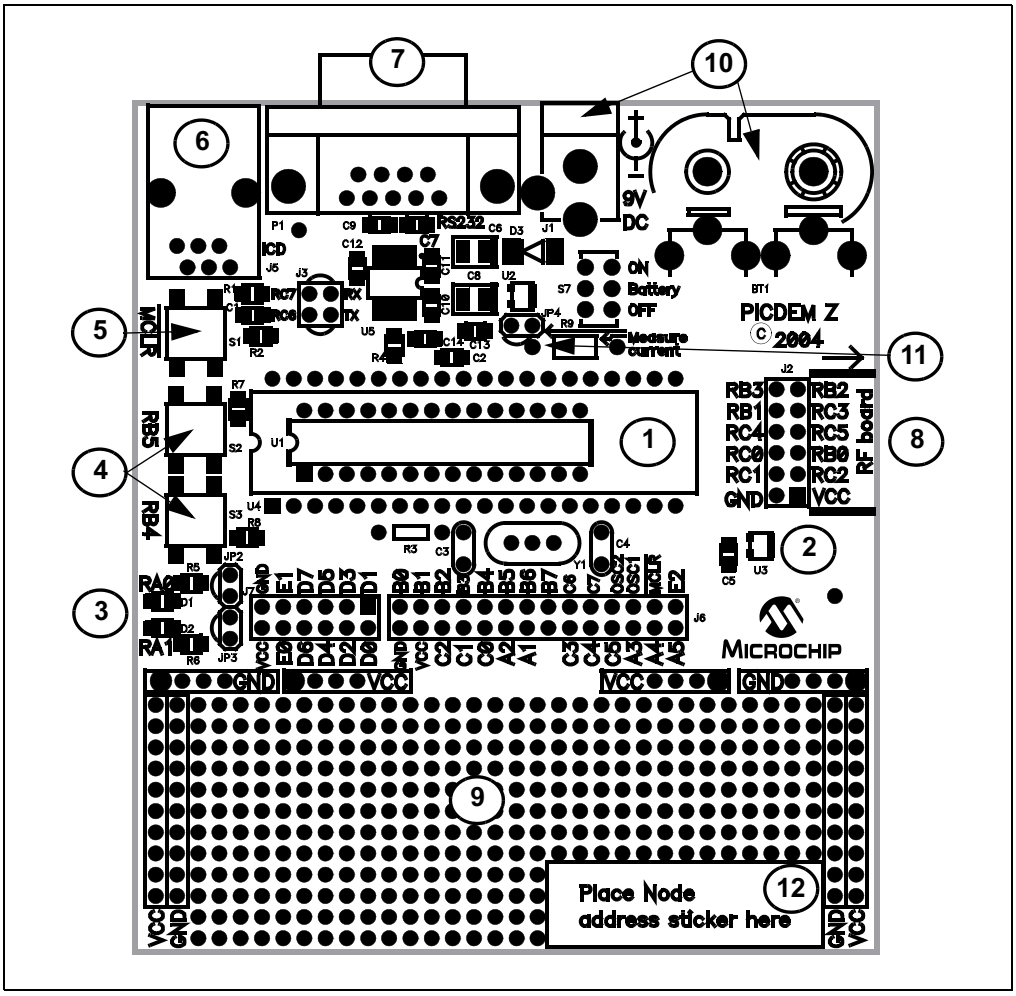
The PICDEM Z Demonstration Kit (also referred to as the PICDEM Z kit) is designed to demonstrate the Microchip solution for the ZigBee protocol. The PICDEM Z kit includes two ZigBee nodes, each preprogrammed with demo Coordinator and Reduced Function Device (RFD) applications. Each node consists of two boards – one motherboard and one RF card. The PICDEM Z motherboard is designed to support different types of RF transceivers. Microchip will be adding support for new RF transceivers as time progresses. For the complete list of supported RF transceivers, please visit the Microchip web site.

In addition to demonstrating standard ZigBee functionality, the PICDEM Z kit can also be used to develop custom applications based on the ZigBee protocol. The kit includes the complete source code for the Microchip Stack for the ZigBee protocol. The Microchip application note AN965, *Microchip Stack for the ZigBee™ Protocol* (DS00965) discusses the Microchip Stack in more detail.

1.5 PICDEM Z MOTHERBOARD

The PICDEM Z demonstration board or motherboard, has all of the features necessary to begin developing ZigBee protocol-based applications using the Microchip PIC18 family of microcontrollers. The preprogrammed firmware allows users to begin evaluating the board right out of the box, with no additional programming or configuration.

FIGURE 1-1: PICDEM Z MOTHERBOARD



Features on the PICDEM Z demonstration board include:

1. **Microcontroller Socket** (U4): 40- and 28-pin DIP sockets are provided for the user's choice of Microchip PIC18 microcontrollers. The board is equipped from the factory with a PIC18LF4620 high-performance microcontroller, clocked at 4 MHz and preprogrammed with the demo application firmware using the Microchip Stack. The microcontroller on each board included in the demonstration kit contains a label that identifies it as either a ZigBee Coordinator or ZigBee RFD.
2. **Temperature Sensor** (U3: TC77): This is a 5-pin thermal sensor with an SPI interface from Microchip.
3. **User-defined LEDs** (D1, D2): These two LEDs are driven by digital I/O pins of the controller, and may be used to simulate a digital output to an embedded device. These LEDs are enabled/disabled by jumpers JP2 and JP3. By default, LEDs are enabled by permanently shorting jumpers via PCB traces. If required, you may cut the traces and install your own jumpers.
4. **User-defined Push Buttons** (S2, S3): These switches are connected to digital I/O pins on the controller, and may be used to simulate a digital input in an embedded application. These switches do not have external pull-up resistors; as a result you must enable the internal pull-up option on PORTB to correctly read the switch status.
5. **Reset Push Button** (S1): This switch is tied to the $\overline{\text{MCLR}}$ pin on the controller, and is used to reset the board.
6. **RJ-11 (six-wire) Modular Connector** (J5): This connector allows the demonstration board to be connected to Microchip MPLAB ICD 2 systems for advanced microcontroller debugging and programming.
7. **RS-232 (DB9F) Connector** (P1): This connector allows the demonstration board to be connected to any other board or PC serial port. The preprogrammed demo application firmware uses this connector to communicate with a PC and offer application configuration options. If required, you may disconnect the on-board RS-232 driver circuit from the controller by breaking the PCB traces on the J3 jumper.
8. **RF Card Connector** (J2): This is a common connector to connect all supported RF cards. This connector provides +3.3V DC, an SPI bus, and a few discrete digital I/O control signals.
9. **Prototype Area**: A prototype area is provided to breadboard additional circuitry for development. Connections are provided for +3.3V DC, ground, and all I/O ports of a microcontroller.
10. **On-board Power**: An on-board regulator provides 9V DC to 3.3V DC rated at 100 mA. The board may be powered via either an external 9V DC input (J1) or the on-board 9V battery (B1). The board contains a diode to protect against an accidental reverse power connection. When using a 9V battery to power the board, switch S7 must be set to ON. The 2.5 mm 9V DC jack is wired such that when a 9V DC plug is inserted, the on-board battery is automatically disconnected from the circuit.
11. **Measure Current** (JP4): This jumper can be used to measure current drawn by all of the circuits on the board. By default, this jumper is shorted via a PCB trace. To measure the current, cut the JP4 trace and insert an ammeter between the JP4 terminals. You may also install your choice of resistor at R9 and measure voltage across it to determine the current.
12. **Node ID**: This unique serial number is used by the preprogrammed demonstration application firmware to create a unique 64-bit extended Medium Access Control (MAC) address. The extended MAC address of the board can be changed by either serial configuration or by modifying firmware.
13. **Revision Level Indicator** (Back Side): The text on the solder side of the board indicates the hardware revision level.

1.6 PICDEM Z RF CARD

The PICDEM Z motherboard is designed to support RF cards using RF transceivers from various vendors. Microchip is planning to add support for new RF transceivers. Please check the Microchip web site for the list of supported RF transceivers. You may find details of an individual RF card in its respective user's guide document.

See **Appendix B. "PICDEM Z 2.4 GHz RF Card"** for information on the RF cards supplied in your PICDEM Z Demonstration Kit.

1.7 PICDEM Z SOFTWARE CD

The CD provides the complete source code for the Microchip Stack for the ZigBee protocol. It also includes two demo applications based on the Microchip Stack.

You may download the latest version of the Microchip Stack from the Application Design Center at the Microchip web site.

Chapter 2. Getting Started with the PICDEM Z Demonstration Kit

2.1 INTRODUCTION

Topics covered in this chapter include:

- Host Computer Requirements
- Using the PICDEM Z Boards for the First Time
- Executing Preprogrammed Demo Applications

2.2 HOST COMPUTER REQUIREMENTS

The preprogrammed demo applications do not require the host computer to observe the functionality. However, a host computer is required if you want to change the default demo application configuration.

To change the default demo application configuration, you must have a system that meets the following hardware and software requirements:

- Any computer system with one available standard serial port (DB9)
- Any operating system that provides a standard RS-232 terminal program using the available hardware serial port

The PICDEM Z Demonstration Kit includes a CD that contains the complete source code for both demo applications and the Microchip Stack. To view the contents of the CD, modify demo applications or develop your own application, you must have a system that meets Microchip MPLAB system requirements. Please visit the Microchip web site for up-to-date system requirements and to download the Microchip MPLAB software.

2.3 USING THE PICDEM Z BOARDS FOR THE FIRST TIME

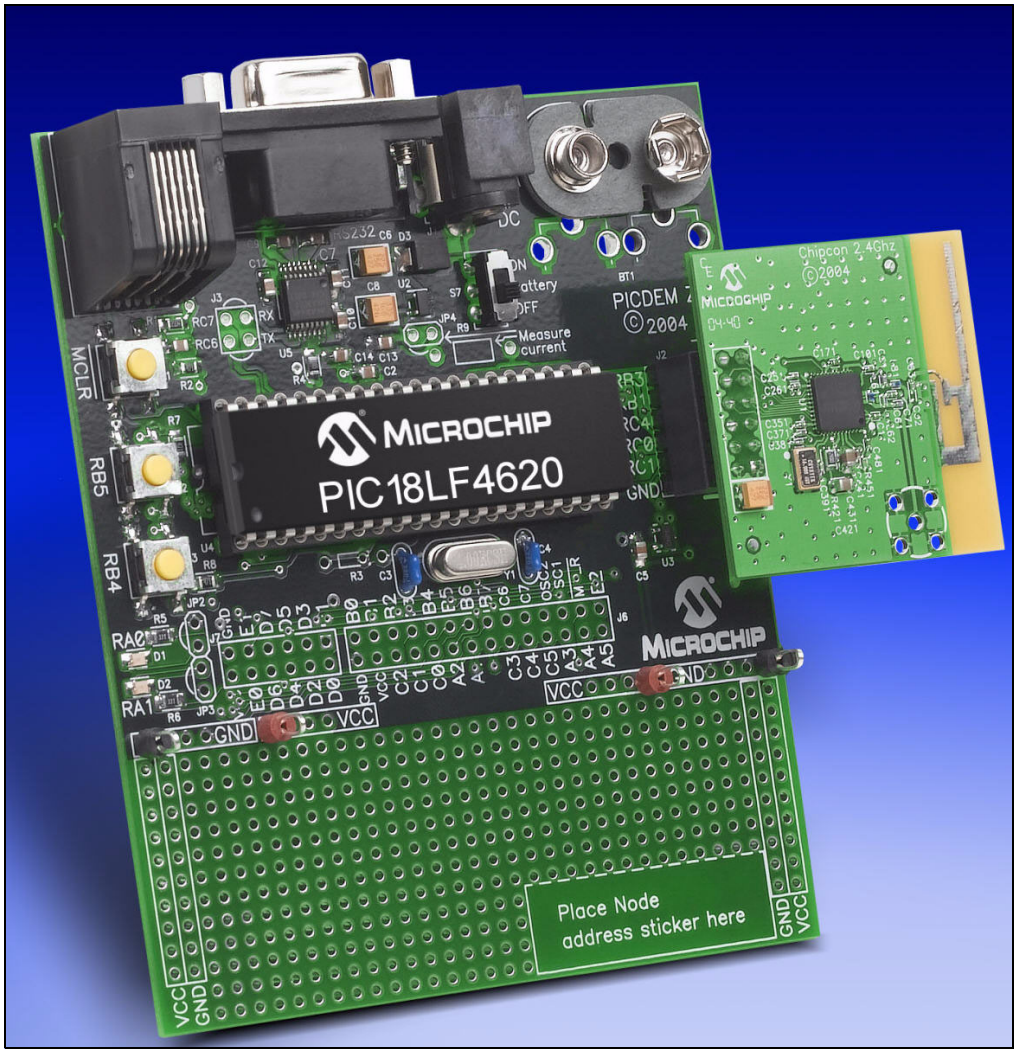
2.3.1 Assembling PICDEM Z Nodes

The PICDEM Z Demonstration Kit consists of two ZigBee node boards. Each node consists of one motherboard and one RF card packaged separately. You must assemble each node before applying power.

Perform the following steps to prepare each node:

1. Unbox and unwrap each board and place on a non-conductive surface.
2. Carefully plug the RF card into the J2 connector on the motherboard. Note that the connectors on the motherboard and the RF card are polarized and will not allow incorrect insertion.
3. If you have a 9V DC power supply with a 2.5 mm plug, power-up the board. If not, connect one of the supplied 9V batteries to the BT1 connector and slide switch S7 to the ON position. Observe that LEDs D1 and D2 have flashed. This confirms that the boards are working properly.

FIGURE 2-1: MOTHERBOARD AND RF CARD CONNECTION



2.3.2 Installing PICDEM Z Software Files

The PICDEM Z Demonstration Kit contains the complete source code for the Microchip Stack for the ZigBee protocol and demo applications. The Microchip Stack for the ZigBee protocol is available free-of-charge to Microchip customers. As part of the installation process, you must accept a no-cost electronic software license to continue installation.

To install the files:

1. Insert the PICDEM Z software CD into your system's CD-ROM drive.
2. Using Windows Explorer, open the CD and start the installation process by double-clicking the `MpZBeev1.00.00.exe` icon. The version number may change as new versions are made available.
3. When presented, review the software license agreement and click **I accept** to accept the license agreement and continue the installation process. If you decide to click **I do not accept**, the installation will terminate.
4. After successful completion, a new program group named "Microchip Stack for ZigBee" will be created and all source files will be copied to the "MpZBee" directory on the root drive of your computer. This program group provides shortcuts for all of the documents.

2.4 EXECUTING PREPROGRAMMED DEMO APPLICATIONS

In order to observe full functionality of the demo applications, you must have one demo Coordinator node and one demo RFD node with similar RF cards. As discussed later in this document, you may reconfigure boards such that you may use more than one RFD node.

The preprogrammed demo Coordinator and RFD applications implement a custom remote control switch and LED application. For more information about these demo applications, please refer to the Microchip application note AN965, *Microchip Stack for the ZigBee™ Protocol* (DS00965).

The demo applications are completely stand-alone and do not require an interface to a host computer. However, if you have access to a host computer, you may use it to observe the activity logs of the applications. An interface to a host computer is useful to understand and troubleshoot any setup issues you might have.

Do the following to execute a preprogrammed demo application:

1. Make sure that you have assembled each node by plugging the RF card into the motherboard.
2. Remove power from both boards, if it was previously applied.
3. Locate the Coordinator node by looking for the “COORD…” label on the controller.
4. **Optional**: Connect the Coordinator node to a PC serial port and launch your favorite terminal program. Select the appropriate COM port and set it to 19200 bps, 8-N-1, no flow control.
5. Apply power to the Coordinator node. Observe that both D1 and D2 flash simultaneously, followed by D2 flashing by itself. If connected to a PC, observe that the terminal program displays the message “`New network successfully started`”.
6. Now locate the RFD node by looking for the “RFD…” label on the controller.
7. **Optional**: Connect the RFD node to a PC serial port and launch your favorite terminal program. Select the appropriate COM port and set it to 19200 bps, 8-N-1, no flow control.
8. While keeping the Coordinator node still powered, apply power to the RFD node. Observe that both LEDs D1 and D2 flash simultaneously, followed by multiple flashes of D2. If connected to a PC, observe that in one to two seconds, the terminal program displays the message “`Rejoin successful`”. If you do not see any message or see the message “`Rejoin failed`”, make sure that you have the Coordinator node powered and running properly; reset the RFD node and try again.
9. At this point, the RFD node has successfully associated with the Coordinator node.
10. Press S2 on the RFD node and observe that D1 on the Coordinator node switches on/off.
11. Press S2 on the Coordinator and observe that D1 on the RFD node switches on/off. When you press S2 on the Coordinator, the D1 on the RFD node will toggle after few moments. This delay occurs due to the frequency at which the RFD node polls the Coordinator node.

Note: The actual radio range for the PICDEM Z nodes depends on the type of RF card and antenna in use. Please refer to the user’s guide of the respective RF card for range information.

NOTES:

Chapter 3. Experimenting with the PICDEM Z Demonstration Kit

3.1 INTRODUCTION

Topics covered in this chapter include:

- Modifying Demo Application Configurations
- Testing RF Performance
- Modifying the Hardware Configuration
- Developing Your Application
- Creating Your Application Source File

3.2 MODIFYING DEMO APPLICATION CONFIGURATIONS

The preprogrammed demo applications are factory configured with certain configurations such as node identifier, network association and binding information. If required, you may easily change these configurations through a PC running a standard RS-232 terminal program or via a stand-alone binding process.

The Demo Coordinator and Demo RFD applications use a similar terminal interface with minor differences in available configuration options. Some of the options require the use of standard terminal software, while other options are performed by a sequence of switch presses without the need for terminal software. To be able to perform the terminal-dependent steps, you must have access to at least one RS-232 (DB9, male-to-female) cable, a host computer with at least one serial port available and a standard serial terminal program.

3.2.1 Modifying Node ID Values

As specified in the IEEE 802.15.4 specification, each ZigBee node must contain a unique 64-bit MAC address value. One part of the 64-bit address consists of a 24-bit IEEE assigned Organization Unique Identifier (OUI) and the other a 40-bit organization assigned number. The PICDEM Z demo applications create a complete MAC address by combining the Microchip OUI of `00-04-a3` and zero padded 16-bits of the node ID value label found on the board. The node ID value is stored in the microcontroller Flash memory. The PICDEM Z boards are factory-configured with their respective node ID values. If required, you may easily change the node ID values by performing the steps that follow.

Note: The following procedure assumes that you are using the Microsoft HyperTerminal program. You may use any terminal program of your choice provided the required port settings are set.

Perform the following steps to modify a Node ID value:

1. Connect a PICDEM Z node to an available serial port on the computer, using a straight male-to-female DB9 RS-232 cable.
2. Launch HyperTerminal (*Start>Programs>Accessories>Communications*).
3. In the "Connection Description" dialog box, enter any convenient name for the connection, then click **OK**.
4. In the "Connect To" dialog box, select the COM port that the PICDEM Z board is connected to. Click **OK**.
5. Configure the serial port connected to the PICDEM Z node with these settings: 19200 bps, 8 data bits, 1 Stop bit, and no parity, no flow control
6. Click **OK** to initiate the connection.
7. Open the "Properties" dialog box by selecting *File>Properties*.
8. Select the "Settings" tab and click **ASCII Setup…**.
9. Check "Echo typed characters locally".
10. Click **OK** to close all open dialog boxes.
11. Apply power to the node while holding the S3 switch, or press and hold both Reset and S3 switches; then release the Reset switch.

    The following configuration menu would appear in the terminal window (Exact header text would depend on the type of node you are trying to reconfigure and date of build):

```
*******************************************************************************
ZigBee Demo RFD Application v1.0 (Microchip Stack for ZigBee v1.0.0)
    Built on Nov 11 2004
*******************************************************************************
    1. Set node ID...
    2. Join a network.
    3. Perform quick demo binding (Must perform #2 first)
    4. Leave a previously joined network (Must perform #2 first)
    5. Change to next channel.
    6. Transmit unmodulated signal.
    7. Transmit random modulated signal.
    0. Save changes and exit.

Enter a menu choice:
```

12. Type **1** to change the Node ID value.
13. Follow the instructions to enter the Node ID value.
14. Press the Reset switch on the node or type **0** to exit configuration mode and run the application.

3.2.2 Modifying Association and Binding Configurations

The PICDEM Z nodes are factory-configured with the following settings:

1. The demo RFD node is associated with the demo Coordinator node.
2. Switch S2 on the demo RFD node is bound to LED D1 on the demo Coordinator node.
3. Switch S2 on the demo Coordinator node is bound to LED D1 on the demo RFD node.

It is these configurations that allow you to press S2 on one node and control LED D1 on the other node. If required, you may easily modify these configurations using the custom binding procedure implemented in the demo applications. For example, you may bind S2 on RFD node to D1 on the same node or on another RFD node (assuming that you have more than one RFD node).

Although the following procedure does not require a PC, you may use one to observe the setup messages displayed by the demo applications. These messages are useful to understand and troubleshoot setup issues. You may view the setup messages using a terminal program set to 19200 bps, 8-N-1, no flow control.

Do the following to modify association and binding configurations:

1. Remove power from all nodes.
2. Apply power to the Coordinator node (a node with a “COORD…” label on its controller) without pressing any switches, or if already powered, simply reset the board by pressing the Reset switch. This puts the demo Coordinator node in the normal mode of operation. Observe that D1 and D2 flash momentarily followed by a brief flash of D2. If connected to a terminal program, note that the message “`New network successfully started`” is displayed. If you see an error message, it means that the demo Coordinator could not find an empty RF channel.
3. While keeping the Coordinator node powered up, apply power to the RFD node (a node with the “RFD…” label on its controller) while holding the S3 switch, or press and hold both the Reset and S3 switches; then release the Reset switch. Observe that D1 and D2 are on. If connected to a terminal program, note that the configuration menu is displayed.
4. If you have more than one RFD node, you may continue step 3 for each RFD node.
5. Press S2 on the RFD node to begin the association sequence with the Coordinator. If connected to a terminal program, note that the message “`Successfully associated`” is displayed. If you do not see this message, make sure that the demo Coordinator node is powered and running in normal mode. If your computer has two serial ports and the demo Coordinator node is still connected to the computer, note that the terminal displays the message “`A new node has just joined`”.
6. If you have more than one RFD node, press S2 on each RFD node to associate them to the Coordinator node.
7. Since there are many different possible combinations of binding a configuration, Table 3-1 is used to describe the necessary sequence of steps for each combination:

TABLE 3-1: STEPS FOR BINDING A CONFIGURATION

To Bind Switch S2 On	To Bind LED D1 On	Result
RFD: Press and hold S3 first then press S2 and release S2, followed by S3	**Coordinator**: Press and hold S3 first then press S2 and release S3, followed by S2	S3 on RFD is bound to D1 on Coordinator
Coordinator: Press and hold S3 first then press S2 and release S2, followed by S3	**RFD**: Press and hold S3 first then press S2 and release S3, followed by S2	S3 on Coordinator is bound to D1 on RFD
RFD: Press and hold S3 first then press S2 and release S2, followed by S3	**RFD**: Press and hold S3 first then press S2 and release S3, followed by S2	S3 on RFD is bound to D1 on same RFD
RFD1: Press and hold S3 first then press S2 and release S2, followed by S3	**RFD2**: Press and hold S3 first then press S2 and release S3, followed by S2	S3 on RFD #1 is bound to D1 on RFD #2
Coordinator: N/A	**Coordinator**: N/A	Not allowed

Note: As each step is performed, LEDs D1 and D2 on the respective node will be toggled between on and off, to off and on. Also note that the terminal program connected to the RFD node displays the message "`Attempting to bind...`" and the terminal connected to the Coordinator node displays the "`Received valid...`" message.

To complete the binding process, you must perform both "To Bind Switch S2 On" and "To Bind LED D1 On" actions.

8. Press the Reset switch on each RFD node to begin normal execution. If connected to a terminal program, note that the message "`Rejoin successful`" is displayed.
9. Depending on how binding was performed, press S2 on one node to confirm that D1 on the same or other node toggles.

Note: To successfully control D1 on the same or other node, the Coordinator node must be powered and running in normal mode.

3.2.3 Clearing Entire Neighbor and Binding Table

As specified in the ZigBee protocol specification, the Coordinator stores all association and binding information in separate tables in its local memory. The Microchip demo Coordinator application uses on-chip Flash memory to store this information.

You may either erase an individual association and binding entry or an entire table. To erase the entire table on the demo Coordinator, perform the following steps:

1. Remove power from all nodes.
2. Connect the Coordinator node to a PC using a standard RS-232 cable.
3. Launch a terminal program on the PC and open the appropriate COM port with these settings: 19200 bps, 8-N-1, and no flow control.
4. Apply power to the Coordinator node (the node with “COORD…” label on its controller) while holding the S3 switch, or press and hold both the Reset and S3 switches, then release the Reset switch. Observe that D1 and D2 are on. Note that the terminal program displays following configuration menu:

```
********************************************************************************
ZigBee Demo Coordinator Application v1.0 (Microchip Stack for ZigBee v1.0.0)
    Built on Nov 11 2004
********************************************************************************
    1. Set node ID...
    2. Clear Neighbor Table.
    3. Clear Binding Table.
    4. Change to next channel.
    5. Transmit unmodulated signal.
    6. Transmit random modulated signal.
    0. Save changes and exit.

Enter a menu choice:
```

5. To clear the association table, type **3**. Upon successful completion, the configuration menu will be redisplayed. Note that clearing the association table automatically clears the associated binding table.
6. To clear the binding table, type **4**. Upon successful completion, the configuration menu will be redisplayed.

3.2.4 Clearing Individual Association and Binding Entry

If you want to clear an individual table entry related to a specific RFD node, you must execute a configuration command on that RFD node. To do this, perform the following steps:

1. Remove power from all nodes.
2. Power-up the Coordinator node in normal mode and make sure that LEDs D1 and D2 flash once followed by a single flash of D2.
3. Select the RFD node whose association and binding entry needs to be cleared and connect it to a PC using a standard RS-232 cable.
4. Launch a terminal program on the PC and open the appropriate COM port with these settings: 19200 bps, 8-N-1 and no flow control.
5. Apply power to the RFD node while holding the S3 switch, or press and hold both the Reset and S3 switches; then release the Reset switch. Observe that D1 and D2 are on. Note that the terminal program displays the following configuration menu:

```
*****************************************************************************
ZigBee Demo RFD Application v1.0 (Microchip Stack for ZigBee v1.0.0)
    Built on Nov 11 2004
*****************************************************************************
    1. Set node ID...
    2. Join a network.
    3. Perform quick demo binding (Must perform #2 first)
    4. Leave a previously joined network (Must perform #2 first)
    5. Change to next channel.
    6. Transmit unmodulated signal.
    7. Transmit random modulated signal.
    0. Save changes and exit.

Enter a menu choice:
```

6. Type **2** to first join the already powered and running demo Coordinator node.
7. Type **4** to leave the already powered and running demo Coordinator node. Upon successful completion, the configuration menu will be redisplayed. This step will automatically remove all binding entries associated with this node.

Note: After completing these steps, you must associate and bind this RFD node with your choice of Coordinator to resume normal application operations. Refer to **Section 3.2.2 "Modifying Association and Binding Configurations"** for more information.

3.3 TESTING RF PERFORMANCE

The PICDEM Z demo applications also provide two special menu options to test the RF performance. Menu options **6** and **7** allow you to transmit either a continuous unmodulated signal or a random modulated signal.

Perform the following steps:

1. Remove power from all nodes.
2. Connect the node to a PC using a standard RS-232 cable.
3. Launch a terminal program on the PC and open the appropriate COM port with these settings: 19200 bps, 8-N-1, and no flow control.
4. Power-up the node while holding the S3 switch, or press and hold both the Reset and S3 switches, then release the Reset switch. Observe that D1 and D2 are on. Note that the terminal program displays following configuration menu (Exact header text would depend on the type of node you are trying to test):

```
*****************************************************************************
ZigBee Demo RFD Application v1.0 (Microchip Stack for ZigBee v1.0.0)
    Built on Nov 11 2004
*****************************************************************************
    1. Set node ID...
    2. Join a network.
    3. Perform quick demo binding (Must perform #2 first)
    4. Leave a previously joined network (Must perform #2 first)
    5. Change to next channel.
    6. Transmit unmodulated signal.
    7. Transmit random modulated signal.
    0. Save changes and exit.

Enter a menu choice:
```

5. On power-up, the demo application selects the very first channel available in the RF transceiver specific band. For example, for the 2.4 GHz frequency band, on power-up, channel 11 is selected. You may change to the next channel by selecting the "`Change to next channel`" option repeatedly until you reach the desired channel. Note that the demo application does not display any channel number information. You must count the number of times the menu option is typed.
6. Type **6** (or **5** if testing demo Coordinator) to transmit a continuous unmodulated signal, or type **7** (or **6** if testing demo Coordinator) to transmit a continuous random modulated signal. You may now use any standard RF network analyzer to evaluate the RF performance.
7. Once you select either test option, you must reset the board to perform any other action.

3.4 MODIFYING THE HARDWARE CONFIGURATION

The PICDEM Z boards are designed to be flexible in terms of enabling/disabling on-board components and adding your own circuit.

Jumper	Purpose
J2	To connect/disconnect on-board RS-232 driver to PICmicro (RC7 and RC6 are shorted via PCB trace to RX and TX respectively)
JP2	To enable/disable D1 LED (Factory enabled by PCB trace shorts)
JP3	Enable/Disable D2 LED (Factory enabled by PCB trace shorts)
JP4	To measure current draw of entire board (Factory shorted via PCB trace)

3.5 DEVELOPING YOUR APPLICATION

The PICDEM Z kit is shipped with complete source files for the Microchip Stack for the ZigBee protocol. Please refer to the Microchip application note AN965 (DS00965) for detailed information. Microchip is committed to continually improve and add new features to the existing version of the Microchip Stack. Please check the Microchip web site for the latest revision of the Microchip Stack source files.

3.6 CREATING YOUR APPLICATION SOURCE FILE

The Microchip Stack includes source files for both the demo Coordinator and RFD applications. You may either modify one of the demo applications to suit your application or use them as a reference to create your application. Please refer to the Microchip application note AN965 (DS00965) for detailed instructions on how to create your own application.

3.6.1 Programming Your Application

Once you have developed your application, you must program it into one of the PICDEM Z nodes. To facilitate easy identification of the Coordinator and RFD node, it is recommended that you program your Coordinator and RFD application into the respective node only. However, note that all PICDEM Z motherboards are exactly the same and can be programmed to run Coordinator, RFD or FFD applications.

The PICDEM Z kit does not include the tools for clearing and reprogramming the microcontroller. To do this, you must use an appropriate device programmer. You may also use the MPLAB ICD 2 Development System, which provides a complete development suite for device debugging and programming. The PICDEM Z motherboard contains a modular connector to connect MPLAB ICD 2, PRO MATE and other compatible programmers.

Use the following configuration options when programming the microcontroller:

1. HS-PLL (or HS) Oscillator Mode depending on your application requirement
2. Watchdog Timer Disabled (Demo applications use software enabled Watchdog)
3. Low-Voltage Programming Disabled
4. All other options should be changed as per your requirements

3.6.2 Restoring Demo Firmware

You may restore the original demo firmware by reprogramming and reconfiguring the PICDEM Z node. You may either use the factory built hex file or a rebuilt hex file to program the microcontroller. The factory built hex file is available in the PICDEM Z Software CD.

Use the file `DemoCoordApp.hex` for the Demo Coordinator application, and `DemoRFDApp.hex` for the Demo RFD application. If you want to rebuild the demo firmware, please refer to the Microchip application note AN965 (DS00965) for detailed instructions. The demo firmware is embedded with the necessary PICmicro configuration options appropriate for the PICDEM Z hardware. You must have access to a compatible PICmicro device programmer to program the on-board microcontroller.

Since the configuration information such as node ID, association and binding information are stored in on-chip Flash memory, reprogramming a microcontroller requires that you reconfigure each node before you can observe demo application functionality. A newly programmed board will automatically enter into configuration mode. Refer to **Section 3.2 “Modifying Demo Application Configurations”** for a detailed procedure for reconfiguring the applications.

NOTES:

Chapter 4. Troubleshooting

4.1 INTRODUCTION

This chapter discusses common operational issues and how to resolve them. Topics covered in this chapter include:

- Common Issues

4.2 COMMON ISSUES

1. When I power up a node, the LEDs are not lit or blinking.

   The primary reason for this issue would be the lack of power and/or incorrectly programmed firmware.

   Check the PICDEM Z motherboard for power:

   - If using an external power supply,
     - Verify that the power supply is plugged in and the wall outlet has power.
     - Check the external 9V power plug for correct polarity.
     - Check that voltage is available at the plug.
   - If using a 9V battery,
     - Verify that the battery is fully charged and correctly plugged into BT1.
     - Verify that the battery power switch S7 is set to On.
     - Disconnect the external 9V power plug from the J1 socket.
   - Verify that the on-board microcontroller is programmed correctly with the appropriate hex file. Refer to **Section 3.6.2 "Restoring Demo Firmware"** for details.
   - If you have installed JP2 and JP3 jumpers on the motherboard, make sure that on-board LEDs are enabled by shorting the JP2 and JP3 jumpers.
   - Make sure that the RF card is correctly plugged into the motherboard.
   - Connect the board to a PC terminal program and see if it displays any error messages.

2. A PICDEM Z node does not communicate with the host system.

   The primary reason for this issue would be the lack of power and/or incorrectly programmed firmware.

   - Verify that the on-board microcontroller is programmed correctly with the appropriate hex file. Refer to **Section 3.6.2 "Restoring Demo Firmware"** for details.
   - Make sure that the on-board RS-232 driver is connected to the microcontroller by appropriately shorting the J3 jumper.
   - Make sure that your terminal program is set to use 19200 bps, 8-N-1, no flow control.
   - Make sure that the RF card is correctly plugged into the motherboard.

3. A PICDEM Z node displays the message "`Unexpected reset occurred`" on the terminal.

   The on-board firmware is stuck in some unexpected infinite loop. This may occur if there is a short or open on certain RF card signals, or if there is a programming mistake in the firmware.

   - Verify that the on-board microcontroller is programmed correctly with the appropriate hex file. Refer to **Section 3.6.2 "Restoring Demo Firmware"** for details.
   - Make sure that the RF card is correctly plugged into the motherboard.
   - If you have modified the hardware, make sure that any of the RF card signals are not shorted or open.
   - If you have reprogrammed the firmware, verify that the Watchdog Timer prescaler is set to maximum.
   - Try plugging in a different RF card to eliminate a bad RF card problem.

4. LEDs D1 and D2 on a node blink continually.

   The on-board firmware is stuck in some unexpected infinite loop.

   - See issue #3.

5. Cannot control the LEDs on another node.

   The primary reason for this issue would be that the demo Coordinator is not running and/or the switch is not correctly bound to the target LED.

   - Make sure that on-board LEDs on the node you are controlling are enabled by shorting the JP3 jumper.
   - Make sure that nodes are bound properly using the procedure described in **Section 3.2 "Modifying Demo Application Configurations"**.
   - Make sure that the demo Coordinator is powered and running.
   - Make sure that two nodes are within the radio sphere of the Coordinator.

6. Cannot control the LEDs on the same node.

   The primary reason for this issue would be that the demo Coordinator is not running and/or the switch is not correctly bound to the LED.

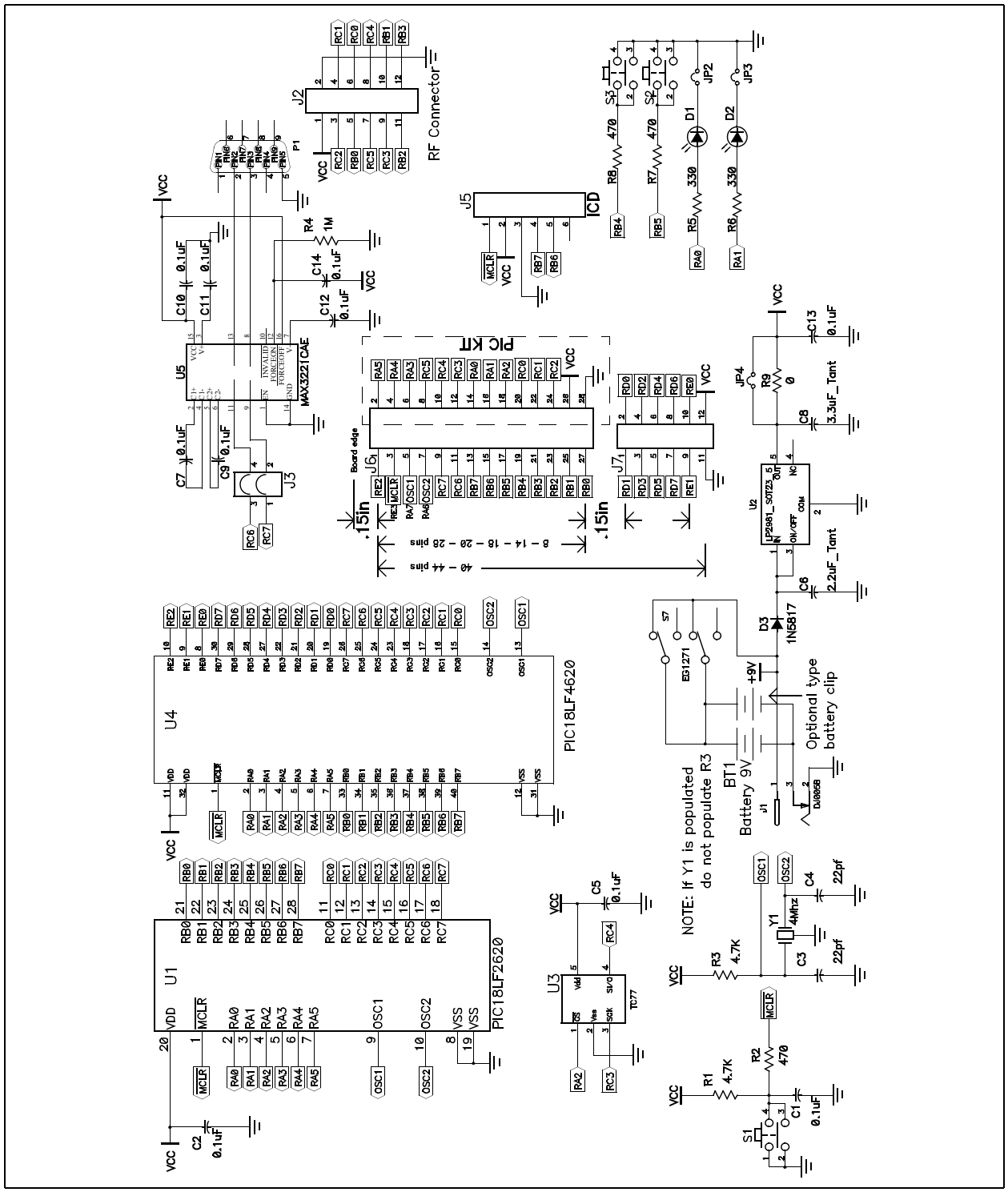
   - Make sure that you have performed the proper binding operation using the procedure described in **Section 3.2 "Modifying Demo Application Configurations"**.
   - Make sure that the demo Coordinator is powered and running.
   - Make sure that the node is within the radio sphere of the Coordinator.
   - Note that binding of the switch and LED on the same Coordinator node is not allowed.

7. RFD node does not associate with the demo Coordinator node.
   - Make sure that both the RFD and the Coordinator are within each other's radio sphere.
   - Make sure that the RFD is put in Configuration mode, and the appropriate Join sequence is performed.

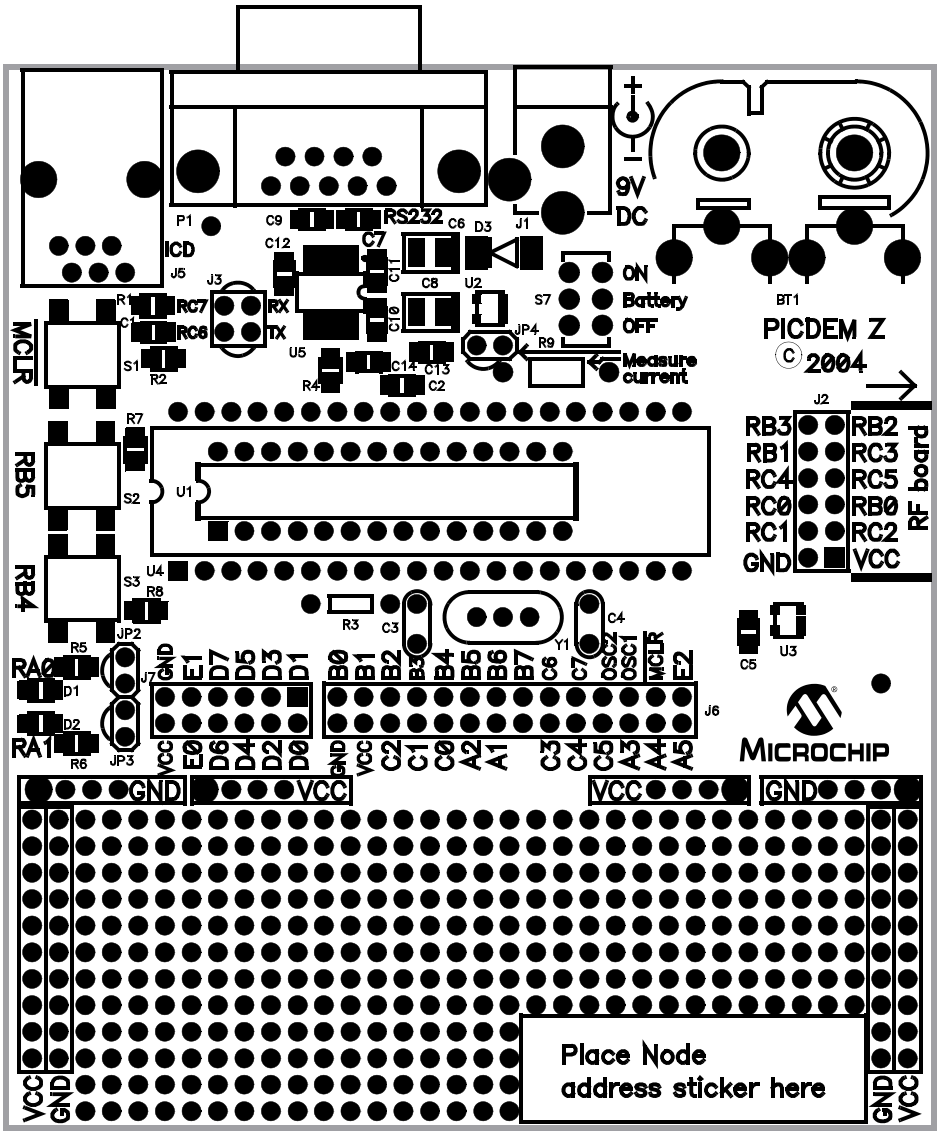
8. RFD node does not rejoin with a demo Coordinator node.
   - Make sure that both the RFD and the demo Coordinator are within each other's radio sphere.
   - Make sure that the RFD node was successfully associated with the Coordinator.
   - Make sure that the demo Coordinator is running in normal mode. Press and release the Reset switch on the demo Coordinator and try again.

Appendix A. PICDEM Z Motherboard Schematics

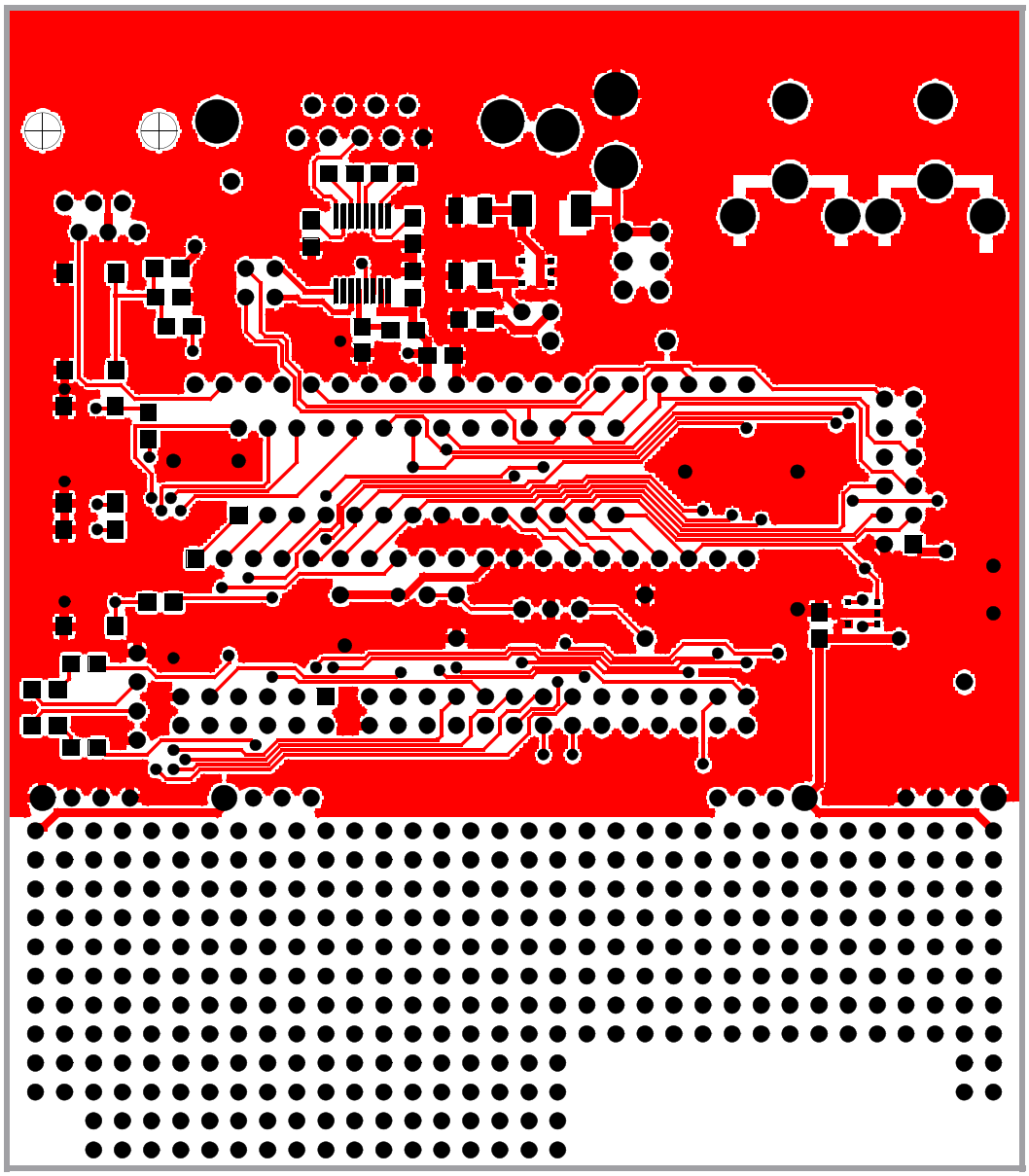
A.1 PICDEM Z MOTHERBOARD



A.2 PICDEM Z MOTHERBOARD TOP ASSEMBLY



A.3 PICDEM Z MOTHERBOARD LAYER 1



A.4 PICDEM Z MOTHERBOARD LAYER 2

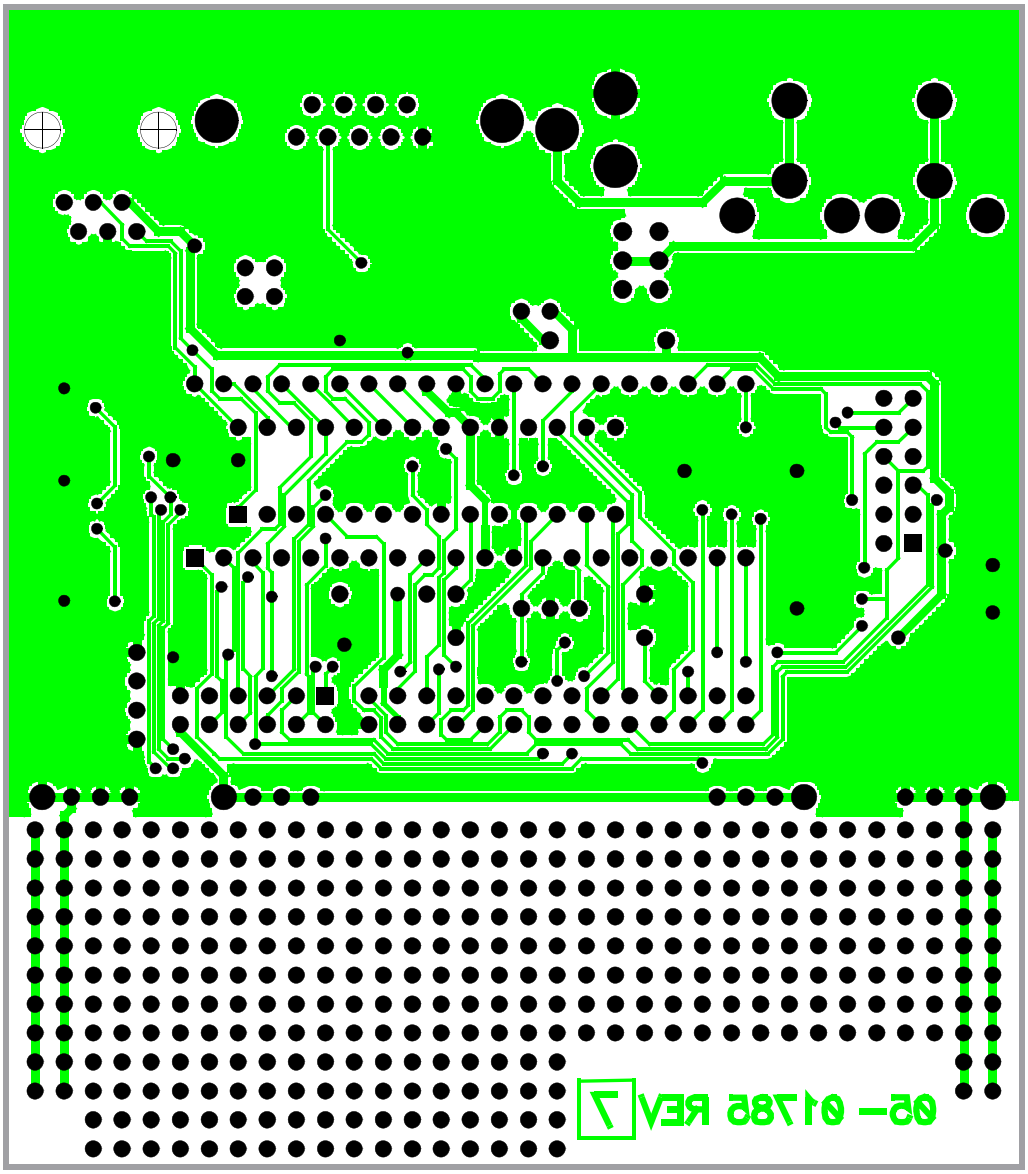


TABLE A-1: PICDEM Z MOTHERBOARD BILL OF MATERIALS (BOM)

Reference	Description	Vendor	Vendor P/N
D3	Diode Schottky 20V 1A SMD MELF	Diodes Inc.	1N5817M-13
BT1	Conn Batt Male 9V Horz Snap-on	Keystone Electronics	593
BT1	Conn Batt Fem 9V Horz Snap-on	Keystone Electronics	594
	Conn PC Vert 9V Snap-on	Keystone Electronics	968
C3, C4	22PF 100V 5% Monolith Cerm Cap	Panasonic - ECG	ECU-S2A220JCA
C1, C2, C5, C7, C9, C10, C11, C12, C13, C14	Cap .1UF 16V Ceramic X7R 0805	Panasonic - ECG	ECJ-2VB1C104K
C6	Capacitor Tant 2.2UF 25V 10% SMD	Kemet	T491B225K025AS
C8	Capacitor Tant 3.3UF 16V 10% SMD	Kemet	T491B335K016AS
Y1	Crystal 4.000 MHZ 20PF HC-49/US	ECS Inc.	ECS-40-20-4
P1	DB9 F		
J1	Conn Powerjack Mini .1" R/A PCMT	Switchcraft Inc.	RAPC712
J3			
J2	2 x 6 .100" Socket/Terminal	Samtec	LST-106-07-F-D
JP2, JP3, JP4			
D1, D2	LED Thin 565NM Grn Diff 0805 SMD	Lumex Opto	SML-LXT0805GW-TR
U2	IC Reg LDO Micropower SOT23-5	National Semiconductor	LP2981AIM5-3.3
U5		Maxim	MAX3221CAE
U1	28-pin Socket	Mill-Max	110-99-328-41-001
U4	40-pin Socket (needs to have no internal ribs)	Mill-Max	110-99-640-41-001
U4	PICmicro® MCU	Microchip	PIC18LF4620-I/P
R3	No Load		
R5, R6	Res 330 OHM 1/8W 5% 0805 SMD	Yageo America	9C08052A3300JLHFT
R2, R7, R8	Res 470 OHM 1/8W 5% 0805 SMD	Yageo America	9C08052A4700JLHFT
R1	Res 4.7K OHM 1/8W 5% 0805 SMD	Yageo America	9C08052A4701JLHFT
R4	Res 1.0M OHM 1/8W 5% 0805 SMD	Yageo America	9C08052A1004JLHFT
J5	Conn Mod Jack 6-6 R/A PCB 50AU	AMP/Tyco	520470-3
S1, S2, S3	Switch Tact 6MM SMD MOM 230GF	Omron Electronics	B3S-1002
S7	Switch Slide SPDT PC MNT L=2MM	E-Switch, Inc.	EG1271
U3	IC Sensor Thermal SPI 3.3V SOT235	Microchip	TC77-3.3MCTTR
	Test Point PC Multi Purpose Blk	Keystone Electronics	5011
	Test Point PC Multi Purpose Red	Keystone Electronics	5010

NOTES:

Appendix B. PICDEM Z 2.4 GHz RF Card

B.1 INTRODUCTION

This appendix presents an overview of the features and requirements of the PICDEM Z 2.4 GHz RF card. Topics covered in this appendix include:

- What is the PICDEM Z 2.4 GHz RF Card?
- PICDEM Z 2.4 GHz RF Card Kit Components
- Overview of the PICDEM Z 2.4 GHz RF Card
- The PICDEM Z 2.4 GHz RF Card Features
- The PICDEM Z Software
- Getting Started with the PICDEM Z 2.4 GHz RF Card
- PICDEM Z 2.4 GHz RF Card Schematics
- PICDEM Z 2.4 GHz RF Card Top Assembly
- PICDEM Z 2.4 GHz RF Card PCB Layer 1
- PICDEM Z 2.4 GHz RF Card PCB Layer 2
- PICDEM Z 2.4 GHz RF Card PCB Layer 3
- PICDEM Z 2.4 GHz RF Card PCB Layer 4
- PICDEM Z 2.4 GHz RF Card Bill of Materials (BOM)

B.2 WHAT IS THE PICDEM Z 2.4 GHz RF CARD?

The PICDEM Z 2.4 GHz RF card is designed to plug into a PICDEM Z motherboard. This board uses the CC2420 RF 2.4 GHz transceiver manufactured by Chipcon. The CC2420 is an IEEE 802.15.4 compatible RF transceiver for the 2.4 GHz band. Please refer to www.chipcon.com for more information on the CC2420 RF transceiver.

The PICDEM Z 2.4 GHz RF card uses a PCB trace antenna. If required, the card may be easily modified to use a standard monopole antenna. The RF schematic and PCB design are a straight adoption of the CC2420 reference design published by Chipcon.

B.3 PICDEM Z 2.4 GHz RF CARD KIT COMPONENTS

The PICDEM Z 2.4 GHz RF card is designed to be part of the PICDEM Z Demonstration Kit.

Your PICDEM Z 2.4 GHz RF Card Kit contains the following items:

1. One PICDEM Z 2.4 GHz RF card
2. A warranty registration card

You may download the complete schematic and PCB design files from the Microchip web site.

B.4 OVERVIEW OF THE PICDEM Z 2.4 GHz RF CARD

The PICDEM Z 2.4 GHz RF card is designed to demonstrate the Microchip solution for the ZigBee protocol for the 2.4 GHz frequency band. All design files related to the RF card are available from the Microchip web site. You may use this board directly in your design or plug it into a PICDEM Z motherboard to complete the ZigBee node. The current version of the Microchip Stack for the ZigBee Protocol provides the necessary software to support this card.

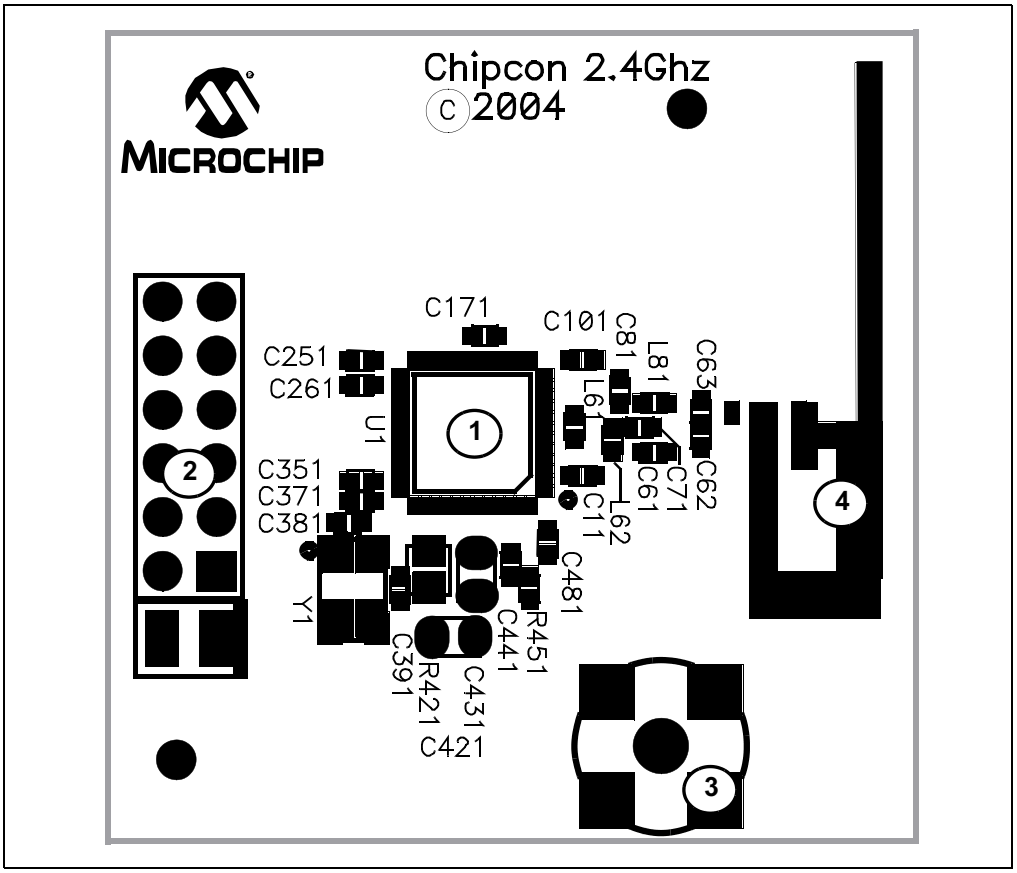
FIGURE B-1: PICDEM Z 2.4 GHz RF CARD

B.5 THE PICDEM Z 2.4 GHz RF CARD FEATURES

The PICDEM Z 2.4 GHz RF card is designed to use the CC2420 RF transceiver. The CC2420 is an IEEE 802.15.4 compliant RF transceiver in the 2.4 GHz frequency band. The card provides a 2-row header to connect to a PICDEM Z motherboard.

The current version of the PICDEM Z 2.4 GHz RF card with on-board PCB trace antenna was found to provide a line sight radio range of about 200 ft. Exact range depends on many factors, including but not limited to obstacles, PCB and antenna design. Microchip has not characterized the RF performance of the Chipcon CC2420 transceiver. For more information about RF characteristics, please refer to Chipcon web site.

FIGURE B-2: PICDEM Z 2.4 GHz RF CARD



Features on the PICDEM Z 2.4 GHz RF card include:

1. **RF Transceiver** (U1): 48-pin QLP packaged CC2420 RF transceiver. This chip implements complete PHY and part of the MAC layer.
2. **RF Board Connector** (J2): This connector is used to connect to the PICDEM Z motherboard. This connector includes +3.3V DC, an SPI bus, and a few discrete digital I/O control signals.
3. **Optional SMA Connector** (P5): This is an optional connector to use with an external antenna. You must remove C63 and install C62 to connect P5 to the transceiver. This connector is designed to accept a mini-SMA connector.
4. **PCB Antenna**: This is the inverted F-type PCB antenna, which is adopted from the Chipcon CC2420 DBK board design. Refer to Chipcon's CC2420DBK User Manual (available for download from the Chipcon web site) for more information.
5. **Revision Level Indicator** (back side): The text on the solder side of the board indicates the hardware revision level.

B.6 THE PICDEM Z SOFTWARE

You may download the latest version of the PICDEM Z software from the Microchip web site.

B.7 GETTING STARTED WITH THE PICDEM Z 2.4 GHZ RF CARD

B.7.1 Introduction

This section covers the following topics:

- Motherboard Requirements
- Using the PICDEM Z 2.4 GHz RF Card for the First Time

B.7.2 Motherboard Requirements

The PICDEM Z 2.4 GHz RF card is designed for use with a PICDEM Z motherboard or similar board. If you are planning to use the RF card with your custom board, use the PICDEM Z motherboard schematic as a reference (see **Section A.1 "PICDEM Z Motherboard"**).

B.7.3 Using the PICDEM Z 2.4 GHz RF Card for the First Time

The PICDEM Z 2.4 GHz RF card must be properly plugged into the PICDEM Z motherboard to complete the setup. Refer to Figure 2-1 for an example.

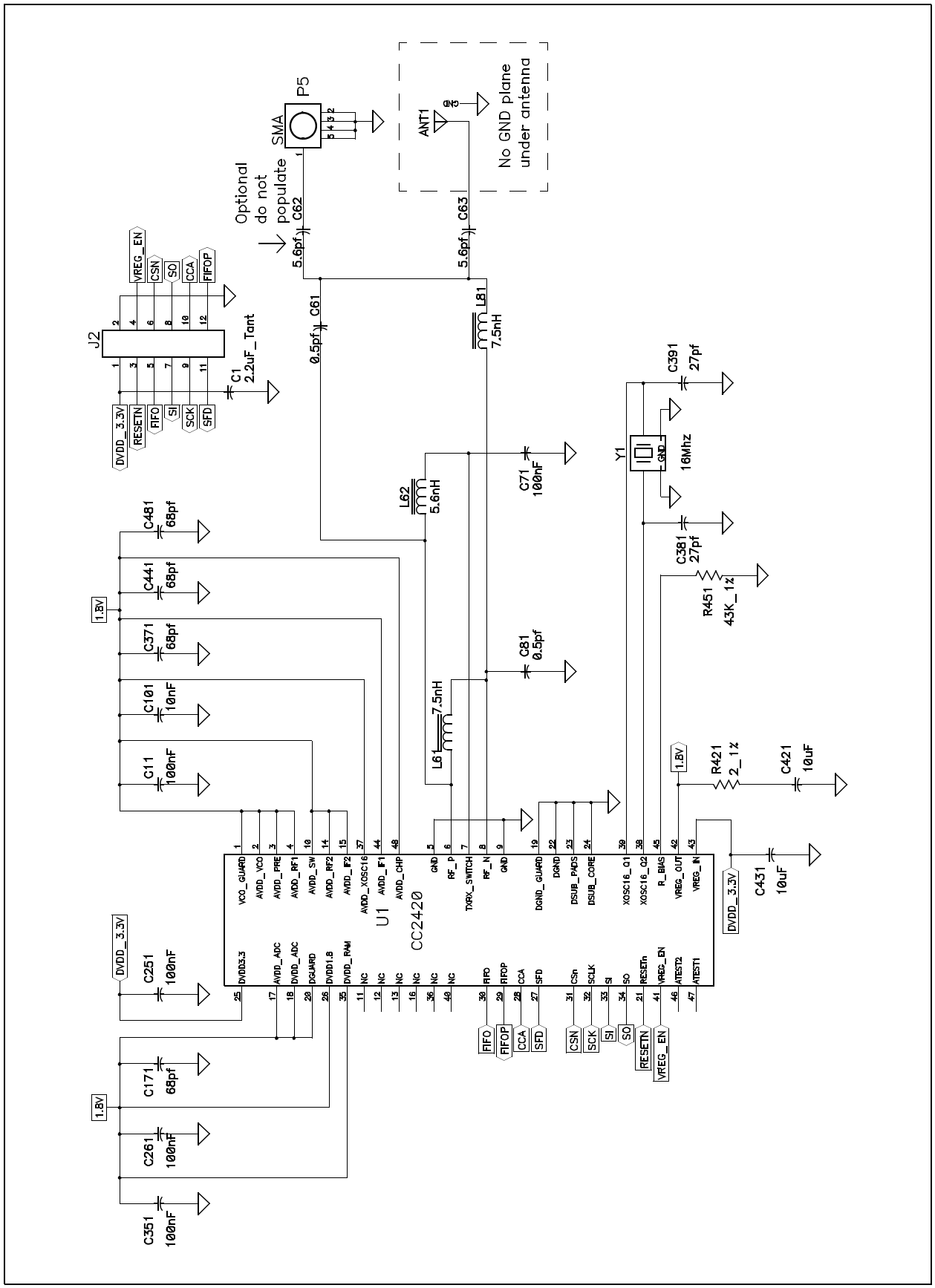
Perform the following steps to prepare each node:

1. Remove from box and unwrap each board and place on a non-conductive surface.
2. Carefully plug the PICDEM Z 2.4 GHz RF card into the J2 connector on the main board. Note that the connectors on the main board and RF card are polarized and will not allow incorrect insertion.
3. Power the PICDEM Z motherboard. Observe that LEDs D1 and D2 have flashed. This confirms that the boards are working properly.

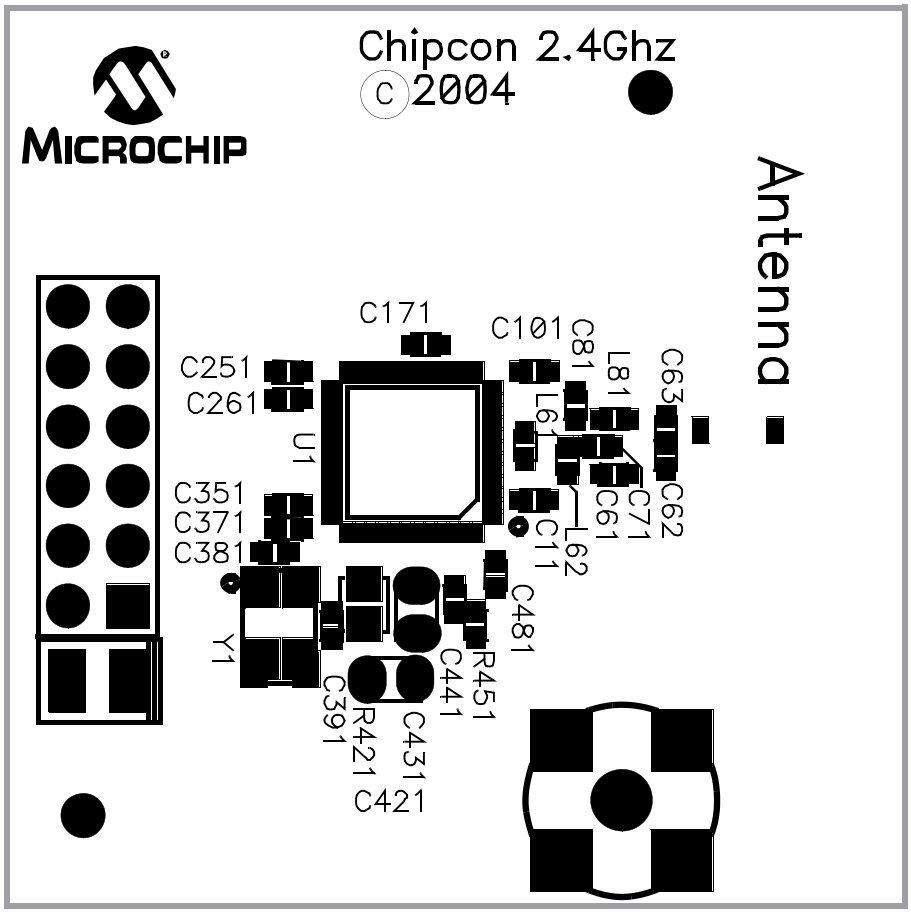
Note: Before transmitting an RF signal, check with your local telecommunication authorities to ensure that no restriction on the use of the 2400-2483.5 MHz ISM band is in effect.

The CC2420 operates in the 2.4 GHz frequency band; however, be advised that even though this band is commonly thought of as a world-wide band, some countries do not allow unlicensed operation in this band.

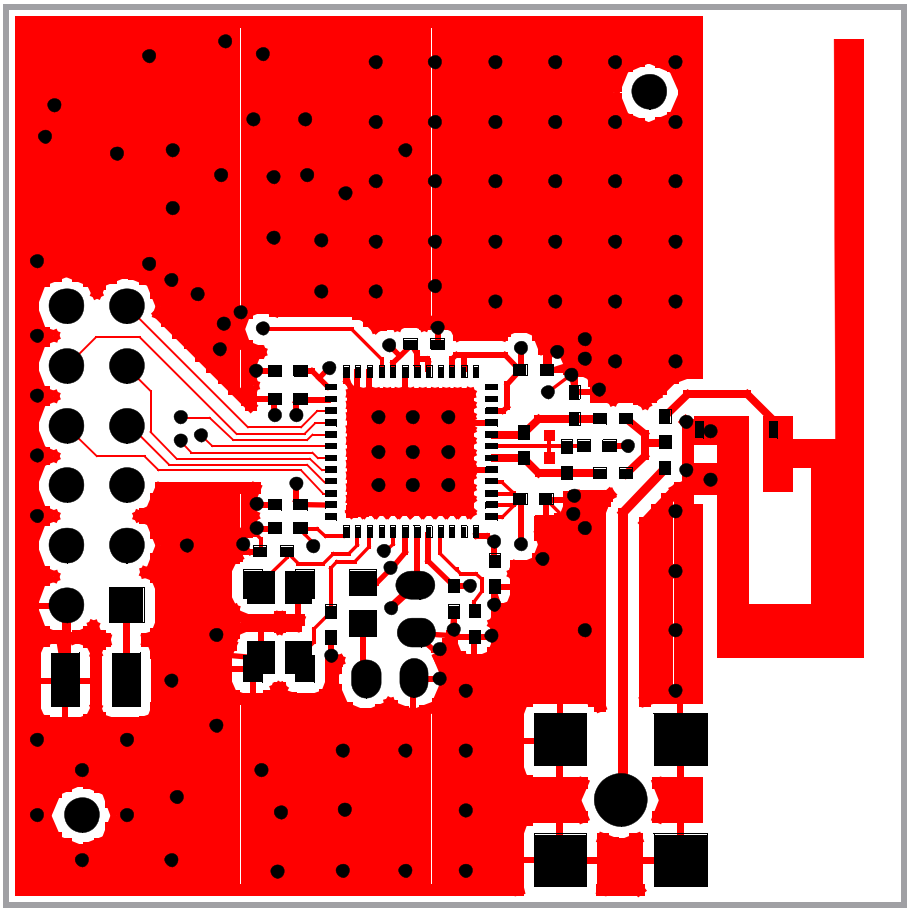
B.8 PICDEM Z 2.4 GHz RF CARD SCHEMATICS



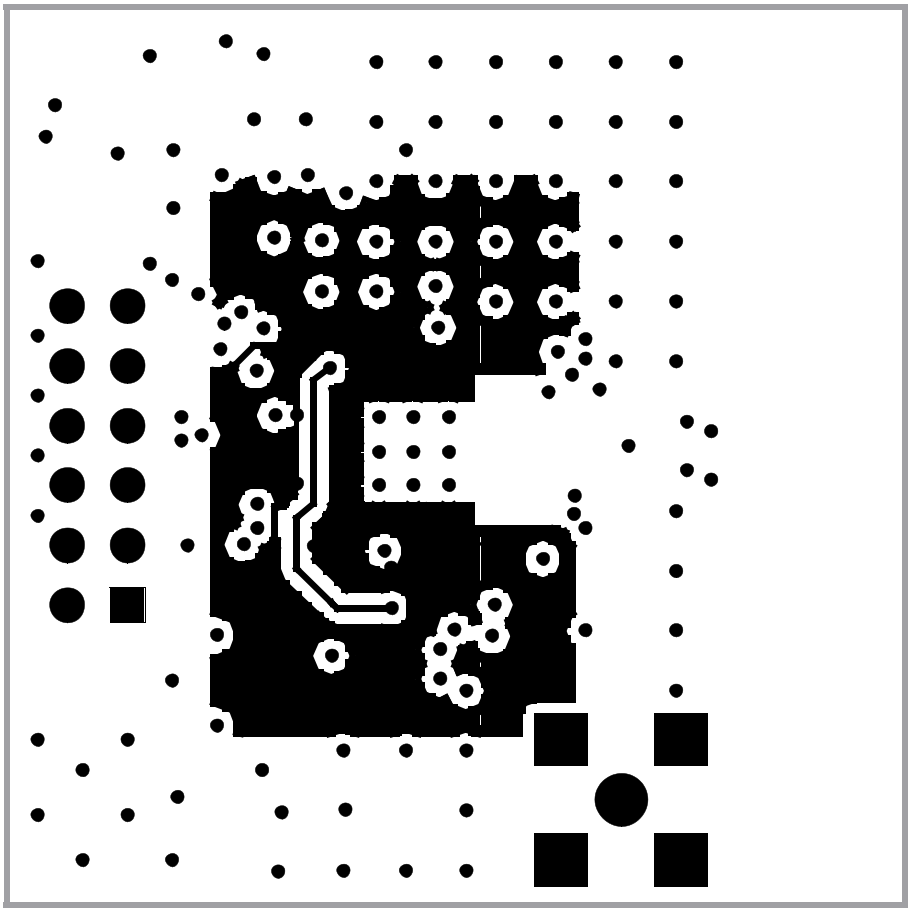
B.9 PICDEM Z 2.4 GHz RF CARD TOP ASSEMBLY



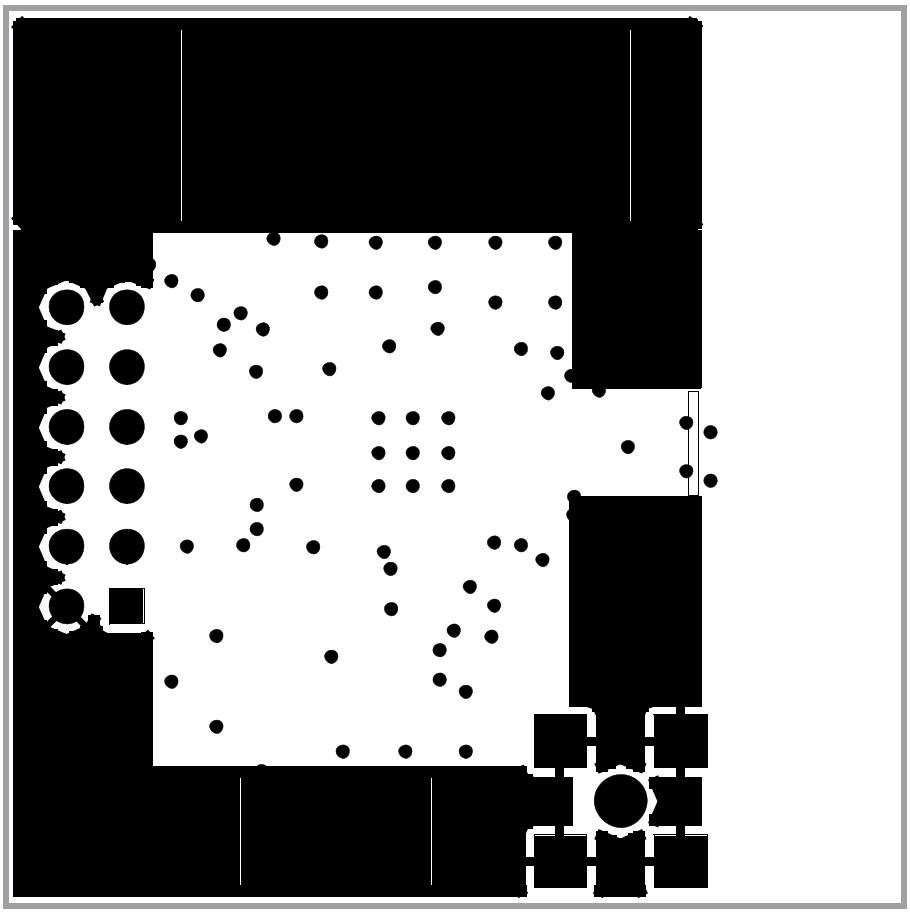
B.10 PICDEM Z 2.4 GHz RF CARD PCB LAYER 1



B.11 PICDEM Z 2.4 GHz RF CARD PCB LAYER 2



B.12 PICDEM Z 2.4 GHz RF CARD PCB LAYER 3



B.13 PICDEM Z 2.4 GHz RF CARD PCB LAYER 4

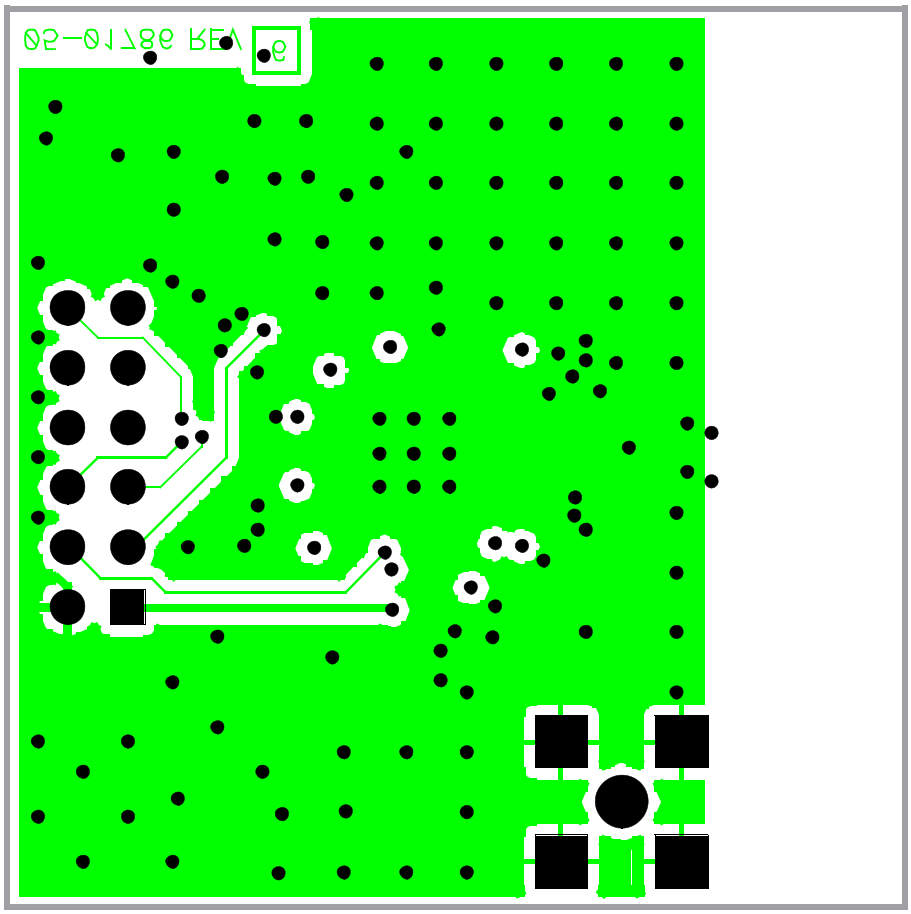


TABLE B-1: PICDEM Z 2.4 GHz RF CARD BILL OF MATERIALS (BOM)

Reference	Description	Vendor	Vendor P/N
C1	Capacitor TANT 2.2UF 25V 10% SMD	Kemet	T491B225K025AS
C61, C81	CAP Ceramic .5PF 50V NP0 0402	Yageo America	0402CG508C9B200
C63	CAP Ceramic 5.6PF 50V NP0 0402	BC Components	0402N5R6D500NT
C62			
C381, C391	CAP Ceramic 22PF 50V NP0 0402	BC Components	0402N220J500NT
C171, C371, C441, C481	CAP 68PF 50V Ceramic 0402 SMD	Panasonic - ECG	ECJ-0EC1H680J
C101	CAP 10000PF 16V Ceramic X7R 0402	Kemet	C0402C103K4RACTU
C11, C71, C251, C261, C351	CAP .10UF 10V Ceramic X5R 0402	Kemet	C0402C104K8PACTU
C421, C431	CAP 10UF 6.3V Ceramic X5R 0805	Panasonic - ECG	ECJ-2FB0J106M
U1	CC2420 Single-chip transceiver	Chipcon	CC2420-STB1 QLP48
L62	Inductor 5.6NH +/-0.2NH 0402	Susumu Co Ltd	HPL1005-5N6
L61, L81	Inductor 7.5NH 570MA 0402	Murata Electronics	LQW15AN7N5J00D
R421	RES 2.00 OHM 1/8W 1% 0805 SMD	Yageo America	9C08052A2R00FGHFT
R451	RES 43.0K OHM 1/16W 1% 0402 SMD	Yageo America	9C04021A4302FLHF3
Y1	Crystal (second vendor)	Crystek	CSX3-AA-1816.000
Y1	Crystal	TOYOCOM	TSX-10A 16M 16pf
J2	.100" Socket/Terminal	Samtec	LST-106-07-F-D
P5	Conn Recept Straight PCB .110" G	Johnson Components	142-0701-231

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