Microchip MRF24W Getting Started Guide for MRF24WB0MA/B, MRF24WG0MA/B for MLA v5

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ISBN: 978-1-62076-981-2

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Object of Declaration: Microchip MRF24W Getting Started Guide for Microchip MRF24WBG0MA/B, MRF24WG0MA/B for MLA v5

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This declaration of conformity is issued by the manufacturer.
The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).
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Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA

Derek Carlson
VP Development Tools

02-May-12
Date

NOTES:

MICROCHIP MRF24W GETTING STARTED GUIDE FOR MRF24WB0MA/B, MRF24WG0MA/B FOR MLA V5

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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 preface contains general information that will be useful to know before using the MRF24WB0MA/B and/or MRF24WG0MA/B. Topics discussed in this preface 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 Revision History

DOCUMENT LAYOUT

This user's guide describes how to use the Microchip MRF24W Getting Started Guide for MRF24WB0MA/B, MRF24WG0MA/B for MLA v5. The document is organized as follows:

- **Chapter 1. "Getting Started with MRF24WB0MA/B or MRF24WG0MA/B"** – This chapter introduces the various wireless network topologies, terminologies, and a brief description of the hardware and software needed.
- **Chapter 2. "Hardware Setup and Configuration"** – This chapter provides information on how to set up the hardware to be used in the development environment.
- **Chapter 3. "Software Setup and Configuration"** – This chapter describes the software to be used in conjunction with the hardware.
- **Chapter 4. "Sample Application Demonstrations"** – This chapter describes the various applications released in the TCP/IP stack MLA release.

- **Chapter 5. “Microchip Development Board Specifics”** – This chapter provides the pin descriptions that interface the hardware platform to the MRF24W.
- **Appendix A** – This appendix provides the web links to access the hardware or software as described in this user guide.

CONVENTIONS USED IN THIS GUIDE

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
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	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly braces 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 MRF24WB0MA/B and/or MRF24WG0MA/B. The device-specific data sheets contain current information on programming the specific microcontroller or digital signal controller devices. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources:

MRF24WB0MA/MRF24WB0MB Data Sheet (DS70632)

MRF24WG0MA/MB Data Sheet (DS70686)

To obtain any of these documents, visit Microchip web site at www.microchip.com.

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® C compiler; MPASM™ and MPLAB 16-bit assemblers; MPLINK™ and MPLAB 16-bit object linkers; and MPLIB™ and MPLAB 16-bit object librarians.
- **Emulators** – The latest information on the Microchip MPLAB REAL ICE™ in-circuit emulator.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 3.
- **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 device programmer and the PICkit™ 3 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 (January 2013)

This is the initial released version of the document

Chapter 1. Getting Started with MRF24WB0MA/B or MRF24WG0MA/B

1.1 OVERVIEW

MRF24WB0MA/B and MRF24WG0MA/B Wi-Fi® PICtail™ are the 802.11 module based boards for evaluating 802.11b/g wireless connectivity on the Microchip Technology's processing platform. MRF24WB0MA/B and MRF24WG0MA/B Wi-Fi® PICtail™ are the expansion boards that are compatible with the Explorer 16 and PICDEM™.NET 2 development boards.

- MRF24WB0MA/B supports only 802.11b (1 Mbps, 2 Mbps)
- MRF24WG0MA/B supports both 802.11b and 802.11g

802.11b, ratified in 1999 is an extension of 802.11 that uses the same 2.4 GHz frequency band, and supports two additional transmission rates, 5.5 Mbps and 11 Mbps along with existing 1 Mbps and 2 Mbps.

802.11g, ratified in 2003 is backward compatible with 802.11b, and supports the additional transmission rates of 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps and 54 Mbps.

1.2 SCOPE

The Getting Started Guide covers these topics:

- MLA v5 based releases
- MPLAB® X IDE

1.3 HARDWARE

The following are required for developing or evaluating of the Microchip MRF24WB0MA/B and MRF24WG0MA/B Wi-Fi® module 802.11b/g solution:

- MRF24WB0MA/MB or MRF24WG0MA/B Wi-Fi® PICtail™
- One of the following Microchip hardware development platforms:
  - Explorer 16 Development Board (PIC24 or PIC32 depending on the personality module)
  - PICDEM.Net2 (PIC18)
  - PIC32 Starter Kit and I/O Expansion Board
- One of the following Microchip development tools:
  - MPLAB Real ICE
  - MPLAB ICD
  - PICKit™ 3 programmer with AC164110 RJ11 to ICSP adapter
- Power supply (different hardware configurations have different power requirements. Use the AC power adapter that comes along with the kit)

- 802.11 access point (AP) (b, b/g, or b/g/n) required for using the development board in Infrastructure BSS mode
  - Linksys WRT54G or WRT54G2 is recommended, and it is used as a reference in this document. If other types of APs are used, the approach remains similar and user must refer to the APs operating manual.

1.4 SOFTWARE

This user's guide consists of sections on installing the Microchip MPLAB X IDE, the Microchip MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® SDK and TCP/IP stack, and the necessary changes to configure the demonstration software for networks with different characteristics apart from the default settings. Refer to Appendix A, for direct links to the specific Microchip software you may require for your project. The latest Microchip documentation is available on the Microchip web site, and takes precedence over software bundles on the installation CD. The latest MRF24WB0MA/B and MRF24WG0MA/B Wi-Fi® documentation is available on the Microchip Wi-Fi® support web site (http://www.microchip.com/pagehandler/en-us/technology/wifi), and is the most accurate.

This user's guide documents how to configure the wireless network by hard coding the network parameters into the software, then compiling, and storing this information on the Microchip MCU. The software uses the C function calls to modify the values in variables used to keep the configurations. Customer application code can therefore create a user interface that allows scanning for networks and then configuring based on the end users selection. As an example of using the variables, the included demonstration projects have a number of source files to allow run-time configuration of the networks (for example, select Ad hoc or Infrastructure network type, change the SSID, change the security methods and keys, and so on).

The required software installation to build the project are:

- Microchip MPLAB® XC compiler
- Microchip MPLAB C18 compiler (PICDEM.Net 2 and PIC18)
- Microchip MPLAB X IDE

Refer to Appendix A, for download information.

1.5 REFERENCES

For more information, refer to the following:

- Microchip TCP/IP Stack Help
  The help file comes with the TCP/IP source code releases.

1.6 COMMON TERMS AND DEFINITIONS

TABLE 1-1: COMMON TERMS AND DEFINITIONS

Parameter	Description
STA	Station (local station) is a device on the network, typically refer to a wireless device. This can be a laptop, PC, or the Microchip development board with MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™.
LAN	Local area network (LAN) is a collection of computers communicating to each other. LAN consists of two devices communicating through a wireless access point (AP) or router (see Figure 1-1). Local networks can communicate to each other, or, with a WAN (internet) connection, and they can communicate to other networks over the internet.
AP	Wireless access point (AP) is a device that creates a wireless network that multiple wireless devices can connect to. When connected to a wired network, wired and wireless devices can communicate with each other. Typically, most APs and routers come as a single unit, making the connection between wired, wireless and internet seamless.
Router	Router is a network device that directs and forwards traffic. Generally, a router and an AP are combined together, so that wired and wireless devices can communicate to each other.
DHCP	Dynamic host configuration protocol (DHCP) is an application layer protocol that manages the IP network. This reduces the amount of manual intervention required when putting a new device on the network. To connect to a network, you are provided with an IP address by the DHCP server.
OUI	Organizationally unique identifier is a 24-bit number (3 bytes) that composes the first three bytes (octets) of the six byte MAC address. The OUI is managed by the IEEE. The OUI that identifies MRF24WB0MA/B or MRF24WG0MA/B is 00:1E:C0. With each OUI, you are guaranteed 224 unique combinations that can be used for device identification.
MAC address	Media access control address is a unique identifier to each device on a network. For a given OUI, there can be 224 uniquely programmed MAC addresses.
BSS	Basic service set is the basic building block of a wireless LAN. This usually consists of an AP, with one or more wireless stations. This is commonly referred to as Infrastructure mode.
IBSS	Independent basic service set is a network with no controlling AP. The first device to start the network will broadcast the SSID, and other local stations can join. This is commonly referred to as Ad hoc mode.
SSID	Service set identifier is a name for the wireless network.
WEP	Wired equivalent privacy is an encryption mechanism for wireless networks. Most APs implement two different flavors of WEP, 64-bit WEP (WEP-40) and 128-bit WEP (WEP-104). Several failings have been identified in WEP, resulting in easily hackable and insecure networks. WEP is no longer recommended for use, except as required to interface with legacy equipment that cannot support WPA/WPA2.
WPA	WiFi protected access is the implementation of the IEEE 802.11i specification. It is considered a secure alternative to WEP.
WAN	Wide area network is a network that connects other networks (LANs) together. The most famous WAN is the internet.
MCU	Microcontroller unit. In the case of this demonstration, this will either be PIC18 (PICDEM.net 2), PIC24 (Explorer 16), or PIC32 (Explorer 16).

1.7 LOCAL NETWORK TOPOLOGIES

1.7.1 Infrastructure Basic Service Set (BSS)

A common example of a local network operating in Infrastructure mode is shown in Figure 1-1.

FIGURE 1-1: INFRASTRUCTURE BSS NETWORK

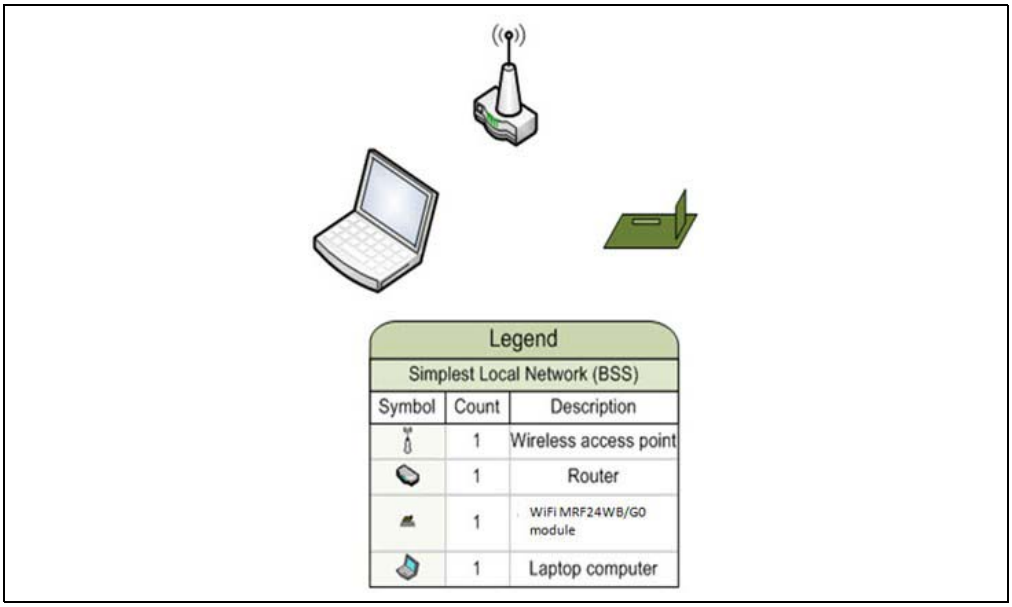
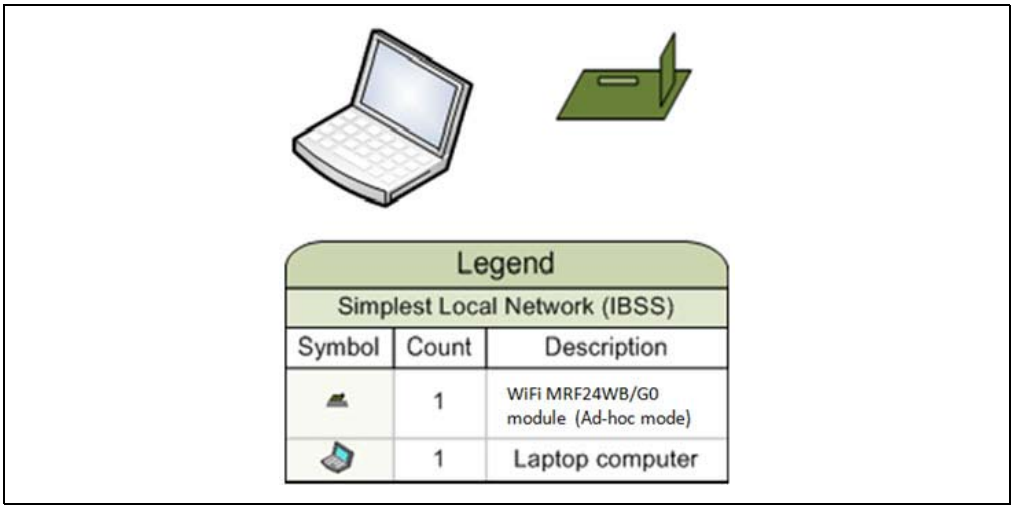


Figure 1-1 illustrates a laptop computer and the Microchip development board with MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ communicating with each other through a wireless AP and router. This network can gain access to the internet if the router is connected to a WAN.

1.7.2 Independent BSS (IBSS) or Ad hoc Network

Another example of a common local network is the ad hoc (IBSS) network, see Figure 1-2.

FIGURE 1-2: IBSS OR AD HOC NETWORK

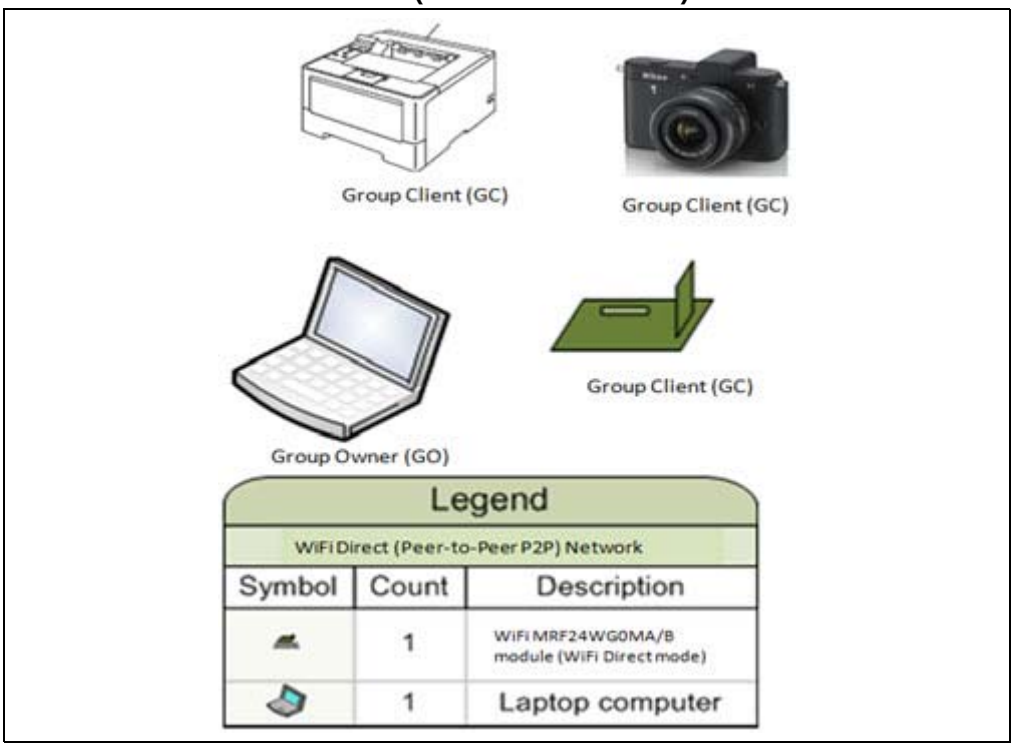


The Microchip development board with MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ is the first station to broadcast when creating the network, see Figure 1-2. In this case, join the laptop to the ad hoc network after the development board has gone through the steps of setting up the ad hoc network. The security mode supported is Open mode and WEP security. According to specifications, ad hoc network only supports 802.11b rates of 1 Mbps, 2 Mbps, 5.5 Mbps and 11 Mbps. Most Android devices do not support ad hoc network.

1.7.3 WiFi Direct (Peer-to-Peer (P2P)) Network

Figure 1-3 provides a typical example of local network, WiFi Direct (peer-to-peer (P2P)) network. WiFi Direct does not support 802.11b, therefore only MRF24WG0MA/B Wi-Fi® PICtail™ can support such network types.

FIGURE 1-3: WIFI DIRECT (PEER-TO-PEER P2P) NETWORK



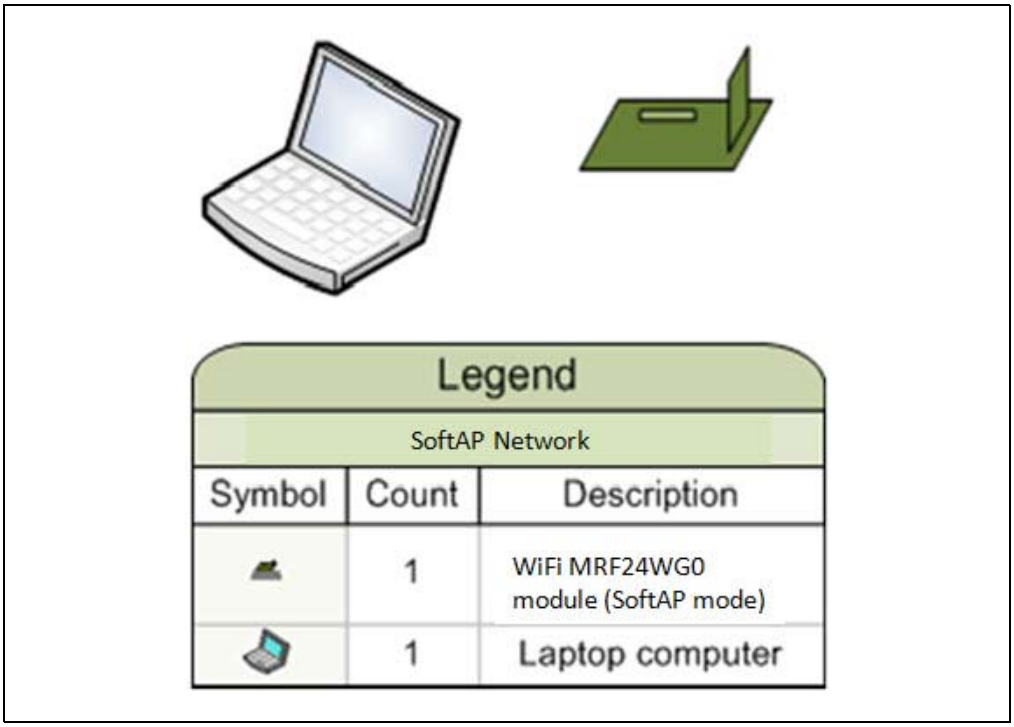
WiFi Direct allows you to configure a secured wireless network between several devices, such as smart devices, laptops or computers with wireless network adapters, without using an AP. WiFi Direct supports WiFi Protected Setup (WPS) connection method, which is known as the WSC (WiFi Simple Configuration) Config Methods in the Wi-Fi Peer-to-Peer (P2P) Technical Specifications, in particular WPS Push Button method with WPA2.

From the negotiation process, each device will determine which devices become group owner (GO) or group client (GC). The “GroupOwnerIntent” field in the P2P information element (IE) will indicate the level of desire to become the GO. The higher the value, the higher the desire to be the GO. Since MRF24WG0MA/B supports the role of GC only, it implies `GroupOwnerIntent=0` (P2P IE). Within each WiFi Direct network, there can be only one GO, similar to only single AP in the infrastructure network.

1.7.4 SoftAP Network

Figure 1-4 provides a typical example of common local network, software enabled AP (SoftAP) network. Current RF module firmware version only has the MRF24WG0MA/B Wi-Fi® PICtail™ programmed to support this network type.

FIGURE 1-4: SOFTAP NETWORK



SoftAP functions can be used to extend wireless coverage and share internet connection with others.

NOTES:

Chapter 2. Hardware Setup and Configuration

2.1 PICTAIL SETUP

The MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ can be plug into either the PICtail Plus (Explorer 16) using the card edge connector or the PICtail slot (PICDEM.net 2) using the pin header on the development board, see Figure 2-1.

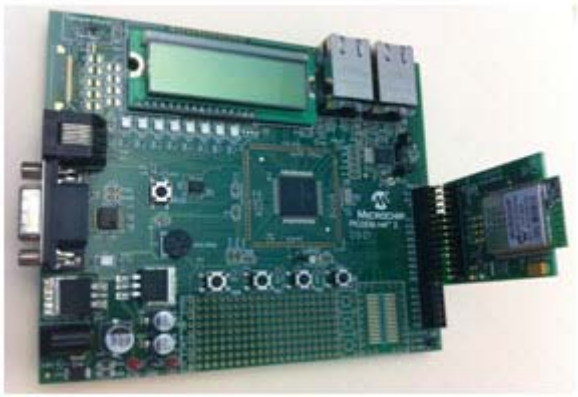
FIGURE 2-1: MRF24WB0MA/B OR MRF24WG0MA/B WI-FI® PICTAIL™

When inserting the PICtail into the development board, orient the PICtail with the module facing the microcontroller.

2.2 PICDEM.NET 2

The PICDEM.net 2 can be used to demonstrate wireless functionality by connecting the PICtail with header J1 on the PICtail inserted into connector J5 on the PICDEM.net 2 Development Board, see Figure 2-2.

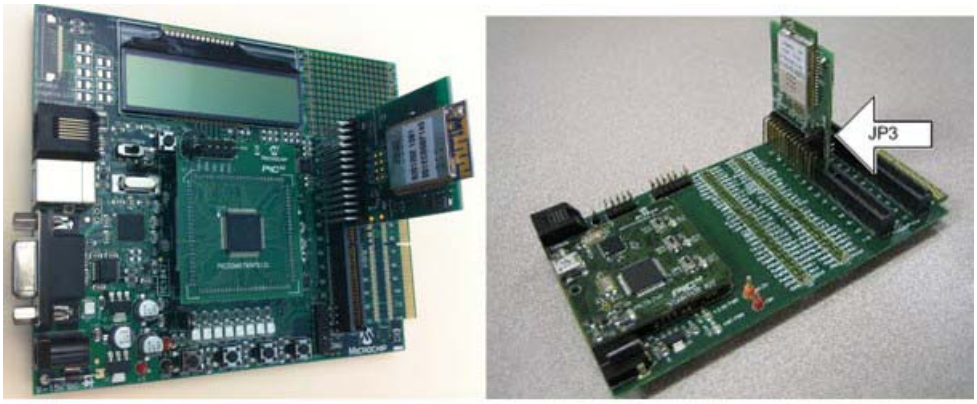
FIGURE 2-2: PICDEM.NET2 DEVELOPMENT BOARD WITH MRF24WB0MA/B OR MRF24WG0MA/B WI-FI® PICTAIL™



2.3 EXPLORER 16 AND PIC32 STARTER KIT

The Explorer 16 and PIC32 Starter Kit can be used to demonstrate wireless functionality by connecting the PICtail with header J1 on the PICtail inserted into the top slot of connector J5 (Explorer 16) or J4 (I/O Expansion Board) on the PIC32 Starter Kit boards, see Figure 2-3.

FIGURE 2-3: EXPLORER 16 AND PIC32 STARTER KIT WITH MRF24WB0MA/B OR MRF24WG0MA/B WI-FI® PICTAIL™



2.4 CONNECTING THE DEVELOPMENT BOARD

Warning: The boards in this kit are highly sensitive to electrostatic discharge (ESD). Maintain ESD practice while in contact with the boards.

Perform the following actions to connect the development board:

1. Connect RJ11 cable (grey phone cable) from the RJ11 port on the development board to the ICD.
2. Applicable only to Explorer 16 and PICDEM.Net2:

   Connect the serial cable to the serial port (UART port) of the development board and to the serial port (COM port) on the PC (typically, the default port on the PC is COM 1, but the default number may differ from PC to PC). This is required to monitor the debug messages from the MLA TCP/IP software stack. Refer to **2.6 "Serial Monitor Setup"**, for more information on setting up the serial connection.
3. Connect the USB cable from the ICD to the PC.
4. Power-up the development board.
5. Power on the AP or router, and connect the PC to the AP or router with an Ethernet cable. If a wireless laptop (PC) is used, associate the computer with the correct SSID of the wireless AP.

2.5 WIRELESS ACCESS POINT (AP) SETUP

The following sections provide the settings and configuration options for the Linksys WRT54G2 Wireless-G Broadband Router. In this scenario, the terms “access point” and “router” are synonymous, and refer to the combination of these two networking parts as a single unit. The graphics in this section are specific to this particular AP. The concepts and items that need to be configured should be identical if a different AP is used.

- Accessing the AP Configuration Pages
- Main AP Configuration Page
- Setting up the Wireless AP

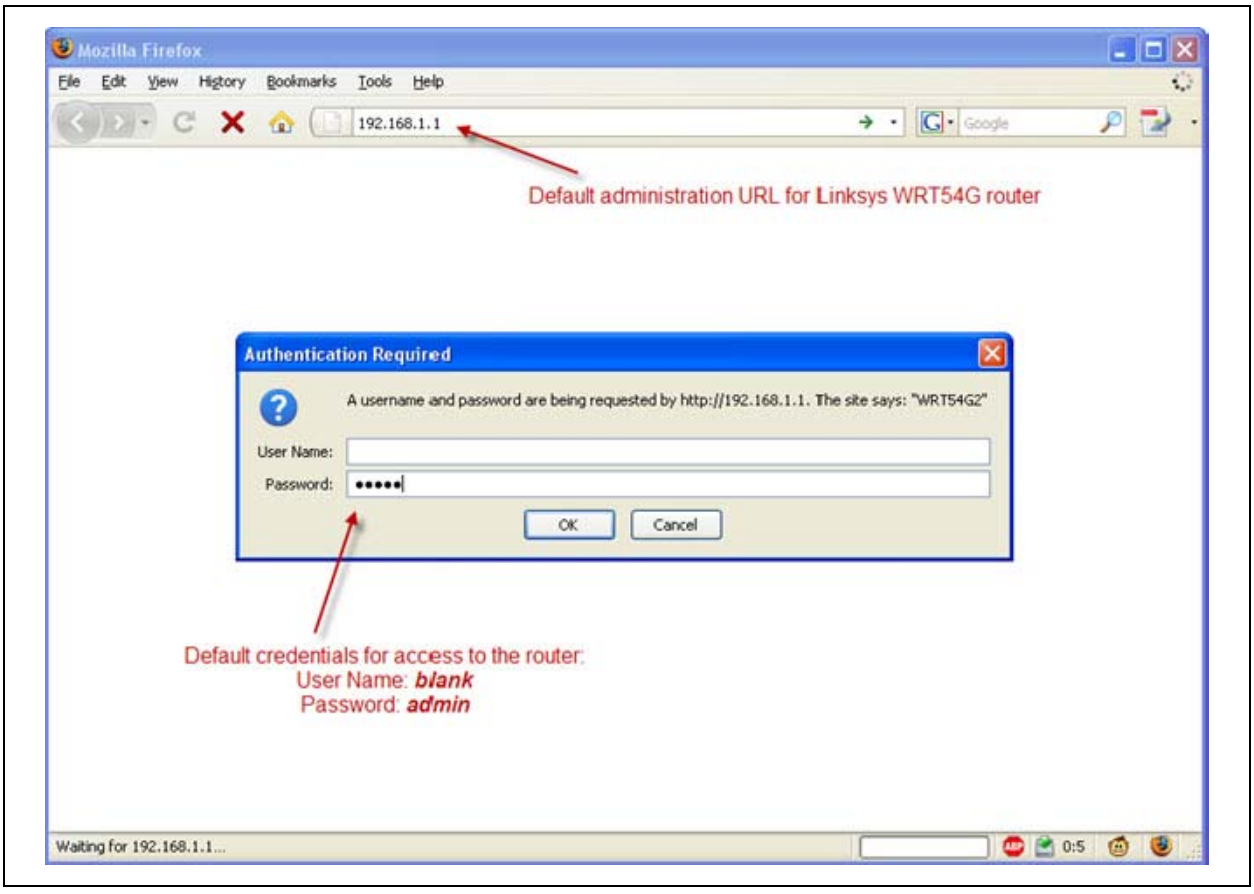
2.5.1 Accessing the AP Configuration Pages

Figure 2-4 shows the web interface to the AP. These web pages can be viewed from any web browser. Enter the IP address of the AP, for example http://192.168.1.1, in the URL. The Linksys WRT54G2 Wireless-G Broadband Router uses the IP address, http://192.168.1.1.

When prompted with the authentication text box, leave the “User Name:” field blank, and use “admin” as the password in the “Password:” field.

The IP address of the AP and configurations or settings may vary for each model. Refer to the access point operating manual, for more information.

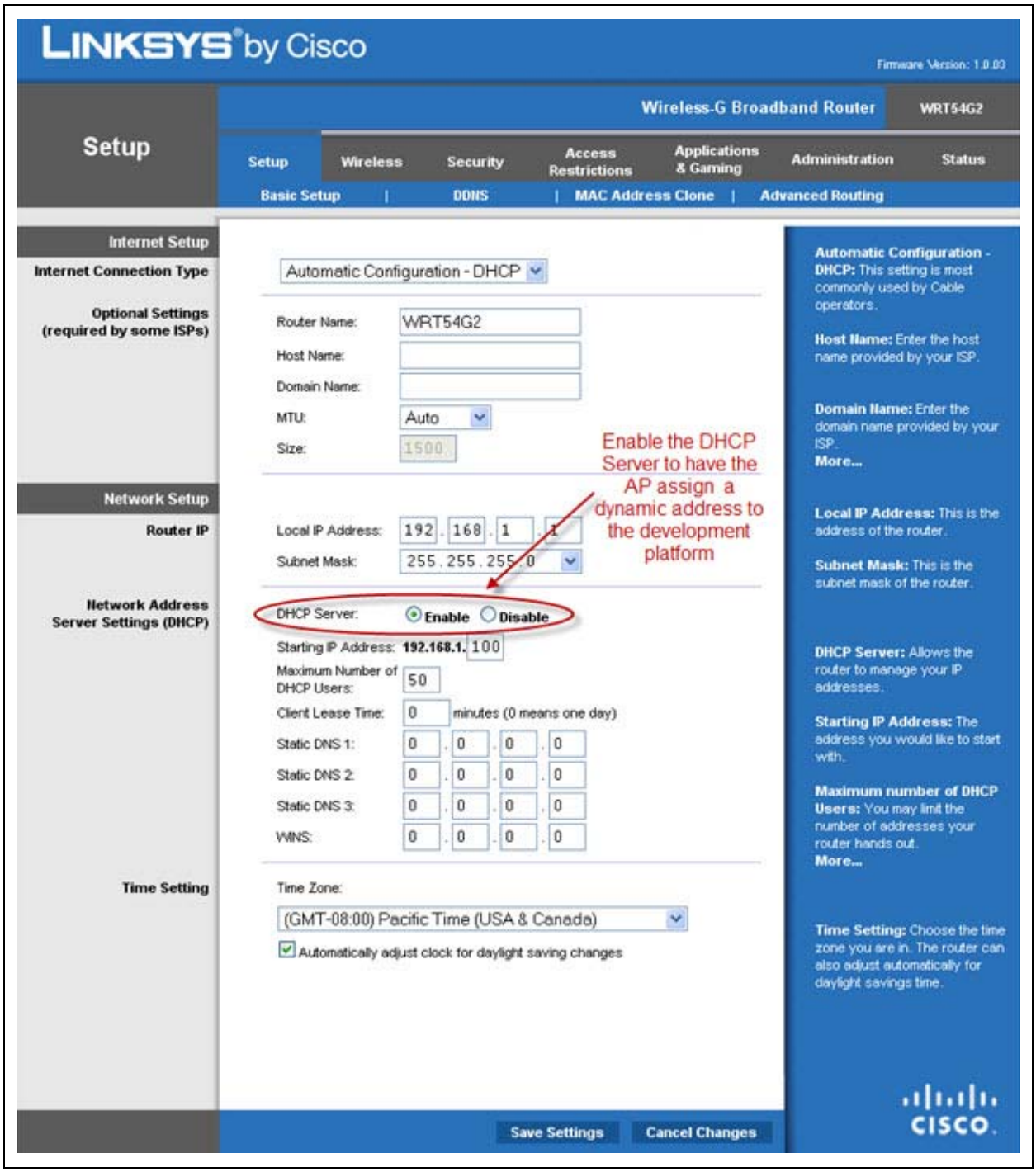
FIGURE 2-4: ACCESS POINT LOGIN



2.5.2 Main AP Configuration Page

After authenticating with AP, the configuration page will be displayed. The settings on the configuration page are for configuring the router portion of the system. Most of the default settings are pre-programmed and enough for the demonstration. By default, the WRT54G router acts as a DHCP server. For the demonstration, consider AP as the DHCP server, as shown in Figure 2-5.

FIGURE 2-5: AP CONFIGURATION PAGE



2.5.3 Setting up the Wireless AP

1. To set up wireless AP, Click **Wireless** tab at the top of the screen.
2. Either Figure 2-6 or Figure 2-7 will be displayed. If Figure 2-6 is displayed, click **Manual** radio button and Figure 2-7 will be displayed. Figure 2-7 shows the basic wireless settings required for the demonstrations.

FIGURE 2-6: WI-FI PROTECTED SETUP (WPS)

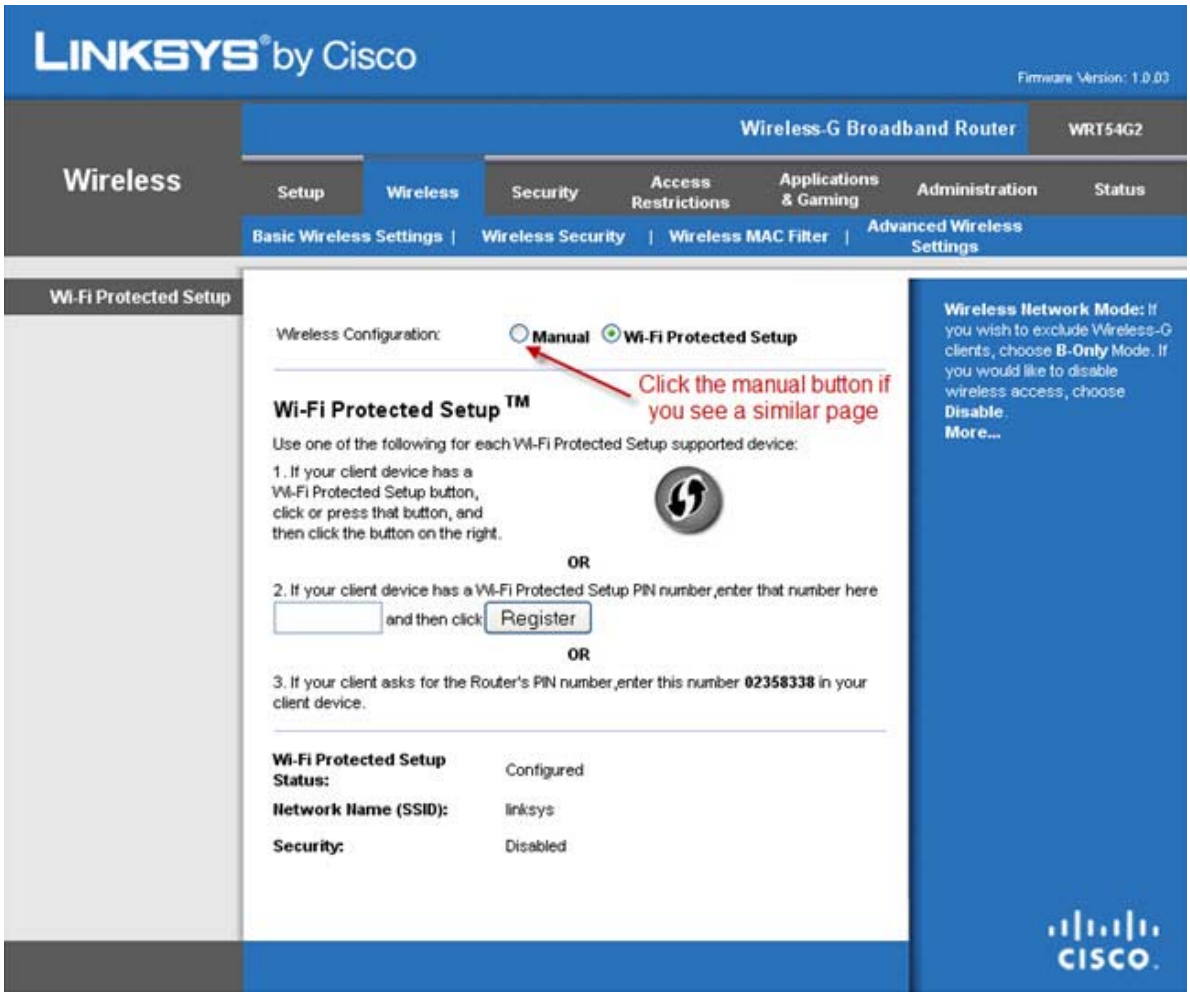


FIGURE 2-7: BASIC WIRELESS SETUP

Table 2-1 provides a summary of the options that is required for the basic wireless settings and its expected values.

Table 2-1: Wireless Settings

Option	Value/Setting
Wireless network name (SSID)	MicrochipDemoAP or MicrochipDemoAP_123 (case sensitive), or any desired SSID network name
Wireless channel	Either channel 1, 6 or 11
Wireless network mode	Either mixed mode (b and g service) or B-only

3. After the set up, click **Save Settings** button. The AP should confirm that the settings have been saved successfully to set up the AP for the demonstrations. For experimenting with wireless security modes, refer to **4.5.7.1 "Wired Equivalent Privacy (WEP)"** or **4.5.8 "WPA/WPA2"**.

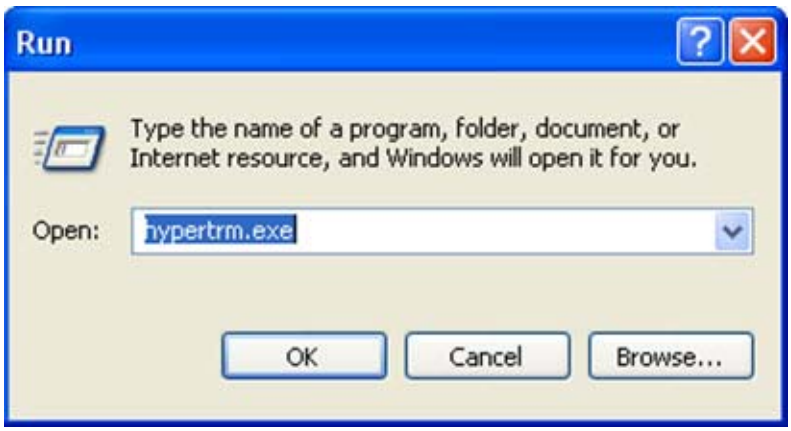
2.6 SERIAL MONITOR SETUP

The Serial Monitor Setup is applicable for Explorer 16 and PICDEM.Net2 development boards. The MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ displays and send status information to the serial UART port on the Microchip development board that is useful for debugging. This section provides detailed information on setting up a terminal session to view this output by using “HyperTerminal” as an example. The same approach is used for other serial port monitors such as Tera Term and so on.

2.6.1 To Set up Serial Monitor

1. Launch HyperTerminal from the **Run** from the Windows **Start** menu or directly from the Windows **Start** menu, see Figure 2-8.

FIGURE 2-8: STARTING HYPERTERMINAL FROM RUN DIALOG



2. Name the connection and press **OK**, see Figure 2-9.

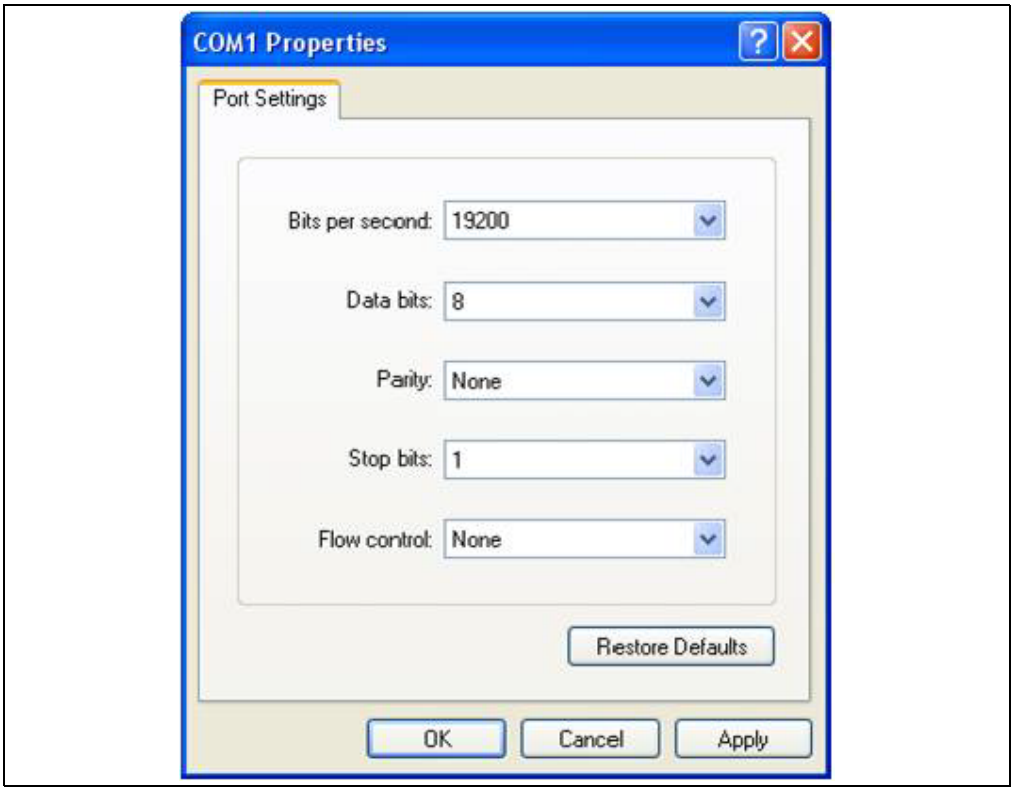
FIGURE 2-9: HYPERTERMINAL NAME SETUP

3. Select the COM port as the listening port. Generally, the COM port will be COM1, check the system to ensure correct port is selected and then press **OK**, see Figure 2-10.

FIGURE 2-10: COM PORT CONNECTION

4. Choose communication port parameters and then press **OK**, see Figure 2-11.

FIGURE 2-11: COM COMMUNICATION SETTINGS



5. After the serial port monitor is set up it will print the messages from the MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™.

Chapter 3. Software Setup and Configuration

3.1 SOFTWARE ITEMS TO INSTALL

The following are required to install the software:

- Microchip MPLAB Integrated Development Environment (MPLAB® X IDE)
- Microchip MPLAB® XC compiler (PIC24/32) and Microchip MPLAB C18 Compiler (PIC18)
- Microchip TCP/IP stack installer (which contains the MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® driver)

Note 1: Microchip In-circuit Debugger, for example ICD 3 or REAL ICE™ driver is embedded with the MPLAB X IDE installation.

2: The screenshots provide references to older versions of the MPLAB X IDE, and older compiler and TCP/IP stack versions. These screenshots are for visual cues only, and the latest versions should be installed from the Microchip web site.

3.2 INSTALLING THE MICROCHIP MPLAB® X IDE

The path to the MPLAB X IDE is available on the Microchip web site, see **A.2 "Microchip Software"**. After downloading the installer, execute the setup file and follow the GUI instructions for installing the MPLAB X IDE on your computer. Restart the computer after the installation.

3.3 INSTALLING THE MICROCHIP MPLAB® XC/C18 COMPILER

Different versions of the MPLAB XC compiler for different PIC microprocessors are available. For PICDEM.net 2 Development Board, the C18 compiler for PIC18 MCUs is required. For Explorer 16 Development Board, either the XC16 compiler for PIC24/dsPIC or the XC32 compiler for PIC32 devices is required.

Microchip offers evaluation copies of the compilers (student versions) that can be downloaded from the Microchip web site, refer to **A.2 "Microchip Software"**. After downloading the installer, run through the setup to install the compiler on your system.

3.4 INSTALLING THE MICROCHIP TCP/IP STACK WITH MRF24WB0MA/B OR MRF24WG0MA/B WI-FI® DRIVER

The TCP/IP stack and MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® driver is available in two different forms:

- CDROM disc
- Download from Microchip web site (www.microchip.com)

A CDROM disc with the installer is bundled with the development kit provided by MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® Wireless. Optionally, the installer can be downloaded from the Microchip web site, refer to **A.2 "Microchip Software"**. It is recommended to download the latest software version from the Microchip web site, which covers latest bug fixes and the best support for current versions of the compilers.

The installer by default installs the stack code, driver, documentation and demonstration project files into `versioned` directory, where version is denoted by the MLA date, for example, `C:\Microchip Solutions v2012-08-22`.

3.5 INSTALLING INTERIM CODE RELEASES

User may need to install special interim code releases that are not part of the functionary code library provided by Microchip and MRF24WB0MA/B or MRF24WG0MA/B. The reasons can be high priority bug fixes, new features that are required by the customers and so on.

3.5.1 To Install the Interim Code

1. Save any open files in the `C:\Microchip Solutions` directory and quit the MPLAB X IDE.
2. Open the zip file to view affected directories.
3. Save required work files from this directories to another location.
4. Unzip or copy the directories in the zip file to the `C:\Microchip Solutions` directory.
5. Restart the MPLAB X IDE to use the codes.

Chapter 4. Sample Application Demonstrations

The development environment is equipped with three out-of-the-box WiFi demonstrations to showcase the MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® module. More demonstrations and features may be added in the future.

These demonstrations are illustrated based on Microsoft Windows® OS and the Linksys WRT54G2 Wireless-G Broadband Router. The concepts remain the same for different OS or router.

The following network types (MY_DEFAULT_NETWORK_TYPE) are supported, as indicated in the `WF_Config.h` file:

- CFG_WF_INFRASTRUCTURE
- CFG_WF_ADHOC
- CFG_WF_P2P (applicable only for MRF24WG0MA/B)
- CFG_WF_SOFT_AP (applicable only for MRF24WG0MA/B)

Note: SoftAP, WiFi Direct (P2P) and WiFi Protected Setup (WPS) are only supported by stack version v5.42 and newer version.

4.1 BASIC DEMONSTRATION APPLICATIONS

- TCPIP – Demo App
- TCPIP – WiFi Console
- TCP/IP – WiFi EZConfig

Detailed information is available in the Microchip `TCPIP Stack Help.chm` help file, which is part of the TCP/IP Stack source code releases.

4.1.1 TCPIP – Demo App

A powerful WiFi demonstration that shows a web server that enables you to perform many application level activities such as send and process form data, send emails, upload files and so on. This demonstration highlights many applications that are supported by the Microchip TCP/IP stack and how they can be used with WiFi.

Supported network types:

- CFG_WF_INFRASTRUCTURE
- CFG_WF_ADHOC
- CFG_WF_P2P (applicable only for MRF24WG0MA/B)

In addition, this demonstration is used to showcase the two WPS connection methods:

- WF_SECURITY_WPS_PUSH_BUTTON
- WF_SECURITY_WPS_PIN

4.1.2 TCPIP – WiFi Console

TCP/IP – WiFi Console is a throughput performance demonstration using a tool called Iperf, which is a commonly used networking test tool. Iperf will allow you to measure the throughput bandwidth on the WiFi link for both receive and transmit.

Supported network types for TCP/IP - WiFi Console:

- CFG_WF_INFRASTRUCTURE
- CFG_WF_ADHOC
- CFG_WF_P2P (applicable only for MRF24WG0MA/B)

4.1.3 TCP/IP – WiFi EZConfig

TCP/IP - WiFi EZConfig demonstration configures an embedded device on a wireless network. It utilizes the web server of the TCP/IP stack and a wireless ad hoc (IBSS) network to allow the user to input the desired network information from a client browser, and then Reset the device to connect to the desired network.

Supported network types:

- CFG_WF_ADHOC
- CFG_WF_SOFT_AP (applicable only for MRF24WG0MA/B)

4.2 WALKTHROUGH AND INSTRUCTIONS ON RUNNING THE DEMONSTRATION

This section consists of the following logical sections:

- Opening Existing Projects
- Hardware Configuration Options
- Compile-Time Configuration Options
- Compiling and Downloading Images
- Running TCP/IP – Demo App
- Running the TCPIP – WiFi Console
- Running the TCPIP – WiFi EZConfig

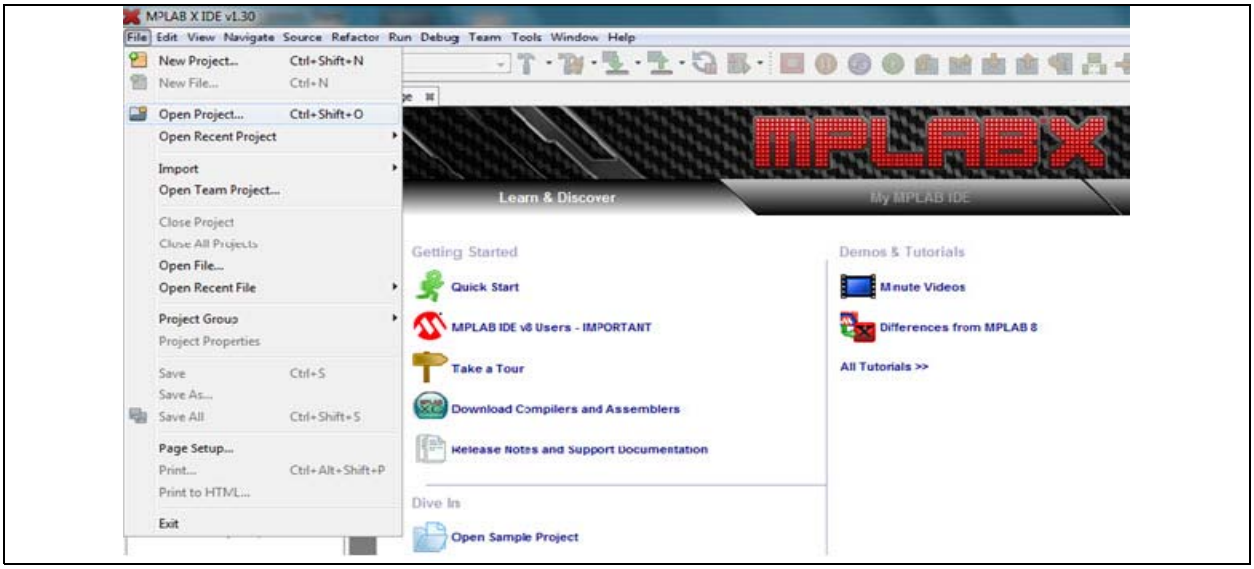
4.3 OPENING EXISTING PROJECTS

This section describes the TCP/IP demonstration application running on an Explorer 16 Development Board with a PIC24/32 PIM module installed. The configuration, compile and downloading of the code image to the PIC MCUs is the same for all of the development boards, MCUs and demonstration applications. After starting the MPLAB X IDE, the user can open an existing project.

4.3.1 To Open an Existing Project

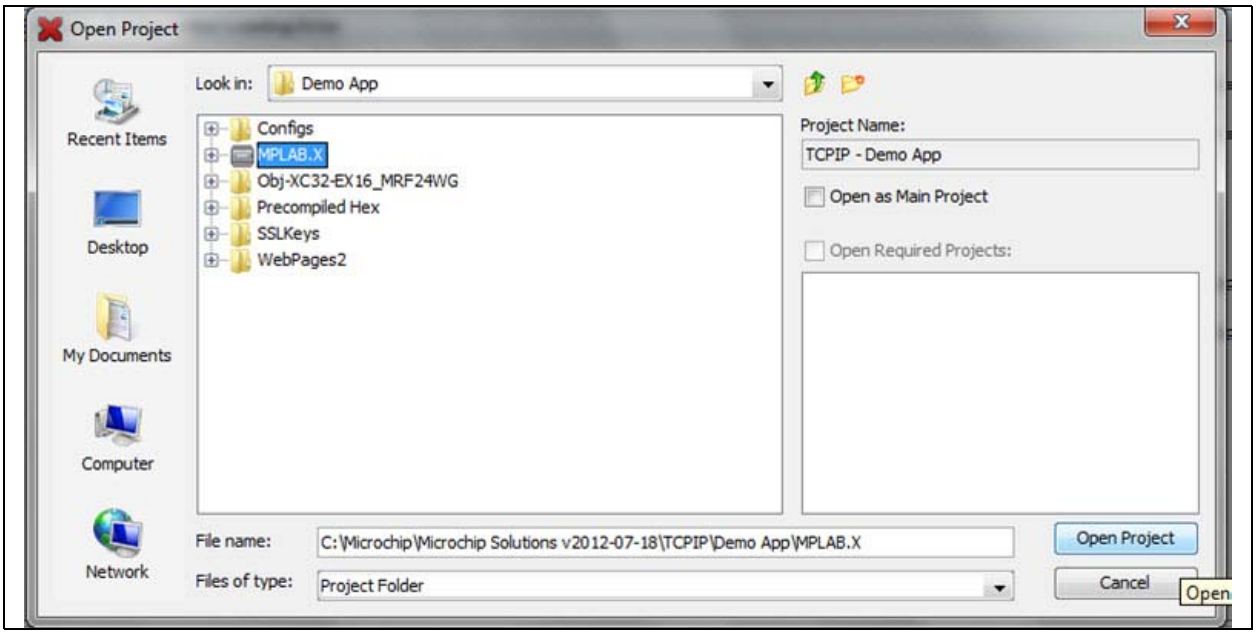
1. To open an existing project, from *File>Open Project*, see Figure 4-1.

FIGURE 4-1: OPEN AN EXISTING MPLAB PROJECT



2. Open Project dialog box is displayed. In the “File name”, choose `C:\Microchip Solutions\TCPIP\Demo App` to display folders, see Figure 4-2.

FIGURE 4-2: OPEN PROJECT DIALOG



3. Click `MPLAB.X` folder, and then click **Open Project** to open a project.

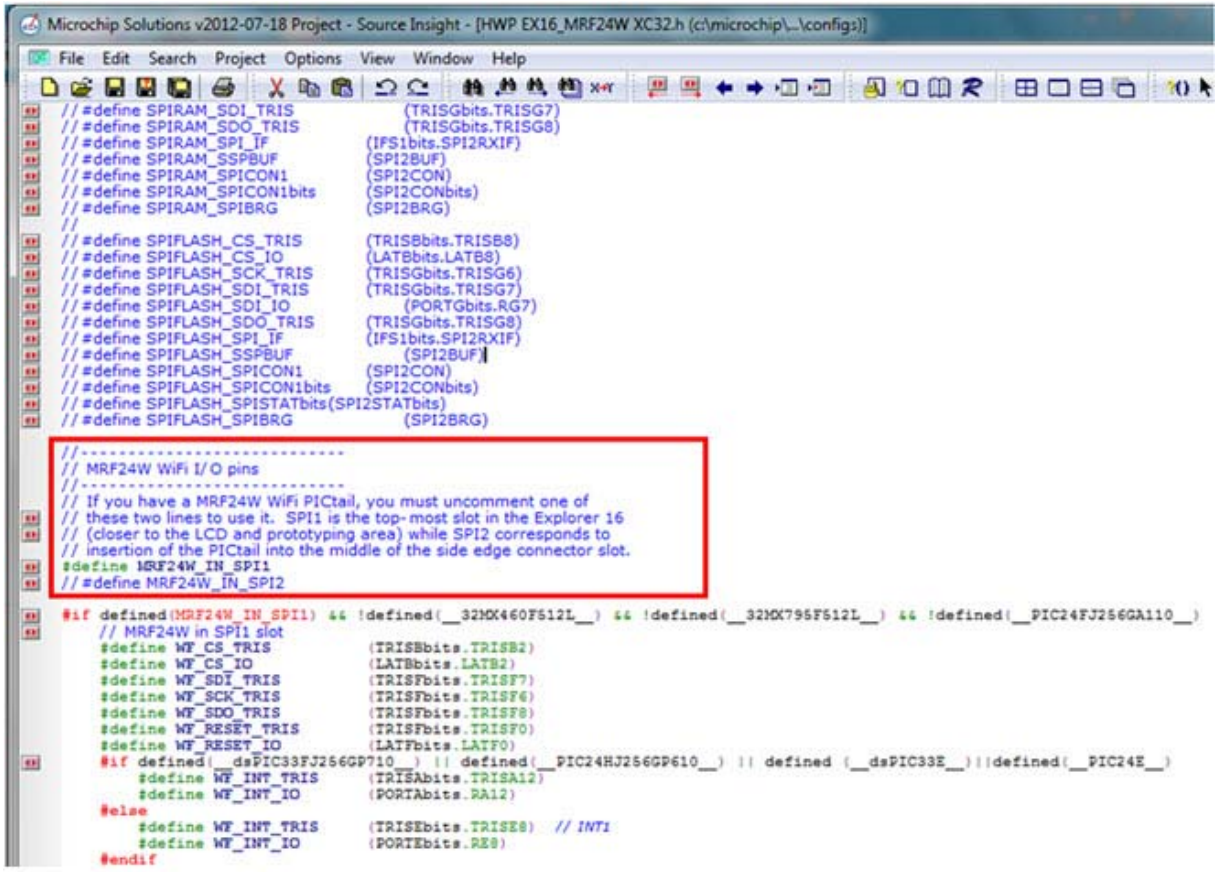
4.4 HARDWARE CONFIGURATION OPTIONS

Depending on the development board used, the relevant hardware profile header file must be changed to match the configuration of the slot on which the PICtail is plugged into. For Explorer 16 with XC32 configurations, the hardware profile header file is `HWP EX16_MRF24W XC32.h`. Ensure that the selected SPI option (MRF24W_IN_SPI1 or MRF24W_IN_SPI2) matches the development board's setup. Figure 4-3 shows the location of the required changes.

Required hardware profile header files for the development boards:

- PICDEM.net 2 Development Boards, only one configuration for the PICtail and `MRF24W_IN_SPI1` to be defined
- Explorer 16 Development Board using PIC24FJ128GA010, use either `MRF24W_IN_SPI1` or `MRF24W_IN_SPI2`; if it matches the location that the PIC-tail is plugged into the card edge connector (SPI1 refers to the upper location, closest to the LCD)
- dsPIC33FJ256GP710, this Plug-In Module (PIM) works only when `MRF24W_IN_SPI2` is defined and the PICtail is plugged into the middle card edge socket

FIGURE 4-3: HWP EX16_MRF24W XC32.H SPI OPTIONS



4.5 COMPILE-TIME CONFIGURATION OPTIONS

The following files contain most of the compile-time options for the demonstrations:

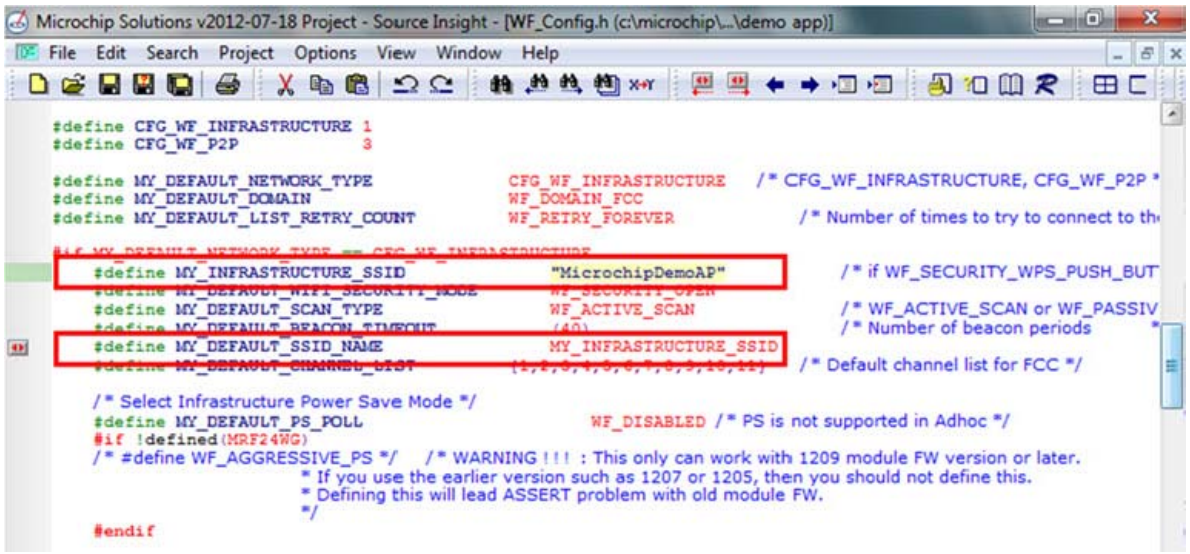
- `TCPIP MRF24W.h`, located in the `Configs` sub folder within individual demonstrations. For example, `\TCPIP\Demo App\Configs\TCPIP MRF24W.h`.
- `WF_Config.h`, located within the individual demonstrations. For example: `\TCPIP\Demo App\WF_Config.h`

These files can be viewed within the MPLAB X IDE using the file navigator.

4.5.1 SSID

The network name is stored in the variable `MY_DEFAULT_SSID_NAME (MY_INFRASTRUCTURE_SSID)` in `WF_Config.h` file. To change the network name, you must modify the defined name as shown in Figure 4-4.

FIGURE 4-4: MODIFYING SSID



Note: If selected network type is WiFi Direct (`CFG_WF_P2P`), the SSID is unique and is defined as `DIRECT-`.

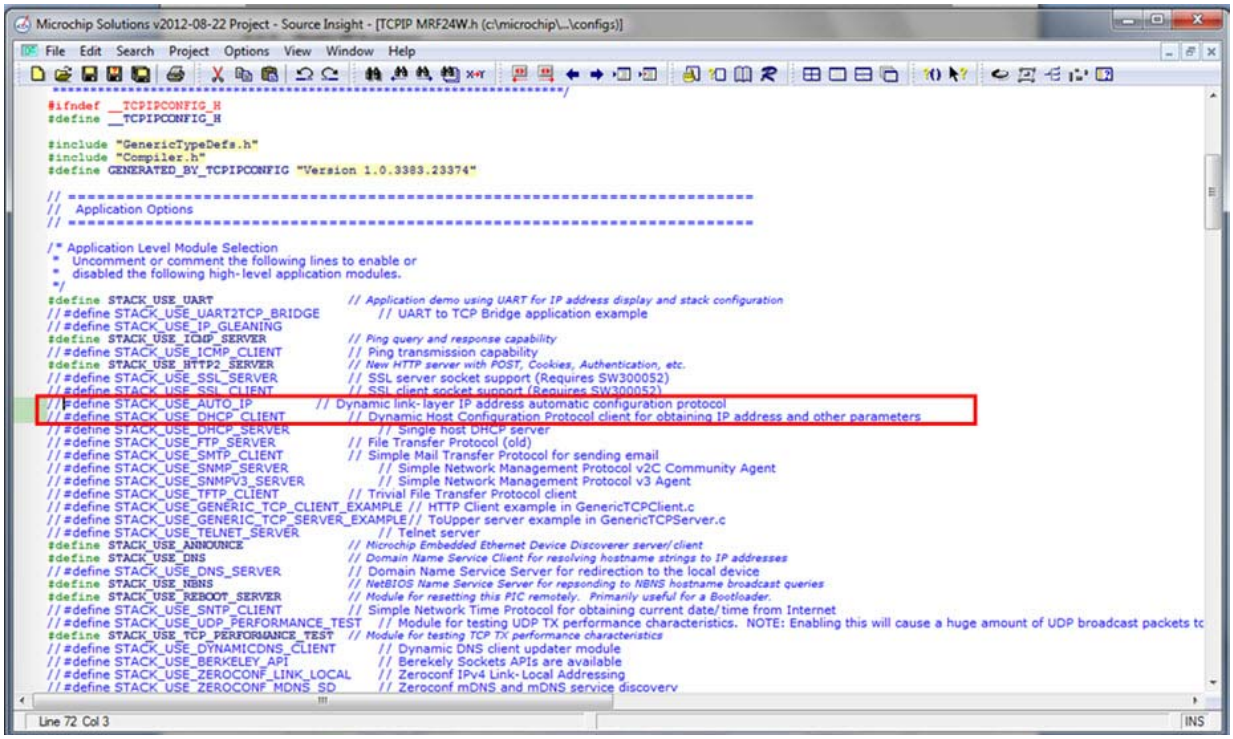
4.5.2 Static IP Address

By default, the demonstrations use DHCP and rely on the DHCP server in the AP or router to give the development board an IP address on the network.

4.5.2.1 TO ENABLE THE USE OF A STATIC IP ADDRESS

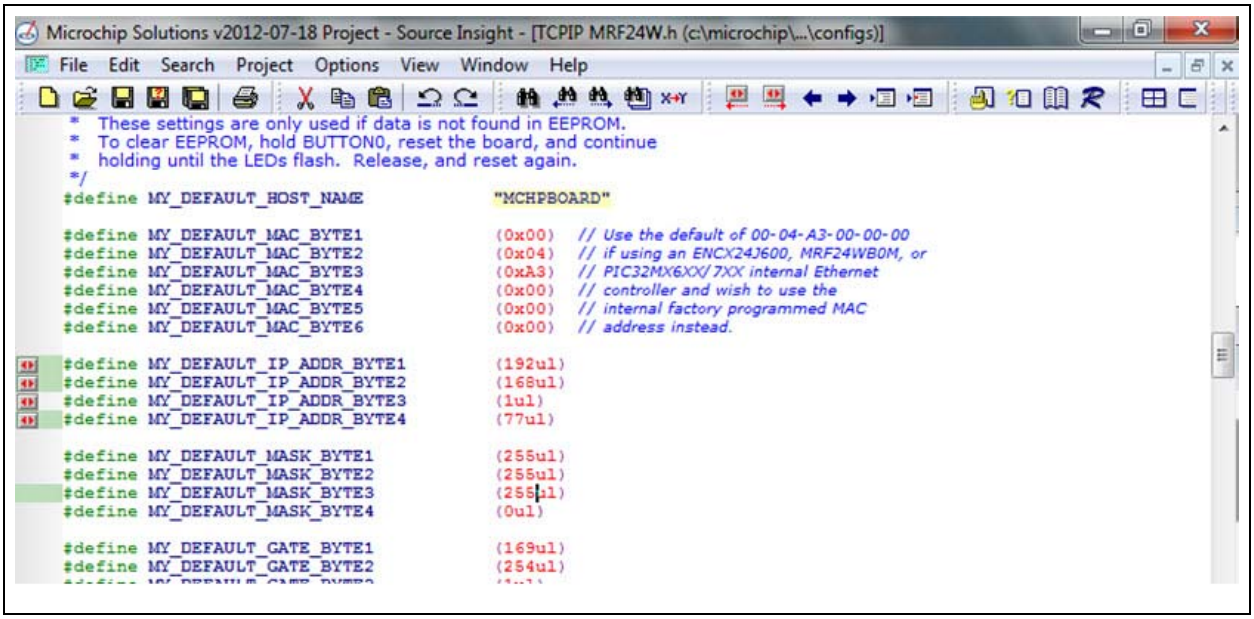
1. The selected static IP address must be on the same subnet as the AP. By default, the Linksys WRT54G manages IP addresses on the subnet 192.168.1.x (192.168.1.1 is for AP). The IP address above 192.168.1.100 are dynamically managed by the DHCP server. Therefore, ideal to assign a unique static IP address in the range of 192.168.1.2 – 192.168.1.99.
2. Two sections of the code must be changed to use the static IP address. To stop the development kit to request a dynamic address, comment the variables `STACK_USE_AUTO_IP` and `STACK_USE_DHCP_CLIENT` in the `\configs\TCPIP MRF24W.h` file, see Figure 4-5.

FIGURE 4-5: DISABLE AUTO IP AND DHCP CLIENT



3. Define the IP address to statically use in `MY_DEFAULT_IP_ADDR_BYTEx`, and match the default mask (`MY_DEFAULT_MASK_BYTEx`) to match the router (for the default Linksys AP, the default mask is 255.255.255.0), see Figure 4-6.

FIGURE 4-6: SETTING UP STATIC IP ADDRESS



4.5.3 MAC Address

In the system there are three sources for the MAC address:

- Built-in MAC address on the MRF24WB0MA/B or MRF24WG0MA/B WiFi® module that is preprogrammed from the factory with the MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® OUI
- Programmed code image
- Value that is stored in the EEPROM

At run-time, a data structure is created in RAM, which stores the valid MAC address (amongst other information) to be used for that session. The code will check if a valid data structure is located in the EEPROM. If the valid data structure exists in EEPROM, then those values will be used, overriding what is programmed inside the chip and/or programmed in the code at compile-time.

If no data structure exists in the EEPROM, then the value that is stored in the `\configs\TCPIP MRF24W.h` file will be used. If the value in the source code is 00:04:A3:00:00:00, then it indicates to the program that the value that has been preprogrammed in the MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® module should be used. Otherwise, the value that is placed into the `MY_DEFAULT_MAC_BYTEx` will be used. Additionally, if no valid data structure exists in the EEPROM, the new value will be programmed and stored to the EEPROM for the future use.

EEPROM has the highest priority. Therefore, if a value for the MAC address is programmed to the EEPROM, no other value can override it. To change the values, EEPROM must be erased. Refer to the instructions specified in **5.3 "Erasing EEPROM"**.

4.5.4 Channel Configuration

802.11b and 802.11g divide the 2.4 GHz spectrum into 14 channels, from channel 1 through channel 14. The bandwidth of each channel is 20 MHz which means that channels may overlap. The commonly used non overlapping channels and social channels are channels 1, 6 and 11.

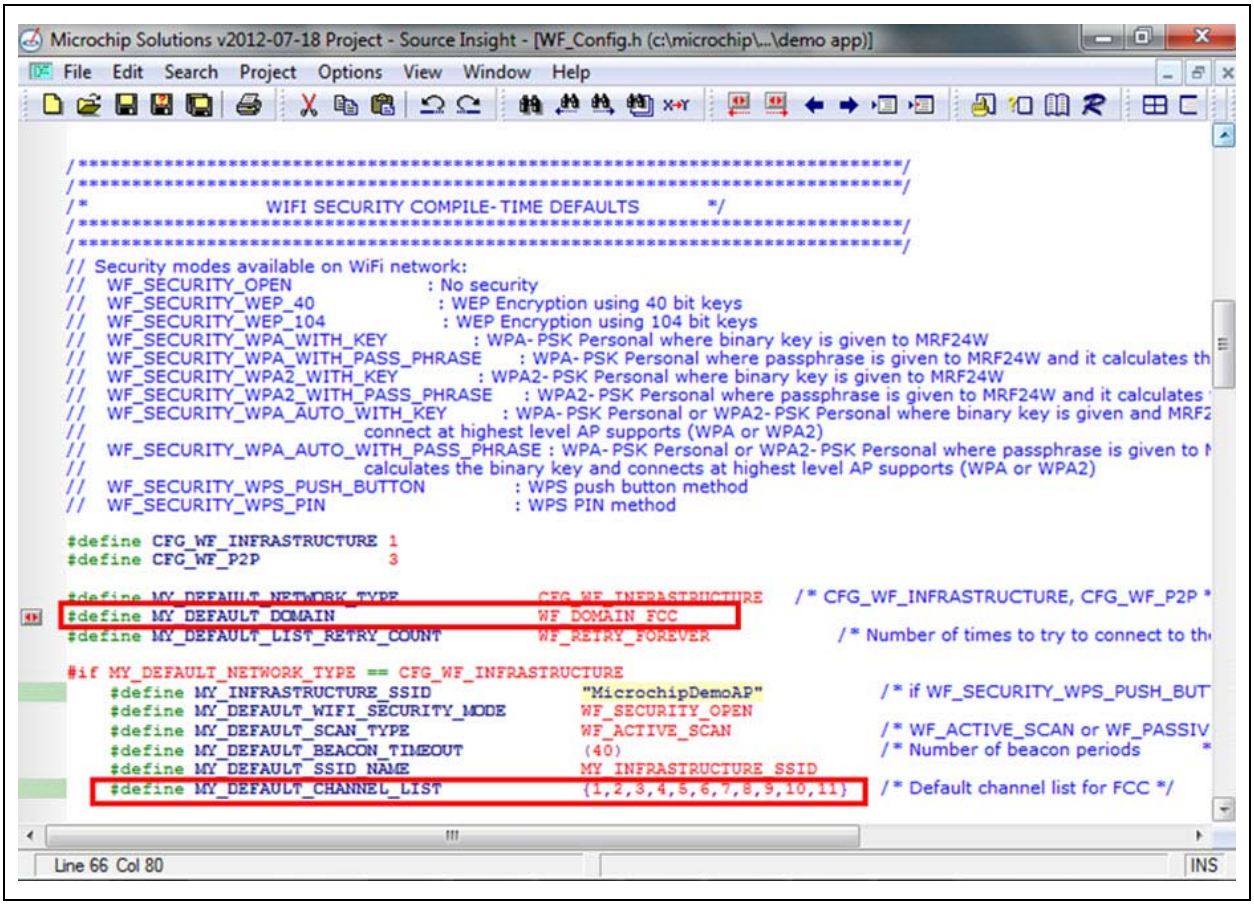
The RF channel that is used can be configured at compile-time. The following two interrelated options control channels data transmission:

- Regulatory domain, as specified by MY_DEFAULT_DOMAIN. Different domains have different channel offerings, hence it must match with the intended country and channel
- Channel scan list (MY_DEFAULT_CHANNEL_LIST), which is an array of channels that will be scanned for RF activity.

Note:	If more channels to scan, it takes longer time to connect.

As illustrated in Figure 4-7, the domain is set to FCC and there are 11 total channels in the scan list (1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11).

FIGURE 4-7: CHANNEL SETUP



Depending on the selected domain (regions), the available channels vary. Refer to `WFApi.h` for detailed definitions, see Example 4-1.

EXAMPLE 4-1: DOMAIN SPECIFIC CHANNELS

```
#define WF_DOMAIN_FCC   (0) /* Available Channels: 1 - 11 */
#define WF_DOMAIN_ETSI  (2) /* Available Channels: 1 - 13 */
#define WF_DOMAIN_JAPAN (7) /*  Available Channels: 1 - 14 */
#define WF_DOMAIN_OTHER (7) /* Available Channels: 1 - 14 */
```

If the network type selected is WiFi Direct (CFG_WF_P2P), the channel list will be social channels, that is channel 1, 6 and 11.

Note: With MRF24WG0MA/B RF module firmware version 0x3107 and future releases, due to changes in FCC regulations, regional domains are not programmable.

4.5.5 Ad hoc Network Configuration

Changing to ad hoc (IBSS) network can be done at compile-time, the MY_DEFAULT_NETWORK_TYPE can be changed to CFG_WF_ADHOC, see Figure 4-8.

FIGURE 4-8: SOURCE CODE AD HOC SETTINGS

4.5.6 WPS Connection Method

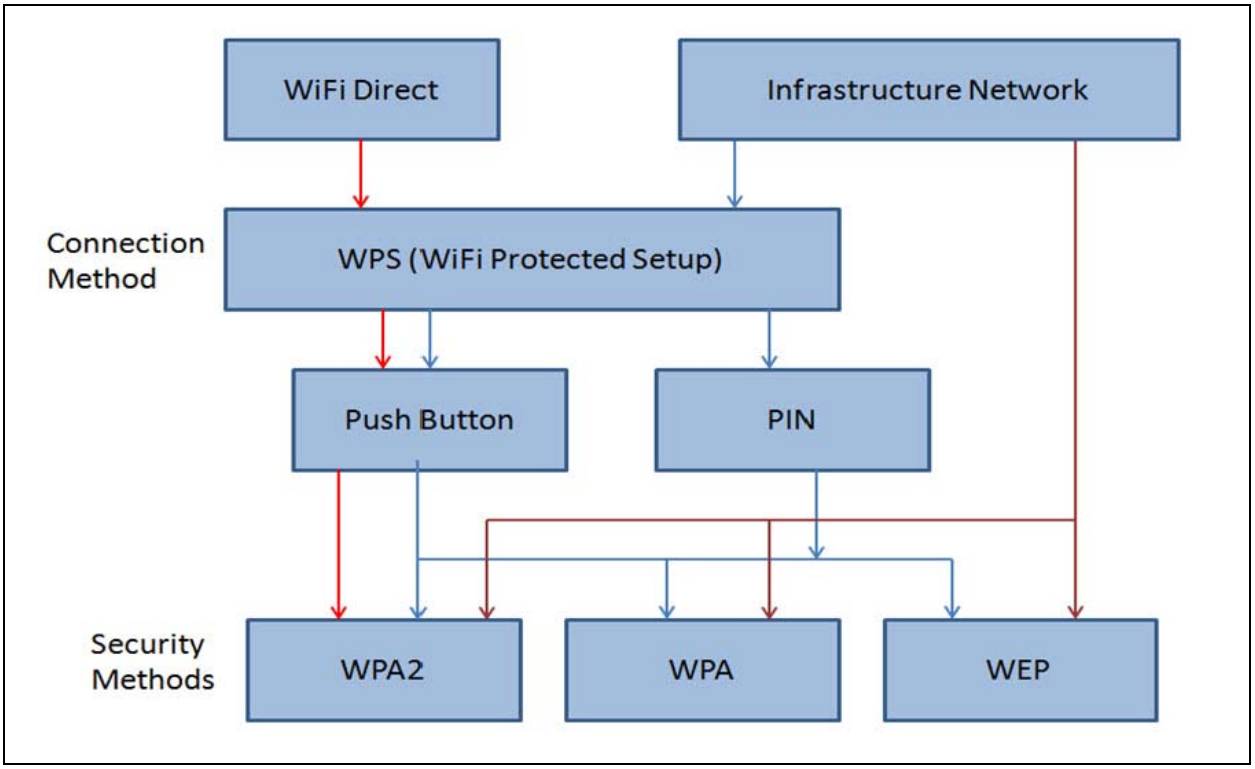
WiFi Protected Setup (WPS) allows users to set up and expand the WiFi networks with security enabled, even if they are not familiar with the underlying technologies or processes involved. For example, users no longer have to know that SSID refers to the network name or WPA2 refers to the security mechanism.

WPS does not support ad hoc networks. WPS will configure the network name SSID and security key for the AP and WPS client devices on a network. It supports the WEP/WPA/WPA2 security methods. Figure 4-9 shows the WPS and security methods.

WPS offers the following setup solutions:

- Push Button Configuration (PBC) - users can connect the device to the network and enable data encryption by pushing the buttons on the AP and client device.
- Personal Information Number (PIN) - PIN is provided for each device which joins the network.

FIGURE 4-9: WPS AND SECURITY METHODS



4.5.7 Wireless Security

4.5.7.1 WIRED EQUIVALENT PRIVACY (WEP)

Note:	Several disadvantages are identified in WEP, which results in hackable and insecure networks. The use of WEP has been superceded by WPA/WPA2.

WEP security has two forms: 64-bit WEP, which uses a 40-bit key (WEP-40) and 128-bit WEP, which uses a 104-bit key (WEP-104).

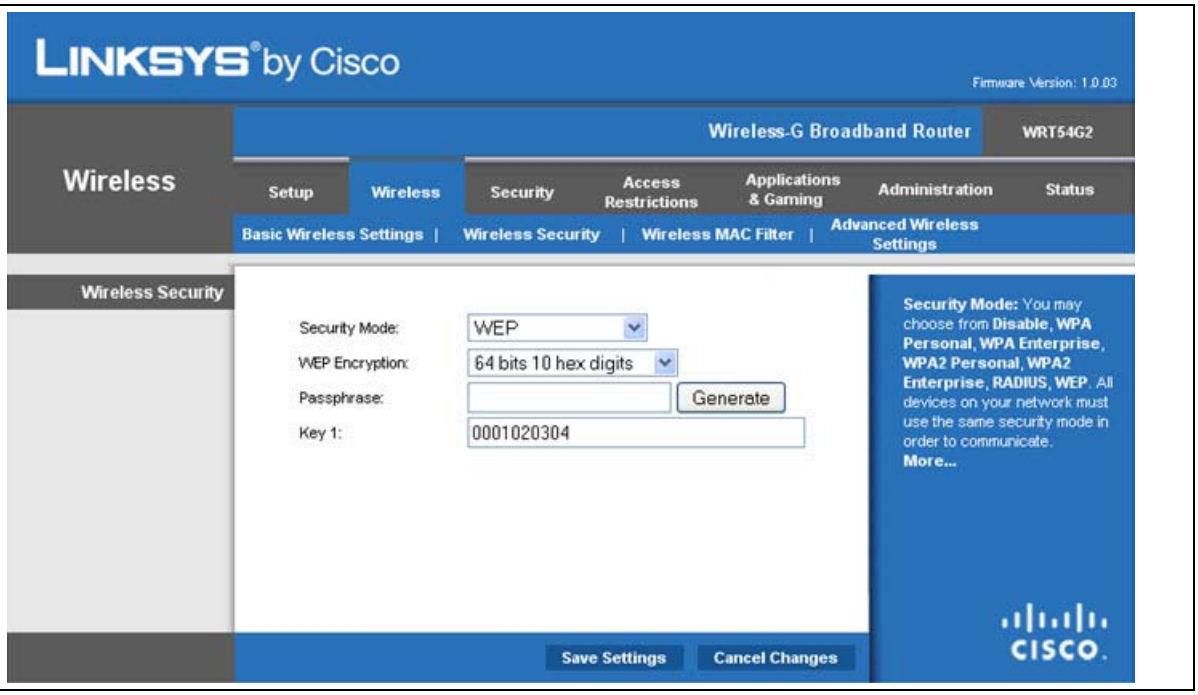
In the basic form, WEP keys have hexadecimal values, 5 bytes for WEP-40 and 13 bytes for WEP-104. Some routers, such as the Linksys WRT54G, increases the random nature of the WEP key by adding an additional layer that converts an ASCII passphrase into a hexadecimal key. The MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ will require a hexadecimal key.

To enable WEP security between the development board and AP, setup the AP for security and program the development board with the correct WEP keys.

4.5.7.2 SETUP ACCESS POINT FOR WEP

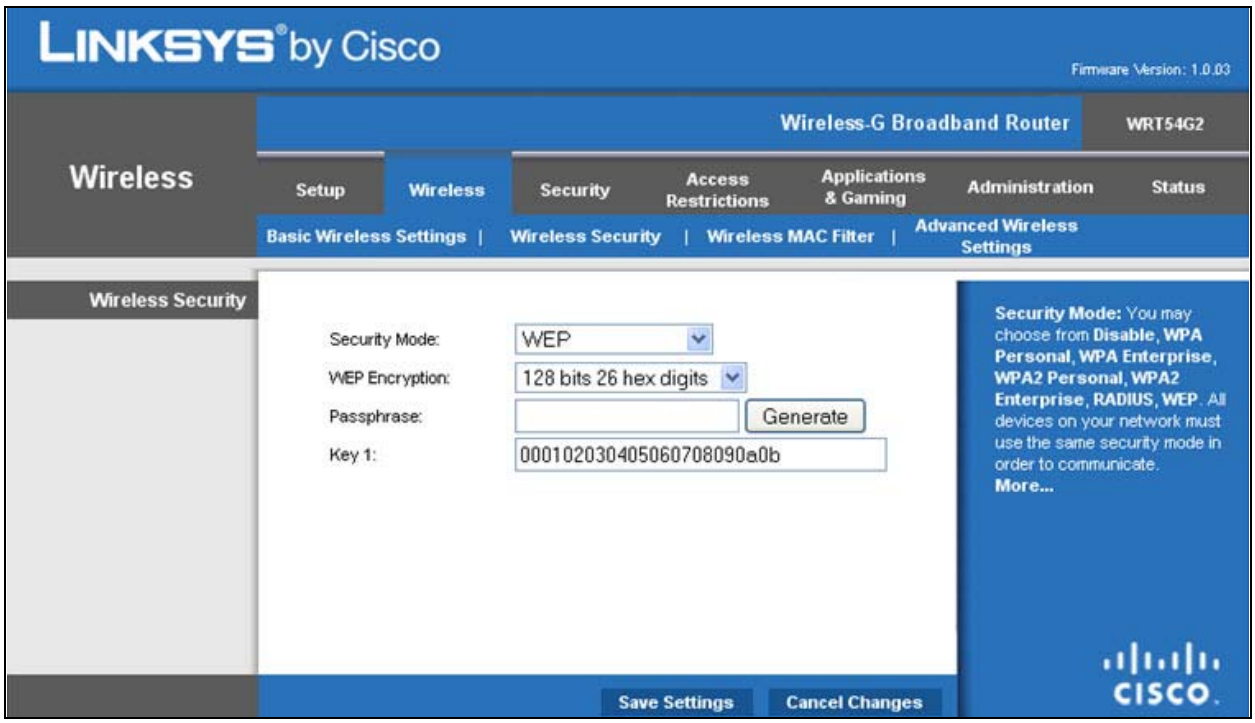
1. Login to the router, see instructions in **2.5 "Wireless Access Point (AP) Setup"**.
2. To access the wireless security options *Wireless>Wireless Security*, see Figure 4-10.

FIGURE 4-10: 64-BIT WEP SECURITY SETUP



3. To match the default code in the hardware, choose security features as shown in Figure 4-11 (depending on whether 64-bit WEP or 128-bit WEP is used).

FIGURE 4-11: 128-BIT WEP SECURITY SETUP

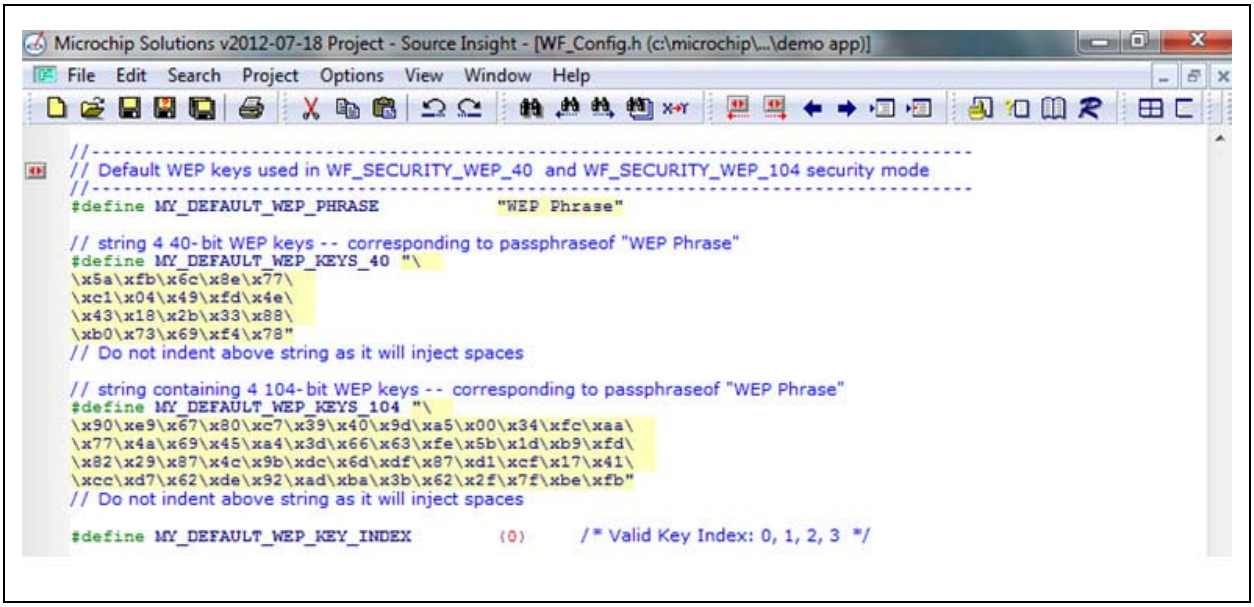


4.5.7.3 SETUP SOURCE CODE FOR WEP

After the AP is configured for WEP, user must program the development board to use WEP. Configure the following for WEP, and it is located in `WF_Config.h`. For more information, see Figure 4-12.

- Set the encryption type to WEP-40 or WEP-104. Define `MY_DEFAULT_WIFI_SECURITY_MODE` to either `WF_SECURITY_WEP_40` or `WF_SECURITY_WEP_104`
- Set the WEP phrase. Refer to `MY_DEFAULT_WEP_KEYS_40` or `MY_DEFAULT_WEP_KEYS_104`.

FIGURE 4-12: SOURCE CODE FOR WEP SECURITY SETUP



4.5.8 WPA/WPA2

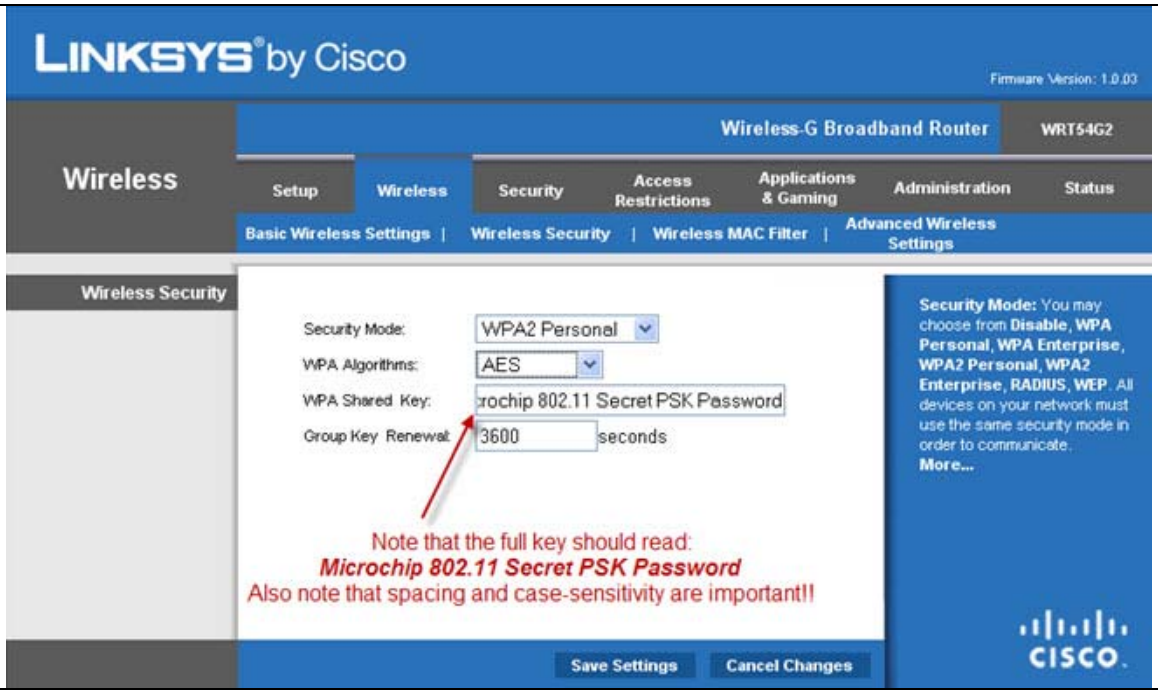
WPA and WPA2 are security modes that implement the 802.11i specification. They are more secure than the WEP encrypted networks and utilizes the SSID and user passphrase to generate the PSK. The MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ has two methods of calculating the PSK for use in WPA/WPA2. Users can program the 32-byte hexadecimal key into the source code, or the MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ can calculate the 32-byte hexadecimal key internally. If the MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ has to calculate the key, this will add an additional 30 seconds to 45 seconds to the initial connection time, as the chip calculates the value.

4.5.8.1 TO SET UP AP FOR WPA/WPA2 PERSONAL

1. Login to the router, refer instructions in the **2.5 "Wireless Access Point (AP) Setup"**.
2. Access the wireless security options by *Wireless>Wireless Security*. For WPA Personal, see Figure 4-13. For WPA2 Personal, use WPA algorithm (AES) only see Figure 4-14.
3. To match the default code in the hardware, set up the security as shown in Figure 4-13 and Figure 4-14.

FIGURE 4-13: WPA PERSONAL SECURITY SETUP

FIGURE 4-14: WPA2 PERSONAL AES SECURITY SETUP



4.5.9 Setup Source Code for WPA/WPA2

The MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ has the following two approaches to run WPA/WPA2 security:

- On-the-fly PSK Calculation - The straight forward approach to supply the passphrase. The PIC18/24/32 or PICtail will calculate the PSK based on the SSID and the supplied passphrase. Due to the computationally intensive nature of this operation, this will take approximately 30 seconds to 45 seconds to complete.
- Pre generated PSK - This approach is to provide the 32 byte PSK, and user can directly plug this value into the source code.

The following section describes setting up and using both the preceding approaches:

4.5.9.1 ON-THE-FLY PSK CALCULATION

Only two pieces of information required to enable the MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ to calculate the PSK and use that for the encryption process, see Figure 4-15.

Define `MY_DEFAULT_WIFI_SECURITY_MODE` to be `WF_SECURITY_WPA_WITH_PASS_PHRASE` or `WF_SECURITY_WPA2_WITH_PASS_PHRASE`.

Define `MY_DEFAULT_PSK_PHRASE`.

FIGURE 4-15: SOURCE CODE CALCULATE PSK SETUP

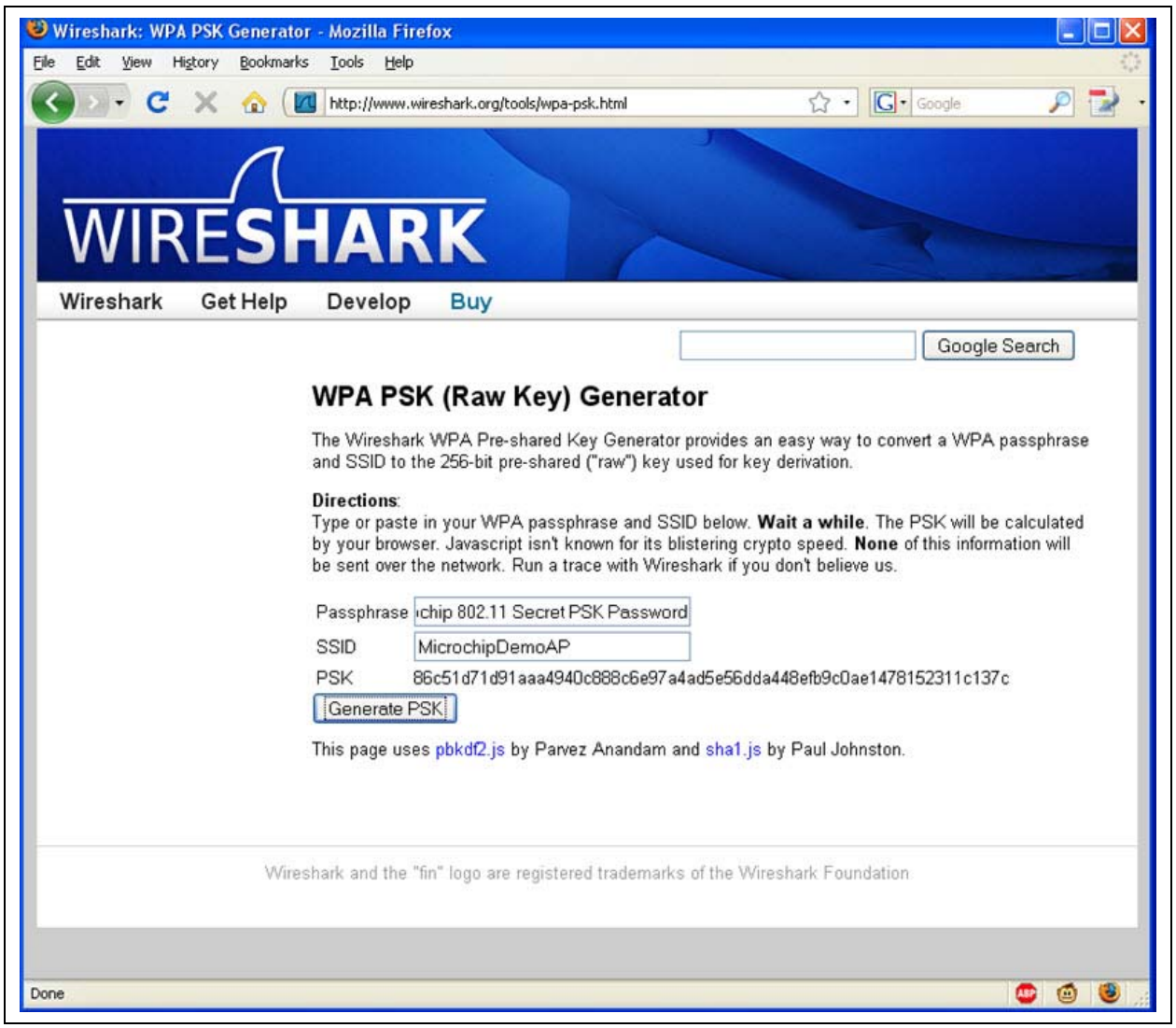
```
// Default pass phrase used for WF_SECURITY_WPA_WITH_PASS_PHRASE and
// WF_SECURITY_WPA2_WITH_PASS_PHRASE security modes
#define MY_DEFAULT_PSK_PHRASE                   "Microchip 802.11 Secret PSK Password"
```

Note that passphrase is case sensitive and spacing does matter.

4.5.9.2 PRE GENERATED PSK

Users can pre generate the PSK and use 32 byte PSK in the source code. The handy tool to generate the PSK is available online at the Wireshark Foundation (see Appendix A.4). The Wireshark web site can generate the expected 32 byte PSK key with the SSID name and the passphrase. Use these values in the variable `MY_DEFAULT_PSK in WF_Config.h`. For more information, see Figure 4-16.

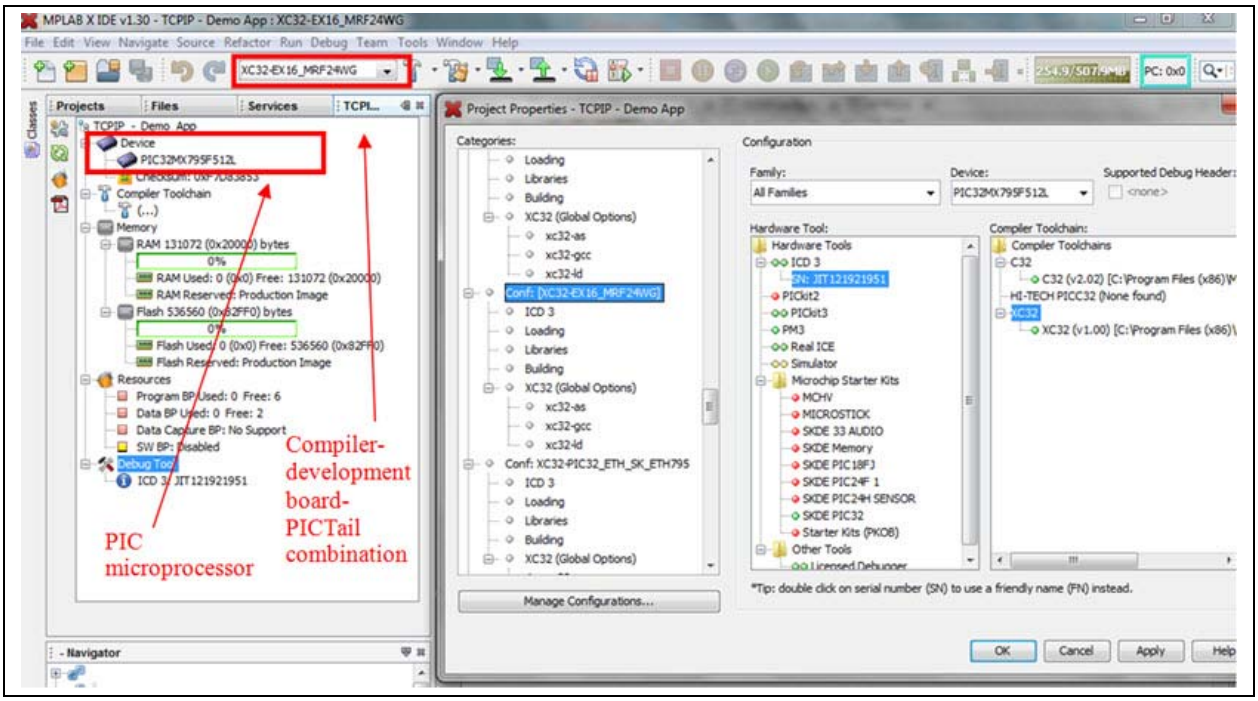
FIGURE 4-16: WPA PSK GENERATION



4.6 COMPILING AND DOWNLOADING IMAGES

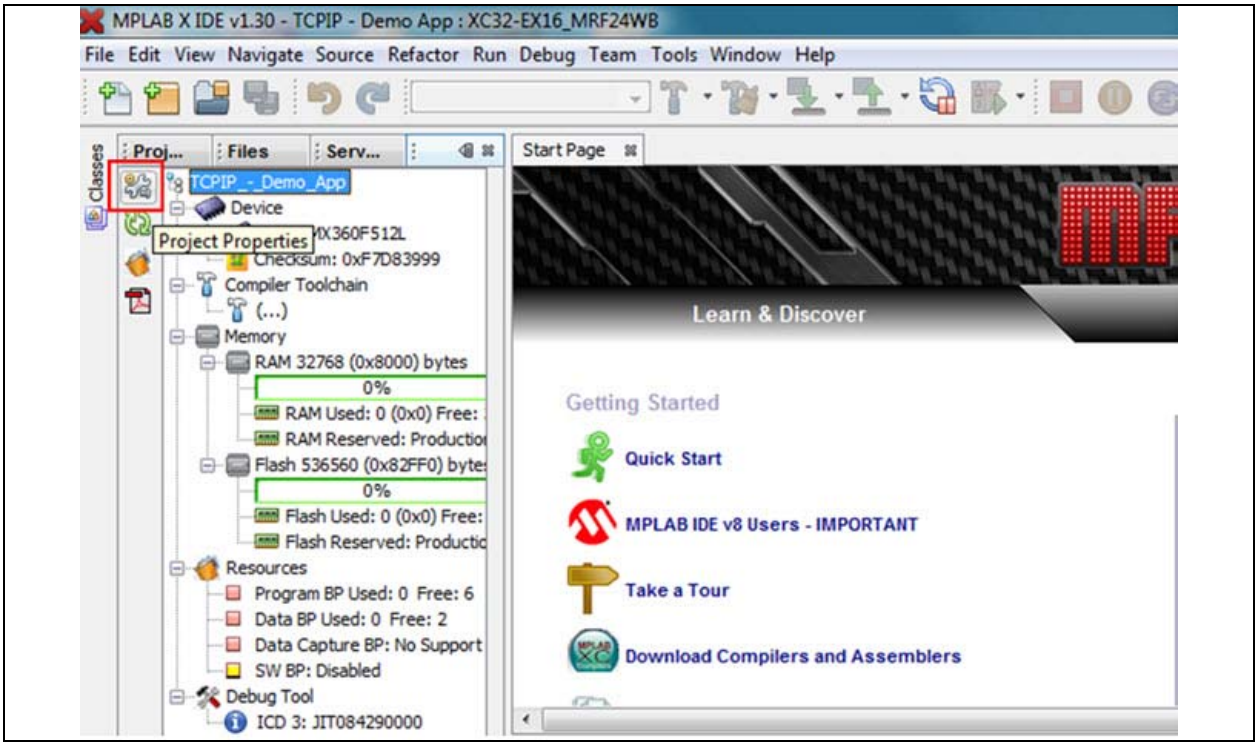
1. From the left pane, under **Device** select appropriate Compiler development board PICtail combination and PIC microprocessor, see Figure 4-17.

FIGURE 4-17: PIC MICROPROCESSOR AND COMPILER-DEVELOPMENT BOARD-PICTAIL COMBINATION



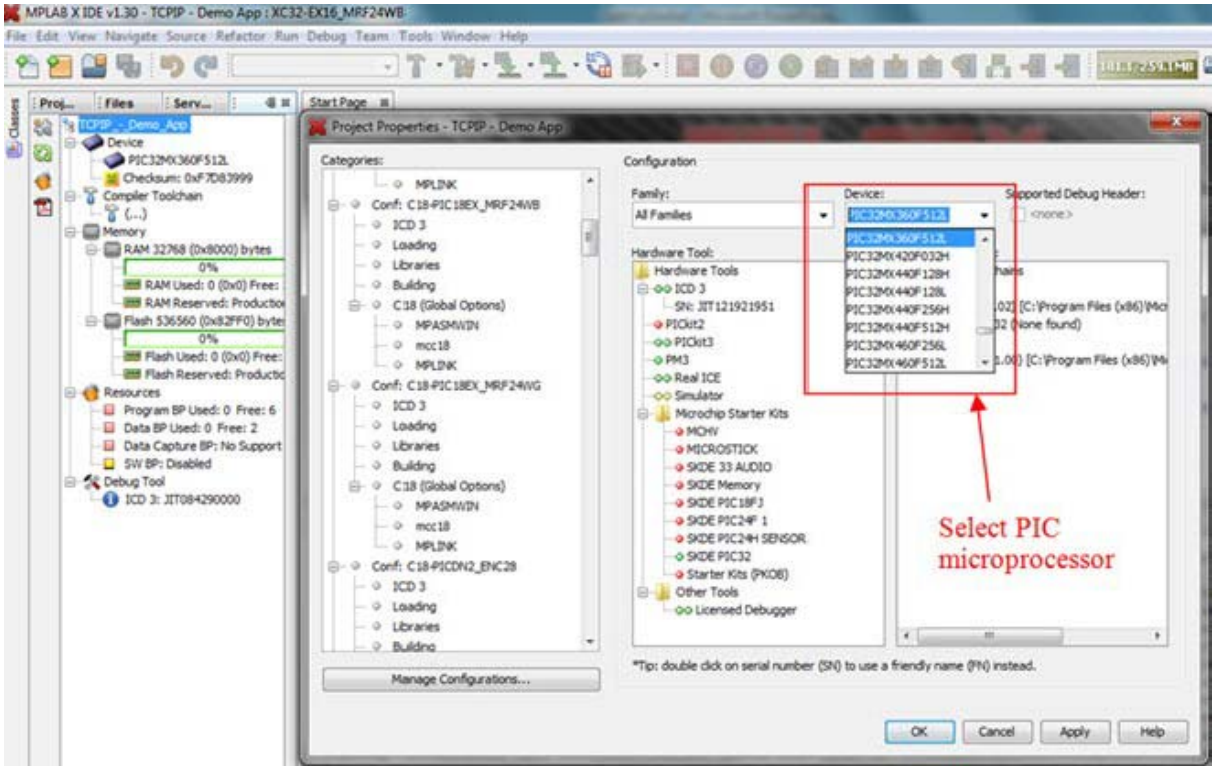
2. To change the device type, click **Project Properties,** see Figure 4-18. The Project Properties sub panel is displayed.

FIGURE 4-18: PROJECT PROPERTIES ICON



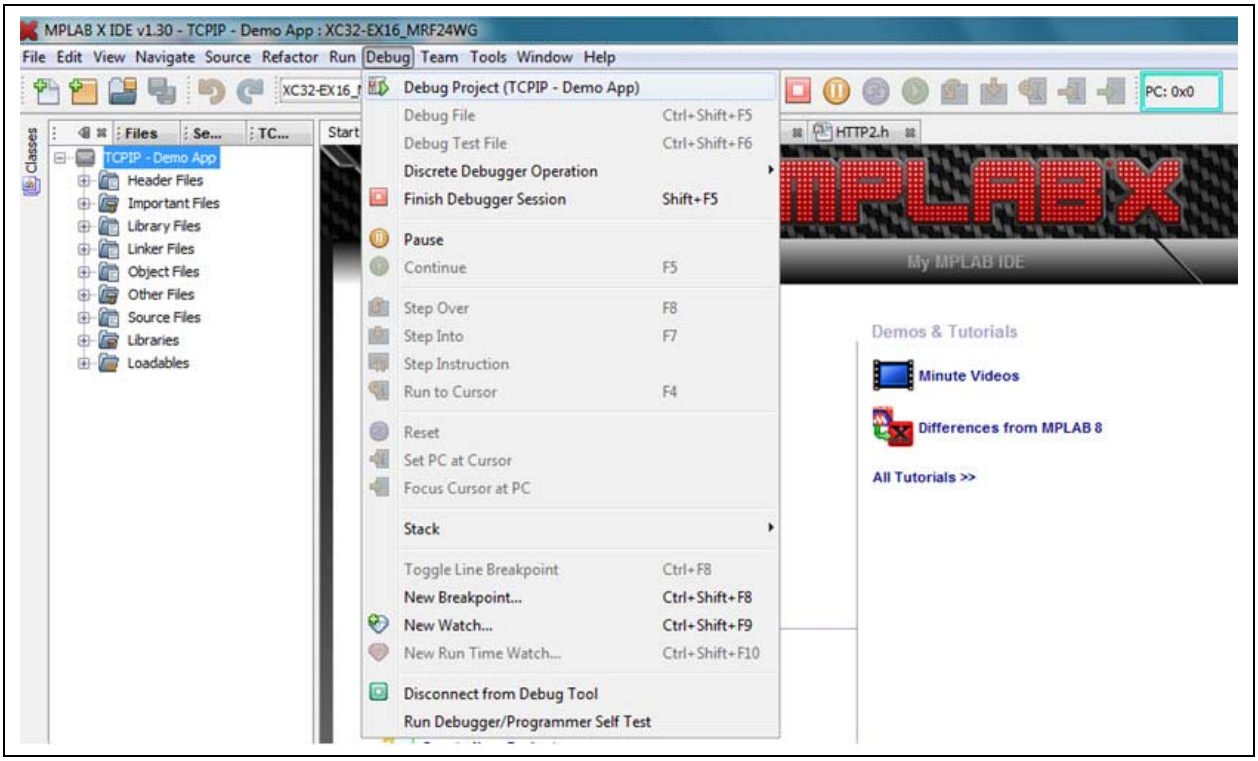
3. Select the device type, as shown in Figure 4-19.

FIGURE 4-19: CHANGE DEVICE TYPE



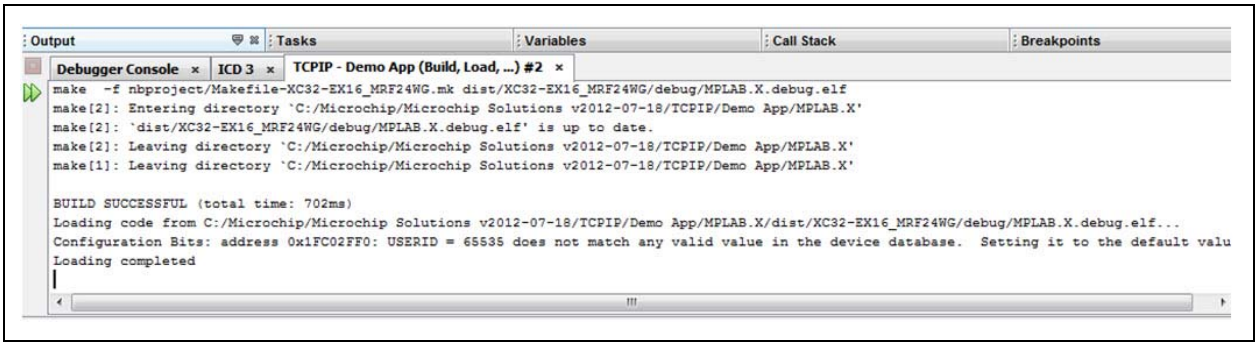
4. Click **Debug** menu and select `Debug Project` command to compile, build, connect to the ICD, detect the target device, program the target device and run, see Figure 4-20.

FIGURE 4-20: DEBUG PROJECT



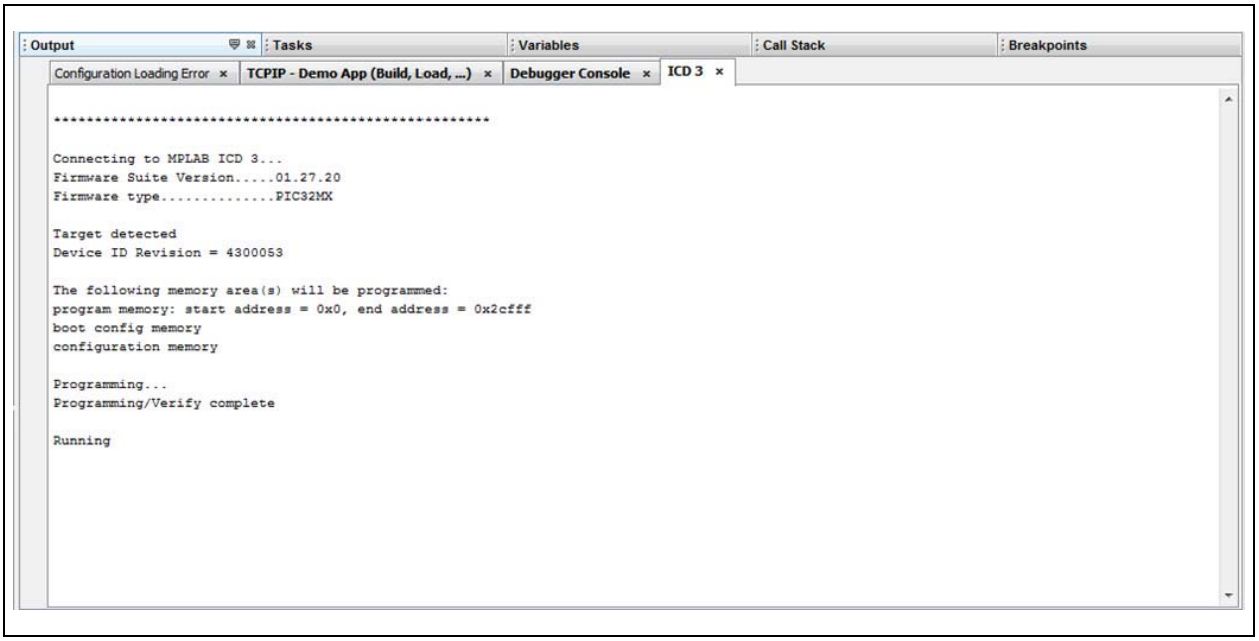
5. Monitor the **Demo App (Build, Load, ...)** tab under the Output window in the MPLAB X IDE to view compiler errors or warnings. When the compilation has completed and built correctly, the output is shown in Figure 4-21.

FIGURE 4-21: BUILD SUCCESSFUL. LOADING COMPLETED.



6. Monitor the **ICD3** tab under the Output window in MPLAB X IDE to view the target being detected and programmed, the output is shown in Figure 4-22.

FIGURE 4-22: SUCCESSFUL PROGRAMMING



4.7 RUNNING TCP/IP – DEMO APP

This is applicable only for Explorer 16 and PICDEM.net2 Development Boards as the PIC32 starter kit does not use the EEPROM. Due to this, you may notice situations where you have made changes in the code that are not reflected during the demonstration (for example, you changed the SSID name, but do not see it is being used), and user must erase the EEPROM, refer to **5.3 "Erasing EEPROM"**.

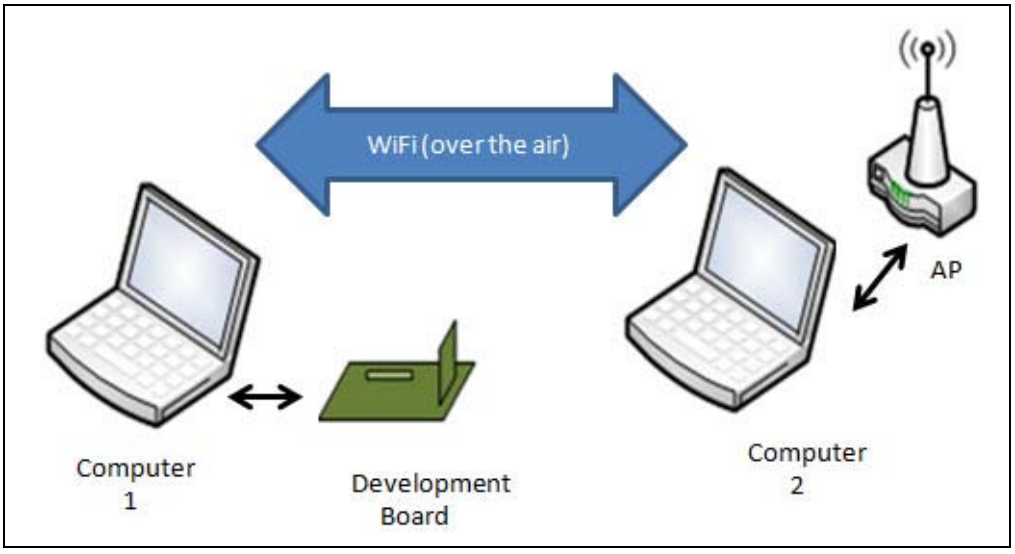
For the first time demonstration, perform these actions. The user must setup hardware and software before the WiFi demonstration.

1. Download web server code into the EEPROM of the development board. To download web server code, from the browser navigate to a special page that will allow you to upload image files. More information on uploading image files are provided in the later section. It is recommended to define `MY_DEFAULT_WIFI_SECURITY_MODE` as `WF_SECURITY_OPEN`.
2. After the development board is connected to the AP (or it has created the network in Ad hoc mode), the LCD panel will display the IP address that is being used. Alternately, the serial output should display the same information.

4.7.1 Network Type: CFG_WF_INFRASTRUCTURE

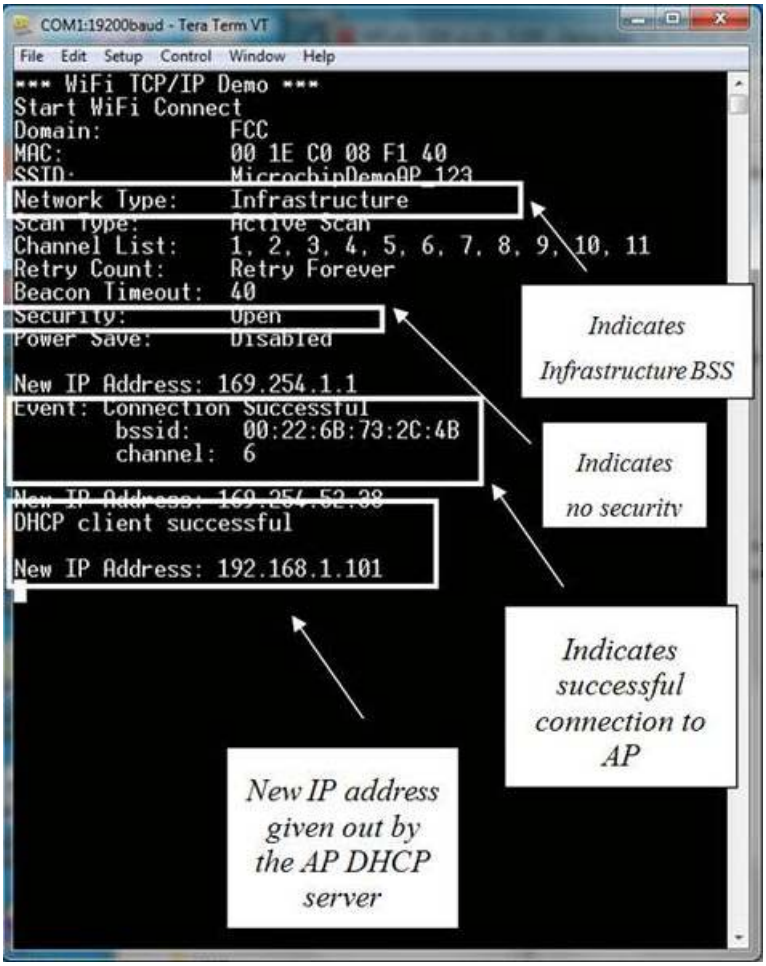
1. CFG_WF_INFRASTRUCTURE is the default network type with the MLA release. Ensure that SSID and Security mode is set to match with the APs configurations. In the `WF_Config.h`, perform these actions:
   a) Define the MY_DEFAULT_NETWORK_TYPE as CFG_WF_INFRASTRUCTURE.
   b) Define the MY_DEFAULT_WIFI_SECURITY_MODE as WF_SECURITY_OPEN.
   c) Define the MY_DEFAULT_SSID_NAME to be same as the AP or router's SSID.

FIGURE 4-23: INFRASTRUCTURE NETWORK ENVIRONMENT SETUP



2. After the development board is connected to the AP, the LCD panel displays the IP address that is being used. Alternately, the serial output should display similar informations, see Figure 4-24.

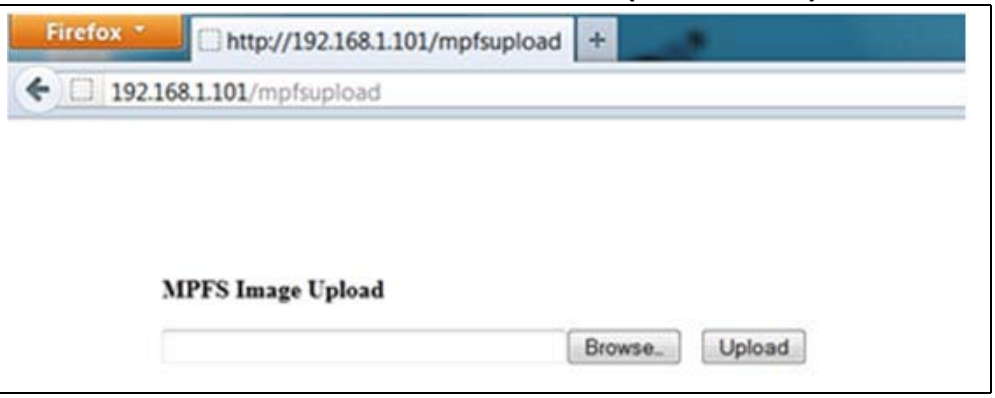
FIGURE 4-24: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY: INFRASTRUCTURE NETWORK TYPE



3. Navigate to the upload page of the development board. On computer 2s web browser, type http://xxx.xxx.xxx.xxx/mpfsupload, where xxx.xxx.xxx.xxx is the IP address of the development board, see Figure 4-25.

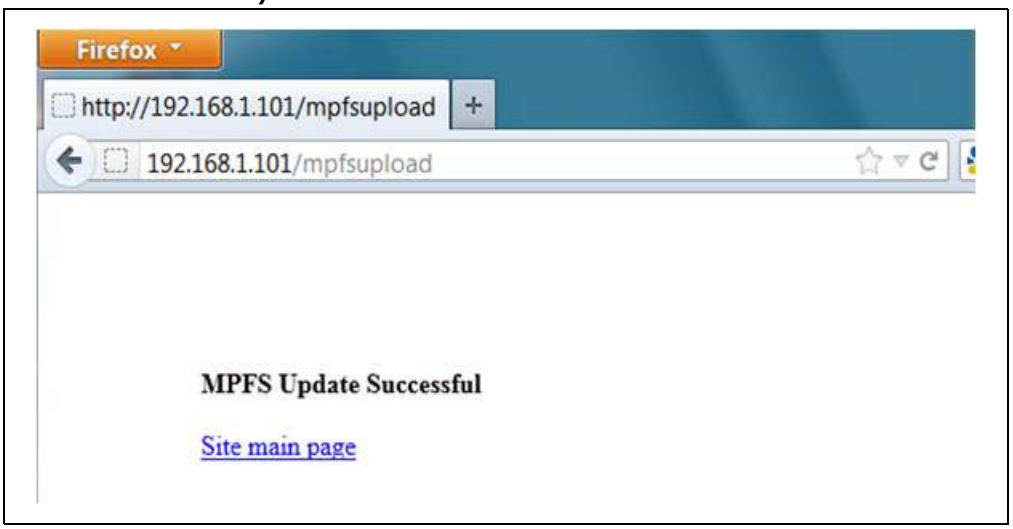
Note: This is only required for the PICDEM.net 2 and the Explorer 16 Development Board. Starter kits do not have the EEPROM, and their image is compiled into program Flash memory.

FIGURE 4-25: WEB SERVER IMAGE UPLOAD (COMPUTER 2)



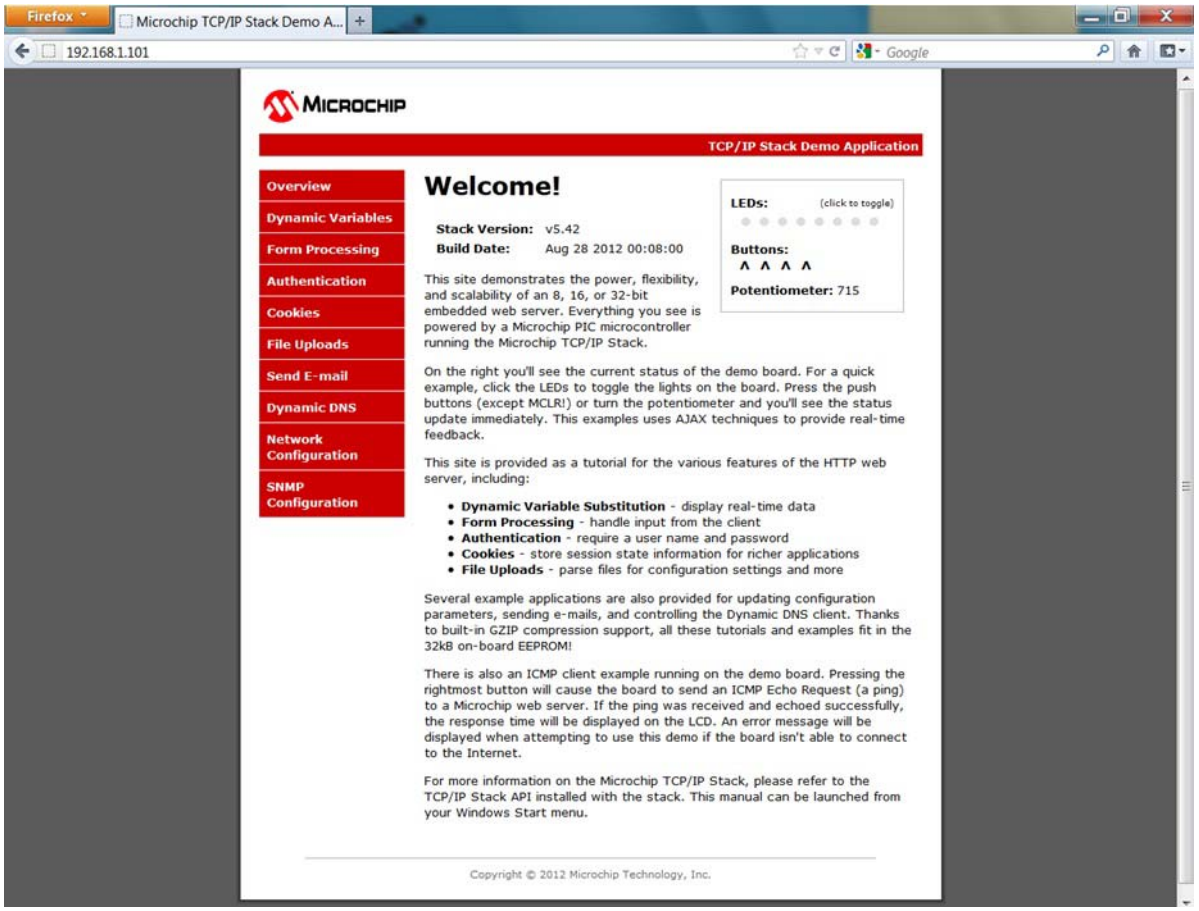
4. Click **Browse** button to upload the `MPFSImg2.bin` file, and this file is located in the root directory of the `TCPIP-Demo App` directory. If all the softwares are installed in the default location, the directory path will be `C:\Microchip Solutions vyyyy-mm-dd\TCPIP\Demo App\`.
5. Open the `MPFSImg2.bin` file and click **Upload** button to upload the file.
6. After the successful uploading, “MPFS Update Successful” message will be displayed, see Figure 4-26.

FIGURE 4-26: WEB SERVER IMAGE UPLOAD SUCCESSFUL (COMPUTER 2)



7. Click **Site main page** link to navigate to the main page of the web server, see Figure 4-27.

FIGURE 4-27: TCPIP – DEMO APPLICATION (COMPUTER 2)



8. The TCP/IP WiFi demonstration application enable users to understand features and applications that are available with the Microchip TCP/IP stack, and how it can be used on wireless medium. From the web main page, user can interact with the development board hardware to toggle LEDs, push buttons and change potentiometer values. For example, from the `Form Processing` page, user can select the LEDs to be turned ON or OFF by clicking **Save** button.
9. On the LCD, enter “Test 1 2 3 3 4 5” and click **Save** button. The respective LEDs on the development board being configured as programmed and the LCD on the development board displays “Test 1 2 3 3 4 5”, see Figure 4-28 and Figure 4-29.

FIGURE 4-28: TCPIP – DEMO APPLICATION: TOGGLING LEDS AND LCD (COMPUTER 2)

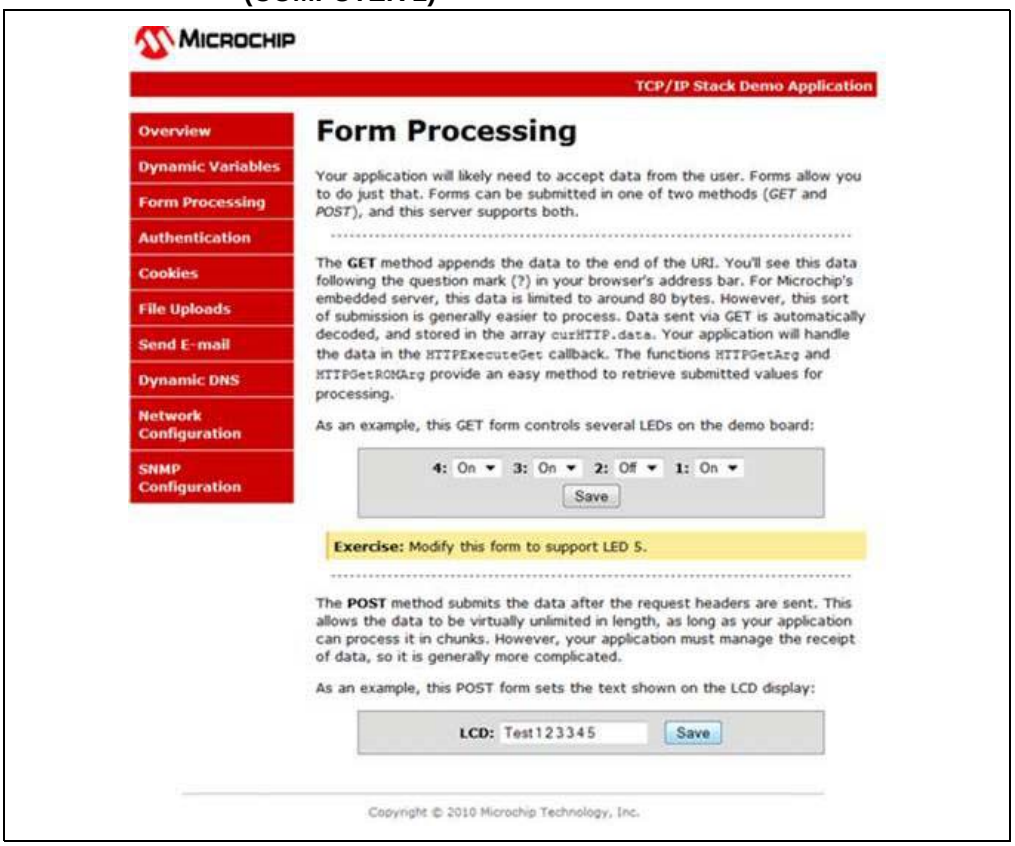
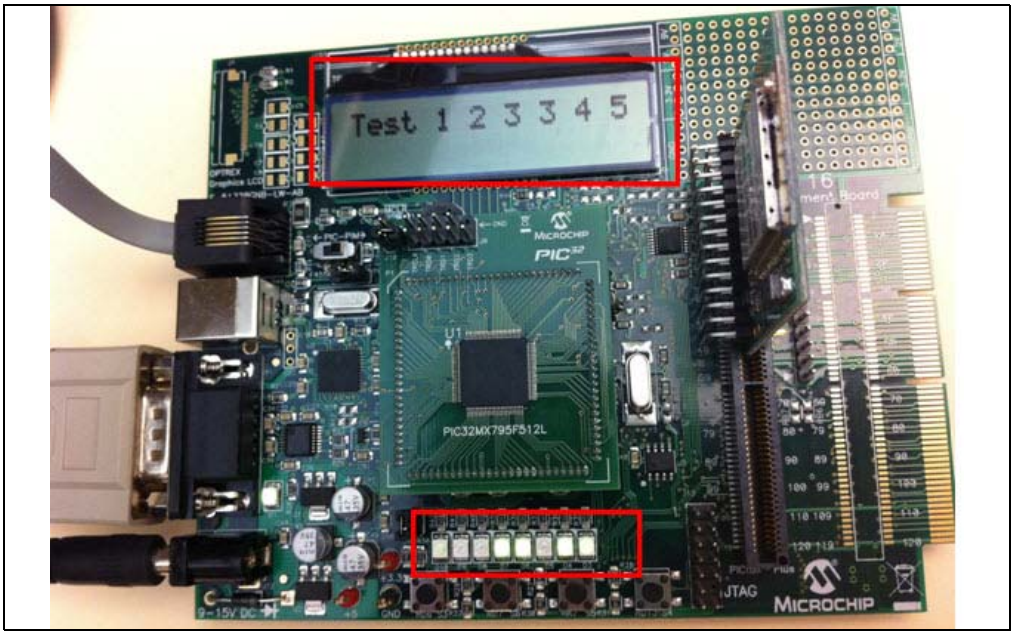


FIGURE 4-29: TCPIP – DEMO APPLICATION: LEDS AND LCD ON DEVELOPMENT BOARD



10. Other web pages of the demonstration allow you to send e-mails, upload files and change network configuration values. Refer to the Microchip `TCP/IP Stack Help.chm` document that is part of the TCP/IP Stack source code release.

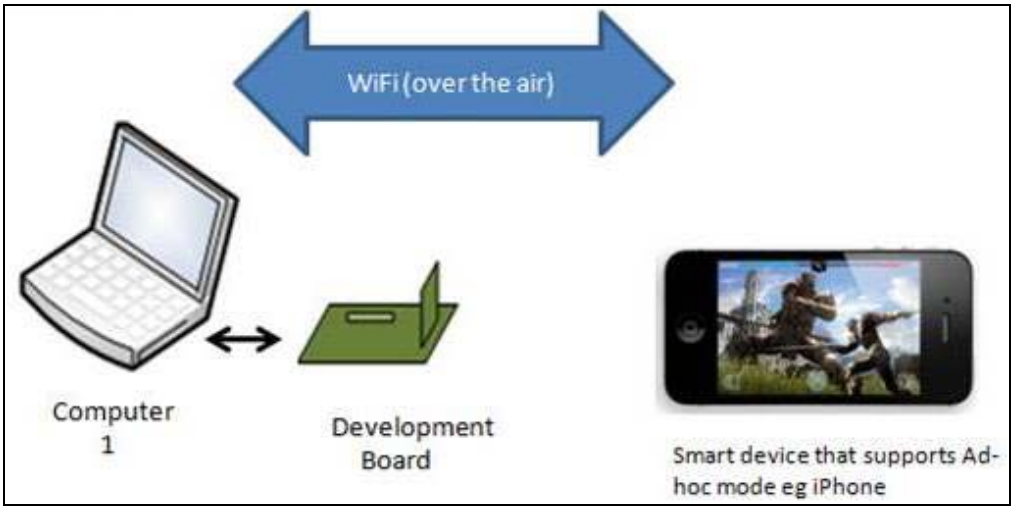
4.7.2 Network Type: CFG_WF_ADHOC

The security mode supported by MRF24WB0MA/B and MRF24WG0MA/B is Open mode and WEP security. In the following example, open security is used.

In the `WF_Config.h` file, perform these actions:

1. Define the MY_DEFAULT_NETWORK_TYPE as CFG_WF_ADHOC.
2. Ensure that the MY_DEFAULT_SSID_NAME is defined to be unique and different from the SSID name used in the CFG_WF_INFRASTRUCTURE. For example, MY_DEFAULT_SSID_NAME is defined as Adhoc_MCHPDemoAP_123.

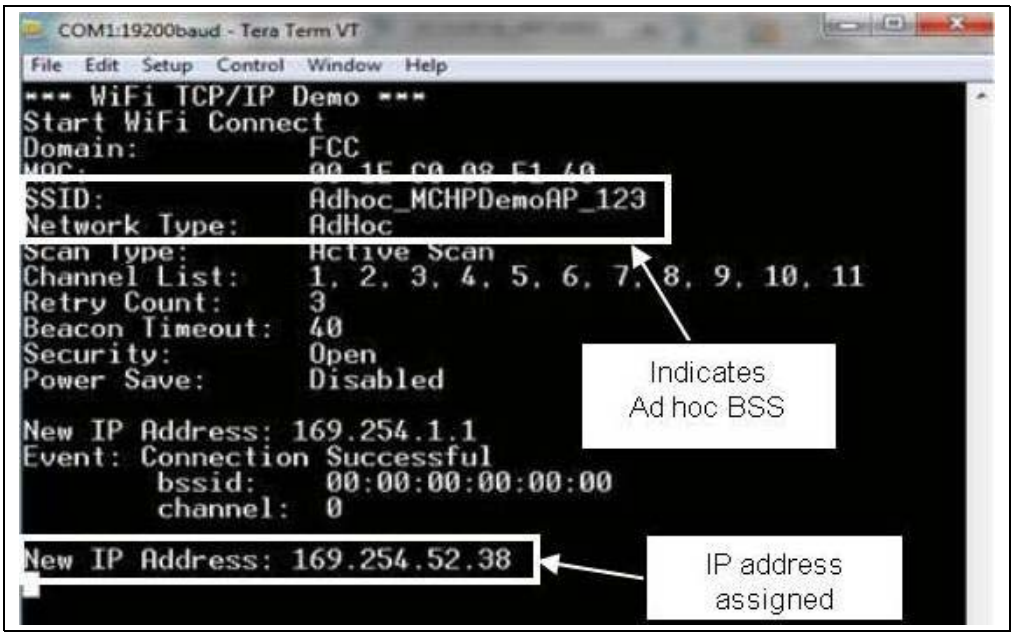
FIGURE 4-30: AD HOC NETWORK ENVIRONMENT SETUP



Note: In this demonstration, iPhone is used as the smart device. Alternatives can be used instead of the iPhone, such as laptop with wireless network adapter.

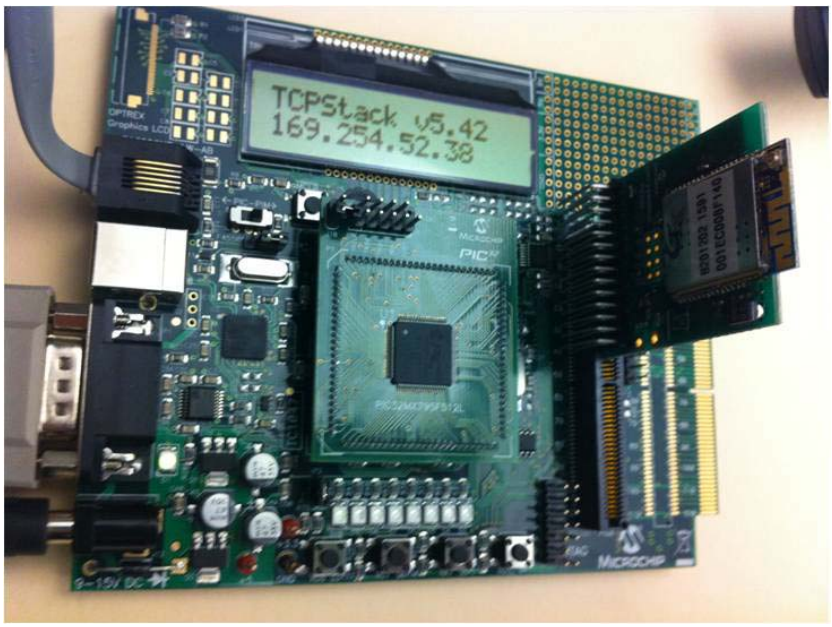
3. MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ is the first station to broadcast the message to create the network. After successful creation of the network, connection successful message will be displayed, see Figure 4-31.

FIGURE 4-31: DEVELOPMENT BOARD SERIAL DISPLAY: AD HOC NETWORK TYPE



4. After the development board is connected to another device, the LCD panel will display new IP address, see Figure 4-32. Alternately, the serial output also displays similar information, see Figure 4-31.

FIGURE 4-32: TCPIP – DEMO APPLICATION: LEDS AND LCD ON DEVELOPMENT BOARD



5. On the smart device, select the menu settings to view the WiFi networks detected, see Figure 4-33.

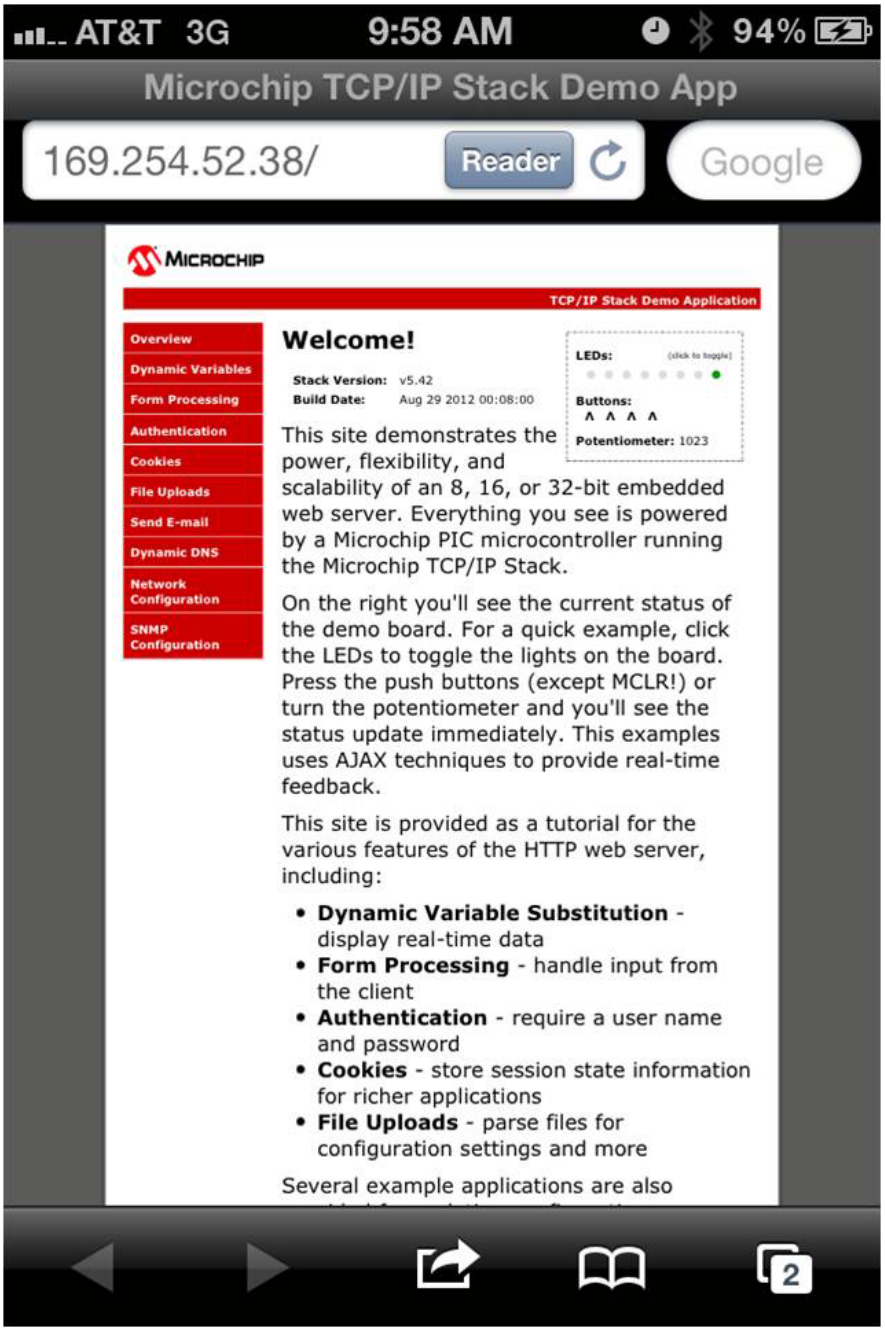
FIGURE 4-33: WIFI NETWORKS DETECTED ON SMART DEVICE

6. Click on the ad hoc network SSID to connect to this ad hoc network, as shown in Figure 4-34.

FIGURE 4-34: SELECT AD HOC NETWORK ON SMART DEVICE

7. After connection to this ad hoc network is established, user can enter IP address of the ad hoc network (for example, 169.254.52.38) on the smart device's web browser. The demonstration is similar to the infrastructure network type. For example, when user presses any of the buttons (S1 through S4) on the development board, the web page will display the same buttons being pressed, see Figure 4-35.

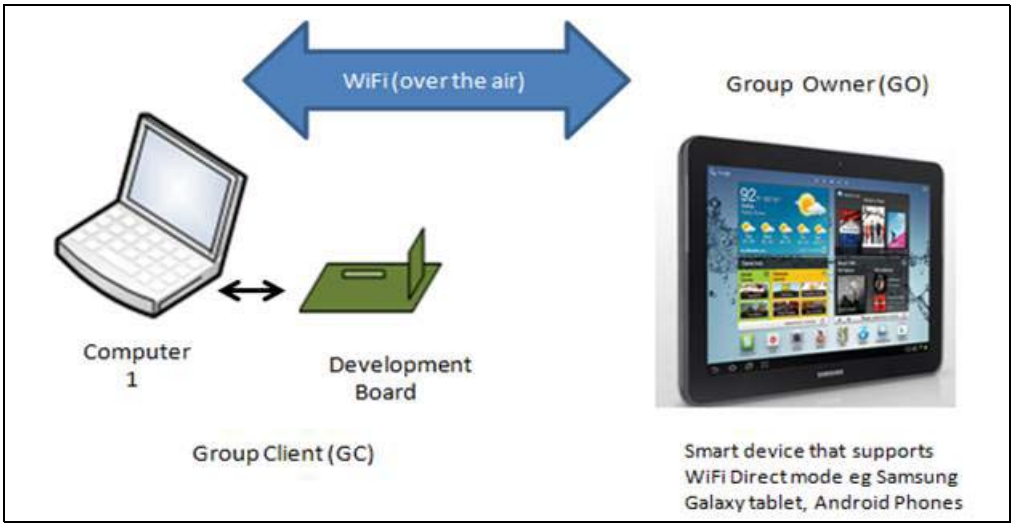
FIGURE 4-35: WEB BROWSER ON SMART DEVICE (AD HOC BSS)



4.7.3 Network Type: CFG_WF_P2P

WiFi Direct (peer-to-peer (P2P)) network type is only applicable for 802.11g hence specific to MRF24WG0MA/B modules. The Samsung Galaxy tablet is used in this demonstration. Figure 4-36 illustrates the WiFi Direct environment setup.

FIGURE 4-36: WIFI DIRECT ENVIRONMENT SETUP



The implementation is restricted to the role of group client (GC) only.

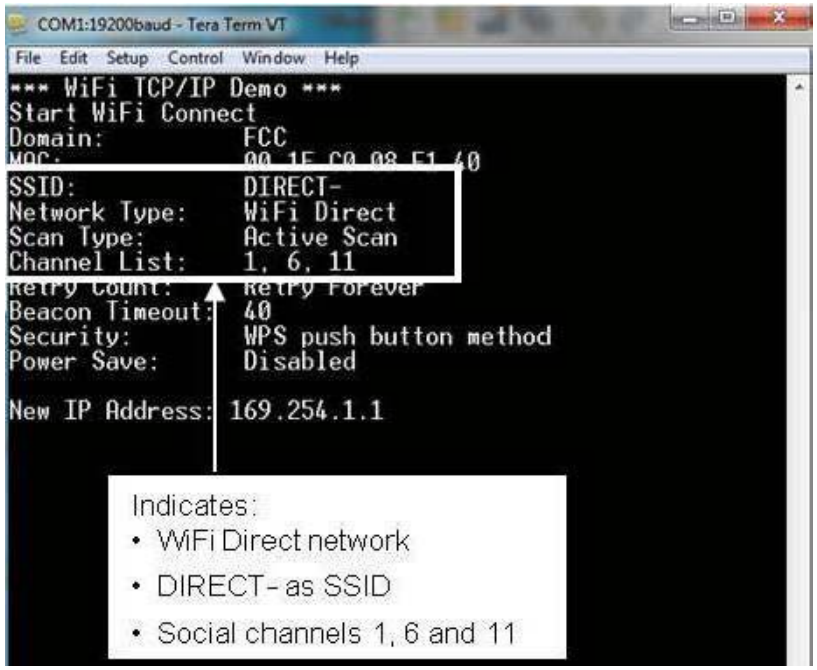
In the `WF_Config.h` file, perform these actions:

1. Define the MY_DEFAULT_NETWORK_TYPE as CFG_WF_P2P.
2. Allow the MY_DEFAULT_WIFI_SECURITY_MODE as default (that is, WF_SECURITY_WPS_PUSH_BUTTON).
3. Allow the MY_DEFAULT_SSID_NAME as default (that is, DIRECT-), which is an unique and specified identifier to identify a WiFi Direct network.
4. Allow the MY_DEFAULT_CHANNEL_LIST as default (that is, {1, 6, 11}), which are the specified channels to be used in the WiFi Direct network.

Note: Specific smart devices may have a de facto security mode such as WPS Push button, and may not prompt for a push button entry.

5. After the development board is powered up and running, the serial output is displayed as shown in Figure 4-37.

FIGURE 4-37: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY: WIFI DIRECT NETWORK TYPE



6. On the smart device, enable WiFi Direct mode, see Figure 4-38.

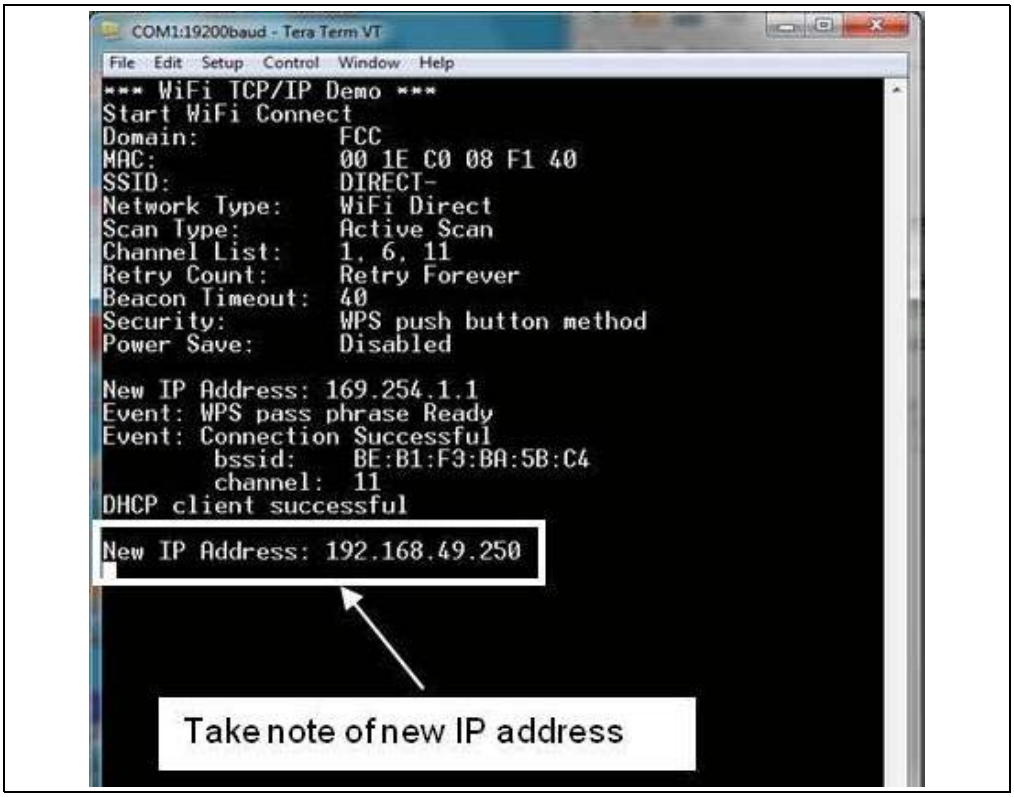
FIGURE 4-38: SMART DEVICE WIFI DIRECT MODE ENABLED

7. The smart device will prompt a message to Accept or Decline the device. Click to accept the connection request, see Figure 4-39.

FIGURE 4-39: SMART DEVICE PROMPT TO ACCEPT OR REJECT CONNECTION REQUEST

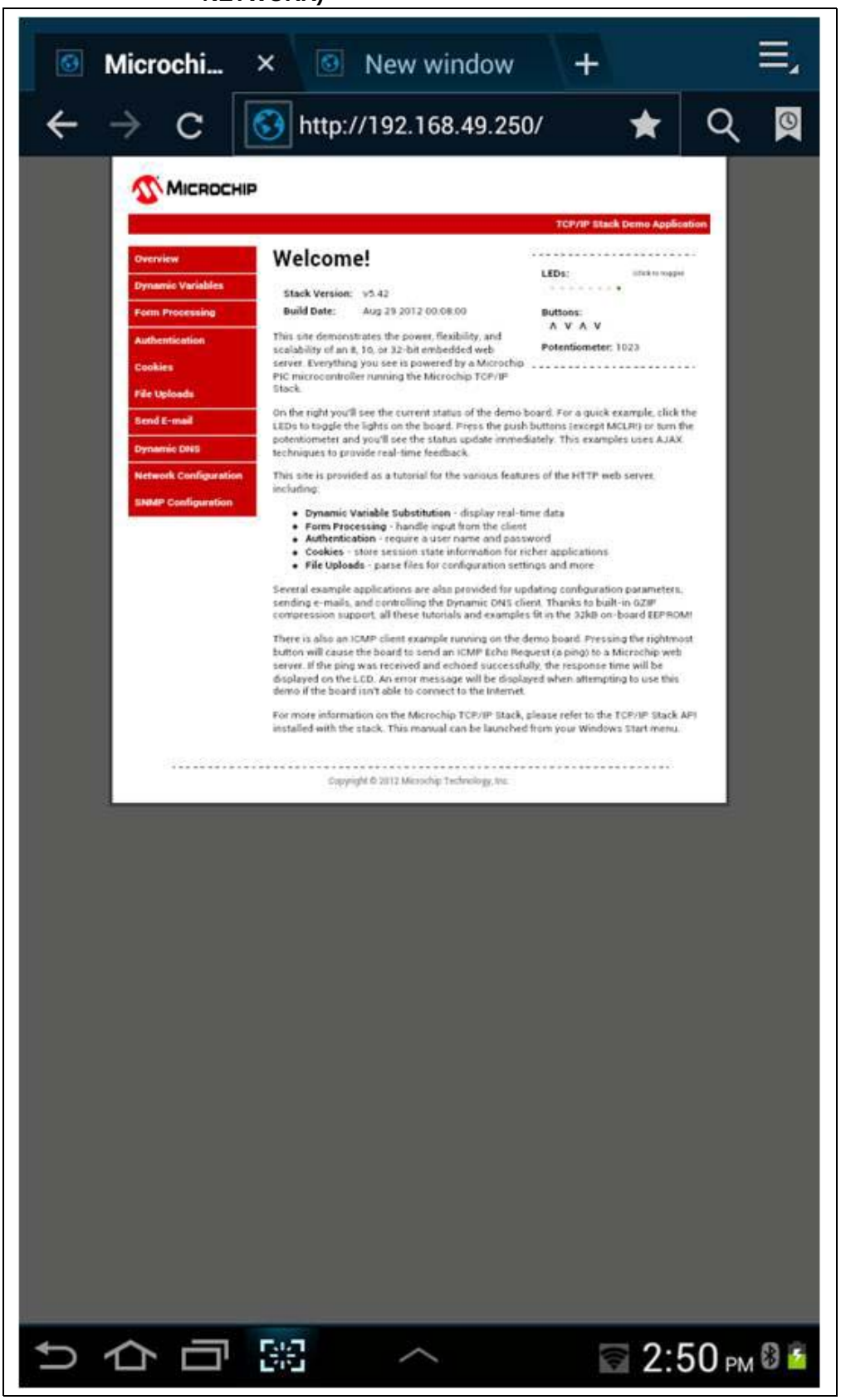
8. The development board will display the successful connection status, as shown in Figure 4-40.

FIGURE 4-40: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY: WIFI DIRECT CONNECTION STATUS



9. After connection to this WiFi Direct network is established, users can enter the Wi-Fi Direct network IP address (for example, 192.168.49.250) on the smart device's web browser. The demonstration is similar to the Infrastructure Network type, see Figure 4-41.

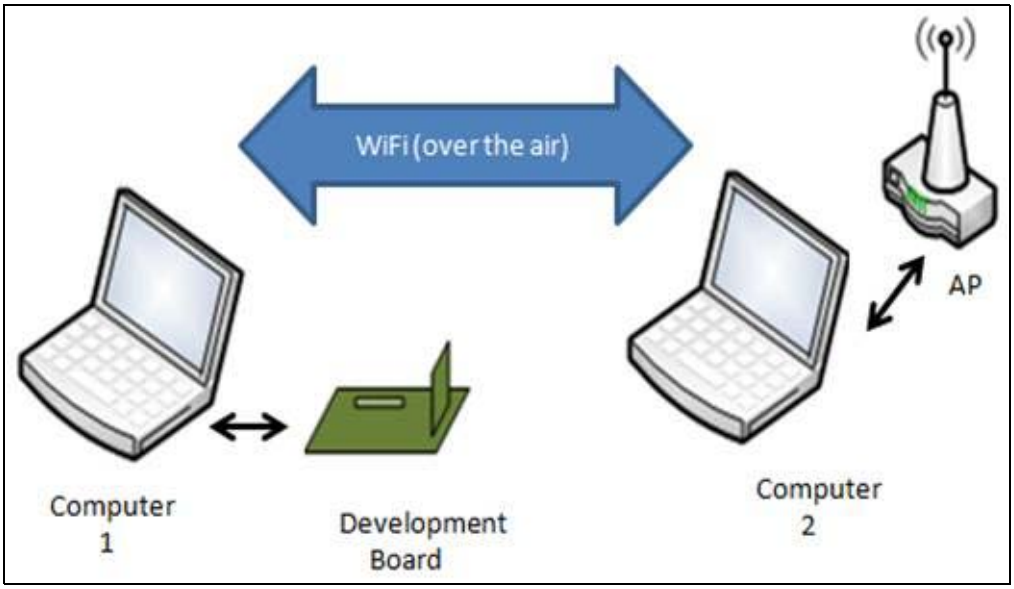
FIGURE 4-41: WEB BROWSER ON SMART DEVICE (WIFI DIRECT NETWORK)



4.7.4 WPS Connection Method

An AP that supports WPS is used in this demonstration. Figure 4-42 illustrates the WPS environment setup.

FIGURE 4-42: WPS ENVIRONMENT SETUP

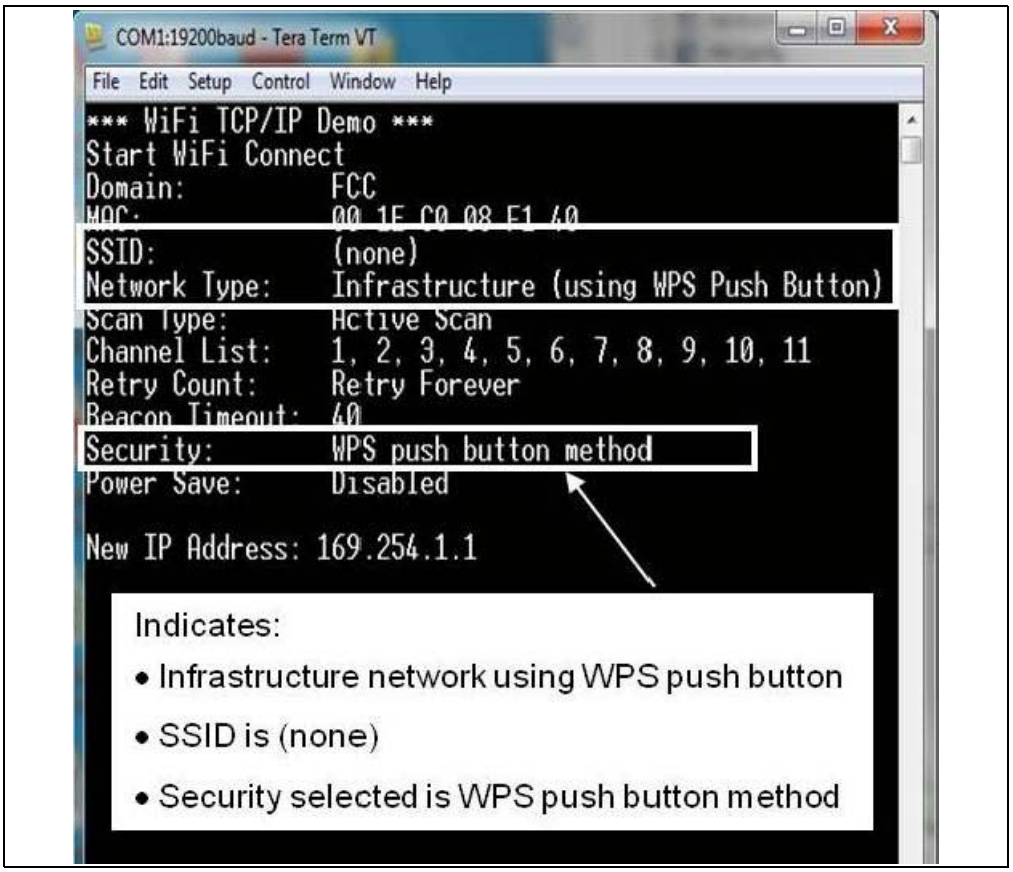


4.7.4.1 WPS METHOD: WF_SECURITY_WPS_PUSH_BUTTON

In the `WF_Config.h` file, perform these actions:

1. Define the MY_DEFAULT_NETWORK_TYPE as CFG_WF_INFRASTRUCTURE.
2. Define the MY_DEFAULT_WIFI_SECURITY_MODE as WF_SECURITY_WPS_PUSH_BUTTON.
3. Define the MY_DEFAULT_SSID_NAME as “”.
4. After the development board is powered up and running, the serial output displays the message shown in Figure 4-43.

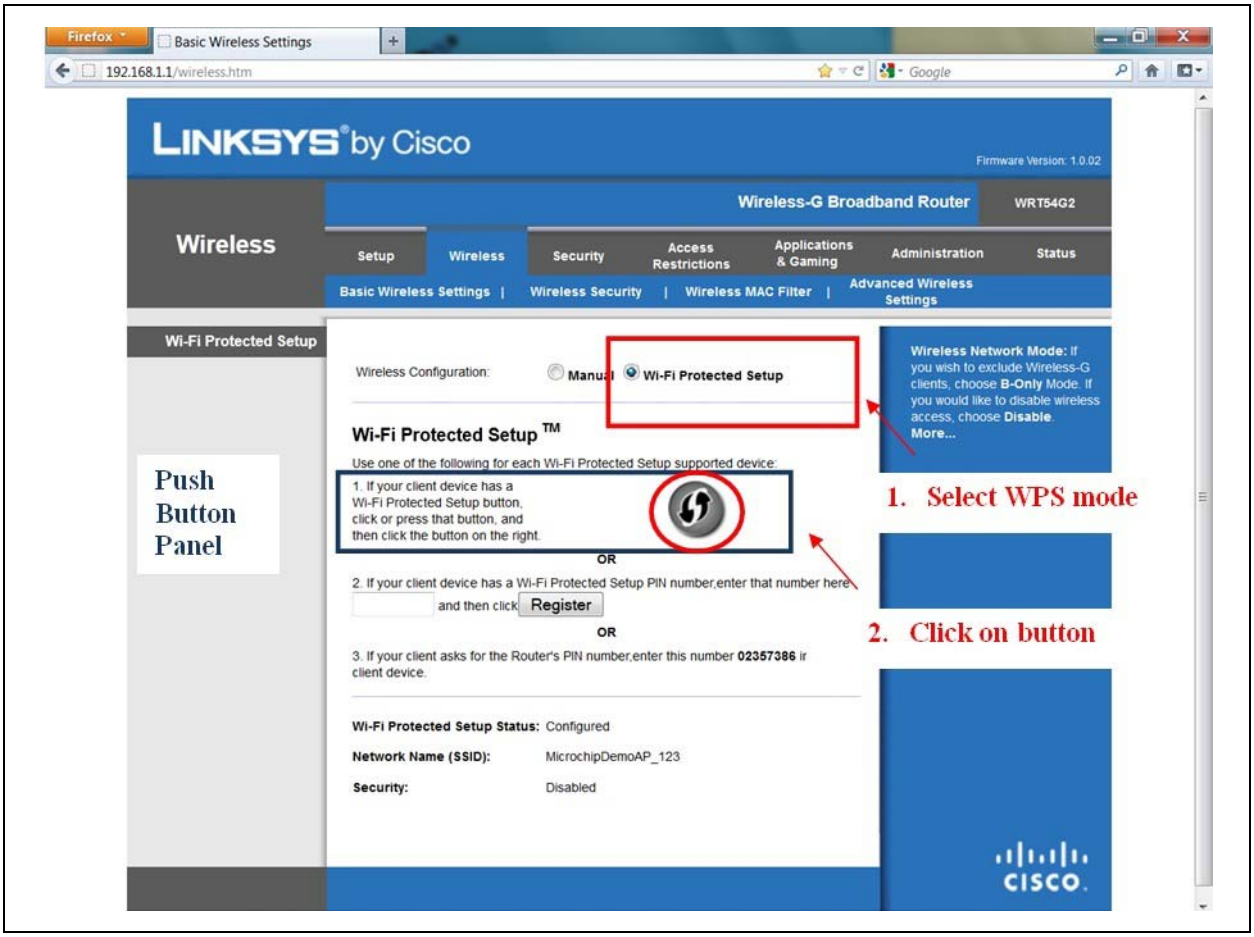
FIGURE 4-43: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY: WPS PUSH BUTTON



Note: The development board with the MRF24WG0MA/B PICtail, by default, has the **Push** button already pressed. For an actual product based on the MRF24WG0MA/B PICtail, the user will need to be prompted to press the **Push** button.

5. On the AP or router settings, select WPS mode, and then click the **Push** button to initiate the WPS procedure.

FIGURE 4-44: ACCESS POINT/ROUTER WPS PUSH BUTTON METHOD



6. The AP will search and connect to the client devices, see Figure 4-45 and Figure 4-46.

FIGURE 4-45: ACCESS POINT/ROUTER IN SEARCH MODE

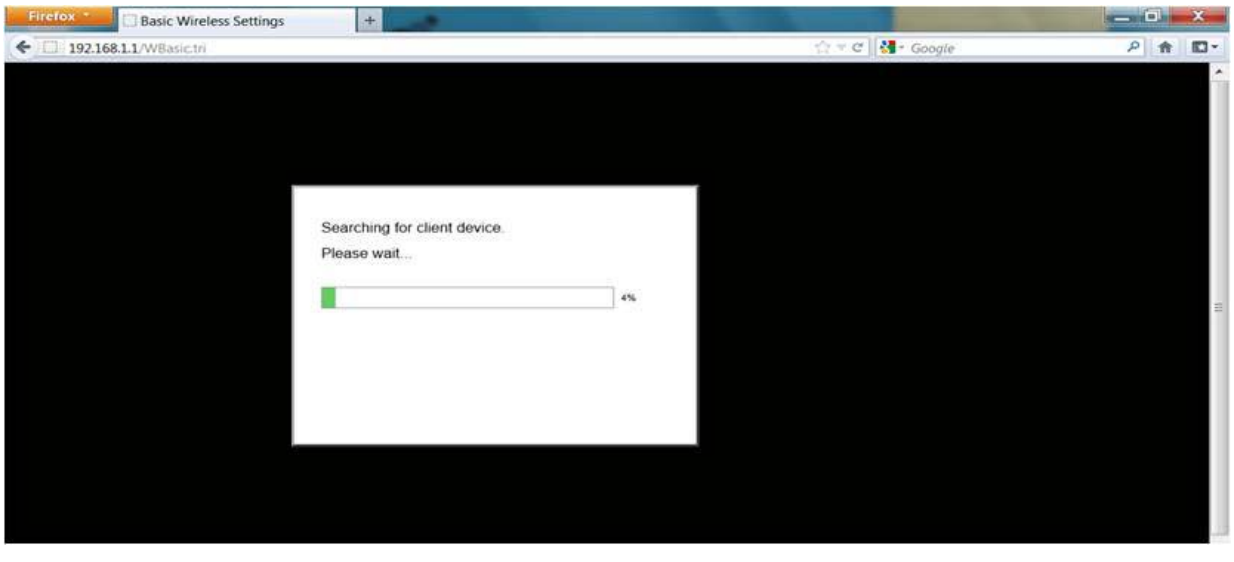
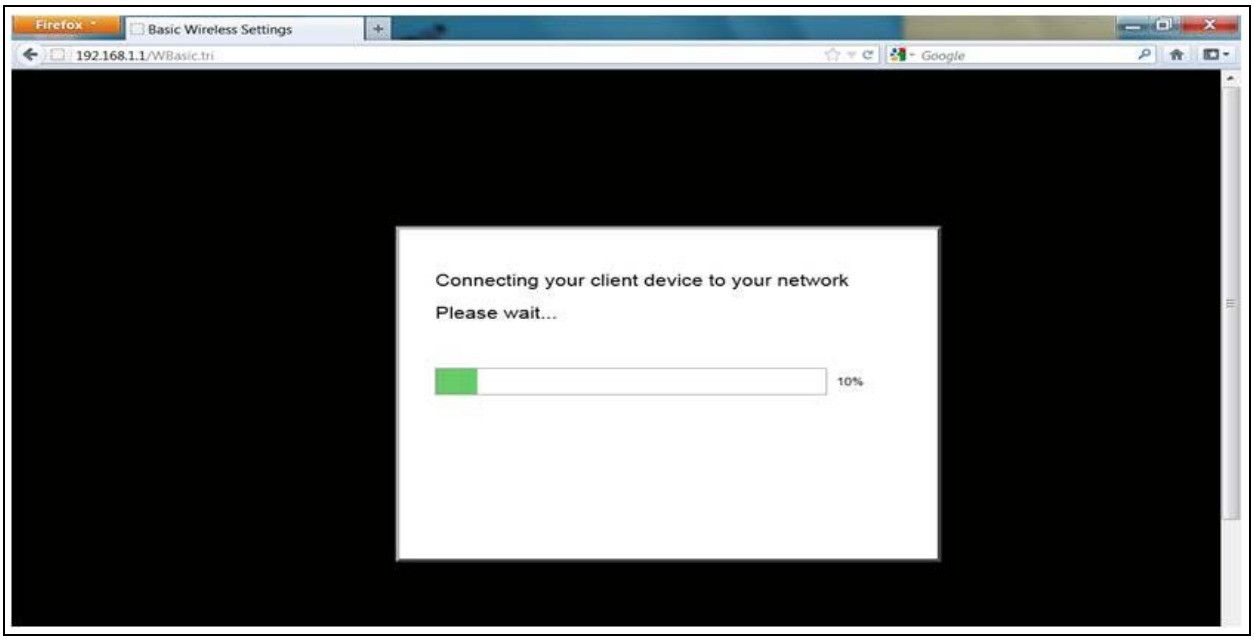
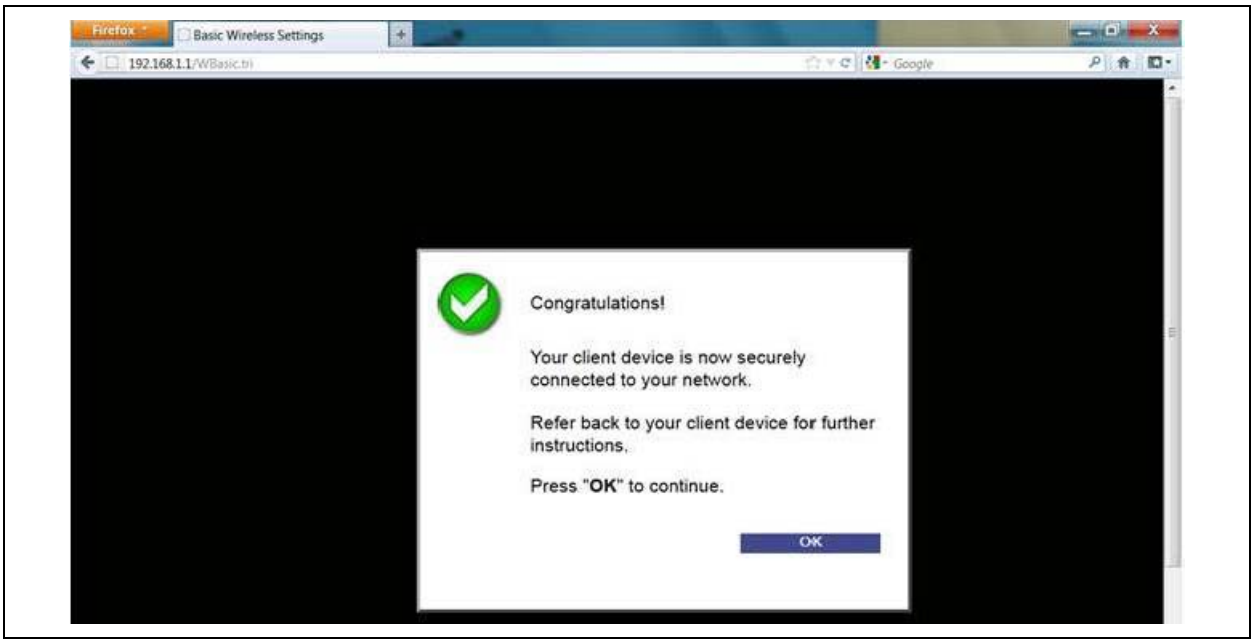


FIGURE 4-46: ACCESS POINT/ROUTER FOUND AND CONNECTING TO DEVELOPMENT BOARD



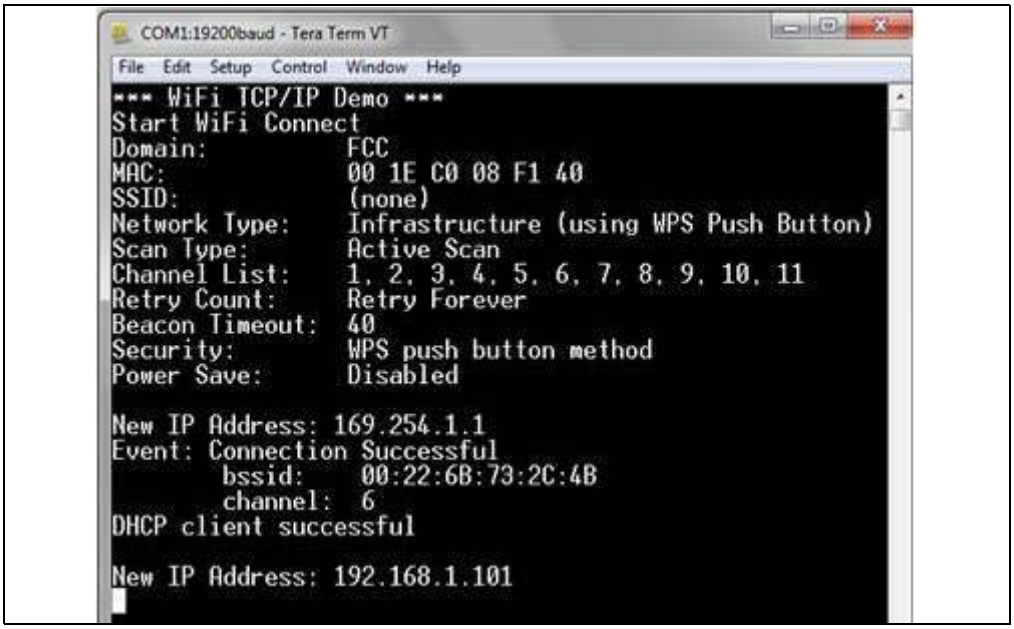
7. After the development board has established the connection, the AP prompts the message as shown in Figure 4-47.

FIGURE 4-47: ACCESS POINT/ROUTER WPS PUSH BUTTON METHOD: SUCCESSFUL CONNECTION



8. Click **OK**.
9. The serial output will display the connection details as shown in Figure 4-48.

FIGURE 4-48: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY: WPS PUSH BUTTON

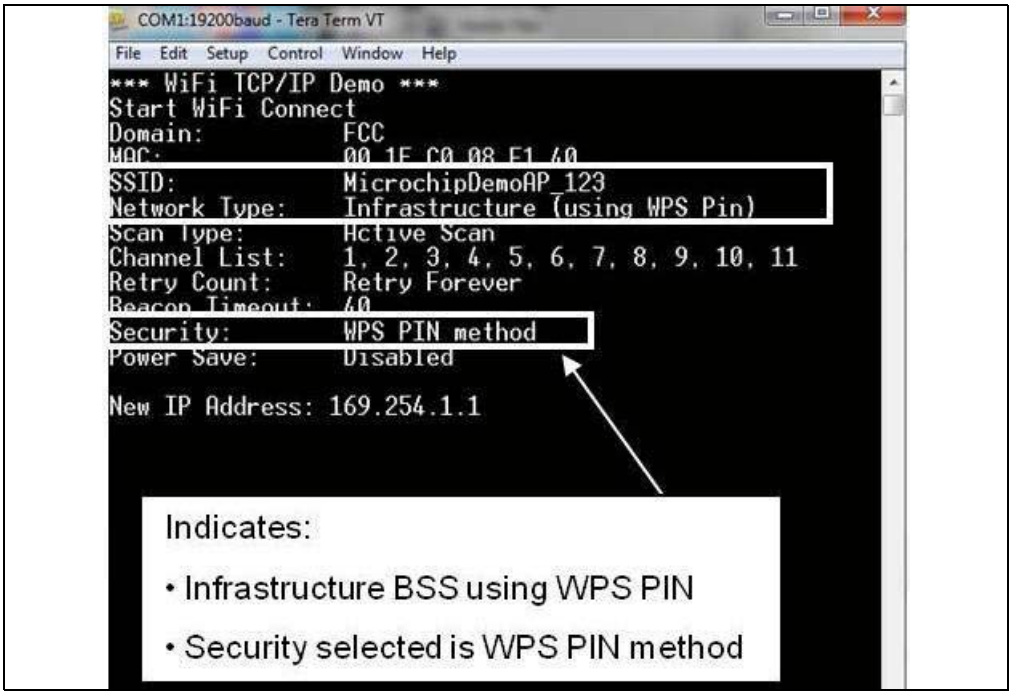


4.7.4.2 WPS METHOD: WF_SECURITY_WPS_PIN

In the `WF_Config.h` file, perform these actions:

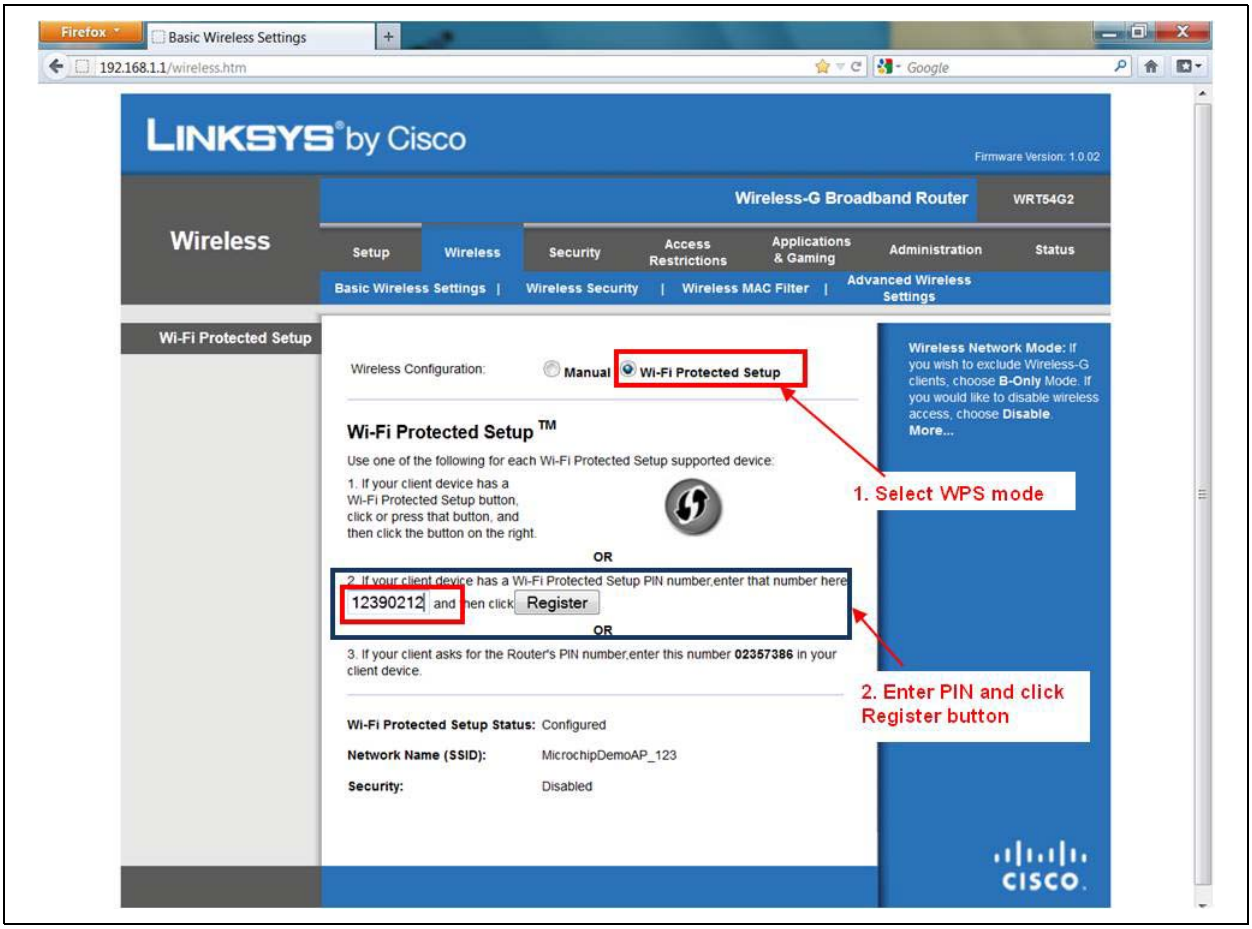
1. Define the MY_DEFAULT_WIFI_SECURITY_MODE as WF_SECURITY_WPS_PIN.
2. Define the MY_DEFAULT_WPS_PIN to be used, and this needs to be an exact match to the AP/router PIN, for example, 12390212.
3. Define the MY_DEFAULT_SSID_NAME to be same as the AP or router's SSID.
4. After the development board is powered up and running, the UART output will display the message shown in Figure 4-49.

FIGURE 4-49: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY: WPS PIN METHOD



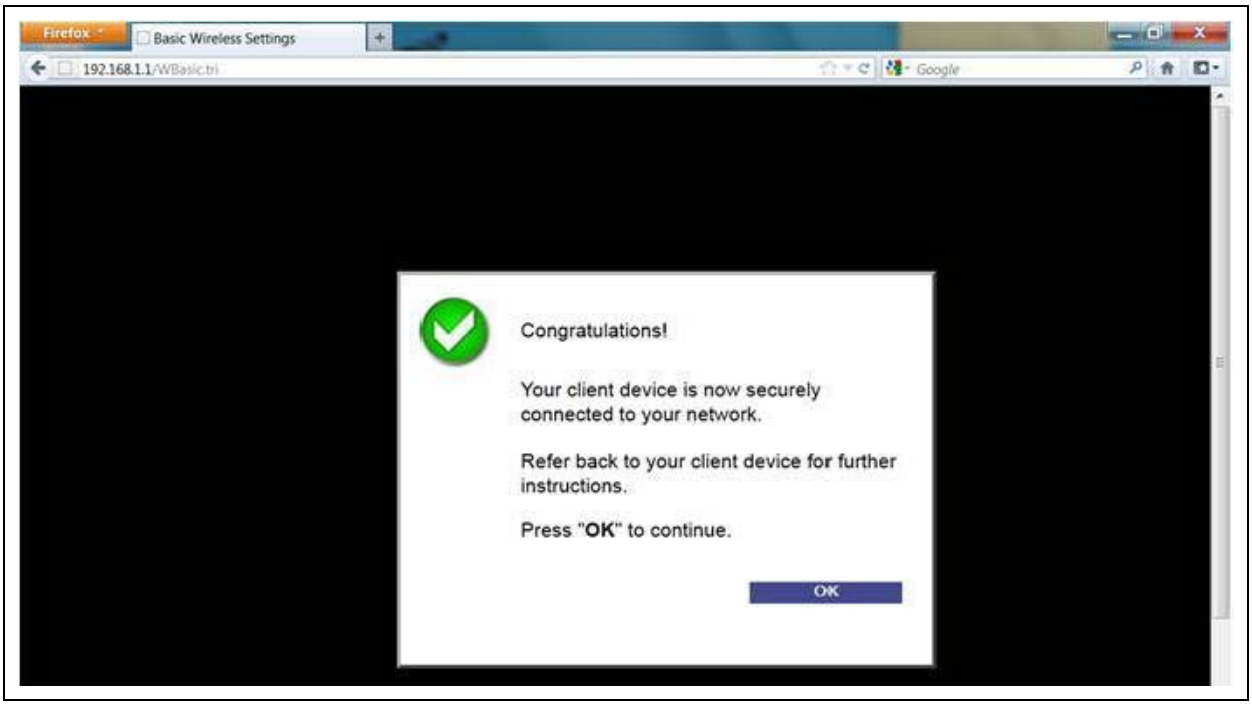
5. With the software running on the development board, on the AP or router settings select WPS mode. Enter the PIN number and click **Register**. These procedures are similar for different APs or routers.

FIGURE 4-50: ACCESS POINT/ROUTER WPS PIN METHOD



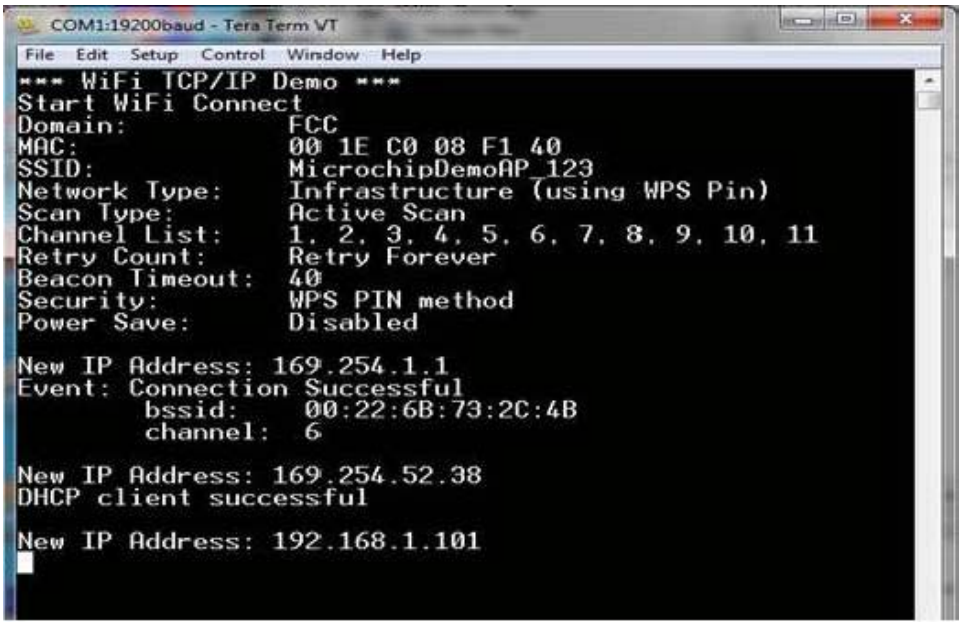
6. The AP or router will search for the development board, and report the status of the successful connection, as shown in Figure 4-51.

FIGURE 4-51: ACCESS POINT/ROUTER WPS PIN METHOD: SUCCESSFUL CONNECTION



7. After AP or router accepts the connection request, the development board will display the status as connection successful, see Figure 4-52.

FIGURE 4-52: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY: WPS PIN METHOD



4.8 RUNNING THE TCPIP – WIFI CONSOLE

This demonstration supports the following network types:

- CFG_WF_INFRASTRUCTURE
- CFG_WF_ADHOC
- CFG_WF_P2P.

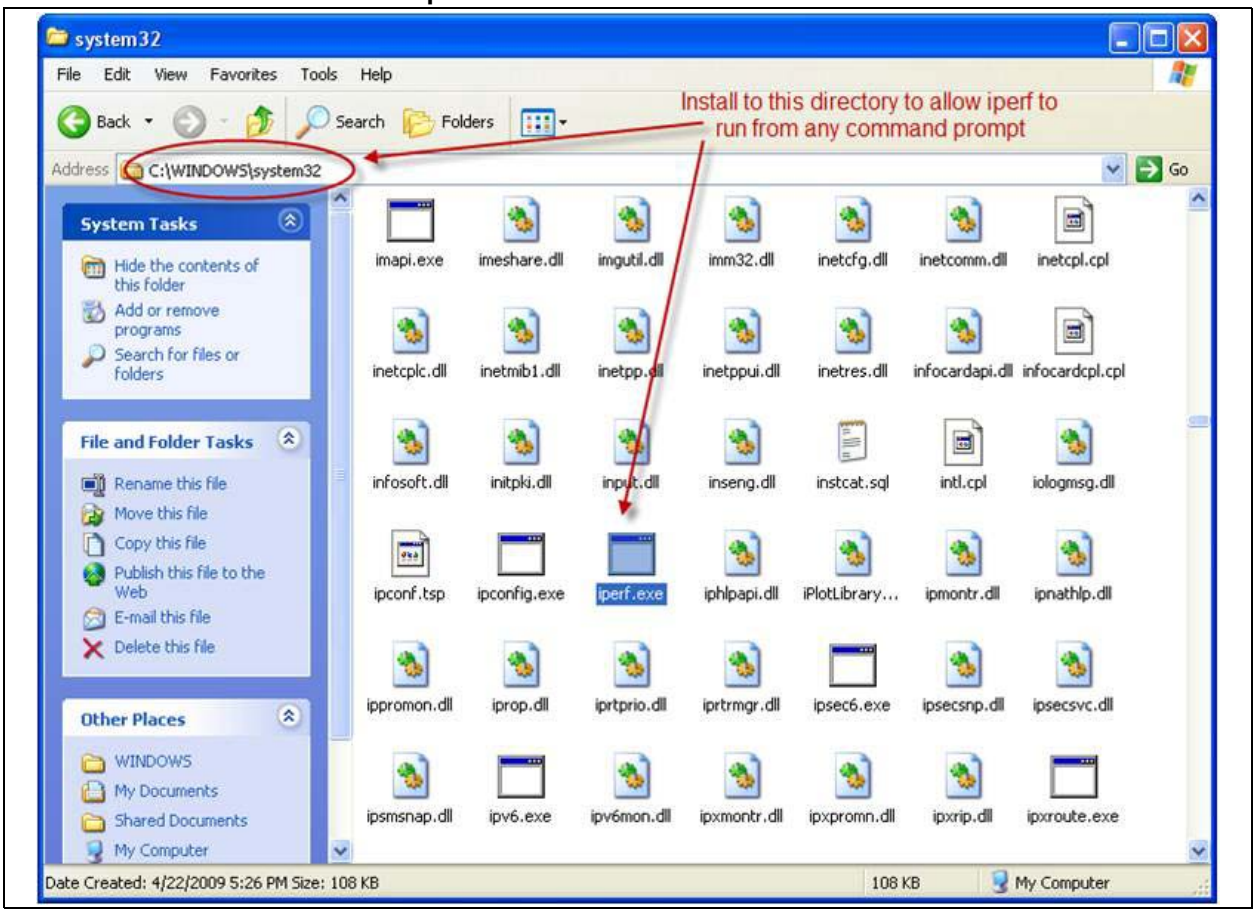
This section only elaborates the CFG_WF_INFRASTRUCTURE network type. Refer to **4.1.1 "TCPIP – Demo App"**, for more information on the CFG_WF_ADHOC and CFG_WF_P2P network types.

Iperf is a commonly used network test tool that allows user to test throughput for network performance measurements. Iperf operates with a server and a client. The client will send data to the server at a specified rate and the bandwidth will be calculated from the server side (even though both the client and server will produce throughput numbers, the numbers that are in the server window are the most accurate). Iperf requires the serial UART port to be connected to a computer (issuing commands through the HyperTerminal session). To run the Iperf demonstration, compile the correct project. Refer to **4.3 "Opening Existing Projects"**, but instead use the projects that are located in `C:\Microchip Solutions\ TCPIP\ WiFi Console\`.

4.8.1 Installing `iperf.exe`

1. After compiling and downloading the code, install `iperf.exe` on the computer. Refer to Appendix A.4, for a link to access the `iperf.exe`.
2. Download and install the `iperf.exe` binary file in the `C:\Windows\system32` that is easier to use from any command prompt in the future.

FIGURE 4-53: INSTALLING `Iperf.exe`



3. After installing Iperf, on the computer open a command prompt either running the `cmd.exe` from the “Run” dialog (see Figure 4-54) or by selecting it from the **All Programs** menu (see Figure 4-55).

FIGURE 4-54: OPENING A COMMAND PROMPT FROM RUN DIALOG

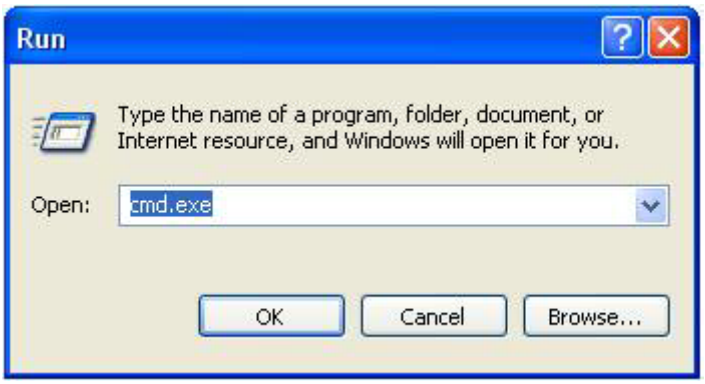
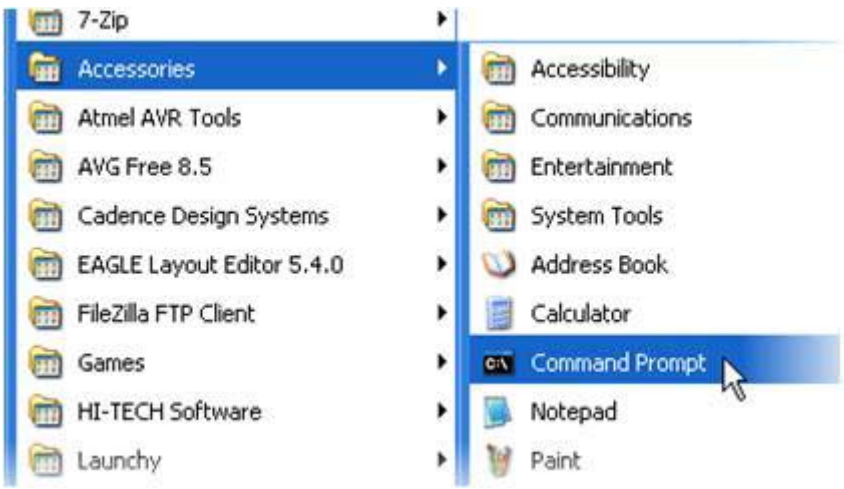
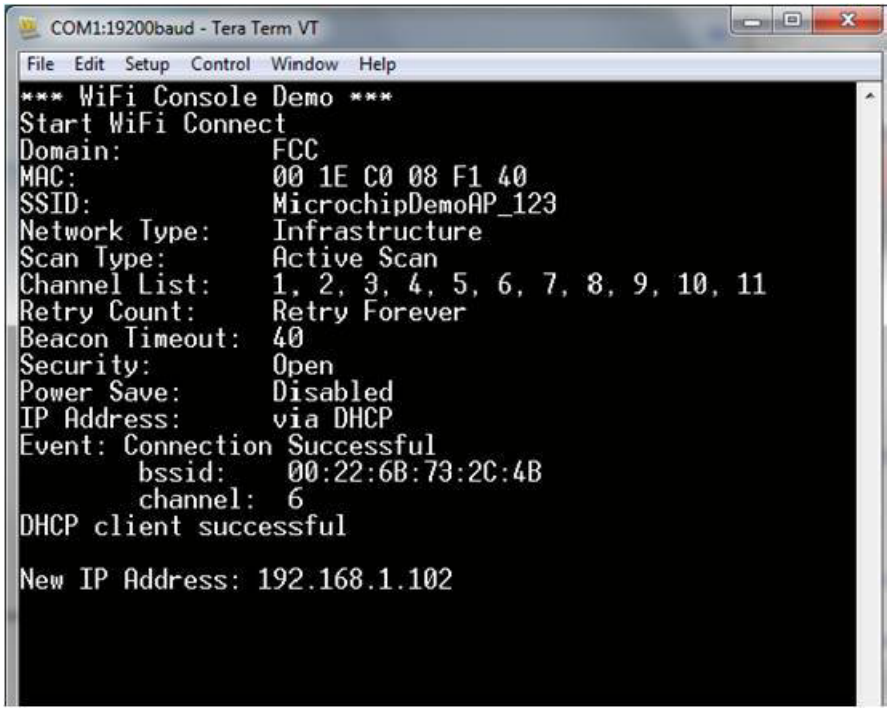


FIGURE 4-55: OPENING A COMMAND PROMPT FROM PROGRAMS MENU



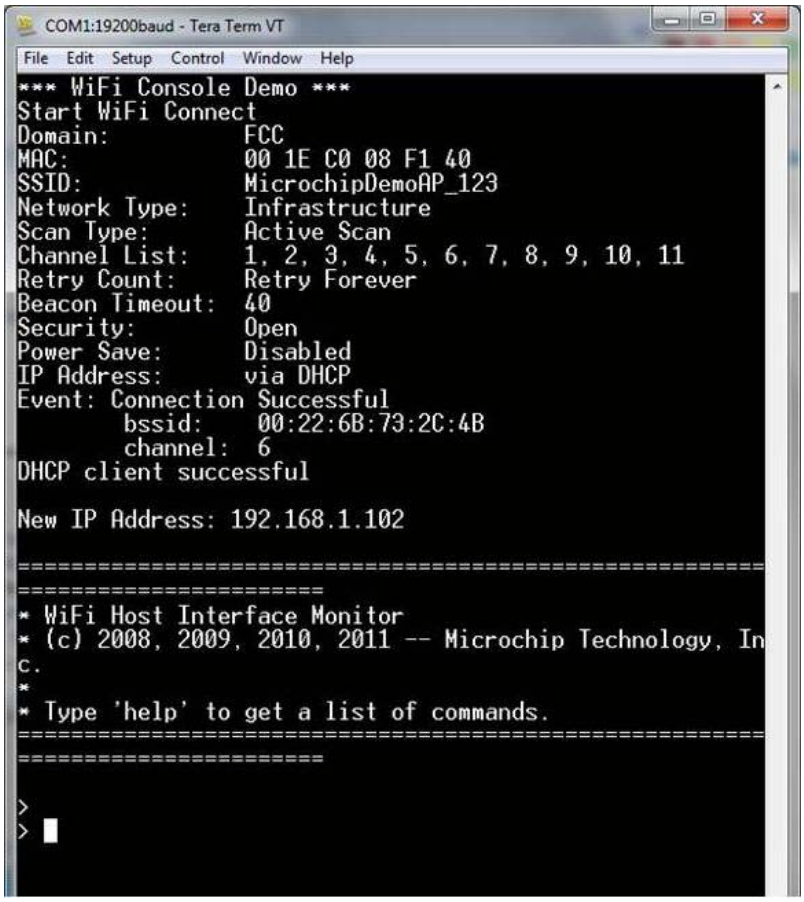
4. To run Iperf, user must know the IP address of the development board and the computer (server and client). The IP address of the development board can be viewed on the LCD or on the serial output, as shown in Figure 4-56.

FIGURE 4-56: DEVELOPMENT BOARD SERIAL OUTPUT



5. In the HyperTerminal window of the development board, press the **Enter** key, Figure 4-57 is displayed and it indicates the development board is ready to run Iperf.

FIGURE 4-57: HYPERTERMINAL WINDOW READY



6. To get the IP address of the computer, run `ipconfig` command from the command prompt, as shown in Figure 4-58.

FIGURE 4-58: USING IPCONFIG TO GET PC IP ADDRESS

4.8.2 `ipconfig` Command Details

A typical server and client command, and what the options meaning is provided below:

- `iperf –s –u –i <seconds>`
  Where,
  `-s` indicates the server
  `-u` sends UDP datagrams
  `–i <seconds>` indicates frequency of the status update
- `iperf –c <ip_addr> -b <bw> -i <seconds> -t <seconds>`
  Where,
  `-c` indicates the client
  `<ip_addr>` is the IP address of the server to communicate to
  `-b <bw>` specifies the amount of data to try and pass through as bandwidth
  `-i <seconds>` indicates how often the screen updates the status
  `-t <seconds>` indicates how long to run the test for

4.8.3 Testing Transmit Performance

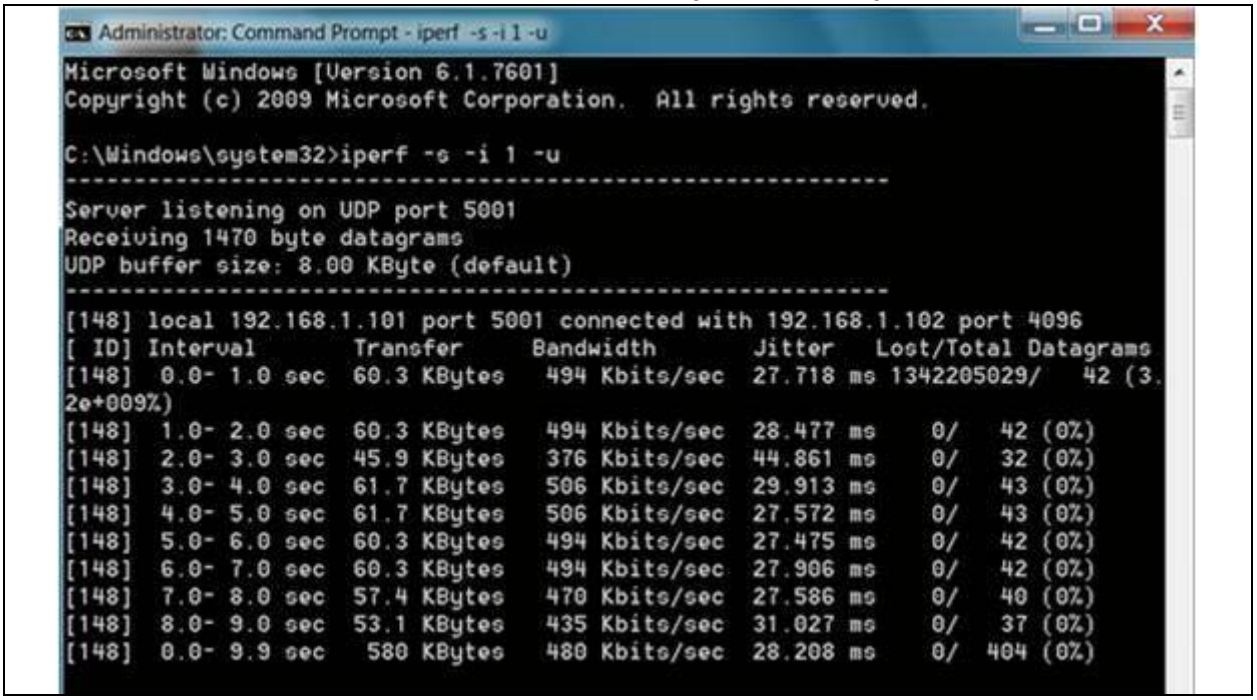
To test the MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ transmit performance, set up the following:

1. Computer (command prompt) as the server.
2. PICtail (HyperTerminal session) as the client.

Note:	Before starting user must start the server connection.

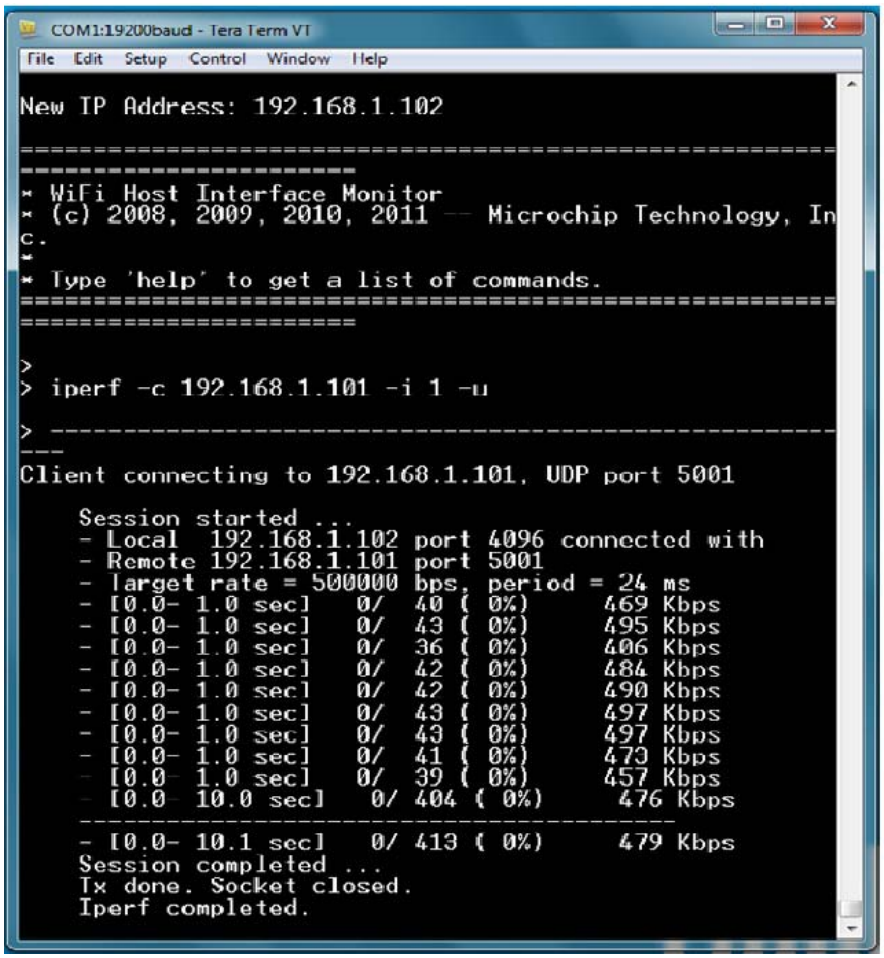
3. A sample of the typical Iperf run for testing the transmit performance on the computer (server) and Development Board (client), see Figure 4-59 and Figure 4-60.

FIGURE 4-59: IPERF TRANSMIT PERFORMANCE (PC – SERVER)



Note:	If encounter error in running Iperf under WinOS, run Iperf in Administrator mode.

FIGURE 4-60: IPERF TRANSMIT PERFORMANCE (DEVELOPMENT BOARD – CLIENT)



4. To know the development board receiver performance, the server and client must reverse roles (server is the development board HyperTerminal session and client is the computer command prompt window). Also, change the IP address to match the server's address.

4.9 RUNNING THE TCPIP – WIFI EZCONFIG

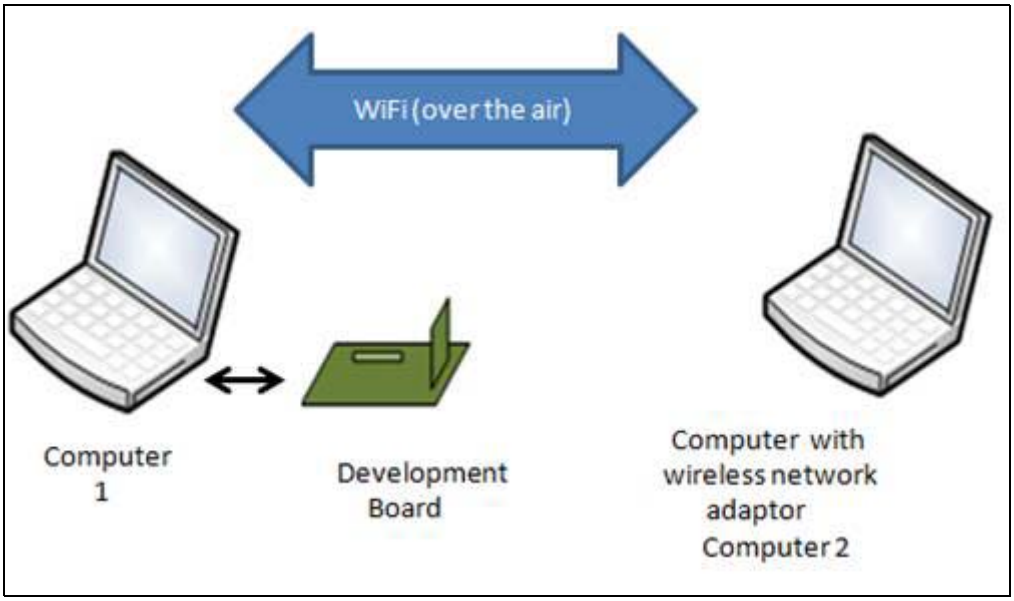
This demonstration supports the following network types:

- CFG_WF_ADHOC
- CFG_WF_SOFT_AP

4.9.1 Network Type: CFG_WF_ADHOC

In this demonstration, a computer with wireless network adapter is used. Smart devices, such as iPhone can also be used. This demonstration will direct the user to connect to another AP in infrastructure network type. Figure 4-61 shows the ad hoc network environment setup.

FIGURE 4-61: AD HOC NETWORK ENVIRONMENT SETUP



In the `WF_Config.h` file, perform these actions:

1. Define MY_DEFAULT_NETWORK_TYPE as CFG_WF_ADHOC.

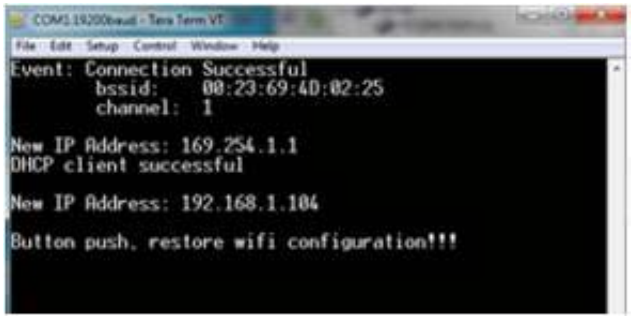
   The demonstration will attempt to connect to the last known network.

Note:	If the user wants to Reset the demonstration to startup in Ad hoc mode again, press and hold **S3** button on the Explorer 16 Development Board four seconds.

FIGURE 4-62: PRESS S3 BUTTON ON EXPLORER 16 DEVELOPMENT BOARD TO RESET DEMO)

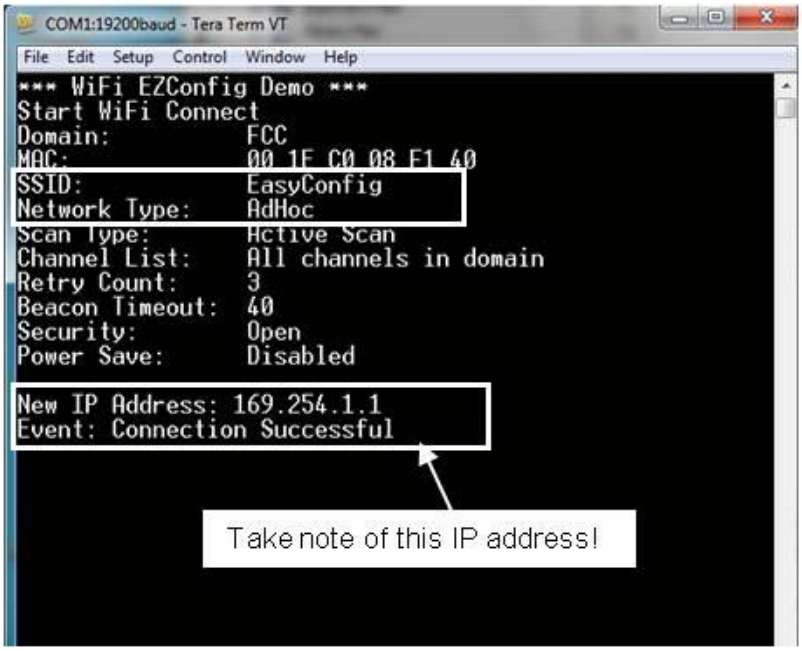
2. The serial output is changed to indicate Reset is effective, see Figure 4-63.

FIGURE 4-63: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY: RESET MESSAGE



3. After the development board has established connection with computer 2, the LCD panel will display the IP address of the computer that is being used. Alternately, the serial output should display similar information, see Figure 4-64.

FIGURE 4-64: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY: SUCCESSFUL CONNECTION

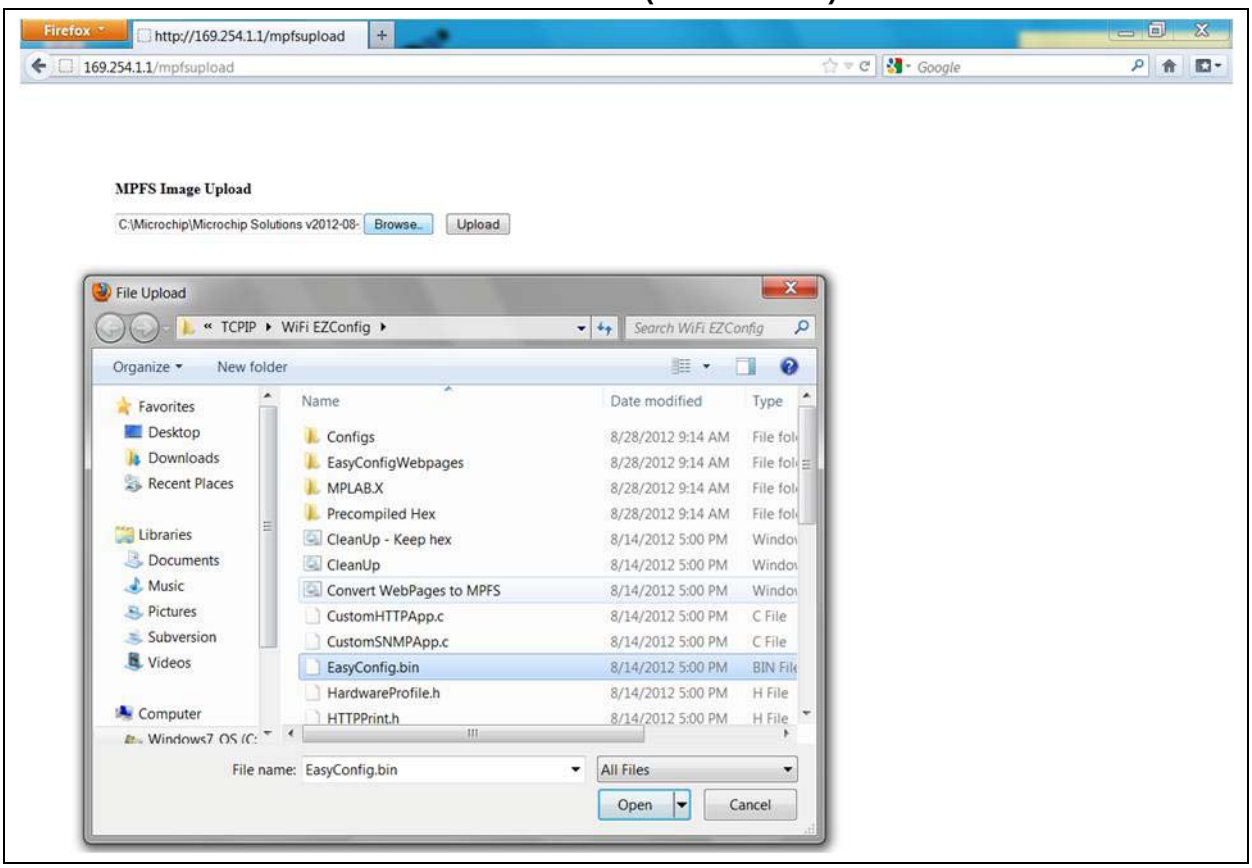


4. Computer 2 will display the list of available wireless networks, and among them is the wireless network with SSID EasyConfig. Click **EasyConfig** to connect to the development board, as shown in Figure 4-65.

FIGURE 4-65: WIRELESS NETWORK CONNECTION (COMPUTER 2)

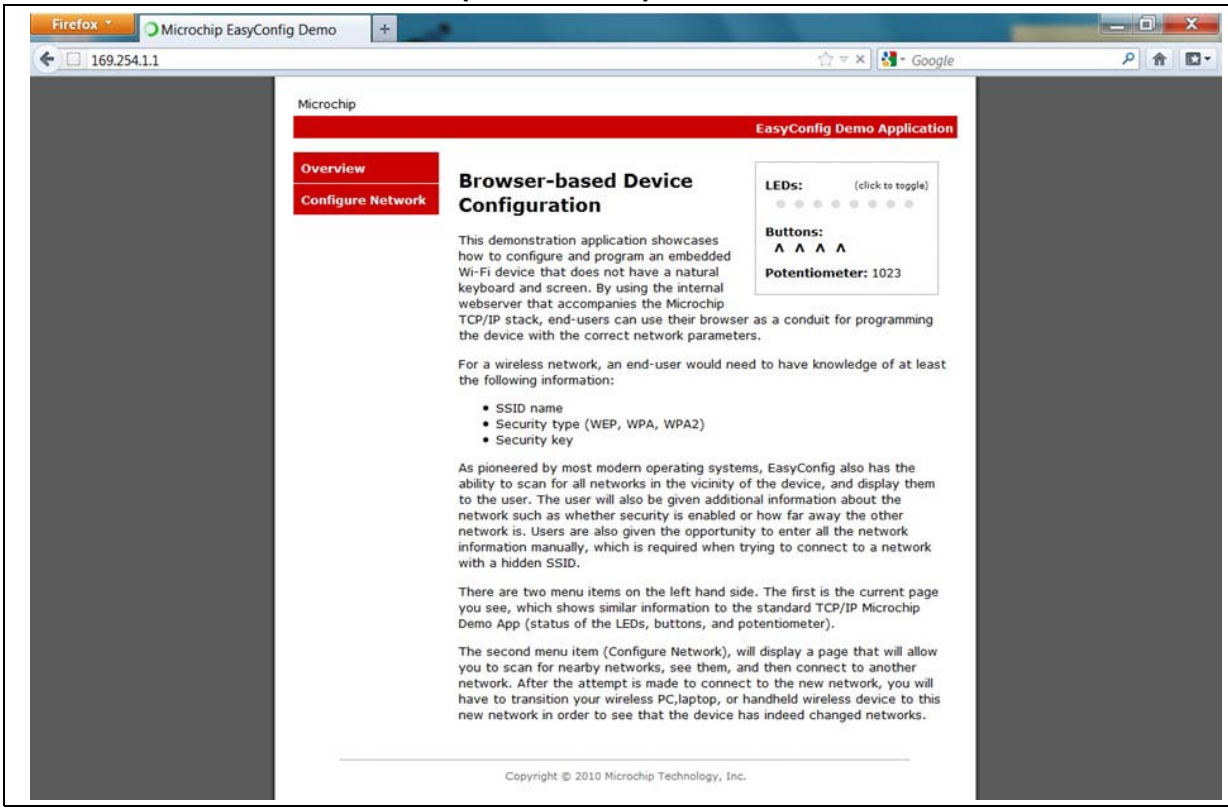
5. On successful connection between the development board (computer 1) and computer 2, use the web browser on computer 2 to download the image and upload the `Easyconfig.bin` file. This file is located in the root directory of the `TCPIP-WiFi EZConfig` directory, see Figure 4-66.
6. On computer 2 web browser, type http://xxx.xxx.xxx.xxx/mpfsupload, where xxx.xxx.xxx.xxx is the IP address of the development board.

FIGURE 4-66: WEB SERVER IMAGE UPLOAD (COMPUTER 2)



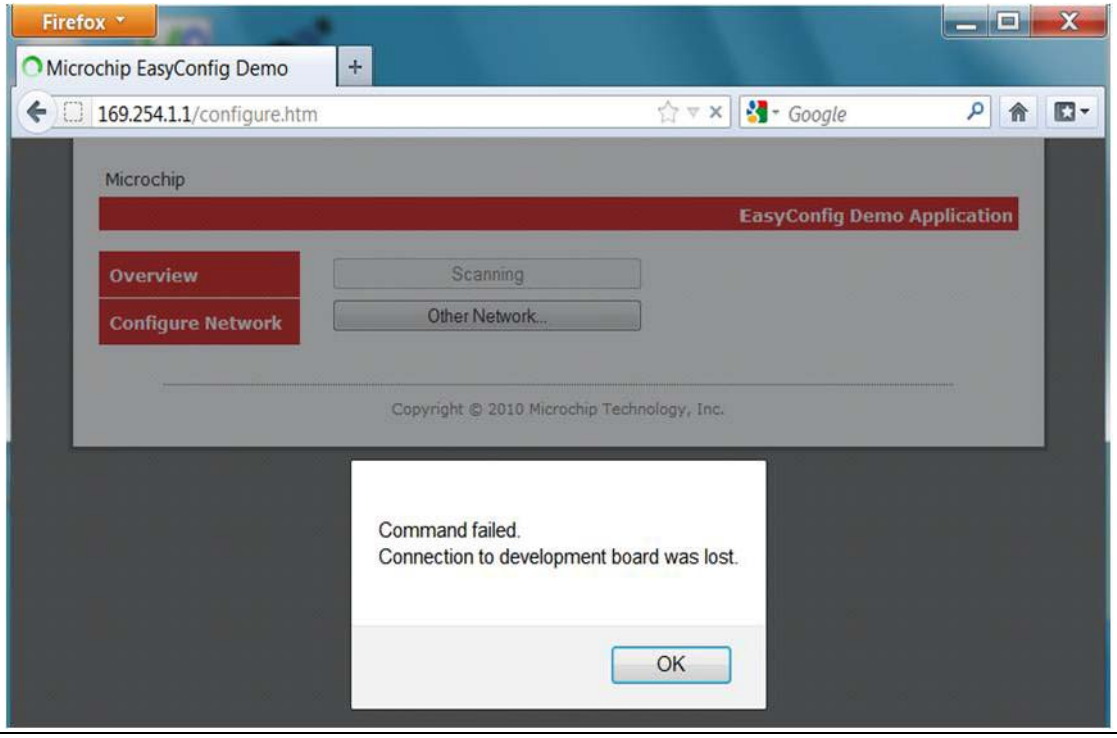
7. On successful uploading, click the site main page link to navigate to the main page of the web browser, see Figure 4-67.

FIGURE 4-67: WEB BROWSER (COMPUTER 2)



8. Click **Configure Network** to scan for wireless networks. As scanning is in progress, you may receive an error message, as shown in Figure 4-68.

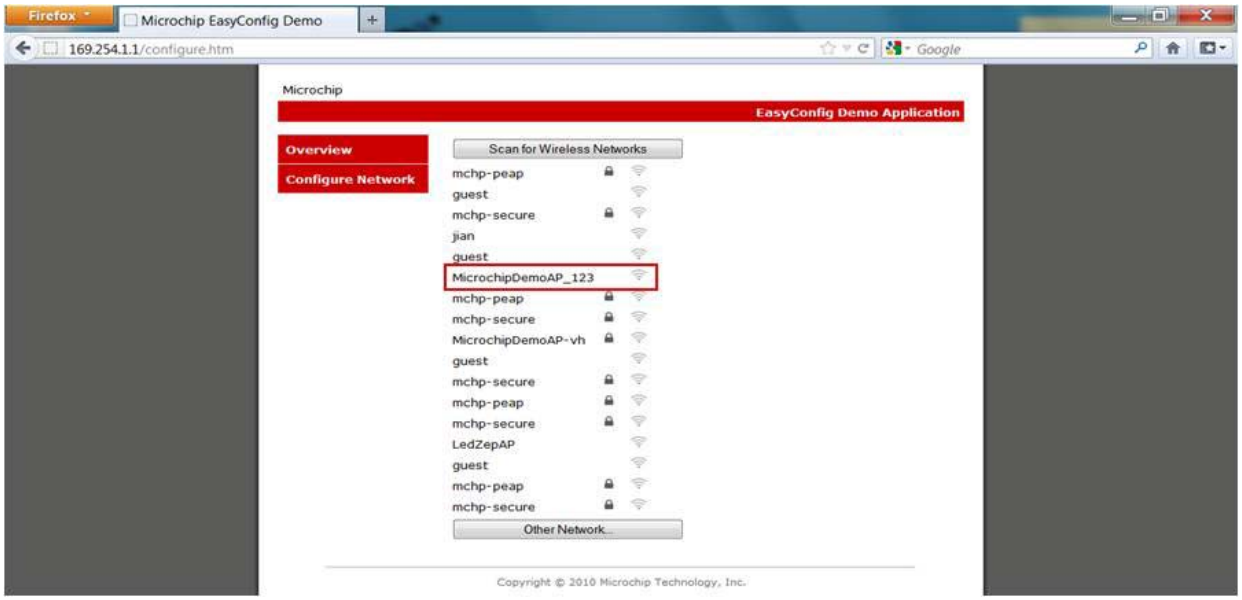
FIGURE 4-68: WEB BROWSER (COMPUTER 2): CONFIGURE NETWORK AND SCANNING



9. Click **OK**.

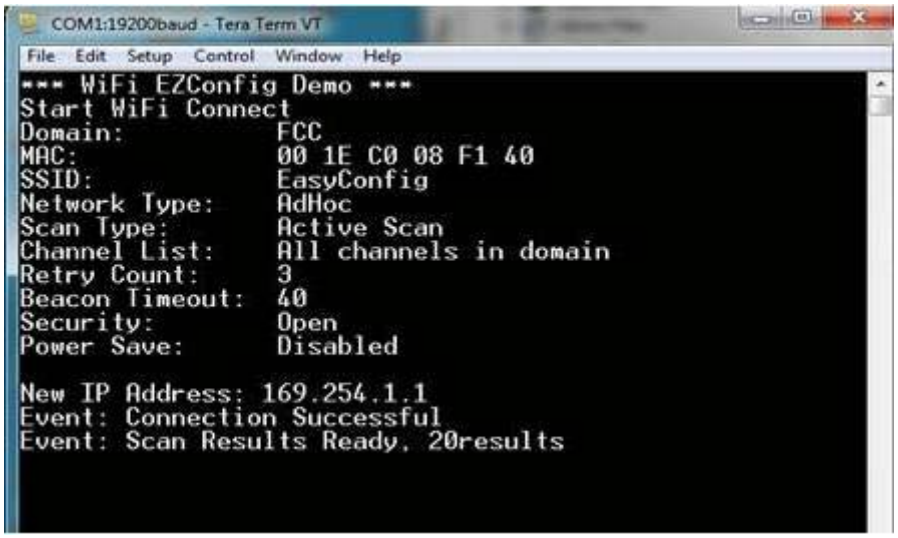
10. After scanning is completed, a list of available wireless network will be displayed, see Figure 4-69.

FIGURE 4-69: WEB BROWSER (COMPUTER 2): LIST OF AVAILABLE WIRELESS NETWORKS



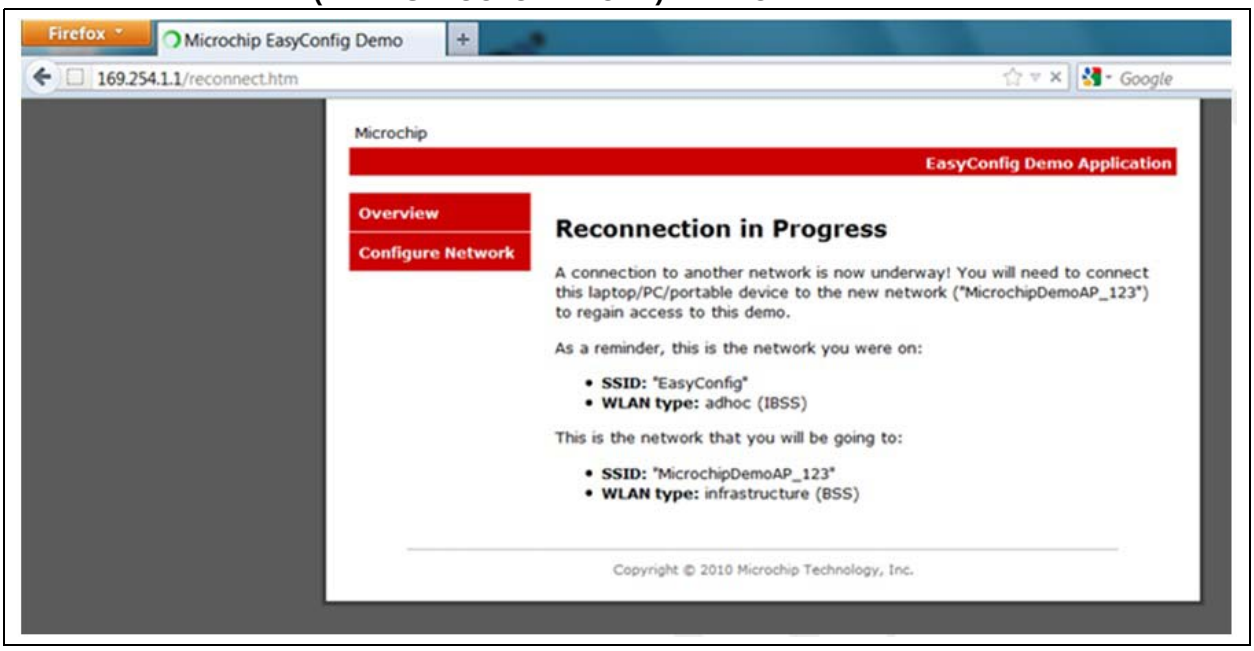
11. Click on the specific network, for example, infrastructure network with SSID MicrochipDemoAP_123.
12. The development board serial output will display the status of the scan results, see Figure 4-70.

FIGURE 4-70: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY (COMPUTER 1): SCAN RESULTS



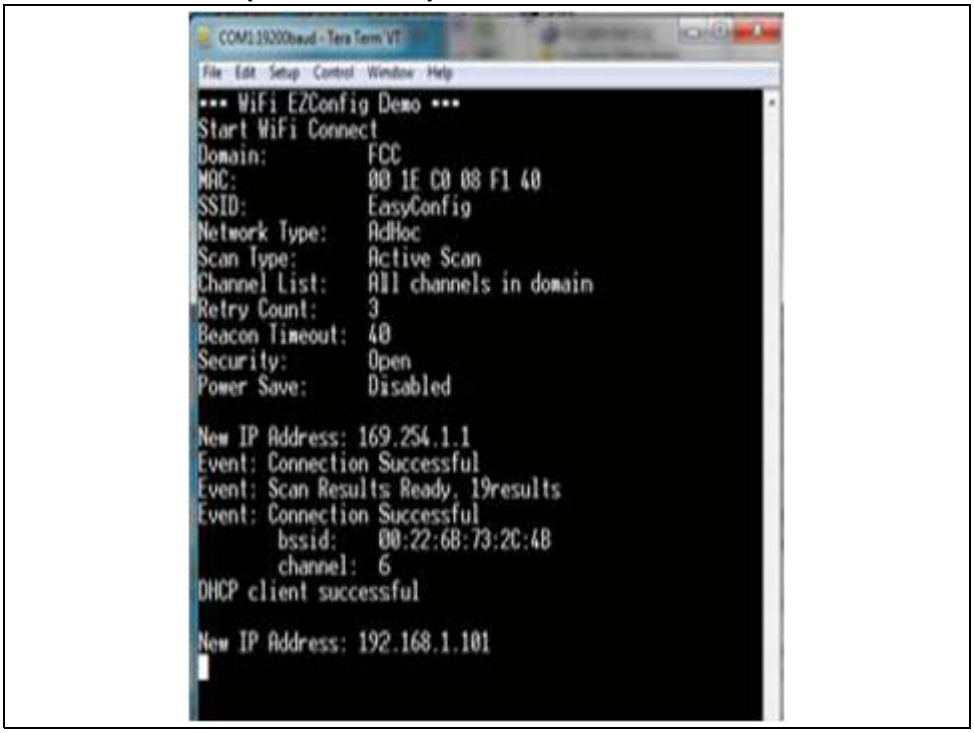
13. The web browser will highlight the transition from the old (ad hoc) network to the newly (infrastructure) selected network, as shown in Figure 4-71. In this example, infrastructure network with SSID MicrochipDemoAP_123.

FIGURE 4-71: WEB BROWSER (COMPUTER 2): TRANSITION FROM OLD (AD HOC MODE) TO NEW (INFRASTRUCTURE MODE) NETWORK



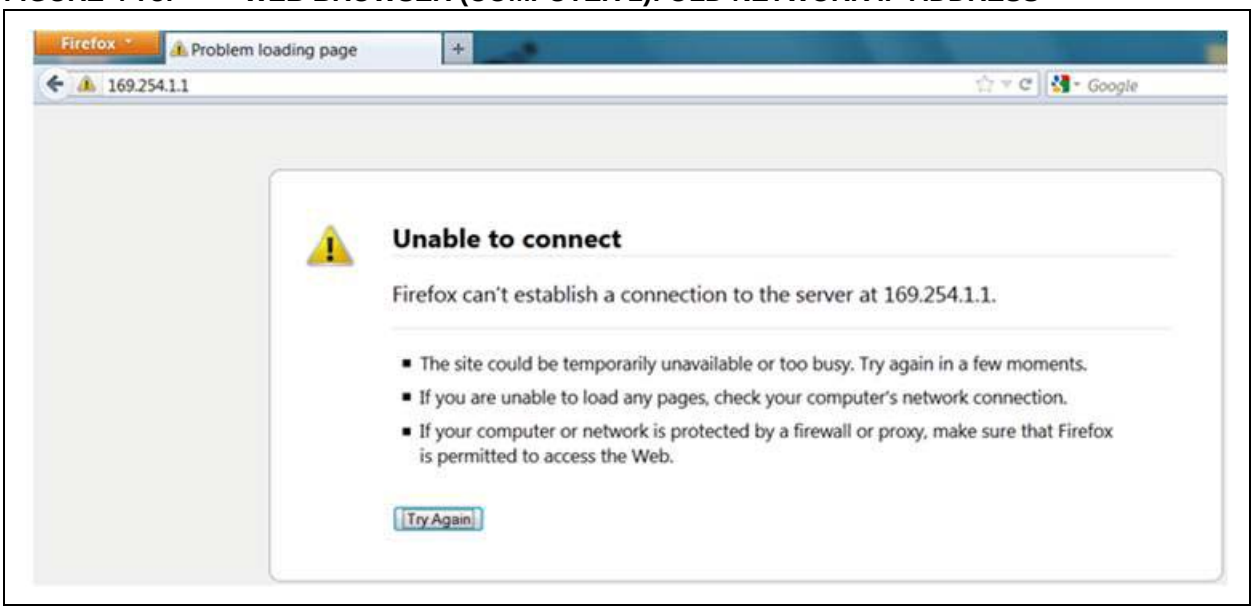
14. The development board serial output will display the status of the new network, as shown in Figure 4-72.

FIGURE 4-72: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY (COMPUTER 1): NEW NETWORK INFO



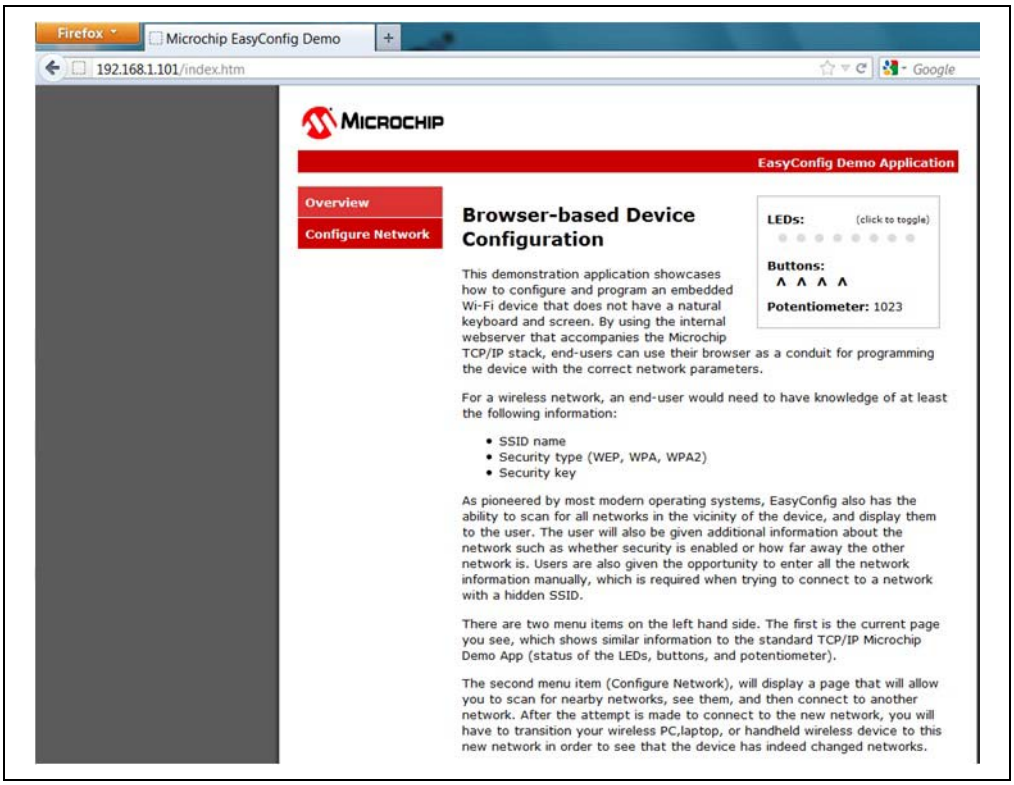
15. On computer 2, if you enter the old network address, the "`Unable to connect`" error message will be displayed.

FIGURE 4-73: WEB BROWSER (COMPUTER 2): OLD NETWORK IP ADDRESS



16. Enter the new IP address of the newly joined network.

FIGURE 4-74: WEB BROWSER (COMPUTER 2): NEW NETWORK IP ADDRESS



4.9.2 Network Type: CFG_WF_SOFT_AP

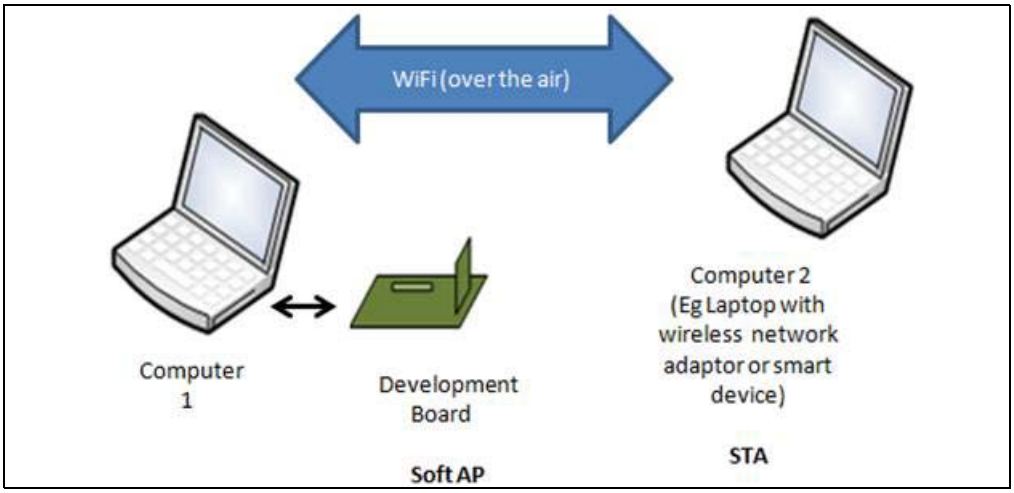
This SoftAP function uses the base EasyConfig demonstration due to the required features: DHCP server and HTTP server. The implementation is a simplified SoftAP (as of MLA October 2012 release), and is limited to the following:

- Only supported by MRF24WG0MA/B
- No routing supported
- Only one client is allowed (RF module FW version 0x3107)
- Initial security mode supported is Open mode and WEP security (MLA October 2012 and future versions). More security modes may be supported in the future.
- Does not support Power-save feature.

In the `WF_Config.h` file, perform these actions:

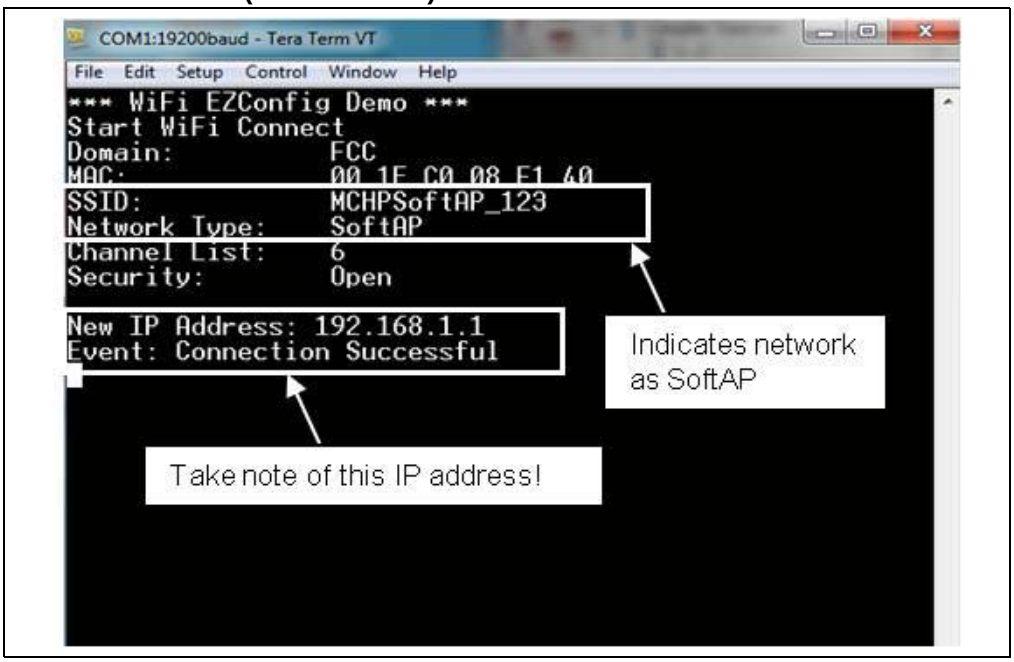
1. Define the MY_DEFAULT_NETWORK_TYPE as CFG_WF_SOFT_AP.
2. Define the MY_DEFAULT_SSID_NAME, for example, MCHPSoftAP_123.
3. The demonstration attempts to connect to the last known network. If the user wants to reset the demonstration to start in SoftAP mode again, press and hold **S3** button on the Explorer 16 Development Board for four seconds. Figure 4-75 shows the SoftAP environment setup.

FIGURE 4-75: SOFTAP ENVIRONMENT SETUP



4. After the software is running on the development board, the serial output should display similar information as shown in Figure 4-76. The development board is SoftAP.

FIGURE 4-76: DEVELOPMENT BOARD SERIAL OUTPUT DISPLAY (COMPUTER 1)

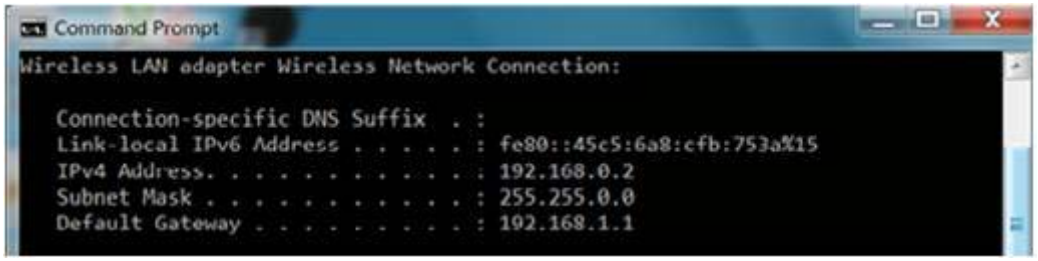


5. On computer 2, user can view the SoftAP SSID in the list of available wireless networks, see Figure 4-77. Select SoftAP SSID to join SoftAP network.

FIGURE 4-77: LIST OF AVAILABLE WIRELESS NETWORK CONNECTION (COMPUTER 2)

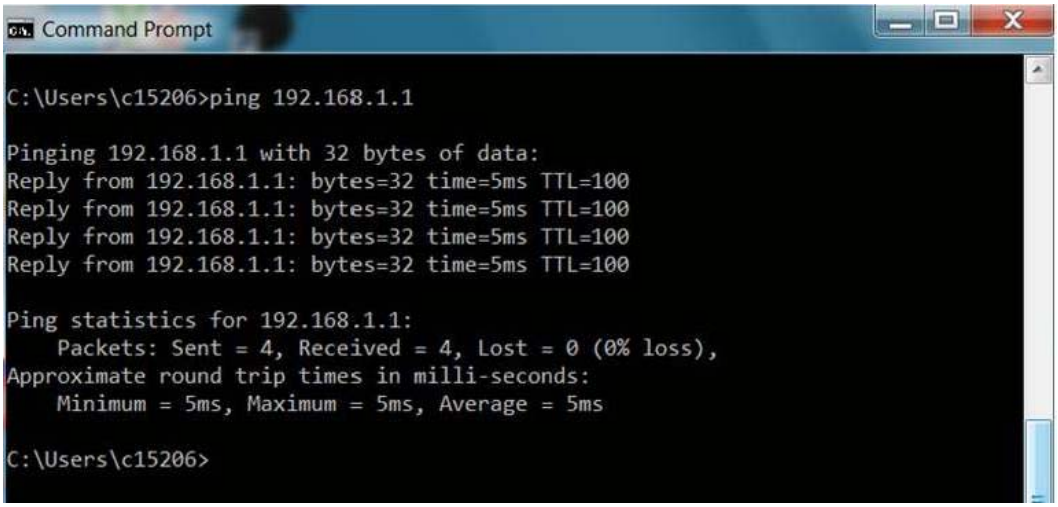
6. On computer 2, enter `ipconfig` in the Command Prompt, the wireless connection to this Soft AP will be displayed, as shown in Figure 4-78.

FIGURE 4-78: IPCONFIG WIRELESS NETWORK CONNECTION STATUS (COMPUTER 2)



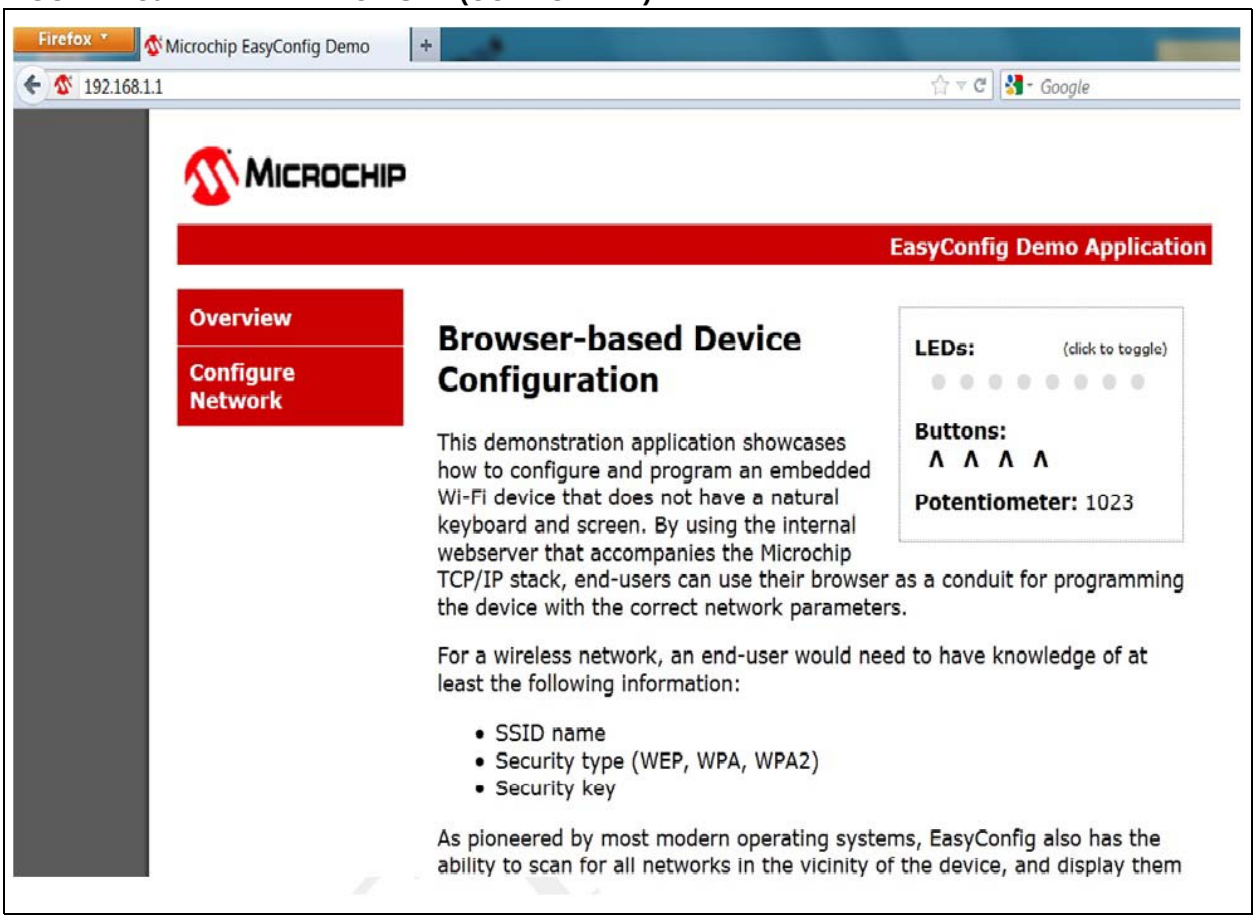
7. Similarly, ping the SoftAP, as shown in Figure 4-79.

FIGURE 4-79: PINGING SOFT AP (COMPUTER 2)



8. Run computer 2 web browser to connect to the web server of the SoftAP.

FIGURE 4-80: WEB BROWSER (COMPUTER 2)



NOTES:

Chapter 5. Microchip Development Board Specifics

5.1 PICDEM.NET 2 USAGE

This section provides instructions specific to the PICDEM.net 2 Development Board. Note the connector (J1) on the PICtail. Table 5-1 provides the PICDEM.net 2 PICtail pin descriptions. If you are using Explorer 16 Development Board, skip this section.

TABLE 5-1: PICDEM.NET 2 PICTAIL PIN DESCRIPTION

Function	I/O	Pin	Descriptions
CSN	I	J1-24/RC2	SPI chip select (asserted low)
SCK	I	J1-12/RC3	SPI clock
SDO	O	J1-10/RC4	SPI data out from MRF24W
SDI	I	J1-8/RC5	SPI data in to MRF24W
INT_NX	O	J1-27	Interrupt signal from MRF24W (asserted low)
RST_N	I	J1-25/RB1	Master Reset (asserted low)
CE_N	I	J1-23/RB2	MRF24W disable (asserted low)
VDD	I	J1-26	5V power input

5.2 EXPLORER 16 USAGE

This section provides instructions specific to the Explorer 16 Development Board. If you are using PICDEM.net 2 Development Board, skip this section. The male connector (J2) on the PICtail is the female connector (J5) on the Explorer 16 Development Board. Table 5-2 provides the PICDEM.net 2 PICtail pin descriptions.

TABLE 5-2: EXPLORER 16 PICTAIL PIN DESCRIPTION

Function	I/O	Pin	Descriptions
CSN	I	J2-1/RB2	SPI chip select (asserted low)
SCK	I	J2-3/RF6/SCK1	SPI clock
SDO	O	J2-5/RF7/SDI1_E	SPI data out from MRF24W
SDI	I	J2-7/RF8/SDO1_E	SPI data in to MRF24W
INT_NX	O	J2-18/RE8/INT1	Interrupt signal from MRF24W (asserted low)
RST_N	I	J2-28/RF0	Master Reset (asserted low)
CE_N	I	J2-30/RF1	MRF24W disable (asserted low)
VDD	I	J2-21 & J2-22	3.3V power input

5.3 ERASING EEPROM

When debugging, if code settings (especially related to SSID name, MAC address and so on) are not effected, then erase the EEPROM. The values in the EEPROM takes precedence over values that are defined in the source code (that is, `TCPIPConfig.h`).

To erase the EEPROM, perform these actions:

1. Ensure that the development board is programmed and not in Debug mode.
2. Disconnect the MPLAB® ICD 3 or MPLAB REAL ICE™ from the Development Board.
3. Press and hold **BUTTON0** (RD13/S4 on Explorer 16 Development Board and RB3/S5 on the PICDEM.net™ 2 Development Board).
4. Press the **MCLR** button.
5. Continue holding **BUTTON0** until several LEDs flash indicates the EEPROM is cleared. This takes about four seconds. Alternately, if UART is connected to the development board, the following output is displayed:

   ```
   BUTTON0 held for more than 4 seconds. Default settings restored
   ```

6. Release the **BUTTON0**.
7. Press the **MCLR** button again to Reset the software.

Appendix A. Appendix

A.1 MICROCHIP HARDWARE

Microchip hardware, including the MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® PICtail™ can be purchased from Microchip Direct (http://www.microchipdirect.com) or from any of the Microchip distributors.

Microchip development tool MPLAB ICD 3 In-Circuit Debugger (ICD) (http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1406&dDocName=en537580)

A.2 MICROCHIP SOFTWARE

- TCP/IP stack source code (http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=2680&dDocName=en537041)
- MPLAB X IDE (http://www.microchip.com/pagehandler/en-us/family/mplabx/)
- MPLAB XC Compiler (http://www.microchip.com/pagehandler/en_us/devtools/mplabxc/)

A.3 MRF24WB0MA/B OR MRF24WG0MA/B WI-FI® RESOURCES

The MRF24WB0MA/B or MRF24WG0MA/B Wi-Fi® support web site (http://www.microchip.com/pagehandler/en-us/technology/wifi), contains the latest information, application notes, errata, module data sheets, and other useful information.

A.4 TOOLS

- Iperf (http://www.softpedia.com/progDownload/Iperf-Download-78352.html)
- Wireshark PSK calculator (http://www.wireshark.org/tools/wpa-psk.html)
- WEP Key calculator (http://wepkey.com)
- WEP Key ASCII calculator (http://www.andrewscompanies.com/tools/wep.asp)

NOTES:

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