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RabbitCore RCM4400W

C-Programmable Wi-Fi Core Module

OEM User's Manual

019-0160 • 090515-G

RabbitCore RCM4400W OEM User's Manual

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1. INTRODUCTION

The RCM4400W RabbitCore module adds Wi-Fi/802.11b functionality to the existing Rabbit® 4000 microprocessor features to allow you to create a low-cost, low-power, embedded wireless control and communications solution for your embedded control system. The Rabbit® 4000 microprocessor features include hardware DMA, clock speeds of up to 60 MHz, I/O lines shared with up to six serial ports and four levels of alternate pin functions that include variable-phase PWM, auxiliary I/O, quadrature decoder, and input capture. Coupled with more than 500 new opcode instructions that help to reduce code size and improve processing speed, this equates to a core module that is fast, efficient, and the ideal solution for a wide range of wireless embedded applications.

The Development Kit has the essentials that you need to design your own wireless microprocessor-based system, and includes a complete Dynamic C software development system. This Development Kit also contains a Prototyping Board that will allow you to evaluate the RCM4400W RabbitCore modules and to prototype circuits that interface to the RCM4400W modules. You will also be able to write and test software for these modules.

In addition to onboard Wi-Fi/802.11b functionality, the RCM4400W model has a Rabbit 4000 microprocessor operating at 58.98 MHz, static RAM, flash memory, two clocks (main oscillator and timekeeping), and the circuitry necessary for reset and management of battery backup of the Rabbit 4000's internal real-time clock and the static RAM. One 50-pin header brings out the Rabbit 4000 I/O bus lines, parallel ports, and serial ports.

The RCM4400W series receives its +3.3 V power from the customer-supplied motherboard on which it is mounted. The RCM4400W series can interface with many CMOS-compatible digital devices through the motherboard.

1.1 RCM4400W Features

- Small size: 1.84" × 2.85" × 0.50"
(47 mm × 72 mm × 13 mm)
- Microprocessor: Rabbit 4000 running at 58.98 MHz
- Up to 35 general-purpose I/O lines configurable with up to four alternate functions
- 3.3 V I/O lines with low-power modes down to 2 kHz
- Six CMOS-compatible serial ports — four ports are configurable as a clocked serial port (SPI), and two ports are configurable as SDLC/HDLC serial ports.
- Alternate I/O bus can be configured for 8 data lines and 6 address lines (shared with parallel I/O lines), I/O read/write
- 512KB flash memory, 512KB data SRAM, 512KB fast program-execution SRAM
- UBEC single-chip 802.11b transceiver
- Real-time clock
- Watchdog supervisor

Currently there is one RCM4400W production model. Table 1 summarizes its main features.

Table 1. RCM4400W Features

Feature	RCM4400W
Microprocessor	Rabbit® 4000 at 58.98 MHz
Flash Memory	512KB
Data SRAM	512KB
Fast Program-Execution SRAM	512KB
Serial Ports	6 shared high-speed, CMOS-compatible ports: 6 are configurable as asynchronous serial ports; 4 are configurable as clocked serial ports (SPI); 2 are configurable as SDLC/HDLC serial ports; 1 asynchronous serial port is used during programming
Wi-Fi	802.11b standard, ISM 2.4 GHz

NOTE: There is a special version of the RCM4400W RabbitCore module for Japan. It is functionally identical to the standard RCM4400W module and uses the same components, but has been assembled to meet the Japan regulatory requirements. Be sure to order the correct version for the market where you plan to use the RCM4400W. The two versions can be distinguished by the labels on the RF shield as shown below.



Standard Release Label



Japan Version Label

The RCM4400W series is programmed over a standard PC USB port through a programming cable supplied with the Development Kit.

NOTE: The RabbitLink cannot be used to program RabbitCore modules based on the Rabbit 4000 microprocessor.

Appendix A provides detailed specifications for the RCM4400W.

1.2 Advantages of the RCM4400W

- Fast time to market using a fully engineered, “ready-to-run/ready-to-program” microprocessor core module.
- Competitive pricing when compared with the alternative of purchasing and assembling individual components.
- Easy C-language program development and debugging
- Rabbit Field Utility to download compiled Dynamic C .bin files, and cloning board options for rapid production loading of programs.
- Generous memory size allows large programs with tens of thousands of lines of code, and substantial data storage.
- Easily scalable for commercial deployment applications

1.3 Development and Evaluation Tools

1.3.1 RCM4400W Development Kit

The RCM4400W Development Kit contains the hardware essentials you will need to use the RCM4400W module. The items in the Development Kit and their use are as follows.

- RCM4400W module with 2.4 GHz *bec* whip dipole antenna.
- Prototyping Board.
- Universal AC adapter, 12 V DC, 1 A (includes Canada/Japan/U.S., Australia/N.Z., U.K., and European style plugs). Development Kits sold in North America may contain an AC adapter with only a North American style plug.
- USB programming cable with 10-pin header.
- 10-pin header to DB9 serial cable.
- *Dynamic C*[®] CD-ROM, with complete product documentation on disk.
- *Getting Started* instructions.
- A bag of accessory parts for use on the Prototyping Board.
- *Rabbit 4000 Processor Easy Reference* poster.
- Registration card.

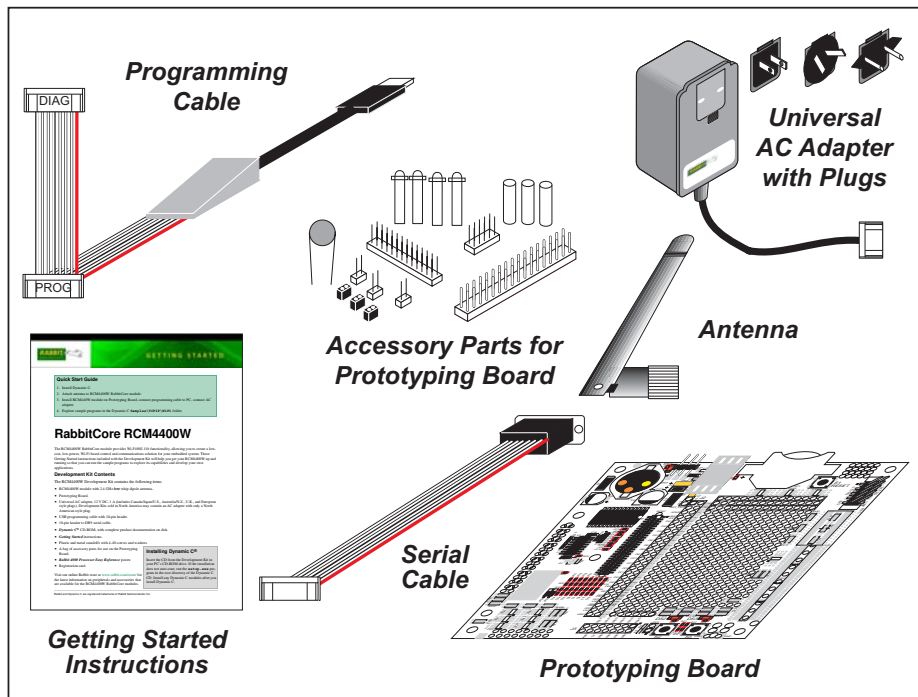


Figure 1. RCM4400W Development Kit

1.3.2 Software

The RCM4400W is programmed using version 10.21 or later of Dynamic C. A compatible version is included on the Development Kit CD-ROM.

RCM4400W RabbitCore modules labelled “For development use only” may be used with Dynamic C v. 10.11, but any applications developed using Dynamic C v. 10.11 will have to be recompiled with a future version of Dynamic C in order to run and meet regulatory requirements on production modules carrying the FCC certification markings. These “For development use only” modules were only sold in 2007.

Rabbit also offers add-on Dynamic C modules containing the popular μ C/OS-II real-time operating system, the FAT file system, as well as PPP, Advanced Encryption Standard (AES), and other select libraries. In addition to the Web-based technical support included at no extra charge, a one-year telephone-based technical support module is also available for purchase. Visit our Web site at www.rabbit.com or contact your Rabbit sales representative or authorized distributor for further information.

1.3.3 Online Documentation

The online documentation is installed along with Dynamic C, and an icon for the documentation menu is placed on the workstation’s desktop. Double-click this icon to reach the menu. If the icon is missing, use your browser to find and load **default.htm** in the **docs** folder, found in the Dynamic C installation folder.

The latest versions of all documents are always available for free, unregistered download from our Web sites as well.

1.4 Certifications

The systems integrator and the end-user are ultimately responsible for the channel range and power limits complying with the regulatory requirements of the country where the end device will be used. Dynamic C function calls and sample programs illustrate how this is achieved by selecting the country or region, which sets the channel range and power limits automatically. See Section 6.2.4.1 for additional information and sample programs demonstrating how to configure an end device to meet the regulatory channel range and power limit requirements.

Only RCM4400W modules bearing the FCC certification are certified for use in Wi-Fi enabled end devices, and any applications must have been compiled using Dynamic C v. 10.21 or later. The certification is valid only for RCM4400W modules equipped with the dipole antenna that is included with the modules. Changes or modifications to this equipment not expressly approved by Rabbit may void the user's authority to operate this equipment.

In the event that these conditions cannot be met, then the FCC certification is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the systems integrator or end-user will be responsible for re-evaluating the end device (including the transmitter) and obtaining a separate FCC certification.

NOTE: Any regulatory certification is voided if the RF shield on the RCM4400W module is removed.

1.4.1 FCC Part 15 Class B

The RCM4400W RabbitCore module has been tested and found to comply with the limits for Class B digital devices pursuant to Part 15 Subpart B, of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential environment. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try and correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Labeling Requirements (FCC 15.19)

FCC ID: VCB-540D144

This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation.



The modular transmitter must be equipped with either a permanently affixed label or must be capable of displaying the FCC identification number electronically.

If using a permanently affixed label, the modular transmitter must be labeled with its own FCC identification number, and, if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains Transmitter Module FCC ID: VCB-540D144” or “Contains FCC ID: VCB-540D144.” Any similar wording that expresses the same meaning may be used.

The following caution must be included with documentation for any device incorporating the RCM4400W RabbitCore module.

Caution — Exposure to Radio-Frequency Radiation.

To comply with FCC RF exposure compliance requirements, for mobile configurations, a separation distance of at least 20 cm must be maintained between the antenna of this device and all persons.

This device must not be co-located or operating in conjunction with any other antenna or transmitter.

1.4.2 Industry Canada Labeling

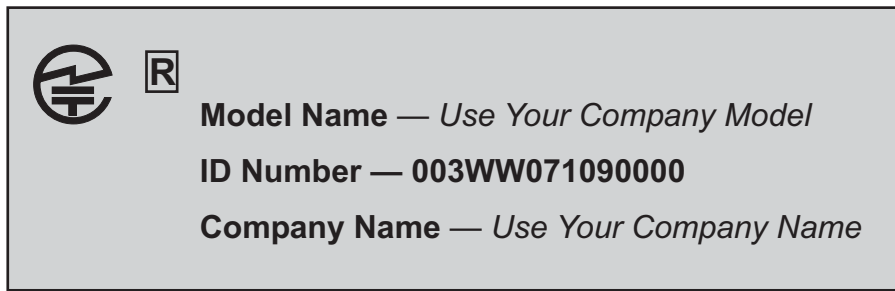


ID: 7143A-540D144

This Class B digital apparatus complies with Canadian standard ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

1.4.3 Japan Labeling



The logo mark diameter must be 5 mm or bigger.

If the equipment is 100 cm³ or smaller in volume, the minimum size of the logo mark is 3 mm.

1.4.4 Europe

The marking shall include as a minimum:

- the name of the manufacturer or his trademark;
- the type designation;
- equipment classification, (see below).

Receiver Class	Risk Assessment of Receiver Performance
1	Highly reliable SRD communication media, e.g., serving human life inherent systems (may result in a physical risk to a person).
2	Medium reliable SRD communication media, e.g., causing Inconvenience to persons that cannot be overcome by other means.
3	Standard reliable SRD communication media, e.g., inconvenience to persons that can simply be overcome by other means.

NOTE: Manufacturers are recommended to declare the classification of their devices in accordance with Table 2 and EN 300 440-2 [5] clause 4.2, as relevant. In particular, where an SRD that may have inherent safety of human life implications, manufacturers and users should pay particular attention to the potential for interference from other systems operating in the same or adjacent bands.

Regulatory Marking

The equipment shall be marked, where applicable, in accordance with CEPT/ERC Recommendation 70-03 or Directive 1999/5/EC, whichever is applicable. Where this is not applicable, the equipment shall be marked in accordance with the National Regulatory requirements.

2. GETTING STARTED

This chapter describes the RCM4400W hardware in more detail, and explains how to set up and use the accompanying Prototyping Board.

NOTE: This chapter (and this manual) assume that you have the RCM4400W Development Kit. If you purchased an RCM4400W module by itself, you will have to adapt the information in this chapter and elsewhere to your test and development setup.

2.1 Install Dynamic C

To develop and debug programs for the RCM4400W series of modules (and for all other Rabbit hardware), you must install and use Dynamic C.

If you have not yet installed Dynamic C version 10.11 (or a later version), do so now by inserting the Dynamic C CD from the Development Kit in your PC's CD-ROM drive. If autorun is enabled, the CD installation will begin automatically.

If autorun is disabled or the installation does not start, use the Windows **Start | Run** menu or Windows Disk Explorer to launch `setup.exe` from the root folder of the CD-ROM.

The installation program will guide you through the installation process. Most steps of the process are self-explanatory.

Dynamic C uses a COM (serial) port to communicate with the target development system. The installation allows you to choose the COM port that will be used. The default selection is COM1. You may select any available port for Dynamic C's use. If you are not certain which port is available, select COM1. This selection can be changed later within Dynamic C.

NOTE: The installation utility does not check the selected COM port in any way. Specifying a port in use by another device (mouse, modem, etc.) may lead to a message such as "could not open serial port" when Dynamic C is started.

Once your installation is complete, you will have up to three new icons on your PC desktop. One icon is for Dynamic C, another opens the documentation menu, and the third is for the Rabbit Field Utility, a tool used to download precompiled software to a target system.

If you have purchased any of the optional Dynamic C modules, install them after installing Dynamic C. The modules may be installed in any order. You must install the modules in the same directory where Dynamic C was installed.

2.2 Hardware Connections

There are three steps to connecting the Prototyping Board for use with Dynamic C and the sample programs:

1. Prepare the Prototyping Board for Development.
2. Attach the antenna to the RCM4400W module.
3. Attach the RCM4400W module to the Prototyping Board.
4. Connect the programming cable between the RCM4400W and the PC.
5. Connect the power supply to the Prototyping Board.



CAUTION: Provide ESD protection such as smocks and grounding straps on your footwear while assembling the RCM4400W module, installing it on another board, and while making or removing any connections.

Remember to use ESD protection regardless of whether you are working with the RCM4400W module on the Prototyping Board or in your own OEM application.

2.2.1 Step 1 — Prepare the Prototyping Board for Development

Snap in four of the plastic standoffs supplied in the bag of accessory parts from the Development Kit in the holes at the corners as shown in Figure 2.

NOTE: Pay attention to use the hole that is pointed out towards the bottom left of the Prototyping Board since the hole below it is used for a standoff when mounting the RCM4400W on the Prototyping Board.

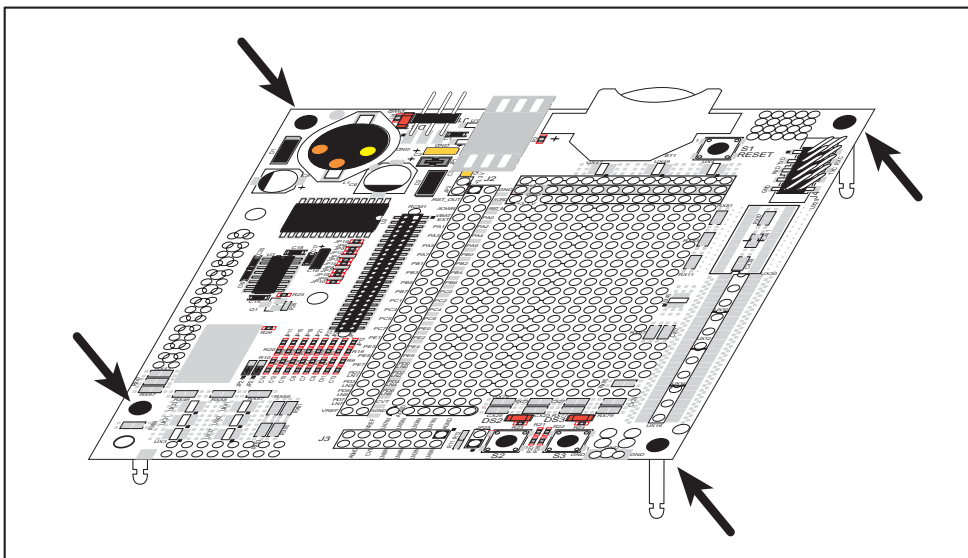


Figure 2. Insert Standoffs

2.2.2 Step 2 — Attach the Antenna to the RCM4400W Module

Attach the antenna to the antenna SMA connector on the RCM4400W as shown in Figure 3.

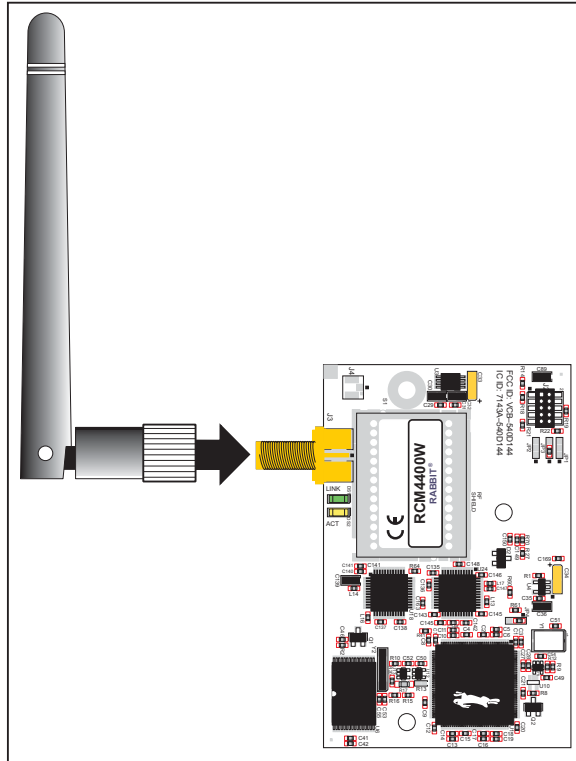


Figure 3. Attach the Antenna to the RCM4400W Module



CAUTION: Do *not* remove the RF shield by the antenna since any attempt to remove the shield will damage the RF circuits underneath it.

Any regulatory certification is voided if the RF shield on the RCM4400W module is removed.

2.2.3 Step 3 — Attach Module to Prototyping Board

Turn the RCM4400W module so that the mounting holes line up with the corresponding holes on the Prototyping Board. Insert the metal standoffs as shown in Figure 4, secure them from the bottom using the 4-40 × 3/16 screws and washers, then insert the module's header J1 on the bottom side into socket RCM1 on the Prototyping Board.

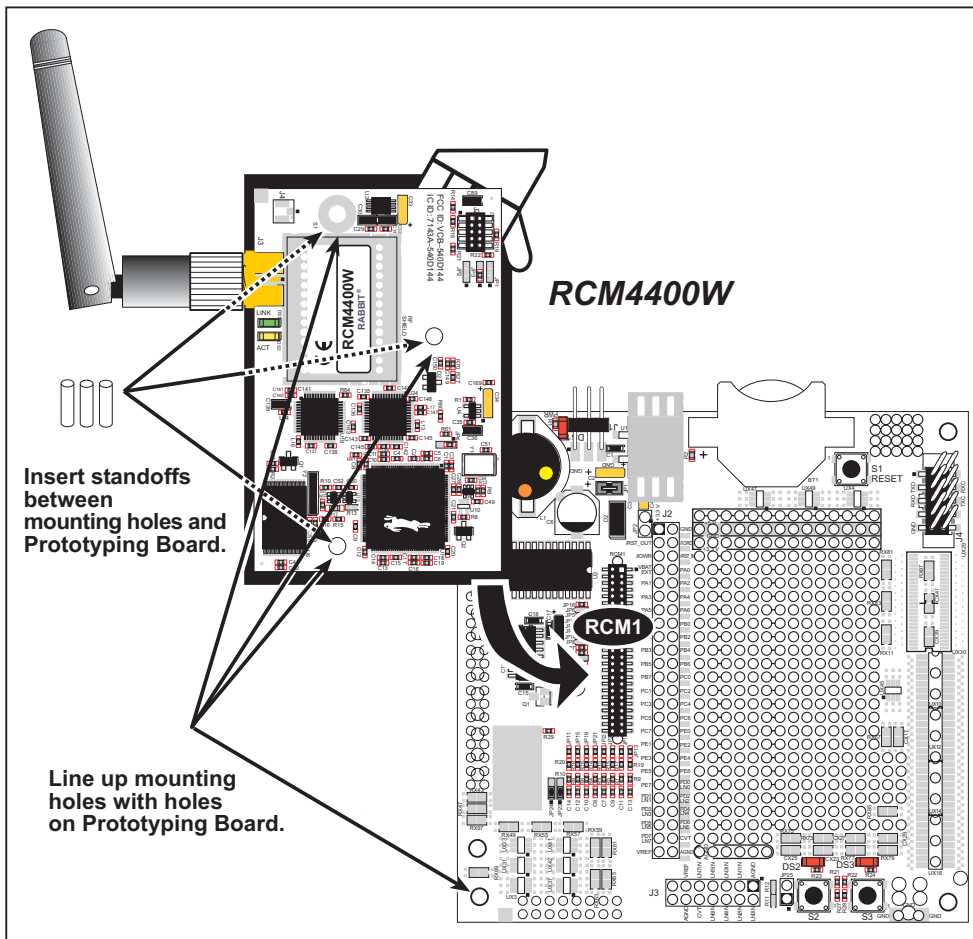


Figure 4. Install the Module on the Prototyping Board

NOTE: It is important that you line up the pins on header J1 of the module exactly with socket RCM1 on the Prototyping Board. The header pins may become bent or damaged if the pin alignment is offset, and the module will not work. Permanent electrical damage to the module may also result if a misaligned module is powered up.

Press the module's pins gently into the Prototyping Board socket—press down in the area above the header pins. For additional integrity, you may secure the RCM4400W to the standoffs from the top using the remaining three screws and washers.

2.2.4 Step 4 — Connect Programming Cable

The programming cable connects the module to the PC running Dynamic C to download programs and to monitor the module during debugging.

Connect the 10-pin connector of the programming cable labeled **PROG** to header J2 on the RCM4400W as shown in Figure 5. Be sure to orient the marked (usually red) edge of the cable towards pin 1 of the connector. (Do not use the **DIAG** connector, which is used for a normal serial connection.)

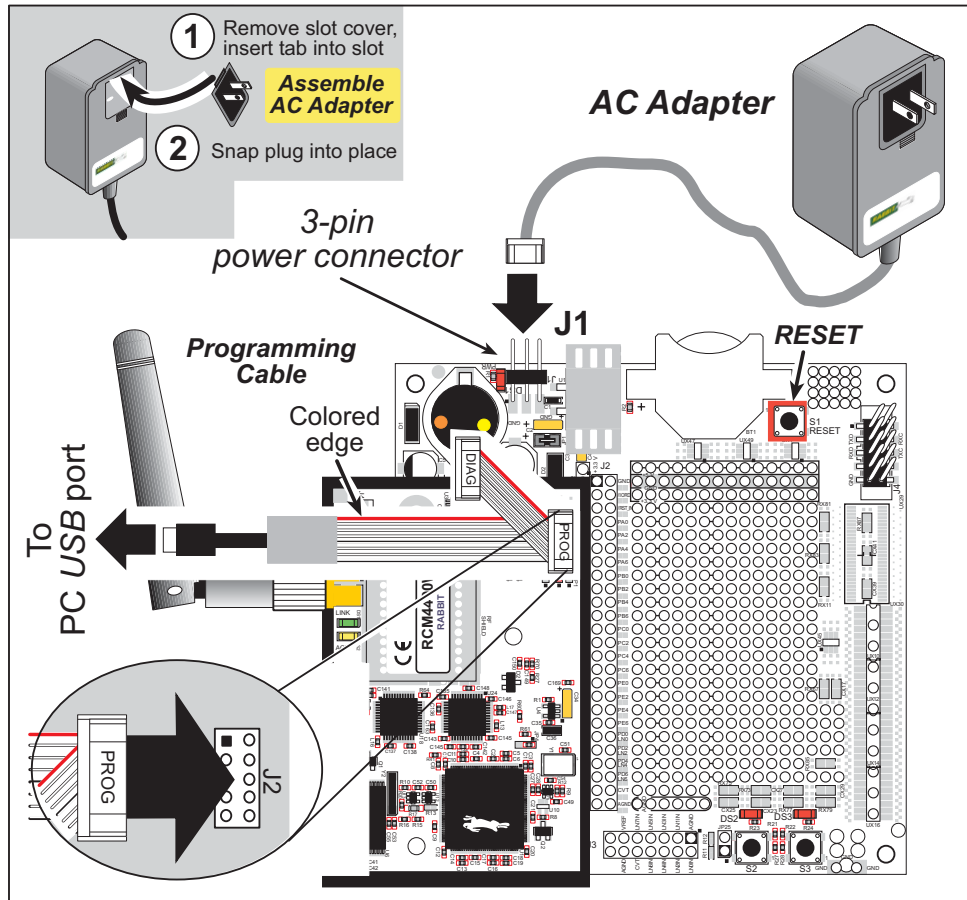


Figure 5. Connect Programming Cable and Power Supply

NOTE: Never disconnect the programming cable by pulling on the ribbon cable. Carefully pull on the connector to remove it from the header.

Connect the other end of the programming cable to an available USB port on your PC or workstation.

Your PC should recognize the new USB hardware, and the LEDs in the shrink-wrapped area of the USB programming cable will flash — if you get an error message, you will have to install USB drivers. Drivers for Windows XP are available in the Dynamic C Drivers\Rabbit USB Programming Cable\WinXP_2K folder — double-click **DPInst.exe** to install the USB drivers. Drivers for other operating systems are available online at www.ftdichip.com/Drivers/VCPC.htm.

2.2.5 Step 5 — Connect Power

Once all the other connections have been made, you can connect power to the Prototyping Board.

If you have the universal AC adapter, prepare the AC adapter for the country where it will be used by selecting the appropriate plug. Snap in the top of the plug assembly into the slot at the top of the AC adapter as shown in Figure 5, then press down on the plug until it clicks into place.

Connect the AC adapter to 3-pin header J1 on the Prototyping Board as shown in Figure 5 above. The connector may be attached either way as long as it is not offset to one side—the center pin of J1 is always connected to the positive terminal, and either edge pin is ground.

Plug in the AC adapter. The **PWR** LED on the Prototyping Board next to the power connector at J1 should light up. The RCM4400W and the Prototyping Board are now ready to be used.

NOTE: A **RESET** button is provided on the Prototyping Board next to the battery holder to allow a hardware reset without disconnecting power.

To power down the Prototyping Board, unplug the power connector from J1. You should disconnect power before making any circuit adjustments in the prototyping area, changing any connections to the board, or removing the RCM4400W from the Prototyping Board.

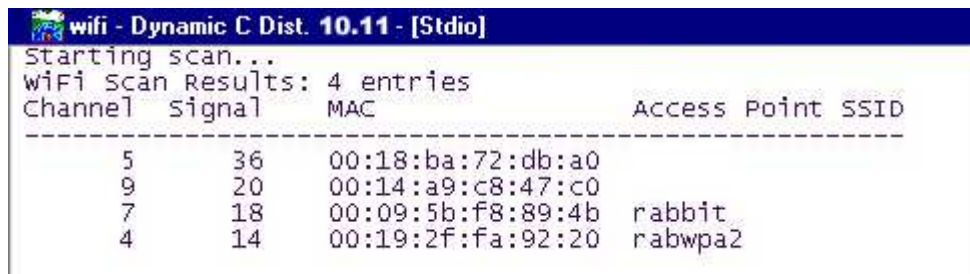
2.3 Run a Sample Program

If you already have Dynamic C installed, you are now ready to test your programming connections by running a sample program. Start Dynamic C by double-clicking on the Dynamic C icon on your desktop or in your **Start** menu. Select **Code and BIOS in Flash, Run in RAM** on the “Compiler” tab in the Dynamic C **Options > Project Options** menu. Then click on the “Communications” tab and verify that **Use USB to Serial Converter** is selected to support the USB programming cable. Click **OK**.

Determine which COM port was assigned to the USB programming cable on your PC. Open **Control Panel > System > Hardware > Device Manager > Ports** and identify which COM port is used for the USB connection. In Dynamic C, select **Options > Project Options**, then select this COM port on the **Communications** tab, then click **OK**. You may type the COM port number followed by **Enter** on your computer keyboard if the COM port number is outside the range on the dropdown menu.

Now find the **WIFISCAN.C** sample program in the Dynamic C **Samples\TCPIP\WiFi** folder, open it with the **File** menu, then compile and run the sample program by pressing **F9**.

The Dynamic C **STDIO** window will display **Starting scan....**, and will display a list of access points/ad-hoc hosts as shown here.



```
wifi - Dynamic C Dist. 10.11 - [Stdio]
Starting scan...
WiFi Scan Results: 4 entries
Channel  signal  MAC                Access Point SSID
-----  -
5        36   00:18:ba:72:db:a0
9        20   00:14:a9:c8:47:c0
7        18   00:09:5b:f8:89:4b  rabbit
4        14   00:19:2f:fa:92:20  rabwpa2
```

The following fields are shown in the Dynamic C **STDIO** window.

- Channel—the channel the access point is on (1–11).
- Signal—the signal strength of the access point.
- MAC—the hardware (MAC) address of access point.
- Access Point SSID—the SSID the access point is using.

2.3.1 Troubleshooting

If you receive the message **Could Not Open Serial Port**, check that the COM port assigned to the USB programming cable was identified and set up in Dynamic C as described in the preceding section.

If you receive the message **No Rabbit Processor Detected**, the programming cable may be connected to the wrong COM port, a connection may be faulty, or the target system may not be powered up. First, check to see that the power LED on the Prototyping Board is lit. If the LED is lit, check both ends of the programming cable to ensure that it is firmly plugged into the PC and the programming header on the RCM4400W with the marked (colored) edge of the programming cable towards pin 1 of the programming header. Ensure that the module is firmly and correctly installed in its connectors on the Prototyping Board.

If Dynamic C appears to compile the BIOS successfully, but you then receive a communication error message when you compile and load a sample program, it is possible that your PC cannot handle the higher program-loading baud rate. Try changing the maximum download rate to a slower baud rate as follows.

- Locate the **Serial Options** dialog on the “Communications” tab in the Dynamic C **Options > Project Options** menu. Select a slower Max download baud rate. Click **OK** to save.

If a program compiles and loads, but then loses target communication before you can begin debugging, it is possible that your PC cannot handle the default debugging baud rate. Try lowering the debugging baud rate as follows.

- Locate the **Serial Options** dialog on the “Communications” tab in the Dynamic C **Options > Project Options** menu. Choose a lower debug baud rate. Click **OK** to save.

Press **<Ctrl-Y>** to force Dynamic C to recompile the BIOS. You should receive a **Bios compiled successfully** message once this step is completed successfully.

2.4 Where Do I Go From Here?

If the sample program ran fine, you are now ready to go on to the sample programs in Chapter 3 and to develop your own applications. The sample programs can be easily modified for your own use. The user's manual also provides complete hardware reference information and software function calls for the RCM4400W series of modules and the Prototyping Board.

For advanced development topics, refer to the *Dynamic C User's Manual*, also in the online documentation set.

2.4.1 Technical Support

NOTE: If you purchased your RCM4400W through a distributor or through a Rabbit partner, contact the distributor or partner first for technical support.

If there are any problems at this point:

- Use the Dynamic C **Help** menu to get further assistance with Dynamic C.
- Check the Rabbit Technical Bulletin Board and forums at www.rabbit.com/support/bb/ and at www.rabbit.com/forums/.
- Use the Technical Support e-mail form at www.rabbit.com/support/.

3. RUNNING SAMPLE PROGRAMS

To develop and debug programs for the RCM4400W (and for all other Rabbit hardware), you must install and use Dynamic C. This chapter provides a tour of its major features with respect to the RCM4400W.

3.1 Introduction

To help familiarize you with the RCM4400W modules, Dynamic C includes several sample programs. Loading, executing and studying these programs will give you a solid hands-on overview of the RCM4400W's capabilities, as well as a quick start with Dynamic C as an application development tool.

This chapter provides sample programs that illustrate the digital I/O and serial capabilities of the RCM4400W RabbitCore module. Section 6.2.4 discusses the sample programs that illustrate the Wi-Fi features.

NOTE: The sample programs assume that you have at least an elementary grasp of the C language. If you do not, see the introductory pages of the *Dynamic C User's Manual* for a suggested reading list.

In order to run the sample programs discussed in this chapter and elsewhere in this manual,

1. Your module must be plugged in to the Prototyping Board as described in Chapter 2, "Getting Started."
2. Dynamic C must be installed and running on your PC.
3. The programming cable must connect the programming header on the module to your PC.
4. Power must be applied to the module through the Prototyping Board.

Refer to Chapter 2, "Getting Started," if you need further information on these steps.

To run a sample program, open it with the **File** menu, then compile and run it by pressing **F9**.

Each sample program has comments that describe the purpose and function of the program. Follow the instructions at the beginning of the sample program.

Complete information on Dynamic C is provided in the *Dynamic C User's Manual*.