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Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
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PRODUCT MANUAL

PowerCore FLEX™

C-Programmable PowerCore Module
with Mass Storage and Ethernet

User's Manual

019–0141 • 070831–E

PowerCore FLEX™ User's Manual

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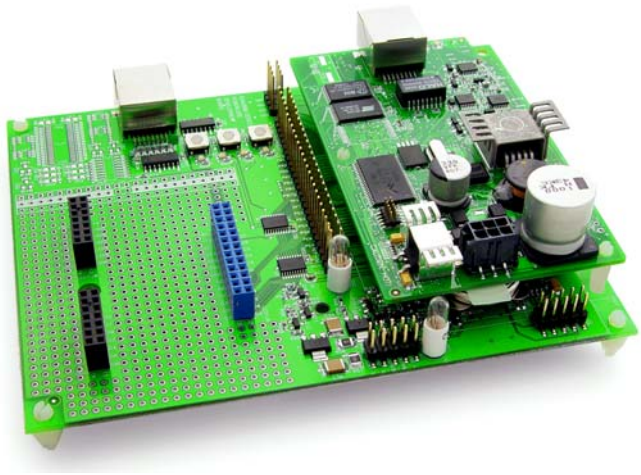
1. INTRODUCTION

The PowerCore is an easy-to-use core module with a networkable microprocessor system that has an optional onboard configurable power supply. In addition to two standard preconfigured models, PowerCore FLEX™ modules can be built on a quick-turn basis based on customer-selected options. Customers can select memory, Ethernet, power supply, and other features to suit their individual needs without having to pay for unneeded features.

The PowerCore is designed to plug into a motherboard designed by the customer. A 50-pin connector brings the various I/Os, the I/O bus, and the power supplies to the customer's motherboard. Three snap-in plastic standoffs provide sturdy mechanical support.



The PowerCore is supported by powerful Dynamic C development platform that includes extensive libraries to support networking and the Internet.

PowerCore modules are programmed over a standard PC serial port through a programming cable supplied with the Tool Kit, and can also be programmed through a USB port with an RS-232/USB converter, or directly over an Ethernet link via a RabbitLink.

1.1 PowerCore Features

1.1.1 Basic Features

- Small size: 2.35" × 4.00" × 1.08"
  (60 mm × 102 mm × 28 mm)
- 39 configurable 5 V tolerant general-purpose I/O lines
- Three additional digital inputs, two additional digital outputs
- Five 3.3 V CMOS-compatible serial ports with a maximum asynchronous baud rate up to 6.45 Mbps. Three ports are configurable as a clocked serial port (SPI), two ports are configurable as HDLC serial ports, and one ports is configurable as an SDLC serial port. One of the serial ports is normally dedicated as a programming port.
- 512K flash memory for storing instructions
- 256K static RAM for data
- Rabbit 3000® microprocessor running at 25.8 MHz. The Rabbit 3000 includes many powerful I/O devices such as serial ports, and precision pulse generation and measurement.
- 50-pin connector brings I/O and I/O bus to customer's motherboard
- Battery backable time/date clock

1.1.2 Options

- Ethernet including RJ-45 connector (10/100 compatible)
- Clock speed 51.6 MHz
- Analog precision ramp generator that can be used in conjunction with low-cost comparators to create rugged A/D converter inputs
- Larger 512K SRAM memory for data
- Second 512K flash memory
- 1 Mbyte serial flash memory that implements file storage
- Coin cell battery to back up the SRAM and the onboard time/date clock
- Onboard +5 V DC switching power supply rated at 1 A or 2 A
- Triac support with AC zero-crossover detection
- Wi-Fi Add-On Kit to enable Wi-Fi interface

- External power-supply options for PowerCore module and motherboard
  - ▶ user-supplied regulated +5 V DC is supplied to the PowerCore module from the motherboard—the +5 V is regulated down to +3.45 V for driving the nominal 3.3 V components on the PowerCore; the motherboard can draw from the 3.45 V supply
  - ▶ user-supplied unregulated DC (8–40 V) is supplied to the PowerCore module from the motherboard or via the locking power connector at J3—requires onboard +5 V switching regulator @ 1 A or 2 A maximum output; the +5 V is regulated down to +3.45 V for driving the nominal 3.3 V components on the PowerCore; the motherboard can draw from both the 3.45 V and the +5 V regulated supplies
  - ▶ AC from two-lead transformer is supplied to the PowerCore module that has half-wave rectifier and filtering capacitor, includes zero-crossover detection to synchronize software drivers for triac support, two-lead transformer with untapped secondary winding may be used—the resulting DC then passes to the onboard +5 V switching regulator @ 1 A or 2 A maximum output, and is further regulated to +3.45 V; additional filtering capacitors may be needed on motherboard if high unregulated DC current will be drawn
  - ▶ AC from three-lead center-tapped transformer is supplied to the PowerCore module that has full-wave rectifier and filtering capacitor, includes zero-crossover detection to synchronize software drivers for triac support, transformer with tapped secondary winding required—the resulting DC then passes to the onboard +5 V switching regulator @ 1 A or 2 A maximum output, and is further regulated to +3.45 V; additional filtering capacitors may be needed on motherboard if high unregulated DC current will be drawn
  - ▶ AC from two-lead transformer is supplied to the PowerCore module that has full-wave bridge rectifier and filtering capacitor, no zero-crossover detection or triac support, transformer with untapped secondary winding may be used—the resulting DC then passes to the onboard +5 V switching regulator @ 1 A or 2 A maximum output, and is further regulated to +3.45 V; additional filtering capacitors may be needed on motherboard if high unregulated DC current will be drawn

1.2 Standard Configurations and PowerCore FLEX Options

There are two preconfigured PowerCore models. Table 1 below summarizes their main features.

Table 1. Standard PowerCore Production Models

Feature	PowerCore 3800	PowerCore 3810
Microprocessor	Rabbit 3000 running at 51.6 MHz	Rabbit 3000 running at 25.8 MHz
Ethernet	10/100 compatible 10Base-T interface	—
SRAM	512K program (fast SRAM) + 512K data	256K data
Flash Memory (program)	512K	512K
Flash Memory (mass data storage)	1 Mbyte (serial flash)	—
Current Limits for Onboard +5 V DC Voltage Regulators	2 A	1 A

If the standard models do not serve your needs, flexible PowerCore FLEX options can be configured to meet your needs.

Appendix A provides detailed specifications for the PowerCore modules.

1.3 PowerCore FLEX Advantages

- Fast time-to-market using a fully engineered, "ready-to-run/ready-to-program" microprocessor core.
- Competitive pricing when compared with the alternative of purchasing and assembling individual components.
- Easy C-language program development and real-time debugging with integrated Dynamic C® environment.
- Onboard regulated power supply, which can be used to power external circuits.
- Program download utility (Rabbit Field Utility) 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.
- Integrated Ethernet port for network connectivity, with royalty-free TCP/IP software.
- Ideal for network-enabling security and access systems, home automation, HVAC systems, and industrial controls.
- Can use either AC or DC power sources.
- Onboard analog circuits (AC zero-crossover detection allows triac control, ramp generator allows 10-bit A/D conversion with temperature sensor to allow for temperature compensation).

1.4 Development and Evaluation Tools

The PowerCore Tool Kit contains the hardware you need to use your PowerCore module.

- PowerCore Prototyping Board.
- 48 V AC, 1 A center-tapped transformer.
- Programming cable with 10-pin header and DE9 connections, and integrated level-matching circuitry.
- Mounting standoffs.
- ***Dynamic C*** CD-ROM, with complete product documentation on disk.
- ***Getting Started*** instructions.
- Accessory parts for use on the Prototyping Board.
- ***Rabbit 3000 Processor Easy Reference*** poster.
- Registration card.

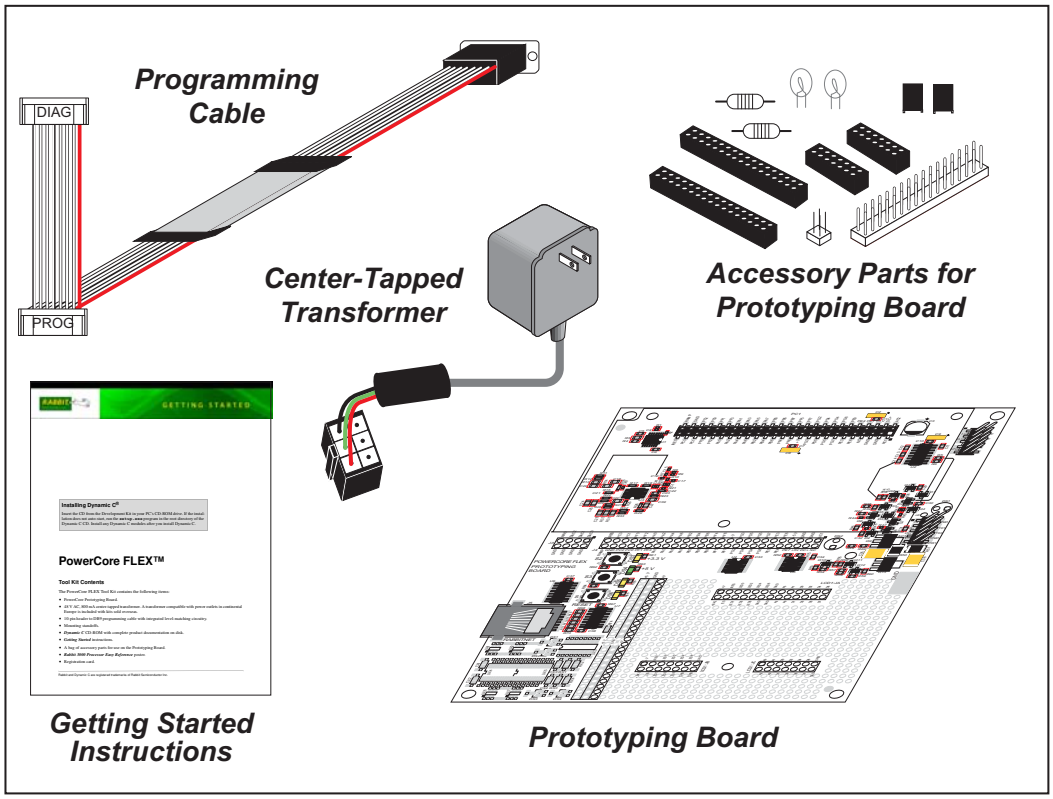


Figure 1. PowerCore Tool Kit

1.4.1 Software

PowerCore FLEX modules are programmed using version 9.20 or later of Rabbit Semiconductor's Dynamic C. A compatible version is included on the Tool Kit CD-ROM.

Rabbit Semiconductor also offers for purchase add-on Dynamic C modules including the popular µC/OS-II real-time operating system, as well as point-to-point protocol (PPP), Advanced Encryption Standard (AES), FAT file system, Secure Sockets Layer (SSL), RabbitWeb, 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 for further information and complete documentation for each module, or contact your Rabbit Semiconductor sales representative or authorized distributor.

1.4.2 Wi-Fi Add-On Kit

Rabbit Semiconductor also offers a Wi-Fi Add-On Kit for PowerCore FLEX modules consisting of a PowerCore Interposer Board, a Wi-Fi CompactFlash card with a CompactFlash Wi-Fi Board, a ribbon interconnecting cable, and the software drivers and sample programs to help you enable your PowerCore module with Wi-Fi capabilities. The PowerCore Interposer Board is placed between the PowerCore module and the PowerCore Prototyping Board so that the CompactFlash Wi-Fi Board, which holds the Wi-Fi CompactFlash card, can be connected to the PowerCore-based system via the ribbon cable provided.

Visit our Web site at www.rabbit.com or contact your Rabbit Semiconductor sales representative or authorized distributor for further information.

1.4.3 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.

2. GETTING STARTED

This chapter explains how to set up and use a PowerCore module with a PowerCore Prototyping Board.

NOTE: It is assumed that you have a Tool Kit. If you purchased a PowerCore FLEX 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 PowerCore FLEX modules (and for all other and Rabbit Semiconductor hardware), you must install and use Dynamic C.

If you have not yet installed Dynamic C version 9.20 (or a later version), do so now by inserting the Dynamic C CD from the Tool 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 otherwise 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, one 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 PowerCore Prototyping Board for use with Dynamic C and the sample programs:

1. Attach the PowerCore module to the Prototyping Board.
2. Connect the programming cable between the PowerCore module and the workstation PC.
3. Connect the power supply to the PowerCore module.

2.2.1 Attach Module to Prototyping Board

Turn the PowerCore module so that the notched corner is on the top left as shown in Figure 2 below. Snap in at least one standoff as shown below and then insert the module's J4 header into the PC1 socket on the Prototyping Board. The notched corner at the top left corner of the PowerCore module should face the same direction as the corresponding notch outline below it on the Prototyping Board

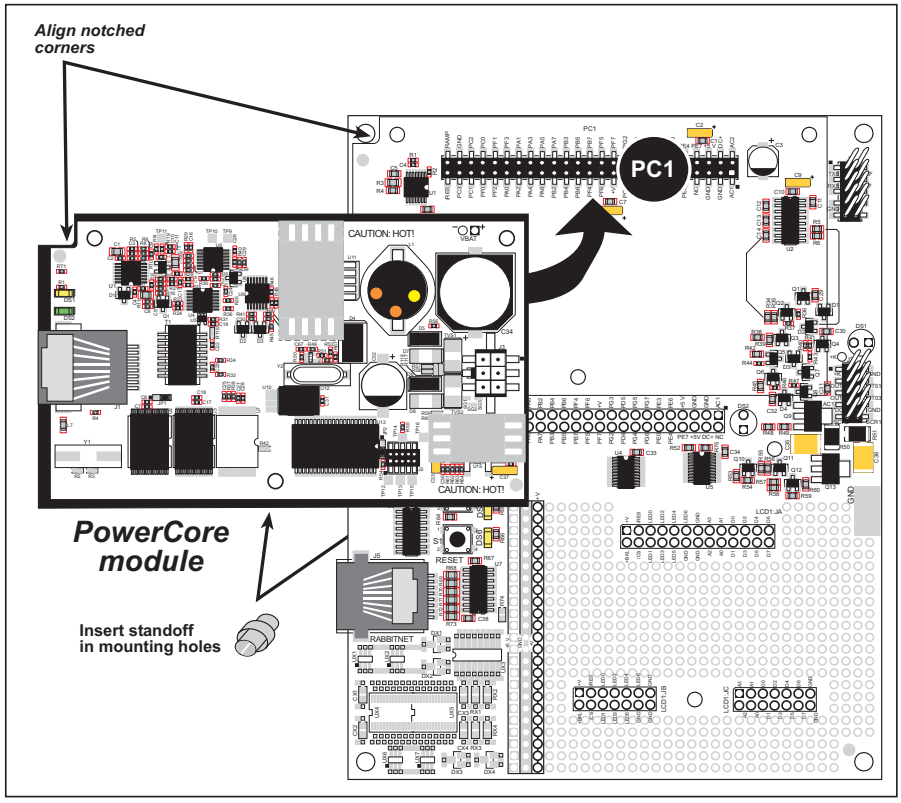


Figure 2. Install the PowerCore Module on the Prototyping Board

NOTE: It is important that you line up the pins on header J4 of the PowerCore module exactly with the corresponding pins of the PC1 socket 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 mis-aligned module is powered up.

Press the standoff into its corresponding hole and press the module's pins firmly into the Prototyping Board socket.

2.2.2 Connect Programming Cable

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

Connect the 10-pin connector of the programming cable labeled **PROG** to header J2 on the PowerCore module as shown in Figure 3. There is a small dot on the circuit board next to pin 1 of header J2. 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 nonprogramming serial connection.)

Attach the DE9 connector end of the programming cable to a COM (serial) port on the PC.

NOTE: Be sure to use the programming cable (part number 101-0542) supplied with this Tool Kit—the programming cable has blue shrink wrap around the RS-232 converter section located in the middle of the cable. Programming cables from other Rabbit Semiconductor kits might not work with PowerCore modules.

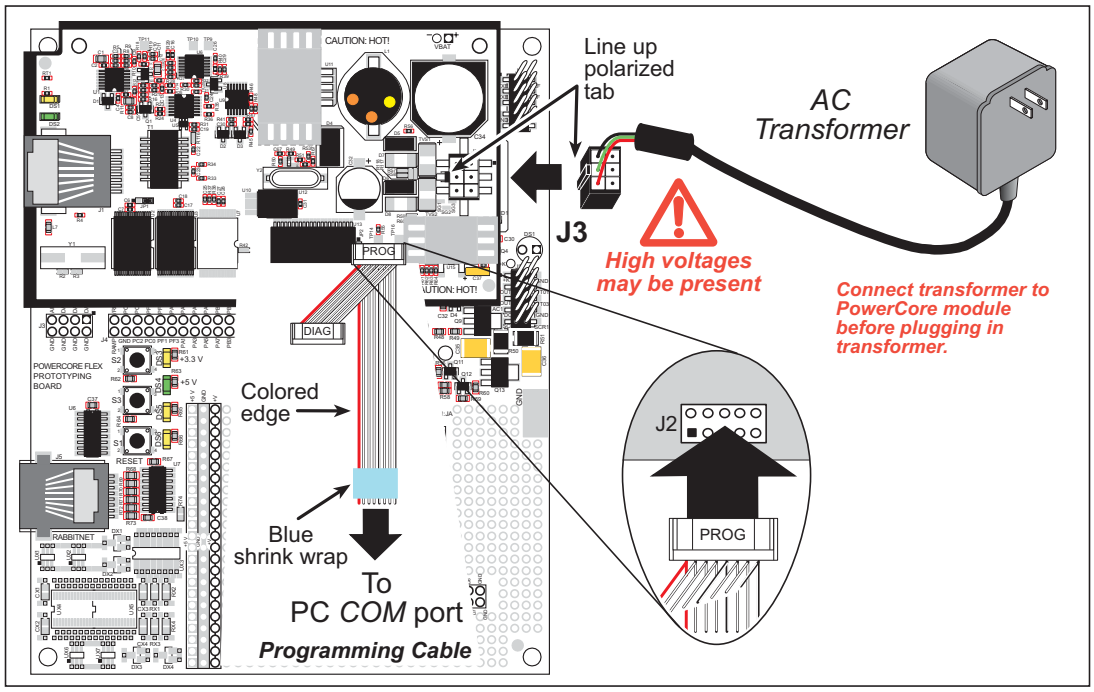


Figure 3. Connect Programming Cable and Power Supply

NOTE: Some PCs now come equipped only with a USB port. It may be possible to use an RS-232/USB converter (Part No. 540-0070) with the programming cable supplied with the PowerCore FLEX Development Kit. Note that not all RS-232/USB converters work with Dynamic C.

2.2.3 Connect Power

When all other connections have been made, you can connect power to the PowerCore module. In most cases where a locking power connector is stuffed at J3, connect the locking plug from the wall transformer to the J3 locking connector on the PowerCore module, taking care to line up the polarized tab on the locking plug with the locking connector as shown in Figure 3.

Plug in the wall transformer. The DS3 and DS4 yellow and green LEDs on the Prototyping Board located near the **RESET** button should light up. The PowerCore module and the Prototyping Board are now ready to be used.

CAUTION: It is important that power is connected in the order specified in these instructions—connect the locking plug from the wall transformer to the J3 locking connector on the PowerCore module ***before*** you plug in the wall transformer. This is important for your safety because of the high AC voltages present and to avoid possible damage to your PowerCore module.

CAUTION: The heat sinks on the PowerCore module can become very hot. Avoid any contact with them.

If you selected one of the FLEX configuration options (Options 1 and 2 in Appendix D.1.1) for regulated or unregulated DC power supplied from outside the PowerCore module, no locking connector is stuffed at J3 on the PowerCore module. Instead, either regulated +5 V DC is supplied to the PowerCore from your motherboard via pins 5 and 6 of header J4, or unregulated DC power is supplied via pins 1 and 5 of header J4, depending on which option you selected. The voltage range for unregulated DC power is established by your selection of a voltage regulator in Option 2 as explained in Appendix D.1.1.

NOTE: This provision of external DC power is not possible when you are using the PowerCore Prototyping Board, which has no provision to supply powerto the PowerCore module. Any external DC power must come from a motherboard of your own design for use with one of these FLEX options.

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

2.3 Starting Dynamic C

Once the PowerCore module is connected as described in the preceding pages, start Dynamic C by double-clicking on the Dynamic C icon or by double-clicking on **dcrabXXXX.exe** in the Dynamic C root directory, where **XXXX** are version-specific characters. Dynamic C uses the serial port on your PC that you specified during installation.

If you are using a USB port to connect your computer to the PowerCore module, go to the **Options > Project Options** dialog box and select "Use USB to Serial Converter" on the **Communications** tab.

2.4 Run a Sample Program

Use the **File** menu to open the sample program **PONG.C**, which is in the Dynamic C **SAMPLES** folder. Press function key **F9** to compile and run the program. The **STDIO** window will open on your PC and will display a small square bouncing around in a box.

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 in the Dynamic C **Options > Project Options > Communications** menu. Select a slower Max download baud rate.

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 in the Dynamic C **Options > Project Options > Communications** menu. Choose a lower debug baud rate.

If Dynamic C cannot find the target system (error message **"No Rabbit Processor Detected."**):

- Check that the PowerCore module is powered correctly — the red and yellow LEDs on the Prototyping Board should be lit when the PowerCore module is mounted on the Prototyping Board and the wall transformer is plugged in.
- Check to make sure you are using the **PROG** connector, not the **DIAG** connector, on the programming cable.
- Check both ends of the programming cable to ensure that they are firmly plugged into the PC and the programming port on the PowerCore module.
- Ensure that the PowerCore module is firmly and correctly installed in its socket on the Prototyping Board.
- Select a different COM port within Dynamic C. From the **Options** menu, select **Project Options**, then select **Communications**. Select another COM port from the list, then click OK. Press **<Ctrl-Y>** to force Dynamic C to recompile the BIOS. If Dynamic C still reports it is unable to locate the target system, repeat the above steps until you locate the active COM port.

2.5 Where Do I Go From Here?

If the sample program ran fine, you are now ready to go on to other sample programs and to develop your own applications. The source code for the sample programs is provided to allow you to modify them for your own use. This manual also provides complete hardware reference information and describes the software function calls for the PowerCore FLEX modules, the Prototyping Board, and the optional LCD/keypad module.

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

2.5.1 Standalone Operation of the PowerCore Module

Once the PowerCore module has been programmed successfully, remove the programming cable from the programming connector and reset the PowerCore module. The PowerCore module may be reset by removing, then reapplying power, or by pressing the **RESET** button on the Prototyping Board if it is connected to the Prototyping Board. The PowerCore module may now be removed from the Prototyping Board for end-use installation.

CAUTION: Disconnect power to the PowerCore module or other boards when removing or installing your PowerCore module to protect against inadvertent shorts across the pins or damage to the PowerCore module if the pins are not plugged in correctly. Do not reapply power until you have verified that the PowerCore module is plugged in correctly.

2.5.2 Technical Support

NOTE: If you purchased your PowerCore through a distributor or through a Rabbit Semiconductor 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 Semiconductor Technical Bulletin Board at www.rabbit.com/support/bb/.
- Use the Technical Support e-mail form at www.rabbit.com/support/.

3. RUNNING SAMPLE PROGRAMS

To develop and debug programs for the PowerCore (and for all other Rabbit Semiconductor hardware), you must install and use Dynamic C.

3.1 Introduction

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

> **NOTE:** The sample programs assume that you have at least an elementary grasp of the C programming 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 PowerCore 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 PowerCore module to your PC.
4. Power must be applied to the PowerCore module.

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, and then compile and run the sample program by selecting **Run** in the **Run** menu (or press **F9**). The PowerCore module must be in Program Mode (see Figure 8) and must be connected to a PC using the programming cable.

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

3.2 Sample Programs

Of the many sample programs included with Dynamic C, several are specific to the PowerCore FLEX modules. Sample programs illustrating the general operation of the PowerCore FLEX modules, serial communication, the serial flash, A/D conversion, D/A conversion, and hardware accessories such as a temperature sensor and triacs are provided in the **SAMPLES\PowerCoreFLEX** folder. Each sample program has comments that describe the purpose and function of the program. Follow the instructions at the beginning of the sample program. Note that the PowerCore module must be installed on the Prototyping Board when using the sample programs described in this chapter. TCP/IP sample programs are described in Chapter 6, "Using the TCP/IP Features," and sample programs for the optional LCD/keypad module are described in Appendix C.

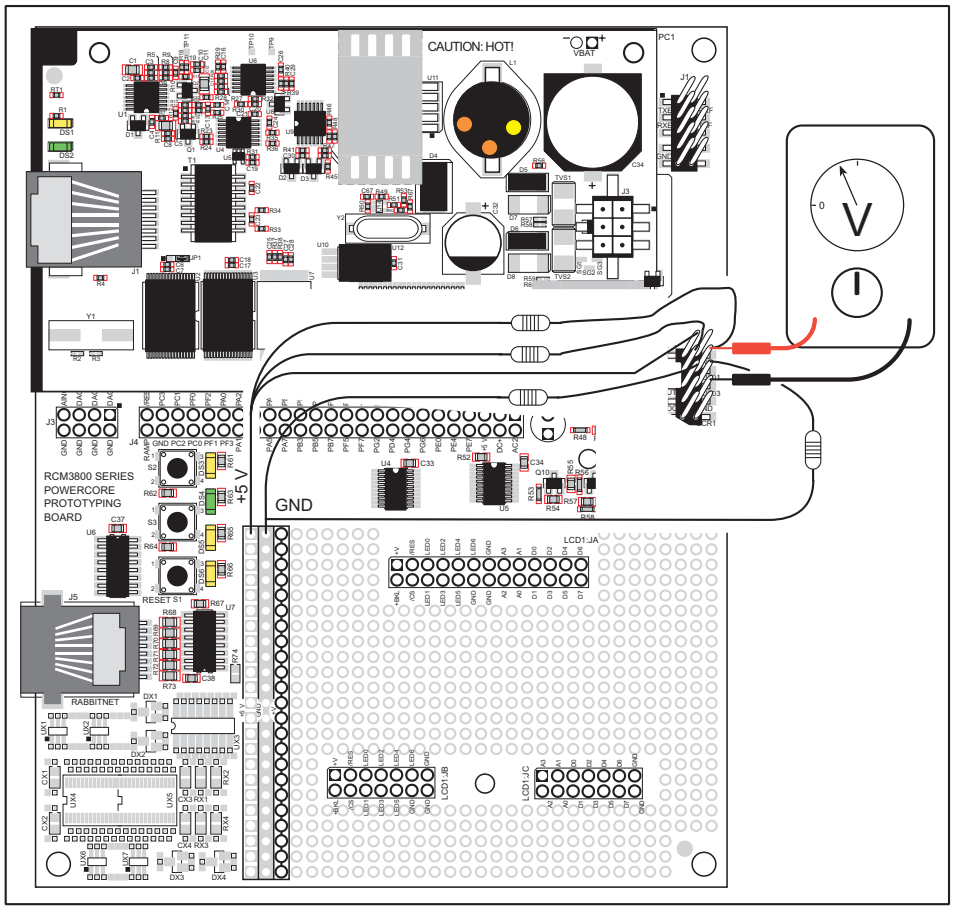
3.2.1 I/O

The following sample programs can be found in the **SAMPLES\PowerCoreFLEX\IO** folder.

- **DIGIN.c**—Demonstrates how to read digital inputs using the **digIn** function call. Press switches S2 and S3 on the Prototyping Board to change the logic levels for IN0 and IN1 as displayed in the Dynamic C **STDIO** window.
- **DIGOUT.c**—Demonstrates the control of sinking and sourcing digital outputs. Connect 100 Ω load resistors from the +5 V supply at pin 6 on header J4 or from the ground at pin 2 on header J2 as indicated in the table below.

Digital Output		Load Resistor	+K
Sinking	OUT0	+5 V to OUT0 (+5 V to J2 pin 3)	+K to +5 V (J2 pin 1 to +5 V)
	OUT1	+5 V to OUT1 (+5 V to J2 pin 4)	
Sourcing	OUT2	GND to OUT2 (GND to J2 pin 5)	+K to + 5 V (J2 pin 1 to +5 V)
	OUT3	GND to OUT3 (GND to J2 pin 6)	

These connections are illustrated below.



After you compile and run this program, select an output channel and logic level via the Dynamic C **STDIO** window. You can see the logic level with a voltmeter connected to the output channel you selected.

- **`LED.c`**—Demonstrates the use of the digital inputs by turning LEDs DS5 and DS6 on the Prototyping Board on and off.