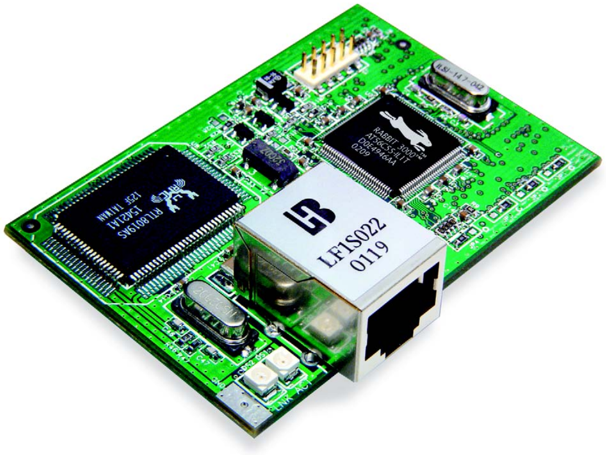

RabbitCore RCM3000

C-Programmable Module with Ethernet

Getting Started Manual

019–0109 • 050131–D

RabbitCore RCM3000 Getting Started Manual

Part Number 019-0109 • 050131–D • Printed in U.S.A.

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Z-World, Inc.

2900 Spafford Street
Davis, California 95616-6800
USA

Telephone: (530) 757-3737
Fax: (530) 757-3792

www.zworld.com

Rabbit Semiconductor

2932 Spafford Street
Davis, California 95616-6800
USA

Telephone: (530) 757-8400
Fax: (530) 757-8402

www.rabbitsemiconductor.com

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1. Introduction & Overview

The Rabbit 3000® is a modern 8-bit microprocessor that is the central element of a complete and fully supported embedded design system that includes development tools, software libraries, core modules, sample designs, a parts store, and readily available expert, human support.

This Development Kit has the essentials that you need to design your own microprocessor-based system, and includes a complete Dynamic C® software development system. This Development Kit contains a powerful RabbitCore™ module (the RCM3010) and Prototyping Board that will allow you to evaluate the Rabbit 3000 and to prototype circuits that interface to a Rabbit 3000 microprocessor. You will also be able to write and test software for the RCM3000 series RabbitCore modules, including TCP/IP applications.

1.1 Rabbit 3000 Microprocessor

The Rabbit 3000 microprocessor shares its instruction set and conceptual design with the successful Rabbit 2000. The instruction set is based on the Z80/Z180, but has been adapted to be C-friendly and to allow a megabyte of code space. Rabbit processors are fast with compact code.

The Rabbit 3000 has an extensive array of on-chip peripherals including 6 serial ports, 56 parallel I/O pins, motion control interfaces, a time/date clock, glueless memory and I/O interfacing, a slave interface, and in-circuit programming. Low-EMI features including a clock spectrum spreader eliminate schedule-wrecking EMI problems.

Software development support is based on Z-World's Dynamic C, and includes extensive libraries for Internet connectivity.

Refer to the ***Rabbit 3000 Microprocessor User's Manual*** for complete information on the Rabbit 3000 microprocessor and complete specifications.

1.2 RCM3000 RabbitCore Modules

Throughout this manual, the term RCM3000 refers to the complete series of RCM3000 RabbitCore modules unless other production models are referred to specifically.

The RCM3000 RabbitCore modules are designed for use on a customer-supplied motherboard that supplies power and interfaces to real-world I/O devices. Their two 34-pin connection headers provide 52 parallel user I/O lines, shared with five serial ports, along with control lines. A sixth serial port and one additional I/O line are available on the programming header.

A fully enabled slave port permits glueless master-slave interface with another Rabbit-based system. The slave port may also be used with non-Rabbit systems, although additional logic may be required.

The RCM3000 is equipped with a 10/100-compatible Ethernet port with a 10Base-T interface, 256K–512K flash memory and 128K–512K static RAM.

There are two production models in the RCM3000 series. If the standard models do not serve your needs, other variations can be specified and ordered in production quantities. Contact your Z-World® or Rabbit Semiconductor sales representative for details.

Table 1 below highlights the differences between the two models in the RCM3000 family.

Table 1. RCM3000 Versions

Feature	RCM3000	RCM3010
Microprocessor	Rabbit 3000 running at 29.4 MHz	
Flash Memory	512K	256K
Static RAM	512K	128K
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 clocked serial port is dedicated for programming	

NOTE: The RCM3010 is the RabbitCore module supplied with the Development Kit.

In addition, there is an RCM3100 series of RabbitCore modules that omits the RCM3000 series' Ethernet connectivity, but offer a much smaller footprint, which is about one-half that of the RCM3000 series.

The RabbitCore modules can be programed locally, remotely, or via a network using appropriate interface hardware.

1.2.1 Physical & Electrical Specifications

Table 2 lists the basic specifications for the RCM3000.

Table 2. RCM3000 Specifications

Specification	Data
Power Supply	3.15 – 3.45 V DC (145 mA at 29.5 MHz clock speed)
Size	1.85" x 2.65"” x 0.86" (47 mm × 67 mm × 22 mm)
Environmental	–40°C to 70°C, 5–95% humidity, noncondensing

> **NOTE:** For complete product specifications, see Appendix A in the ***RabbitCore RCM3000 User's Manual***.

The RCM3000 modules have two 34-pin headers to which cables can be connected, or which can be plugged into matching sockets on a production device. The pinouts for these connectors are shown in Figure 1 below.

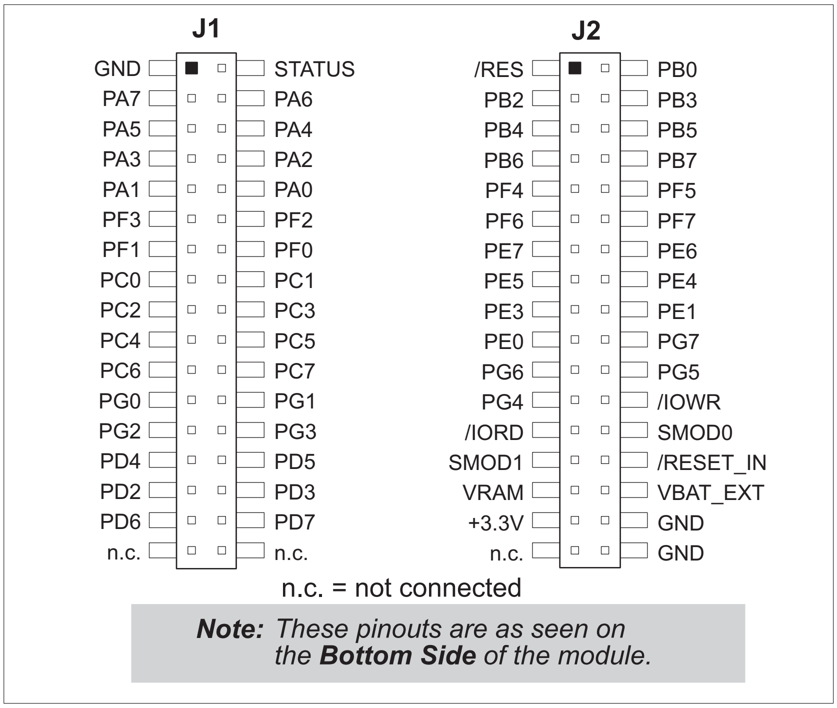


Figure 1. RCM3000 Connector Pinout

1.3 Development Software

The RCM3000 module uses the Dynamic C development environment for rapid creation and debugging of runtime applications. Dynamic C provides a complete development environment with integrated editor, compiler and source-level debugger. It interfaces directly with the target system, eliminating the need for complex and unreliable in-circuit emulators.

Dynamic C must be installed on a Windows workstation with at least one free serial USB or COM port for communication with the target system.

> **NOTE:** An RS-232/USB converter is required if you intend to use a USB port on your computer. Z-World and Rabbit Semiconductor offer a suitable converter—more information is available at www.rabbitsemiconductor.com, or you may telephone your Z-World/Rabbit Semiconductor sales representative or authorized distributor.

See Chapter 3., "Software Installation & Overview." for complete information on installing Dynamic C.

> **NOTE:** The RCM3000 module requires Dynamic C v7.25 or later for development. A compatible version is included on the Development Kit CD-ROM.

1.4 How to Use This Manual

This ***Getting Started*** manual is intended to give users a quick but solid start with the RCM3000 module. It does not contain detailed information on the module hardware capabilities, the Dynamic C development environment, or the TCP/IP software support for the integrated Ethernet port. Most users will want more detailed information on some or all of these topics in order to put the RCM3000 module to effective use.

1.4.1 Additional Product Information

Detailed information about the RCM3000 will be found in the ***RabbitCore RCM3000 User's Manual***, provided on the accompanying CD-ROM in both HTML and Adobe PDF format.

Some advanced users may choose to skip the rest of this introductory manual and proceed directly with the detailed hardware and software information in the ***User's Manual***.

> **TIP:** We recommend that anyone not thoroughly familiar with Z-World controllers at least read through the rest of this manual to gain the necessary familiarity to make use of the more advanced information.

1.4.2 Additional Reference Information

In addition to the product-specific information contained in the ***RabbitCore RCM3000 User's Manual***, several higher level reference manuals are provided in HTML and PDF form on the accompanying CD-ROM. Advanced users will find these references valuable in developing systems based on the RCM3000 module:

- ***Dynamic C User's Manual***
- ***Dynamic C Function Reference Manual***
- ***An Introduction to TCP/IP***
- ***Dynamic C TCP/IP User's Manual***
- ***Rabbit 3000 Microprocessor User's Manual***

1.4.3 Using Online Documentation

We provide the bulk of our user and reference documentation in two electronic formats, HTML and Adobe PDF. We do this for several reasons.

We believe that providing all users with our complete library of product and reference manuals is a useful convenience. However, printed manuals are expensive to print, stock and ship. Rather than include and charge for manuals that every user may not want, or provide only product-specific manuals, we choose to provide our complete documentation and reference library in electronic form with every development kit and with our Dynamic C development environment.

> **NOTE:** The most current version of Adobe Acrobat Reader can always be downloaded from Adobe's web site at **http://www.adobe.com**.
> We recommend that you use version 4.0 or later.

Providing this documentation in electronic form saves an enormous amount of paper by not printing copies of manuals that users don't need.

Finding Online Documents

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, create a new desktop icon that points to **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.

Printing Electronic Manuals

We recognize that many users prefer printed manuals for some uses. Users can easily print all or parts of those manuals provided in electronic form. The following guidelines may be helpful:

- Print from the Adobe PDF versions of the files, not the HTML versions.
- If your printer supports duplex printing, print pages double-sided.
- If you do not have a suitable printer or do not want to print the manual yourself, most retail copy shops (e.g. Kinkos, AlphaGraphics, etc.) will print the manual from the PDF file and bind it for a reasonable charge—about what we would have to charge for a printed and bound manual.

2. Hardware Setup

This chapter describes the RCM3000 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 RCM3000 Development Kit. If you purchased an RCM3000 module by itself, you will have to adapt the information in this chapter and elsewhere to your test and development setup.

2.1 Development Kit Contents

The RCM3000 Development Kit contains the following items:

- RCM3010 module with Ethernet port, 256K flash memory, and 128K SRAM.
- RCM3000 Prototyping Board.
- AC adapter, 12 V DC, 1 A. (Included only with Development Kits sold for the North American market. A header plug leading to bare leads is provided to allow overseas users to connect a power supply compatible with their local mains power.)
- 10-pin header to DE9 programming cable with integrated level-matching circuitry.
- ***Dynamic C*** CD-ROM, with complete product documentation on disk.
- This ***Getting Started*** manual.
- A bag of accessory parts for use on the Prototyping Board.
- Registration card.

2.2 Prototyping Board

The Prototyping Board included in the Development Kit makes it easy to connect an RCM3000 module to a power supply and a PC workstation for development. It also provides some basic I/O peripherals (switches and LEDs), as well as a prototyping area for more advanced hardware development.

For the most basic level of evaluation and development, the Prototyping Board can be used without modification.

As you progress to more sophisticated experimentation and hardware development, modifications and additions can be made to the board without modifying or damaging the RCM3000 module itself.

The Prototyping Board is shown below in Figure 2, with its main features identified.

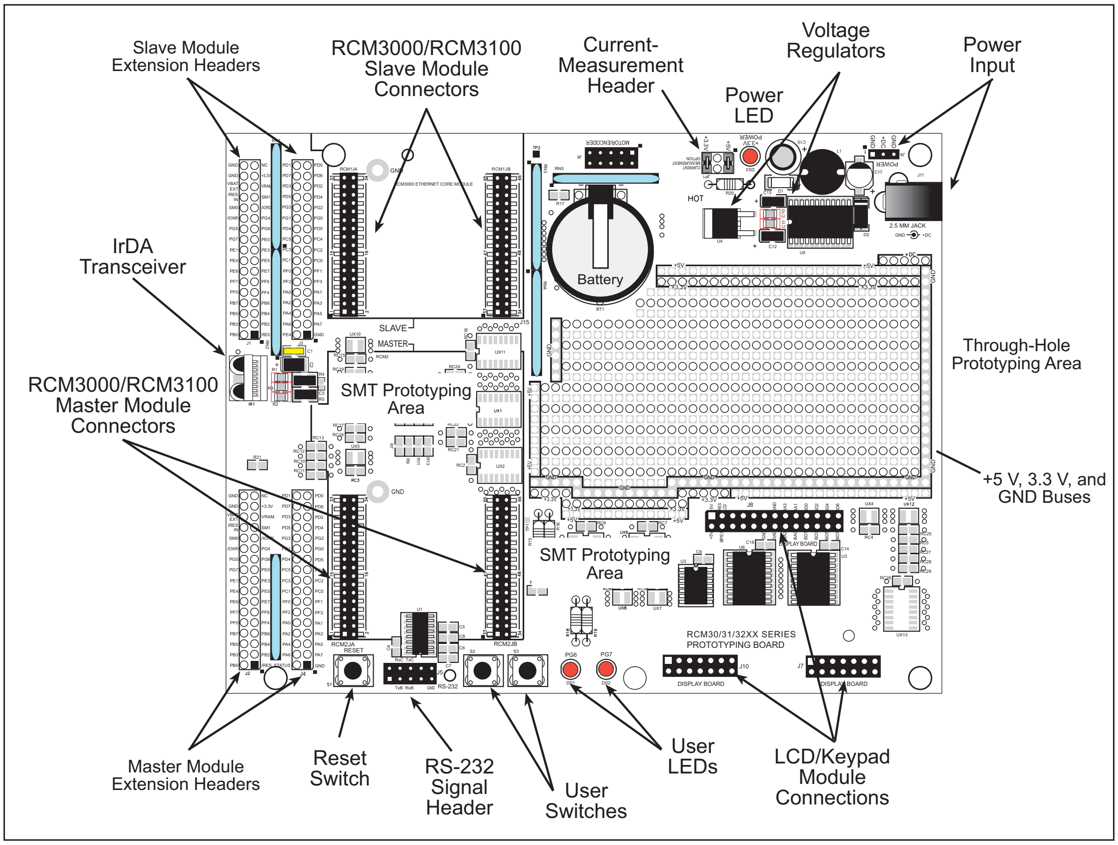

Slave Module Extension Headers
RCM3000/RCM3100 Slave Module Connectors
Current-Measurement Header
Power LED
Voltage Regulators
Power Input
IrDA Transceiver
Battery
Through-Hole Prototyping Area
RCM3000/RCM3100 Master Module Connectors
SMT Prototyping Area
SLAVE
MASTER
SMT Prototyping Area
+5 V, 3.3 V, and GND Buses
RCM30/31/32XX SERIES PROTOTYPING BOARD
DISPLAY BOARD
Master Module Extension Headers
Reset Switch
RS-232 Signal Header
User Switches
User LEDs
LCD/Keypad Module Connections

Figure 2. RCM3000/RCM3100 Prototyping Board

2.2.1 Prototyping Board Features

- **Power Connection**—A power-supply jack and a 3-pin header are provided for connection to the power supply. Note that the 3-pin header is symmetrical, with both outer pins connected to ground and the center pin connected to the raw V+ input. The cable of the AC adapter provided with the North American version of the Development Kit ends in a plug that connects to the power-supply jack. The header plug leading to bare leads provided for overseas customers can be connected to the 3-pin header in either orientation.

  Users providing their own power supply should ensure that it delivers 8–24 V DC at 1 A. The voltage regulators will get warm while in use.

- **Regulated Power Supply**—The raw DC voltage provided at the POWER IN jack is routed to a 5 V switching voltage regulator, then to a separate 3.3 V linear regulator. The regulators provide stable power to the RCM3000 module and the Prototyping Board.

- **Power LED**—The power LED lights whenever power is connected to the Prototyping Board.

- **Reset Switch**—A momentary-contact, normally open switch is connected directly to the RCM3000's **/RESET_IN** pin. Pressing the switch forces a hardware reset of the system.

- **I/O Switches and LEDs**—Two momentary-contact, normally open switches are connected to the PG0 and PG1 pins of the master RCM3000 module and may be read as inputs by sample applications.

  Two LEDs are connected to the PG6 and PG7 pins of the master module, and may be driven as output indicators by sample applications.

- **Prototyping Area**—A generous prototyping area has been provided for the installation of through-hole components. +3.3 V, +5 V, and Ground buses run around the edge of this area. Several areas for surface-mount devices are also available. (Note that there are SMT device pads on both top and bottom of the Prototyping Board.) Each SMT pad is connected to a hole designed to accept a 30 AWG solid wire.

- **Slave Module Connectors**—A second set of connectors is pre-wired to permit installation of a second, slave RCM3000, RCM3100, or RCM3200 module. This capability is reserved for future use, although the schematics in this manual contain all of the details an experienced developer will need to implement a master-slave system.

- **Module Extension Headers**—The complete pin sets of both the **MASTER** and **SLAVE** RabbitCore modules are duplicated at these two sets of headers. Developers can solder wires directly into the appropriate holes, or, for more flexible development, 26-pin header strips can be soldered into place. See Figure 1 for the header pinouts.

- **RS-232**—Two 3-wire or one 5-wire RS-232 serial port are available on the Prototyping Board. Refer to the Prototyping Board schematic (090-0137) for additional details.

  A 10-pin 0.1-inch spacing header strip is installed at J5 to permit connection of a ribbon cable leading to a standard DE-9 serial connector.

- **Current Measurement Option**—Jumpers across pins 1–2 and 5–6 on header JP1 can be removed and replaced with an ammeter across the pins to measure the current drawn from the +5 V or the +3.3 V supplies, respectively.
- **Motor Encoder**—A motor/encoder header is provided at header J6 for future use.
- **LCD/Keypad Module**—Z-World’s LCD/keypad module may be plugged in directly to headers J7, J8, and J10.

2.3 Development Hardware Connections

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

1. Attach the RCM3000 module to the Prototyping Board.
2. Connect the programming cable between the RCM3000 module and the workstation PC.
3. Connect the module's Ethernet port to a PC's Ethernet port, or to an Ethernet network.
4. Connect the power supply to the Prototyping Board.

2.3.1 Attach Module to Prototyping Board

Turn the RCM3000 module so that the Ethernet connector end of the module extends off the Prototyping Board, as shown in Figure 3 below. Align the pins from headers J1 and J2 on the bottom side of the module into header sockets RCM2JA and RCM2JB on the Prototyping Board (these sockets were labeled J12 and J13 on earlier versions of the Prototyping Board).

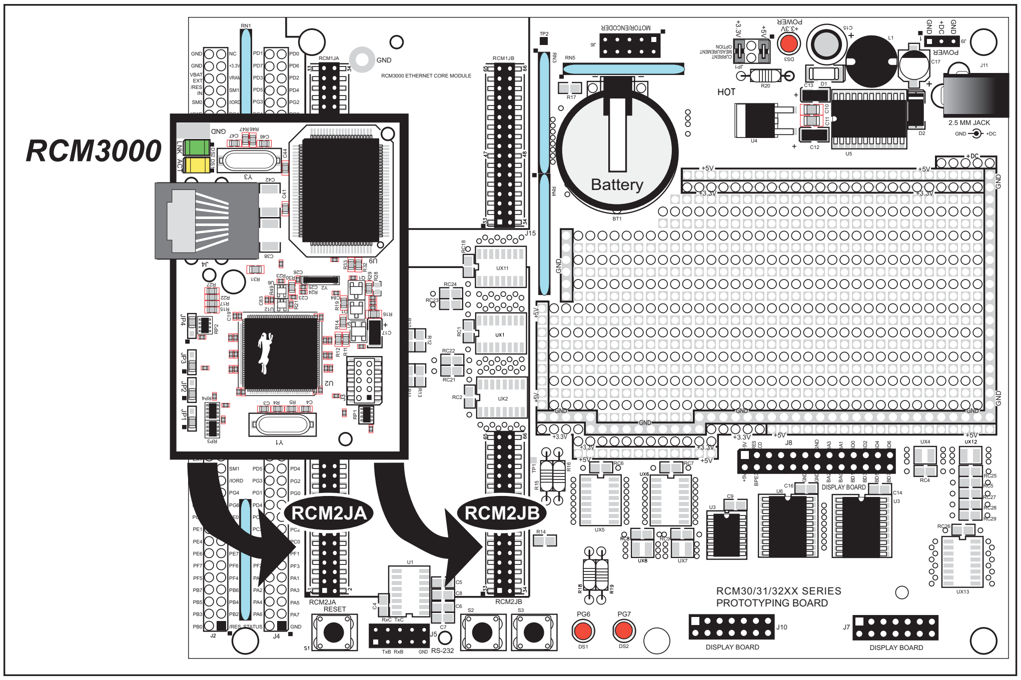


Figure 3. Installing the RCM3000 Module on the Prototyping Board

Although you can install a single module into either the **MASTER** or the **SLAVE** position on the Prototyping Board, all the Prototyping Board features (switches, LEDs, serial port drivers, etc.) are connected to the **MASTER** position. We recommend you install a single module in the **MASTER** position.

> **NOTE:** It is important that you line up the pins on headers J1 and J2 of the RCM3000 module exactly with the corresponding pins of sockets RCM2JA and RCM2JB 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 firmly into the Prototyping Board header sockets.

2.3.2 Connect Programming Cable

The programming cable connects the RCM3000 module to the PC running Dynamic C to download programs and to monitor the RabbitCore module for debugging.

Connect the 10-pin connector of the programming cable labeled **PROG** to header J1 on the RCM3000 module as shown in Figure 4. 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.)

> **NOTE:** Be sure to use the programming cable supplied with this Development Kit—the programming cable has red shrink wrap around the RS-232 converter section located in the middle of the cable. Programming cables with clear shrink wrap from other Z-World or Rabbit Semiconductor kits were not designed to work with RCM3000 modules.

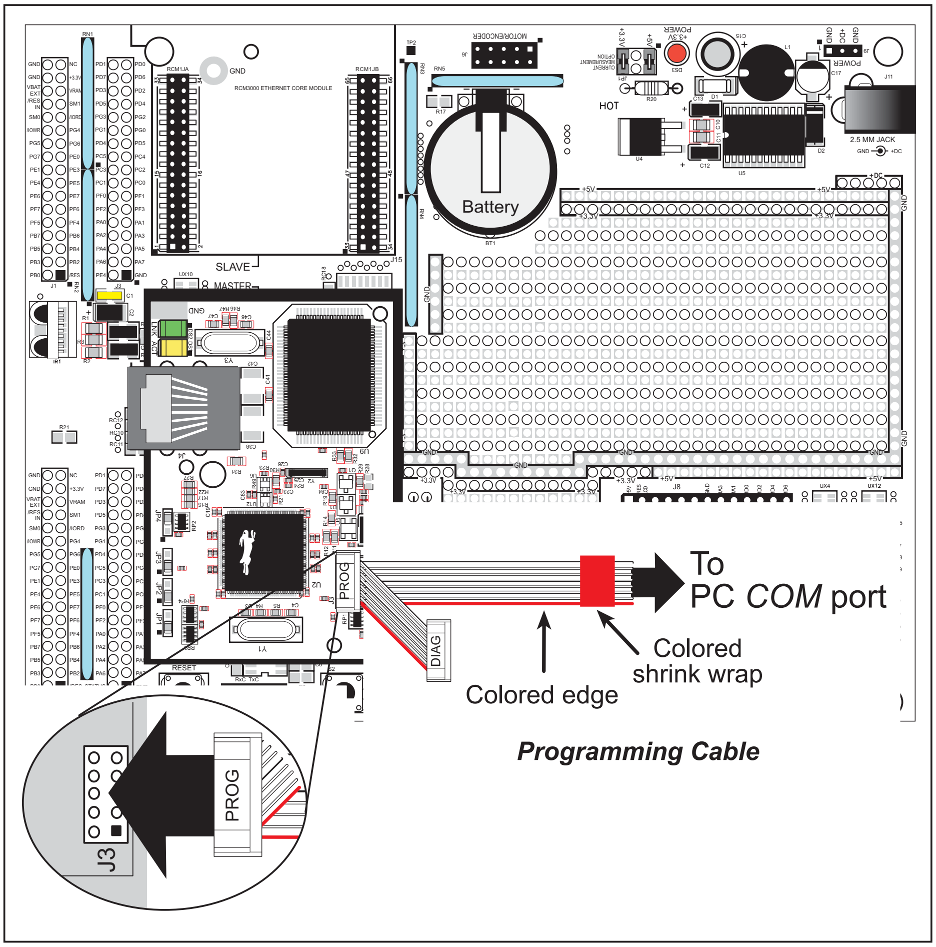


Figure 4. Connect Programming Cable to RCM3000

Connect the other end of the programming cable to a COM port on your PC.

> **NOTE:** Some PCs now come equipped only with a USB port. It may be possible to use an RS-232/USB converter with the programming cable supplied with your RCM3000 module. An RS-232/USB converter is available through the Z-World Web store.

2.3.3 Connect Power

When all other connections have been made, you can connect power to the RCM3000 Prototyping Board.

Connect the wall transformer to jack J11 on the Prototyping Board as shown in Figure 6 below.

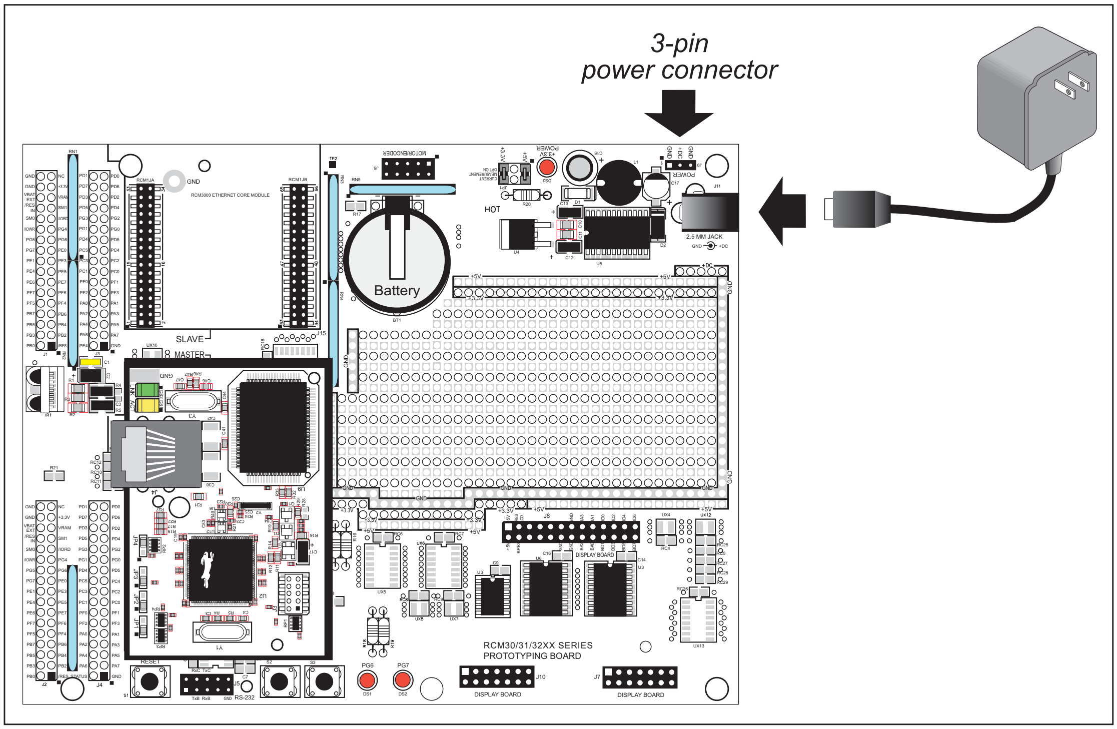


Figure 6. Power Supply Connections

Plug in the wall transformer. The power LED on the Prototyping Board should light up. The RCM3000 and the Prototyping Board are now ready to be used.

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

To power down the Prototyping Board, unplug the power connector from J11. You should disconnect power before making any circuit adjustments in the prototyping area, changing any connections to the board, or removing the RCM3000 from the Prototyping Board.

2.3.3.1 Overseas Development Kits

Development kits sold outside North America include a header connector that may be connected to 3-pin header J9 on the Prototyping Board. The connector may be attached either way as long as it is not offset to one side. The red and black wires from the connector can then be connected to the positive and negative connections on your power supply. The power supply should deliver 8 V–30 V DC at 8 W.

2.4 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.

If you are using a USB port to connect your computer to the RCM3000 module, choose **Options > Project Options** and select “Use USB to Serial Converter” under the **Communications** tab.

Find the file **`PONG.C`**, which is in the Dynamic C **`SAMPLES`** folder. To run the program, open it with the **File** menu (if it is not still open), compile it using the **Compile** menu, and then run it by selecting **Run** in the **Run** menu. The **STDIO** window will open and will display a small square bouncing around in a box.

This program shows that the CPU is working. The sample program described in Section 4.10, “Run the PINGME.C Sample Program,” tests the TCP/IP portion of the board.

2.4.1 Troubleshooting

If Dynamic C appears to compile the BIOS successfully, but you then receive a communication error message when you compile and load the 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 there are any other problems:

- 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 RCM3000.
- Ensure that the RCM3000 module is firmly and correctly installed in its connectors 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?

We recommend that you proceed to the next chapter and install Dynamic C (if you do not already have it installed), then run the **PONG.C** sample program to verify that the RCM3000 module and the Prototyping Board are set up and functioning correctly.

If everything appears to be working, we recommend the following sequence of action:

1. Run all of the sample programs described in Section 3.3 to get a basic familiarity with Dynamic C and the RCM3000 module's capabilities.
2. For further development, refer to the ***RabbitCore RCM3000 User's Manual*** for details of the module's hardware and software components.

   A documentation icon should have been installed on your workstation's desktop; click on it to reach the documentation menu. You can create a new desktop icon that points to **default.htm** in the **docs** folder in the Dynamic C installation folder.
3. 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 Technical Support

NOTE: If you purchased your RCM3000 through a distributor or through a Z-World or 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 Z-World/Rabbit Semiconductor Technical Bulletin Board at www.zworld.com/support/bb/.
- Use the Technical Support e-mail form at www.zworld.com/support/questionSubmit.shtml.

3. Software Installation & Overview

To develop and debug programs for the RCM3000 (and for all other Z-World and Rabbit Semiconductor hardware), you must install and use Dynamic C. Dynamic C is an integrated development system for writing embedded software. It runs on an IBM-compatible PC and is designed for use with Z-World controllers and other controllers based on the Rabbit microprocessor. Chapter 3 provides the libraries, function calls, and sample programs related to the RCM3000.

3.1 An Overview of Dynamic C

Dynamic C has been in use worldwide since 1989. It is specially designed for programming embedded systems, and features quick compile and interactive debugging in the real environment. A complete reference guide to Dynamic C is contained in the ***Dynamic C User's Manual***.

You have a choice of doing your software development in the flash memory or in the data SRAM included on the RCM3000. The advantage of working in RAM is to save wear on the flash memory, which is limited to about 100,000 write cycles. The disadvantage is that the code and data might not both fit in RAM.

> **NOTE:** Do not depend on the flash memory sector size or type. Due to the volatility of the flash memory market, the RCM3000 and Dynamic C were designed to accommodate flash devices with various sector sizes.

The disadvantage of using flash memory for debug is that interrupts must be disabled for up to approximately 5 ms whenever a break point is set in the program. This can crash fast interrupt routines that are running while you stop at a break point or single-step the program. The flash memory and SRAM options are selected through the “BIOS Memory Setting” from the **Options > Project Options > Compiler** menu.

Dynamic C provides a number of debugging features. You can single-step your program, either in C, statement by statement, or in assembly language, instruction by instruction. You can set break points, where the program will stop, on any statement. You can evaluate watch expressions. A watch expression is any C expression that can be evaluated in the context of the program. If the program is at a break point, a watch expression can view any expression using local or global variables. If a periodic call to **`runwatch()`** is included in your program, you will be able to evaluate watch expressions by hitting **<Ctrl-U>** without stopping the program.

3.2 Installing Dynamic C

Insert the Dynamic C CD from the Development Kit in your PC's CD-ROM drive. If the installation does not auto-start, run the **`setup.exe`** program in the root directory of the Dynamic C CD. Install any Dynamic C modules after you install Dynamic C.

Dynamic C has two components that can be installed together or separately. One component is Dynamic C itself, with the development environment, support files and libraries. The other component is the documentation library in HTML and PDF formats, which may be left uninstalled to save hard drive space or installed elsewhere (on a separate or network drive, for example).

The installation type is selected in the installation menu shown above. The options are:

- **Typical Installation —** Both Dynamic C and the documentation library will be installed in the specified folder (default).
- **Compact Installation —** Only Dynamic C will be installed.
- **Custom Installation —** You will be allowed to choose which components are installed. This choice is useful to install or reinstall just the documentation.

3.3 Sample Programs

To help familiarize you with the RCM3000 modules, Dynamic C includes several sample programs in the Dynamic C **`SAMPLES\RCM3000`** directory. Loading, executing and studying these programs will give you a solid hands-on overview of the RabbitCore's capabilities, as well as a quick start with Dynamic C as an application development tool.

Two folders contain sample programs that illustrate features unique to the RCM3000.

- **`RCM3000`**—Demonstrates the basic operation and the Ethernet functionality of the RCM3000.
- **`TCPIP`**—Demonstrates more advanced TCP/IP programming for Z-World's Ethernet-enabled Rabbit-based boards.

Follow the instructions included with the sample program to connect the RCM3000 and the other hardware identified in the instructions. The RCM3000 module must be installed on the Prototyping Board as shown in Figure 3.

To run a sample program, open it with the **File** menu (if it is not still open), compile it using the **Compile** menu (or press **F5**), and then run it by selecting **Run** in the **Run** menu (or press **F9**). The RCM3000 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***.

- **`CONTROLLED.C`**—uses the **STDIO** window to demonstrate digital outputs by toggling LEDs DS1 and DS2 on the Prototyping Board on and off.

  Parallel Port G bit 6 = LED DS1
  Parallel Port G bit 7 = LED DS2

  Once you have compile this program and it is running, you will be prompted via the Dynamic C **STDIO** window to select LED DS1 or DS2. Use your PC keyboard to make your selection.

  Once you have selected the LED, you will be prompted to select to turn the LED either ON or OFF. A logic low will light up the LED you selected.

- **`FLASHLED1.c`**—demonstrates the use of costatements to flash LEDs DS1 and DS2 on the Prototyping Board at different rates. Once you have compile this program and it is running, LEDs DS1 and DS2 will flash on/off at different rates.
- **`FLASHLED2.c`**—demonstrates the use of cofunctions and costatements to flash LEDs DS1 and DS2 on the Prototyping Board at different rates. Once you have compile this program and it is running, LEDs DS1 and DS2 will flash on/off at different rates.
- **`TOGGLESWITCH.c`**—demonstrates the use of costatements to detect switches using the press-and-release method of debouncing. LEDs DS1 and DS2 on the Prototyping Board are turned on and off when you press switches S2 and S3.

- **IR_DEMO.c**—Demonstrates sending Modbus ASCII packets between two Prototyping Board assemblies via the IrDA transceivers with the IrDA transceivers facing each other. Note that this sample program will only work with the RCM30/31/32XX Prototyping Board.

  First, compile and run this program on one Prototyping Board assembly, then remove the programming cable and press the **RESET** button on the Prototyping Board so that the first RabbitCore module is operating in the **Run** mode. Then connect the programming cable to the second Prototyping Board assembly with the RCM3000 and compile and run the same sample program. With the programming cable still connected to the second Prototyping Board assembly, press switch S2 on the second Prototyping Board to transmit a packet. Once the first Prototyping Board assembly receives a test packet, it will send back a response packet that will be displayed in the Dynamic C **STDIO** window. The test packets and response packets have different codes.

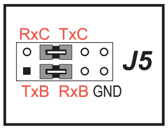
Once you have loaded and executed these sample programs and have an understanding of how Dynamic C and the RCM3000 modules interact, you can move on and try the other sample programs, or begin building your own.

3.3.1 Serial Communication

The following sample programs can be found in the **SAMPLES\RCM3000\SERIAL** folder.

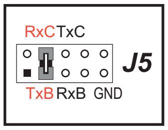
- **FLOWCONTROL.C**—This program demonstrates hardware flow control by configuring Serial Port C (PC3/PC2) for CTS/RTS with serial data coming from TxB at 115,200 bps. One character at a time is received and is displayed in the **STDIO** window.

  To set up the Prototyping Board, you will need to tie TxB and RxB together on the RS-232 header at J5, and you will also tie TxC and RxC together using the jumpers supplied in the Development Kit as shown in the diagram.

  A repeating triangular pattern should print out in the **STDIO** window. The program will periodically switch flow control on or off to demonstrate the effect of no flow control.

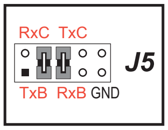
- **PARITY.C**—This program demonstrates the use of parity modes by repeatedly sending byte values 0–127 from Serial Port B to Serial Port C. The program will switch between generating parity or not on Serial Port B. Serial Port C will always be checking parity, so parity errors should occur during every other sequence.

  To set up the Prototyping Board, you will need to tie TxB and RxC together on the RS-232 header at J5 using the jumpers supplied in the Development Kit as shown in the diagram.

  The Dynamic C **STDIO** window will display the error sequence.

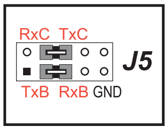
- **SIMPLE3WIRE.C**—This program demonstrates basic RS-232 serial communication. Lower case characters are sent by TxC, and are received by RxB. The characters are converted to upper case and are sent out by TxB, are received by RxC, and are displayed in the Dynamic C **STDIO** window.



  To set up the Prototyping Board, you will need to tie TxB and RxC together on the RS-232 header at J5, and you will also tie RxB and TxC together using the jumpers supplied in the Development Kit as shown in the diagram.

- **SIMPLE5WIRE.C**—This program demonstrates 5-wire RS-232 serial communication with flow control on Serial Port C and data flow on Serial Port B.

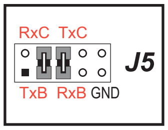
  To set up the Prototyping Board, you will need to tie TxB and RxB together on the RS-232 header at J5, and you will also tie TxC and RxC together using the jumpers supplied in the Development Kit as shown in the diagram.



  Once you have compiled and run this program, you can test flow control by disconnecting TxC from RxC while the program is running. Characters will no longer appear in the **STDIO** window, and will display again once TxC is connected back to RxC.

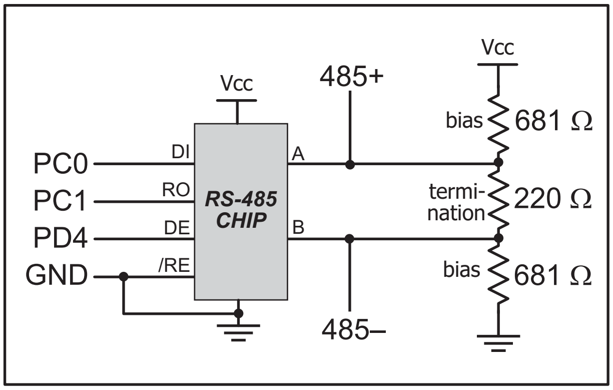
- **SWITCHCHAR.C**—This program demonstrates transmits and then receives an ASCII string on Serial Ports B and C. It also displays the serial data received from both ports in the **STDIO** window.

  To set up the Prototyping Board, you will need to tie TxB and RxC together on the RS-232 header at J5, and you will also tie RxB and TxC together using the jumpers supplied in the Development Kit as shown in the diagram.



  Once you have compiled and run this program, press and release S2 and S3 on the Prototyping Board. The data sent between the serial ports will be displayed in the **STDIO** window.

Two sample programs, **SIMPLE485MASTER.C** and **SIMPLE485SLAVE.C**, are available to illustrate RS-485 master/slave communication. To run these sample programs, you will need a second Rabbit-based system with RS-485, and you will also have to add an RS-485 transceiver such as the SP483E and bias resistors to the RCM30/31/32XX Prototyping Board.



The diagram shows the connections. You will have to connect PC0 and PC1 (Serial Port D) on the RCM30/31/32XX Prototyping Board to the RS-485 transceiver, and you will connect PD4 to the RS-485 transceiver to enable or disable the RS-485 transmitter.

The RS-485 connections between the slave and master devices are as follows.

- RS485+ to RS485+
- RS485– to RS485–
- GND to GND

- **`SIMPLE485MASTER.C`**—This program demonstrates a simple RS-485 transmission of lower case letters to a slave RCM3000. The slave will send back converted upper case letters back to the master RCM3000 and display them in the **STDIO** window. Use **`SIMPLE485SLAVE.C`** to program the slave RCM3000.
- **`SIMPLE485SLAVE.C`**—This program demonstrates a simple RS-485 transmission of lower case letters to a master RCM3000. The slave will send back converted upper case letters back to the master RCM3000 and display them in the **STDIO** window. Use **`SIMPLE485MASTER.C`** to program the master RCM3000.

3.3.2 Other Sample Programs

Section 4.11 describes the TCP/IP sample programs, and the ***RabbitCore RCM3000 User's Manual*** provides sample programs for the optional LCD/keypad module that can be installed on the Prototyping Board.

3.4 Upgrading Dynamic C

Dynamic C patches that focus on bug fixes are available from time to time. Check the Web sites

- www.zworld.com/support/

or

- www.rabbitsemiconductor.com/support/

for the latest patches, workarounds, and bug fixes.

3.4.1 Add-On Modules

Dynamic C installations are designed for use with the board they are included with, and are included at no charge as part of our low-cost kits. Z-World offers add-on Dynamic C modules for purchase, including the popular µC/OS-II real-time operating 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.

4. Using the TCP/IP Features

4.1 TCP/IP Connections

Programming and development can be done with the RCM3000 RabbitCore modules without connecting the Ethernet port to a network. However, if you will be running the sample programs that use the Ethernet capability or will be doing Ethernet-enabled development, you should connect the RCM3000 module's Ethernet port at this time.

Before proceeding you will need to have the following items.

- If you don't have Ethernet access, you will need at least a 10Base-T Ethernet card (available from your favorite computer supplier) installed in a PC.
- Two RJ-45 straight through Ethernet cables and a hub, or an RJ-45 crossover Ethernet cable.

The Ethernet cables and a 10Base-T Ethernet hub are available from Z-World in a TCP/IP tool kit. More information is available at www.zworld.com.

1. Connect the AC adapter and the programming cable as shown in Chapter 2, "Hardware Setup."
2. Ethernet Connections

   There are four options for connecting the RCM3000 module to a network for development and runtime purposes. The first two options permit total freedom of action in selecting network addresses and use of the "network," as no action can interfere with other users. We recommend one of these options for initial development.

- **No LAN —** The simplest alternative for desktop development. Connect the RCM3000's Ethernet port directly to the PC's network interface card using an RJ-45 *crossover cable*. A crossover cable is a special cable that flips some connections between the two connectors and permits direct connection of two client systems. A standard RJ-45 network cable will not work for this purpose.
- **Micro-LAN —** Another simple alternative for desktop development. Use a small Ethernet 10Base-T hub and connect both the PC's network interface card and the RCM3000's Ethernet port to it, using standard network cables.

The following options require more care in address selection and testing actions, as conflicts with other users, servers and systems can occur:

- **LAN —** Connect the RCM3000's Ethernet port to an existing LAN, preferably one to which the development PC is already connected. You will need to obtain IP addressing information from your network administrator.
- **WAN —** The RCM3000 is capable of direct connection to the Internet and other Wide Area Networks, but exceptional care should be used with IP address settings and all network-related programming and development. We recommend that development and debugging be done on a local network before connecting a RabbitCore system to the Internet.

> **TIP:** Checking and debugging the initial setup on a micro-LAN is recommended before connecting the system to a LAN or WAN.

The PC running Dynamic C through the serial port on the RCM3000 does not need to be the PC with the Ethernet card.

3. Apply Power

Plug in the AC adapter. The RCM3000 module is now ready to be used.

4.2 TCP/IP Primer on IP Addresses

Obtaining IP addresses to interact over an existing, operating, network can involve a number of complications, and must usually be done with cooperation from your ISP and/or network systems administrator. For this reason, it is suggested that the user begin instead by using a direct connection between a PC and the RCM3000 board using an Ethernet crossover cable or a simple arrangement with a hub. (A crossover cable should not be confused with regular straight through cables.)

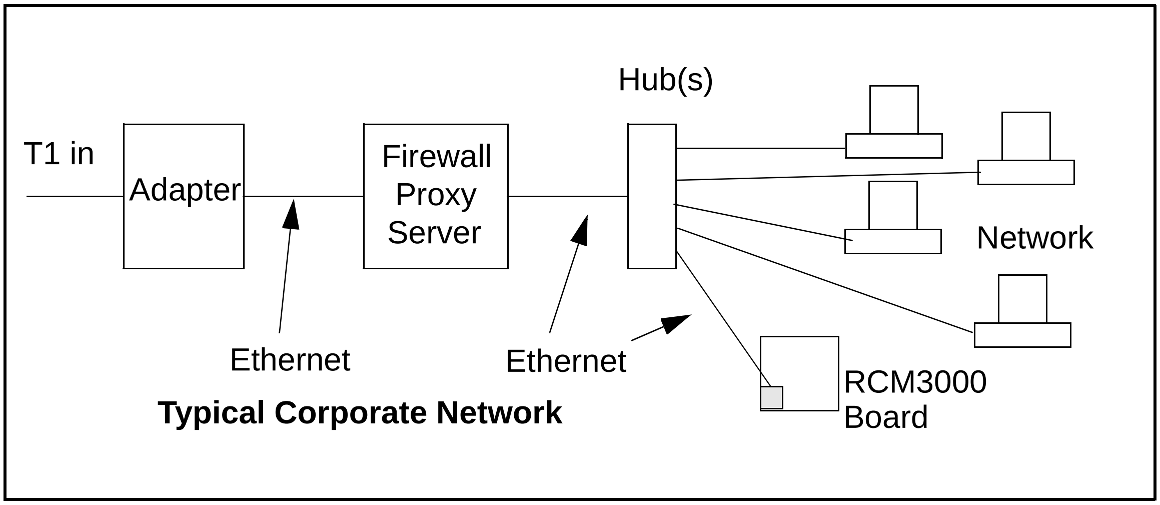
In order to set up this direct connection, the user will have to use a PC without networking, or disconnect a PC from the corporate network, or install a second Ethernet adapter and set up a separate private network attached to the second Ethernet adapter. Disconnecting your PC from the corporate network may be easy or nearly impossible, depending on how it is set up. If your PC boots from the network or is dependent on the network for some or all of its disks, then it probably should not be disconnected. If a second Ethernet adapter is used, be aware that Windows TCP/IP will send messages to one adapter or the other, depending on the IP address and the binding order in Microsoft products. Thus you should have different ranges of IP addresses on your private network from those used on the corporate network. If both networks service the same IP address, then Windows may send a packet intended for your private network to the corporate network. A similar situation will take place if you use a dial-up line to send a packet to the Internet. Windows may try to send it via the local Ethernet network if it is also valid for that network.

The following IP addresses are set aside for local networks and are not allowed on the Internet: 10.0.0.0 to 10.255.255.255, 172.16.0.0 to 172.31.255.255, and 192.168.0.0 to 192.168.255.255.

The RCM3000 board uses a 10Base-T type of Ethernet connection, which is the most common scheme. The RJ-45 connectors are similar to U.S. style telephone connectors, are except larger and have 8 contacts.

An alternative to the direct connection using a crossover cable is a direct connection using a hub. The hub relays packets received on any port to all of the ports on the hub. Hubs are low in cost and are readily available. The RCM3000 board uses 10 Mbps Ethernet, so the hub or Ethernet adapter must be either a 10 Mbps unit or a 10/100 unit that adapts to either 10 or 100 Mbps.

In a corporate setting where the Internet is brought in via a high-speed line, there are typically machines between the outside Internet and the internal network. These machines include a combination of proxy servers and firewalls that filter and multiplex Internet traffic. In the configuration below, the RCM3000 board could be given a fixed address so any of the computers on the local network would be able to contact it. It may be possible to configure the firewall or proxy server to allow hosts on the Internet to directly contact the controller, but it would probably be easier to place the controller directly on the external network outside of the firewall. This avoids some of the configuration complications by sacrificing some security.



Typical Corporate Network

If your system administrator can give you an Ethernet cable along with its IP address, the netmask and the gateway address, then you may be able to run the sample programs without having to setup a direct connection between your computer and the RCM3000 board. You will also need the IP address of the nameserver, the name or IP address of your mail server, and your domain name for some of the sample programs.

4.3 IP Addresses Explained

IP (Internet Protocol) addresses are expressed as 4 decimal numbers separated by periods, for example:

216.103.126.155

10.1.1.6

Each decimal number must be between 0 and 255. The total IP address is a 32-bit number consisting of the 4 bytes expressed as shown above. A local network uses a group of adjacent IP addresses. There are always 2^N IP addresses in a local network. The netmask (also called subnet mask) determines how many IP addresses belong to the local network. The netmask is also a 32-bit address expressed in the same form as the IP address. An example netmask is:

255.255.255.0

This netmask has 8 zero bits in the least significant portion, and this means that 2^8 addresses are a part of the local network. Applied to the IP address above (216.103.126.155), this netmask would indicate that the following IP addresses belong to the local network:

216.103.126.0

216.103.126.1

216.103.126.2

etc.

216.103.126.254

216.103.126.255

The lowest and highest address are reserved for special purposes. The lowest address (216.102.126.0) is used to identify the local network. The highest address (216.102.126.255) is used as a broadcast address. Usually one other address is used for the address of the gateway out of the network. This leaves 256 - 3 = 253 available IP addresses for the example given.

4.4 How IP Addresses are Used

The actual hardware connection via an Ethernet uses Ethernet adapter addresses (also called MAC addresses). These are 48-bit addresses and are unique for every Ethernet adapter manufactured. In order to send a packet to another computer, given the IP address of the other computer, it is first determined if the packet needs to be sent directly to the other computer or to the gateway. In either case, there is an IP address on the local network to which the packet must be sent. A table is maintained to allow the protocol driver to determine the MAC address corresponding to a particular IP address. If the table is empty, the MAC address is determined by sending an Ethernet broadcast packet to all devices on the local network asking the device with the desired IP address to answer with its MAC address. In this way, the table entry can be filled in. If no device answers, then the device is nonexistent or inoperative, and the packet cannot be sent.

IP addresses are arbitrary and can be allocated as desired provided that they don't conflict with other IP addresses. However, if they are to be used with the Internet, then they must be numbers that are assigned to your connection by proper authorities, generally by delegation via your service provider.

Each RCM3000 RabbitCore module has its own unique MAC address, which consists of the prefix 0090C2 followed by the code that appears on the label affixed to the RCM3000 module. For example, a MAC address might be 0090C2C002C0.

> **TIP:** You can always verify the MAC address on your board by running the sample program **`DISPLAY_MAC.C`** from the **`SAMPLES\TCPIP`** folder.

4.5 Dynamically Assigned Internet Addresses

In many instances, there are no fixed IP addresses. This is the case when, for example, you are assigned an IP address dynamically by your dial-up Internet service provider (ISP) or when you have a device that provides your IP addresses using the Dynamic Host Configuration Protocol (DHCP). The RCM3000 RabbitCore modules can use such IP addresses to send and receive packets on the Internet, but you must take into account that this IP address may only be valid for the duration of the call or for a period of time, and could be a private IP address that is not directly accessible to others on the Internet. These private address can be used to perform some Internet tasks such as sending e-mail or browsing the Web, but usually cannot be used to participate in conversations that originate elsewhere on the Internet. If you want to find out this dynamically assigned IP address, under Windows 98 you can run the **`winipcfg`** program while you are connected and look at the interface used to connect to the Internet.

Many networks use private IP addresses that are assigned using DHCP. When your computer comes up, and periodically after that, it requests its networking information from a DHCP server. The DHCP server may try to give you the same address each time, but a fixed IP address is usually not guaranteed.

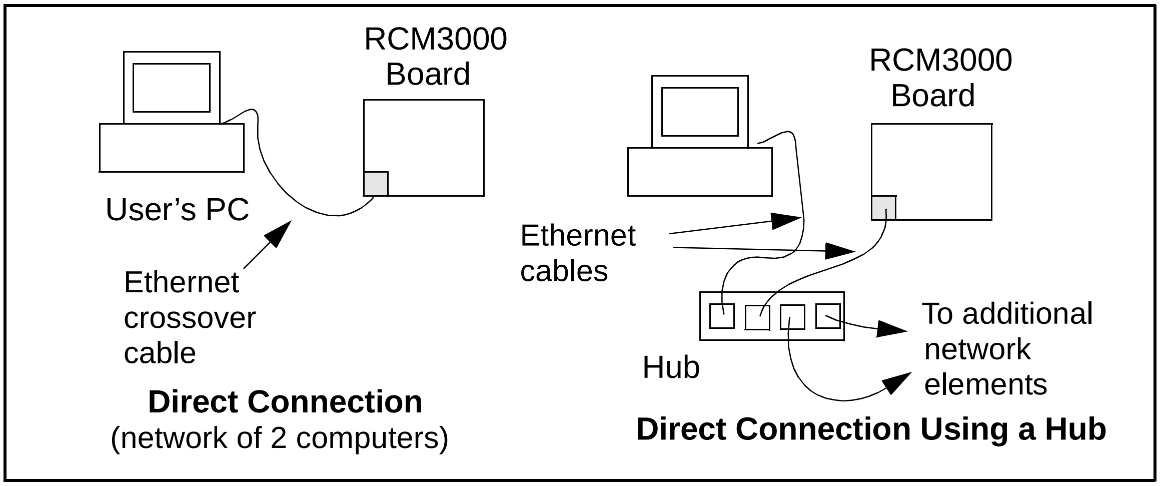
If you are not concerned about accessing the RCM3000 from the Internet, you can place the RCM3000 on the internal network using a private address assigned either statically or through DHCP.

4.6 Placing Your Device on the Network

In many corporate settings, users are isolated from the Internet by a firewall and/or a proxy server. These devices attempt to secure the company from unauthorized network traffic, and usually work by disallowing traffic that did not originate from inside the network. If you want users on the Internet to communicate with your RCM3000, you have several options. You can either place the RCM3000 directly on the Internet with a real Internet address or place it behind the firewall. If you place the RCM3000 behind the firewall, you need to configure the firewall to translate and forward packets from the Internet to the RCM3000.

4.7 Running TCP/IP Sample Programs

We have provided a number of sample programs demonstrating various uses of TCP/IP for networking embedded systems. These programs require you to connect your PC and the RCM3000 board together on the same network. This network can be a local private network (preferred for initial experimentation and debugging), or a connection via the Internet.



4.8 How to Set IP Addresses in the Sample Programs

With the introduction of Dynamic C 7.30 we have taken steps to make it easier to run many of our sample programs. Instead of the **MY_IP_ADDRESS** and other macros, you will see a **TCPCONFIG** macro. This macro tells Dynamic C to select your configuration from a list of default configurations. You will have three choices when you encounter a sample program with the **TCPCONFIG** macro.

1. You can replace the **TCPCONFIG** macro with individual **MY_IP_ADDRESS**, **MY_NETMASK**, **MY_GATEWAY**, and **MY_NAMESERVER** macros in each program.
2. You can leave **TCPCONFIG** at the usual default of 1, which will set the IP configurations to **10.10.6.100**, the netmask to **255.255.255.0**, and the nameserver and gateway to **10.10.6.1**. If you would like to change the default values, for example, to use an IP address of **10.1.1.2** for the RCM3000 board, and **10.1.1.1** for your PC, you can edit the values in the section that directly follows the "General Configuration" comment in the **TCP_CONFIG.LIB** library. You will find this library in the **LIB/TCPIP** directory.
3. You can create a **CUSTOM_CONFIG.LIB** library and use a **TCPCONFIG** value greater than 100. Instructions for doing this are at the beginning of the **TCP_CONFIG.LIB** file.

There are some other "standard" configurations for **TCPCONFIG** that let you select different features such as DHCP. Their values are documented at the top of the **TCP_CONFIG.LIB** library. More information is available in the ***Dynamic C TCP/IP User's Manual***.

IP Addresses Before Dynamic C 7.30

Most of the sample programs such as shown in the example below use macros to define the IP address assigned to the board and the IP address of the gateway, if there is a gateway.

```
#define MY_IP_ADDRESS "10.10.6.170"
#define MY_NETMASK "255.255.255.0"
#define MY_GATEWAY "10.10.6.1"
#define MY_NAMESERVER "10.10.6.1"
```

In order to do a direct connection, the following IP addresses can be used for the RCM3000:

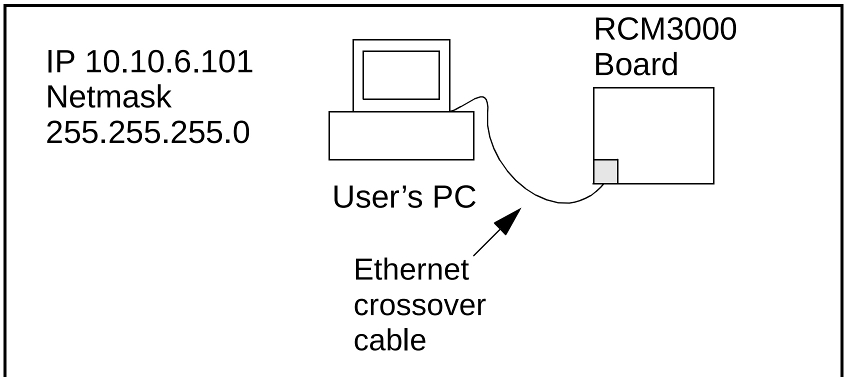
```
#define MY_IP_ADDRESS "10.1.1.2"
#define MY_NETMASK "255.255.255.0"
// #define MY_GATEWAY "10.10.6.1"
// #define MY_NAMESERVER "10.10.6.1"
```

In this case, the gateway and nameserver are not used, and are commented out. The IP address of the board is defined to be **10.1.1.2**. The IP address of your PC can be defined as **10.1.1.1**.

4.9 How to Set Up Your Computer's IP Address for Direct Connect

When your computer is connected directly to the RCM3000 board via an Ethernet connection, you need to assign an IP address to your computer. To assign the PC the address `10.10.6.101` with the netmask `255.255.255.0`, do the following.

Click on **Start > Settings > Control Panel** to bring up the Control Panel, and then double-click the Network icon. Depending on which version of Windows you are using, look for the **TCP/IP Protocol**/**Network > Dial-Up Connections**/**Network** line or tab. Double-click on this line or select **Properties** or **Local Area Connection > Properties** to bring up the TCP/IP properties dialog box. You can edit the IP address and the subnet mask directly. (Disable "obtain an IP address automatically.") You may want to write down the existing values in case you have to restore them later. It is not necessary to edit the gateway address since the gateway is not used with direct connect.



Direct Connection PC to RCM3000 Board

4.10 Run the `PINGME.C` Sample Program

Connect the crossover cable from your computer's Ethernet port to the RCM3000 board's RJ-45 Ethernet connector. Open this sample program from the **SAMPLES\TCPIP\ICMP** folder, compile the program, and start it running under Dynamic C. When the program starts running, the green **LNK** light on the RCM3000 board should be on to indicate an Ethernet connection is made. (Note: If the **LNK** light does not light, you may not have a crossover cable, or if you are using a hub perhaps the power is off on the hub.)

The next step is to ping the board from your PC. This can be done by bringing up the MS-DOS window and running the pingme program:

```
ping 10.10.6.100
```

or by **Start > Run**

and typing the entry

```
ping 10.10.6.100
```

Notice that the red **ACT** light flashes on the RCM3000 board while the ping is taking place, and indicates the transfer of data. The ping routine will ping the board four times and write a summary message on the screen describing the operation.

4.11 Running More Sample Programs With Direct Connect

The sample programs discussed here are in the Dynamic C **SAMPLES\RCM3000\TCPIP\** folder.

- **BROWSELED.C**—This program demonstrates a basic controller running a Web page. Two "LEDs" are created on the Web page, with two buttons to toggle them. Users can change the status of the lights from the Web browser. The LEDs on the Prototyping Board match the ones on the Web page. As long as you have not modified the **TCPCONFIG 1** macro in the sample program, enter the following server address in your Web browser to bring up the Web page served by the sample program.

  http://10.10.6.100.

  Otherwise use the TCP/IP settings you entered in the **TCP_CONFIG.LIB** library.

- **ECHOCLIENT.C**—This program demonstrates a basic client that will send a packet and wait for the connected server to echo it back. After every number of sends and receives, transfer times are shown in the **STDIO** window.

  Use **ECHO_SERVER.C** to program a server controller.

- **ECHOSERVER.C**—This program demonstrates This program demonstrates a basic server that will echo back any data sent from a connected client.

  Use **ECHO_CLIENT.C** to program a client controller.

- **ENET_AD.C**—This program demonstrates Ethernet communication between two single-board computers. The program sends an A/D voltage value to the second controller via Ethernet for display.

  Use **ENET_MENU.C** to program the other single-board computer.

- **ENET_MENU.C**—This program demonstrates how to implement a menu system using a highlight bar on a graphic LCD display and to communicate it to another single-board computer via Ethernet.

  Use **ENET_AD.C** to program the other single-board computer with analog inputs and outputs.

- **MBOXDEMO.C**—Implements a Web server that allows e-mail messages to be entered and then shown on the LCD/keypad module.
- **SMTP.C**—This program allows you to send an E-mail when a switch on the Prototyping Board is pressed. Follow the instructions included with the sample program.
- **PINGLED.C**—This program demonstrates ICMP by pinging a remote host. It will flash LEDs DS1 and DS2 on the Prototyping Board when a ping is sent and received.

4.12 Where Do I Go From Here?

NOTE: If you purchased your RCM3000 through a distributor or through a Z-World or Rabbit Semiconductor partner, contact the distributor or Z-World 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 Z-World/Rabbit Semiconductor Technical Bulletin Board at www.zworld.com/support/bb/.
- Use the Technical Support e-mail form at www.zworld.com/support/questionSubmit.shtml.

If the sample programs ran fine, you are now ready to go on.

Additional sample programs are described in the ***Dynamic C TCP/IP User's Manual***.

Please refer to the ***Dynamic C TCP/IP User's Manual*** to develop your own applications. ***An Introduction to TCP/IP*** provides background information on TCP/IP, and is available on the CD and on Z-World's Web site.

NOTICE TO USERS

Z-WORLD PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE-SUPPORT DEVICES OR SYSTEMS UNLESS A SPECIFIC WRITTEN AGREEMENT REGARDING SUCH INTENDED USE IS ENTERED INTO BETWEEN THE CUSTOMER AND Z-WORLD PRIOR TO USE. Life-support devices or systems are devices or systems intended for surgical implantation into the body or to sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling and user's manual, can be reasonably expected to result in significant injury.

No complex software or hardware system is perfect. Bugs are always present in a system of any size. In order to prevent danger to life or property, it is the responsibility of the system designer to incorporate redundant protective mechanisms appropriate to the risk involved.

All Z-World products are 100 percent functionally tested. Additional testing may include visual quality control inspections or mechanical defects analyzer inspections. Specifications are based on characterization of tested sample units rather than testing over temperature and voltage of each unit. Z-World products may qualify components to operate within a range of parameters that is different from the manufacturer's recommended range. This strategy is believed to be more economical and effective. Additional testing or burn-in of an individual unit is available by special arrangement.

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SCHEMATICS

090-0136 RCM3000 Schematic

www.zworld.com/documentation/schemat/090-0136.pdf

090-0137 RCM30/31/32XX Prototyping Board Schematic

www.zworld.com/documentation/schemat/090-0137.pdf

090-0156 LCD/Keypad Module Schematic

www.zworld.com/documentation/schemat/090-0156.pdf

090-0128 Programming Cable Schematic

www.zworld.com/documentation/schemat/090-0128.pdf

The schematics included with the printed manual were the latest revisions available at the time the manual was last revised. The online versions of the manual contain links to the latest revised schematic on the Web site. You may also use the URL information provided above to access the latest schematics directly.