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Coyote (BL2500)

C-Programmable Single-Board Computer with Ethernet

User's Manual

019-0120_M

BL2500 User's Manual

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1. INTRODUCTION

The Coyote single-board computer gives OEM designers extremely low-cost embedded control for high-volume applications. Two standard models—one with Ethernet, one without—feature the Rabbit[®] 3000 microprocessor running at 29.4 MHz, with standard 256K flash and 128K SRAM. These compact boards are rich with the I/O (including one A/D input and two D/A outputs) designers need for embedded control and monitoring applications, and the Coyote's compact board size of 3.95" × 3.95" (100 × 100 mm) is easily mountable in standard 100 mm DIN rail trays.

Customized BL2500 models can be manufactured in volume in OEM versions to user-specified configurations. Pin-compatible RabbitCore modules allow multiple configurations of the Coyote with Ethernet and memory options.

1.1 Features

- Rabbit 3000[®] microprocessor operating at 29.4 MHz (option for 44.2 MHz with 10/100Base-T Ethernet interface)
- 128K SRAM and 256K flash memory standard, optional 512K SRAM/512K flash
- 24 digital I/O: 9 protected and filtered digital inputs, 7 high-speed protected but unfiltered digital inputs, and 8 digital outputs sinking up to 200 mA at up to 36 V DC
- one 8-bit analog input channel
- two 9-bit PWM analog output channels
- six serial ports, including RabbitNet[™] expansion ports
- one 10/100-compatible RJ-45 Ethernet port with standard 10Base-T interface (optional 10/100Base-T interface)
- 4 user-programmable LEDs.
- battery-backed real-time clock.
- watchdog supervisor.
- onboard backup battery for real-time clock and SRAM

Two BL2500 models are available. Their standard features are summarized in Table 1.

Table 1. BL2500 Models

Feature	BL2500	BL2510
Microprocessor	Rabbit 3000 [®] running at 29.4 MHz	
Flash Memory	256K*	
Static RAM	128K*	
Ethernet Connections	Yes	No
RabbitCore Module Used	RCM3010	RCM3110
A/D Converter Input	Yes	Yes

* 512K options available

The BL2500 consists of a main board with a RabbitCore module. Refer to the RabbitCore module manuals, available on Rabbit's [Web site](#), for more information on the RabbitCore modules, including their schematics.

Appendix A provides detailed specifications.

Visit our [Web site](#) for up-to-date information about additional add-ons and features as they become available. The Web site also has the latest revision of this user's manual.

1.1.1 OEM Versions

The BL2500 and BL2510 models are also available in OEM versions as the OEM2500 and the OEM2510 (minimum quantity 500) where certain features have been removed or eliminated:

- fewer digital inputs—only 16 digital I/O, with 8 protected and filtered digital inputs and 8 digital outputs sinking up to 200 mA at up to 36 V DC (no header J12)
- no backup battery
- no RabbitNet™ hardware—no RS-422/multiplexer chips, no RabbitNet RJ-45 jacks, no RabbitNet™ power connectors (headers J7 and J8)

1.2 Development and Evaluation Tools

1.2.1 Development Kit

A Development Kit contains the hardware essentials you will need to use your BL2500/OEM2500. The items in the Development Kit and their use are as follows.

- BL2500 single-board computer.
- *Getting Started* instructions.
- *Dynamic C* CD-ROM, with complete product documentation on disk.
- Programming cable, used to connect your PC serial port to the BL2500.
- 12 V AC adapter, used to power the BL2500. An AC adapter is supplied with development kits sold in the North American market. If you are using your own power supply, it must provide 8 to 40 V DC.
- Demonstration Board with pushbutton switches and LEDs. The Demonstration Board can be hooked up to the BL2500 to demonstrate the I/O.
- Parts to build your own wire assemblies: wire, twenty-five 0.1" crimp terminals; ten 0.156" crimp terminals; 1 × 2, 1 × 4, and 1 × 10 friction-lock connectors.
- Nylon machine screws to serve as legs for the BL2500 board during development.
- *Rabbit 3000 Processor Easy Reference* poster.
- Registration card.

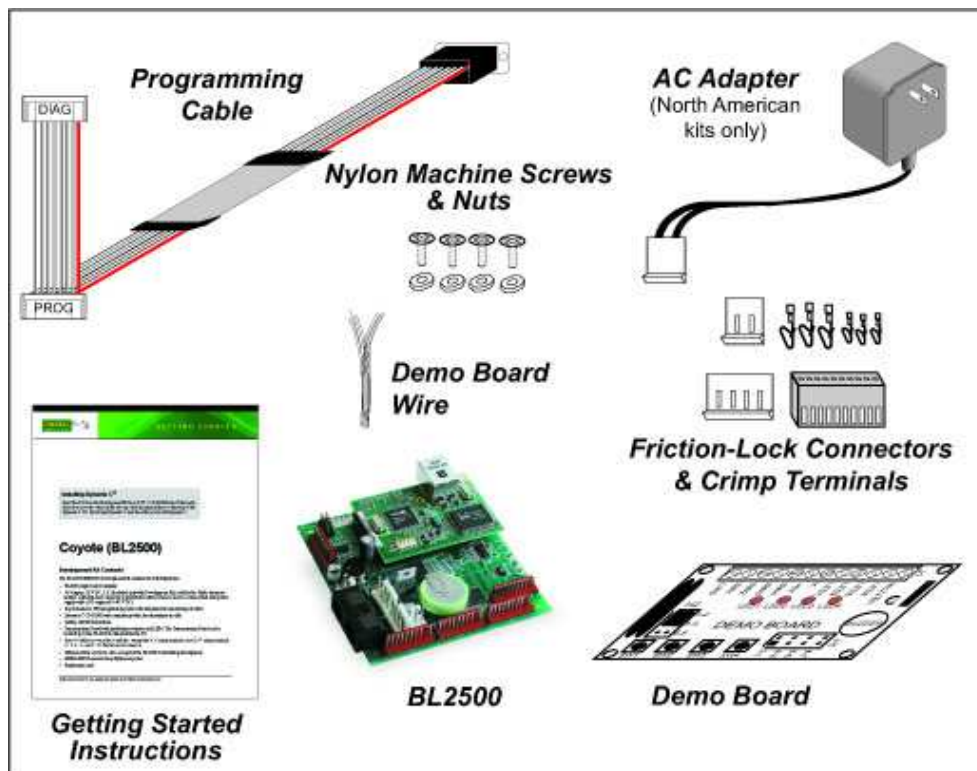


Figure 1. BL2500/OEM2500 Development Kit

1.2.2 Software

The Coyote is programmed using version 7.33 or later of Rabbit's Dynamic C. A compatible version is included on the Development Kit CD-ROM. Web-based technical support is included at no extra charge. Dynamic C v. 9.60 includes the popular μ C/OS-II real-time operating system, point-to-point protocol (PPP), FAT file system, RabbitWeb, and other select libraries that were previously sold as individual Dynamic C modules.

Rabbit also offers for purchase the Rabbit Embedded Security Pack featuring the Secure Sockets Layer (SSL) and a specific Advanced Encryption Standard (AES) library. In addition to the Web-based technical support included at no extra charge, a one-year telephone-based technical support subscription is also available for purchase. Visit our Web site at www.rabbit.com for further information and complete documentation, or contact your Rabbit sales representative or authorized distributor.

1.2.3 Connectivity Tools

Rabbit also has available additional tools and parts to allow you to make your own wiring assemblies in quantity to interface with the friction-lock connectors on the Coyote.

- Connectivity Kit (Part No. 101-0581)—Six 1×10 friction-lock connectors (0.1" pitch) with sixty 0.1" crimp terminals; and two 1×4 friction-lock connectors (0.156" pitch) and two 1×2 friction-lock connectors (0.156" pitch) with fifteen 0.156" crimp terminals. Each kit contains sufficient parts to interface with one Coyote board (some parts may be left over).
- Crimp tool (Part No. 998-0013) to secure wire in crimp terminals.

Table 3 in Chapter 3 provides information on specific friction-lock connectors and crimp terminals to be used with the various headers on the BL2500. Contact your authorized Rabbit distributor or your sales representative for more information.

1.2.4 DIN Rail Mounting

The Coyote may be mounted in 100 mm DIN rail trays as shown in Figure 2.

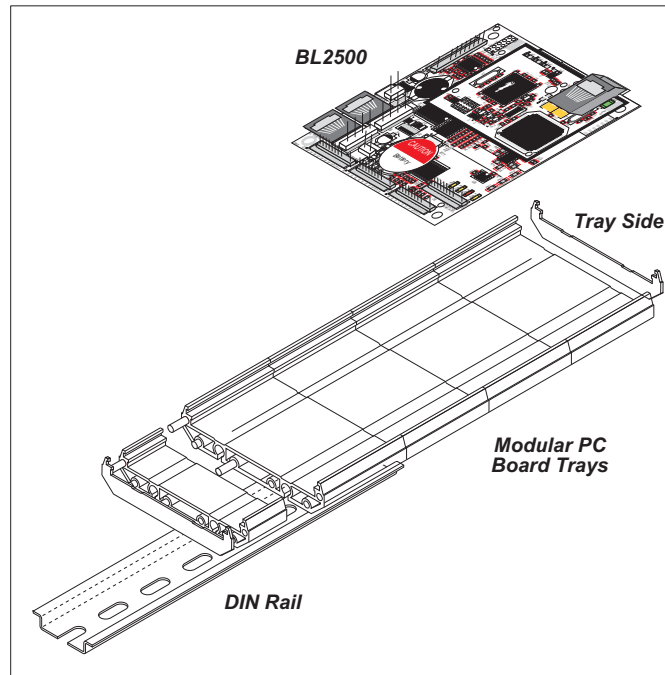


Figure 2. Mounting Coyote in DIN Rail Trays

DIN rail trays are typically mounted on DIN rails with “feet.” Table 2 lists Phoenix Contact part numbers for the DIN rail trays, rails, and feet. The tray side elements are used to keep the Coyote in place once it is inserted in a DIN rail tray, and the feet are used to mount the plastic tray on a DIN rail.

Table 2. Phoenix Contact DIN Rail Mounting Components

DIN Rail Mounting Component	Phoenix Contact Part Description	Phoenix Contact Part Number
Trays	UM 100-PROFIL cm*	19 59 87 4
Tray Side Elements	UM 108-SE	29 59 47 6
Foot Elements	UM 108-FE	29 59 46 3

* Length of DIN rail tray in cm

NOTE: Other major suppliers besides Phoenix Contact also offer DIN rail mounting hardware. Note that the width of the plastic tray should be 100 mm (3.95") since that is the width of the Coyote. 108 mm plastic trays may be used with spacers.

1.3 RabbitNet Peripheral Cards

RabbitNet™ is an SPI serial protocol that uses a robust RS-422 differential signalling interface (twisted-pair differential signaling) to run at a fast 1 Megabit per second serial rate. The Coyote has two RabbitNet ports, each of which can support one peripheral card. Distances between a master processor unit and peripheral cards can be up to 10 m or 33 ft.

The following low-cost peripheral cards are currently available.

- Digital I/O
- A/D converter
- D/A converter
- Relay card
- Display/Keypad interface

Appendix D provides additional information on RabbitNet peripheral cards and the RabbitNet protocol. Visit our [Web site](#) for up-to-date information about additional add-ons and features as they become available.

1.4 CE Compliance

Equipment is generally divided into two classes.

CLASS A	CLASS B
Digital equipment meant for light industrial use	Digital equipment meant for home use
Less restrictive emissions requirement: less than 40 dB $\mu\text{V}/\text{m}$ at 10 m (40 dB relative to 1 $\mu\text{V}/\text{m}$) or 300 $\mu\text{V}/\text{m}$	More restrictive emissions requirement: 30 dB $\mu\text{V}/\text{m}$ at 10 m or 100 $\mu\text{V}/\text{m}$

These limits apply over the range of 30–230 MHz. The limits are 7 dB higher for frequencies above 230 MHz. Although the test range goes to 1 GHz, the emissions from Rabbit-based systems at frequencies above 300 MHz are generally well below background noise levels.

The BL2500 single-board computer has been tested and was found to be in conformity with the following applicable immunity and emission standards. The BL2510 and OEM single-board computers are also CE qualified as they are sub-versions of the BL2500 single-board computer. Boards that are CE-compliant have the CE mark.



NOTE: Earlier versions of the BL2500 that do not have the CE mark are *not* CE-compliant.

Immunity

The BL2500 series of single-board computers meets the following EN55024/1998 immunity standards.

- EN61000-4-3 (Radiated Immunity)
- EN61000-4-4 (EFT)
- EN61000-4-6 (Conducted Immunity)

Additional shielding or filtering may be required for a heavy industrial environment.

Emissions

The BL2500 series of single-board computers meets the following emission standards.

- EN55022:1998 Class B
- FCC Part 15 Class B

Your results may vary, depending on your application, so additional shielding or filtering may be needed to maintain the Class B emission qualification.

1.4.1 Design Guidelines

Note the following requirements for incorporating the BL2500 series of single-board computers into your application to comply with CE requirements.

General

- The power supply provided with the Tool Kit is for development purposes only. It is the customer's responsibility to provide a CE-compliant power supply for the end-product application.
- When connecting the BL2500 single-board computer to outdoor cables, the customer is responsible for providing CE-approved surge/lightning protection.
- Rabbit recommends placing digital I/O or analog cables that are 3 m or longer in a metal conduit to assist in maintaining CE compliance and to conform to good cable design practices.
- When installing or servicing the BL2500, it is the responsibility of the end-user to use proper ESD precautions to prevent ESD damage to the BL2500.

Safety

- All inputs and outputs to and from the BL2500 series of single-board computers must not be connected to voltages exceeding SELV levels (42.4 V AC peak, or 60 V DC).
- The lithium backup battery circuit on the BL2500 single-board computer has been designed to protect the battery from hazardous conditions such as reverse charging and excessive current flows. Do not disable the safety features of the design.

1.4.2 Interfacing the BL2500 to Other Devices

Since the BL2500 series of single-board computers is designed to be connected to other devices, good EMC practices should be followed to ensure compliance. CE compliance is ultimately the responsibility of the integrator. Additional information, tips, and technical assistance are available from your authorized Rabbit distributor, and are also available on our Web site at www.rabbit.com.

2. GETTING STARTED

Chapter 2 explains how to connect the programming cable and power supply to the BL2500.

2.1 Preparing the BL2500 for Development

Position the BL2500 as shown below in Figure 3. Attach the four nylon 4-40 × ¼ machine screws and nuts supplied with the Development Kit in the holes at the corners as shown.

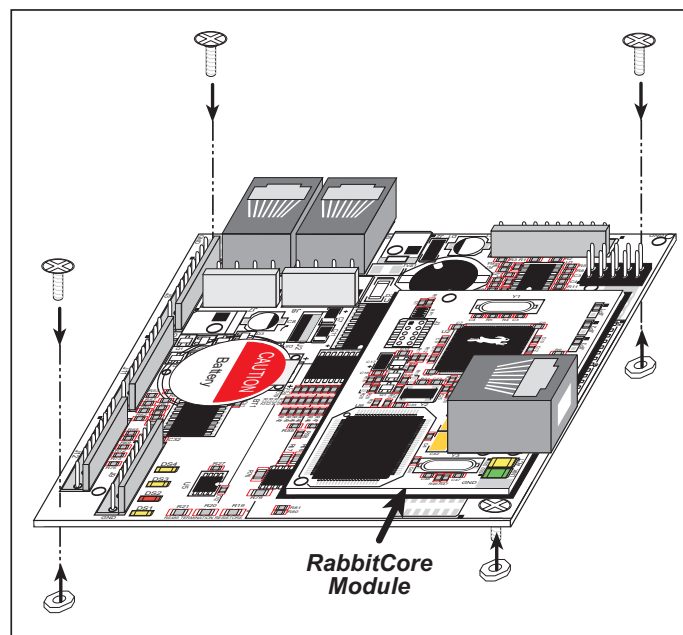


Figure 3. Attach Nylon Screws to BL2500 Board

NOTE: You will have to remove the RabbitCore module to install one screw under the module. When replacing the RabbitCore module, it is important that you line up the pins on the module exactly with the corresponding pins on the BL2500. The header pins may become bent or damaged if the pin alignment is offset, and the module will not work. Permanent electrical damage may also result if a misaligned module is powered up.

The nylon screws serve as standoffs to facilitate handling the BL2500 during development, and protect the bottom of the printed circuit board against scratches or short circuits while you are working with the BL2500.

2.2 BL2500 Connections

1. Connect the programming cable to download programs from your PC and to program and debug the BL2500.

NOTE: Use only the programming cable that has a red shrink wrap around the RS-232 level converter (Part No. 20-101-0513). If you are using a BL2500 with the optional 10/100Base-T Ethernet interface, you will need the programming cable that has a blue shrink wrap around the RS-232 level converter (Part No. 20-101-0542). Other Rabbit programming cables might not be voltage-compatible or their connector sizes may be different.

Connect the 10-pin **PROG** connector of the programming cable to header J3 on the BL2500's RabbitCore module. Ensure that the colored edge lines up with pin 1 as shown. There is a small dot on the circuit board next to pin 1 of header J3. (Do not use the **DIAG** connector, which is used for monitoring only.) Connect the other end of the programming cable to a COM port on your PC. Make a note of the port to which you connect the cable, as Dynamic C will need to have this parameter configured. Note that COM1 on the PC is the default COM port used by Dynamic C.

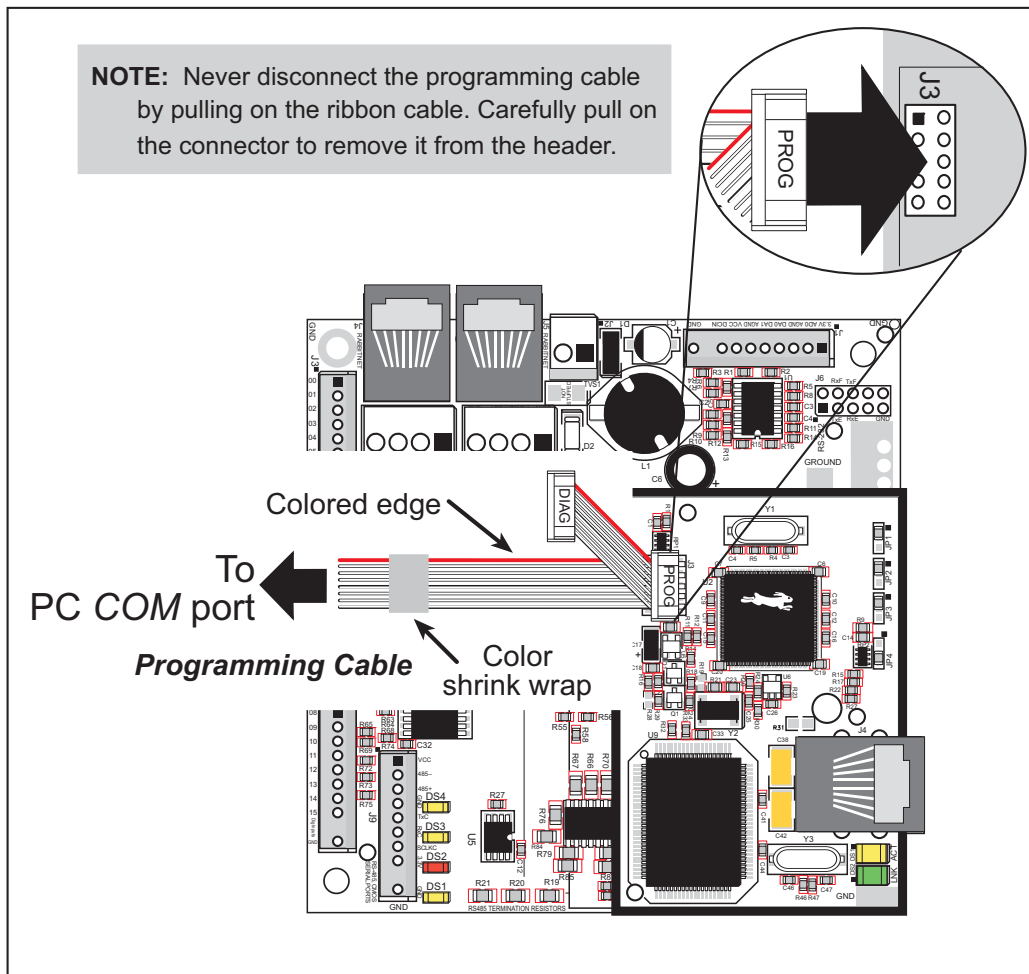


Figure 4. Programming Cable Connections

2. When all other connections have been made, you can connect power to the BL2500.

Connect the AC adapter to header J2 on the BL2500 as shown in Figure 5. Match the friction lock tab on the friction-lock connector to the back of header J2 on the BL2500 as shown. The friction-lock connector will only fit one way.

Development Kits sold outside North America include a friction lock friction-lock connector that may be connected to header J2 on the BL2500. Connect the leads from your power supply to the friction-lock connector to preserve the polarity indicated in Figure 5. The power supply should deliver 8 V–40 V DC at 500 mA.

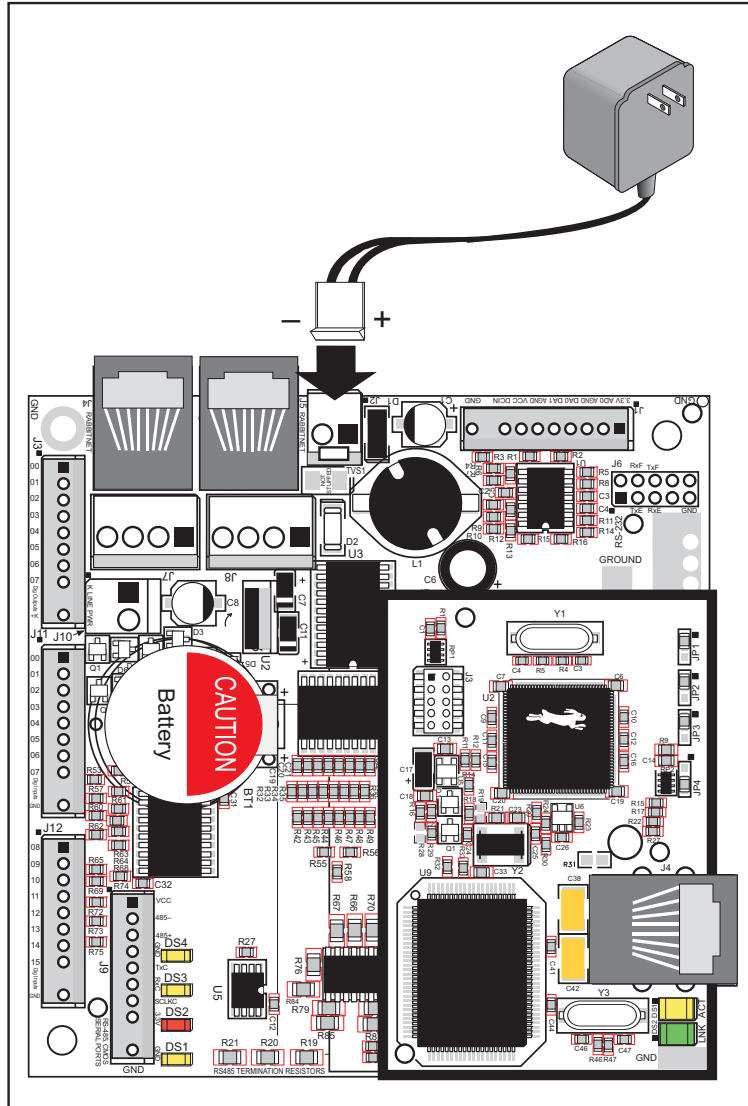


Figure 5. Power Supply Connections

3. Apply power.

Plug in the AC adapter.

CAUTION: Unplug the power supply while you make or otherwise work with the connections to the headers. This will protect your BL2500 from inadvertent shorts or power spikes.

2.2.1 Hardware Reset

A hardware reset is done by unplugging the AC adapter, then plugging it back in, or by shorting out the reset pads on the back of the BL2500 (see Figure 6).

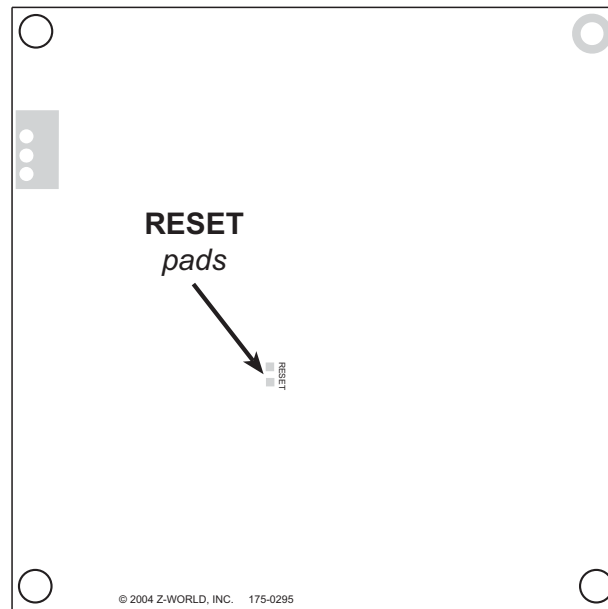


Figure 6. Location of RESET Pads

2.3 Installing Dynamic C

If you have not yet installed Dynamic C version 7.33 (or a later version), do so now by inserting the Dynamic C CD from the BL2500/OEM2500 Development Kit in your PC's CD-ROM drive. The CD will auto-install unless you have disabled auto-install on your PC.

If the CD does not auto-install, click **Start > Run** from the Windows **Start** button and browse for the Dynamic C **setup.exe** file on your CD drive. Click **OK** to begin the installation once you have selected the **setup.exe** file.

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.

The *Dynamic C User's Manual* provides detailed instructions for the installation of Dynamic C and any future upgrades.

NOTE: If you have an earlier version of Dynamic C already installed, the default installation of the later version will be in a different folder, and a separate icon will appear on your desktop.

2.4 Starting Dynamic C

Once the BL2500 is connected to your PC and to a power source, start Dynamic C by double-clicking on the Dynamic C icon on your desktop or in your **Start** menu.

Dynamic C defaults to using the serial port on your PC that you specified during installation. If the port setting is correct, Dynamic C should detect the BL2500 and go through a sequence of steps to cold-boot the BL2500 and to compile the BIOS. (Some versions of Dynamic C will not do the initial BIOS compile and load until the first time you compile a program.)

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 both ends of the programming cable to ensure that it is firmly plugged into the PC and the programming port.

If there are no faults with the hardware, select a different COM port within Dynamic C. From the **Options** menu, 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. You should receive a **Bios compiled successfully** message once this step is completed successfully.

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 > 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 > Communications** menu. Choose a lower debug baud rate.

2.5 PONG.C

You are now ready to test your set-up by running a sample program.

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 on the PC 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 5.2.3, “Run the PINGME.C Demo,” tests the TCP/IP portion of the board.

2.6 Where Do I Go From Here?

NOTE: If you purchased your BL2500 through a distributor or 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/.

If the sample program ran fine, you are now ready to go on to explore other BL2500 features and develop your own applications.

Chapter 3, “Subsystems,” provides a description of the BL2500’s features, Chapter 4, “Software,” describes the Dynamic C software libraries and introduces some sample programs. Chapter 5, “Using the TCP/IP Features,” explains the TCP/IP features.

2.7 Using the Coyote In High-Vibration Environments

If you plan to use your Coyote in a high-vibration environment, the RabbitCore module may be secured more solidly to a swage on the Coyote main board using a 2-56 \times 1/4" machine screw as shown in Figure 7.

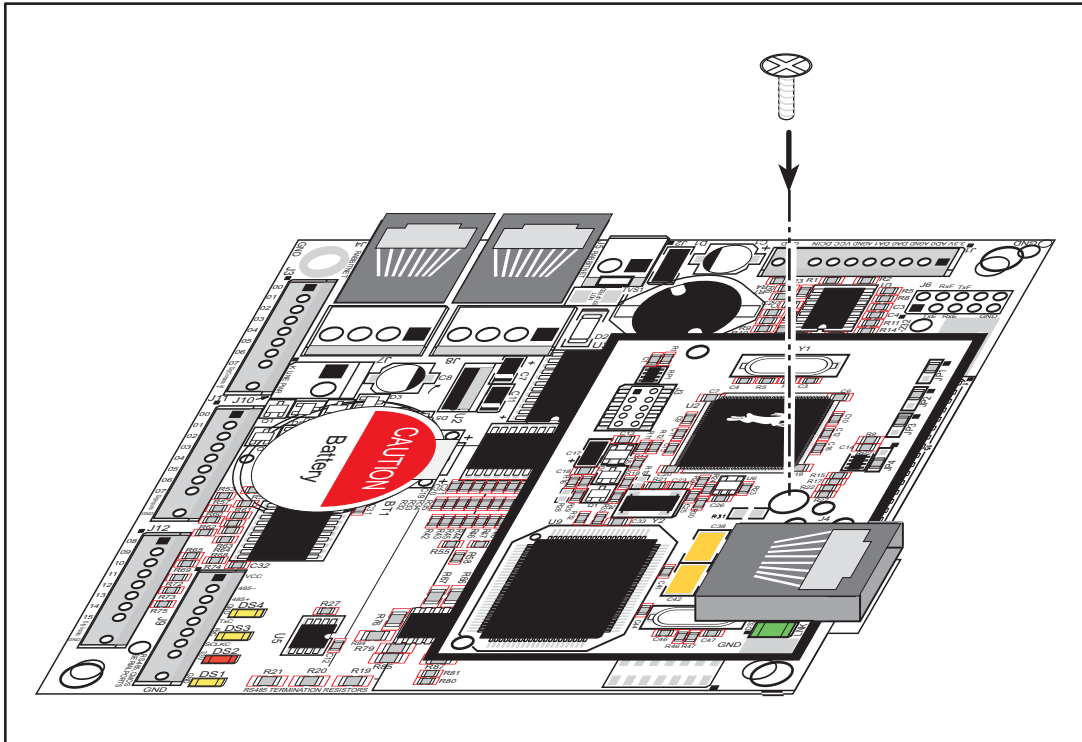


Figure 7. Secure RabbitCore Module to Coyote for High-Vibration Environments

3. SUBSYSTEMS

Chapter 3 describes the principal subsystems for the Coyote.

- Digital I/O
- Analog Features
- Serial Communication
- Memory

Figure 8 shows these Rabbit-based subsystems designed into the Coyote.

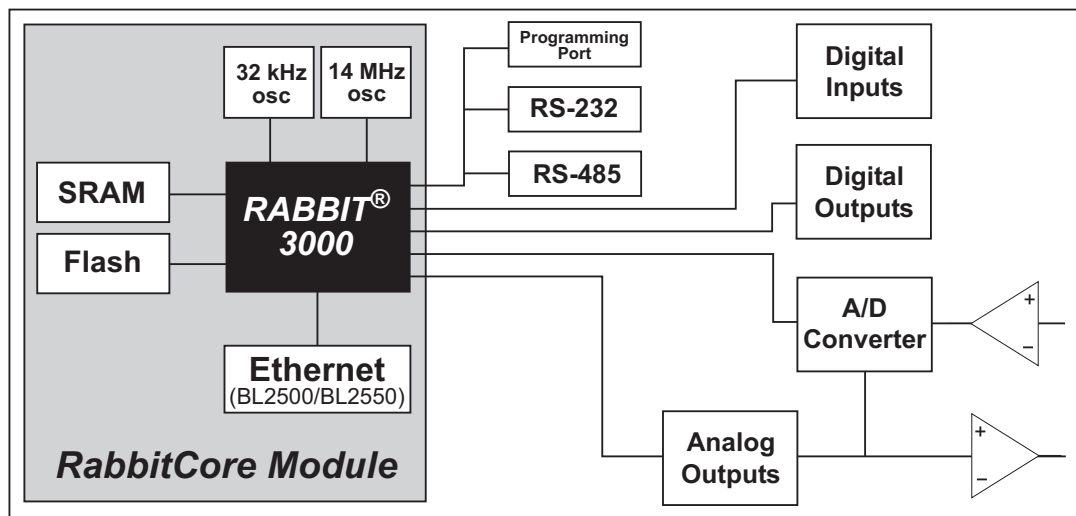


Figure 8. Coyote Subsystems

The memory and microprocessor are located on the RabbitCore module. If you have more than one Coyote or other Rabbit products built around RabbitCore modules, take care not to swap the RabbitCore modules since they contain system ID block information and calibration constants that are unique to the board they were originally installed on. It is a good idea to save the calibration constants should you need to replace a RabbitCore module in the future. See Section 4.2.6, “Using System Information from the RabbitCore Module,” for more information.

3.1 Coyote Pinouts

The Coyote pinouts are shown in Figure 9.

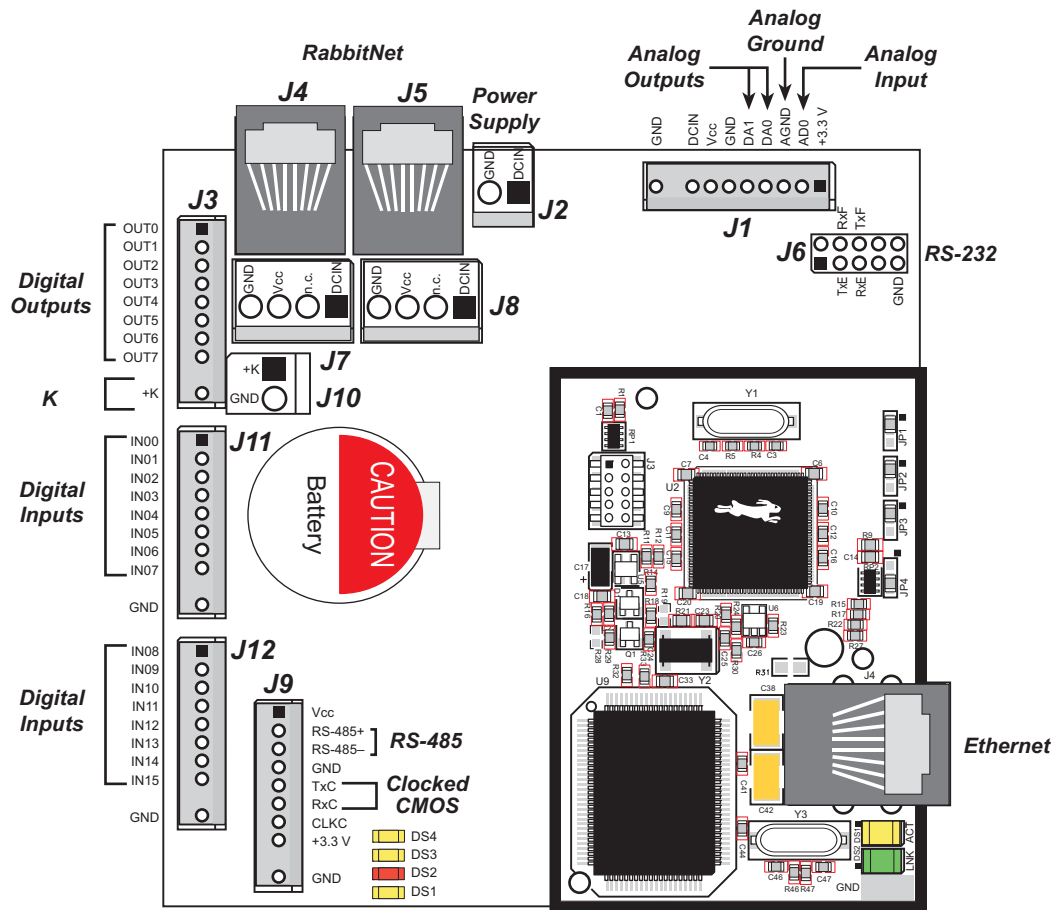


Figure 9. Coyote Pinouts

3.1.1 Headers

Standard Coyote models are equipped with five 1 × 10 friction-lock connector terminals (J1, J3, J9, J11, and J12) where pin 9 is removed to polarize the connector terminals, a 2 × 5 RS-232 signal header, a 2 × 5 programming header, and an RJ-45 Ethernet jack on the RabbitCore module.

The RJ-45 jacks at J4 and J5 labeled *RabbitNet* are serial I/O expansion ports for use with digital I/O and analog I/O boards currently being developed. The *RabbitNet* jacks do *not* support Ethernet connections. Be careful to connect your Ethernet cable to the jack labeled *Ethernet*.

Two 4-pin 0.156" friction-lock connector terminals at J7 and J8 are installed to supply power (DCIN and +5 V) to the peripheral cards currently being developed for use with the RabbitNet. Two 2-pin 0.156" friction-lock connector terminals at J2 and J10 are for power supply and +K connections.

Table 3 lists Molex connector part numbers for the crimp terminals, housings, and polarizing keys needed to assemble female friction-lock connector assemblies for use with their male counterparts on the BL2500.

Table 3. Female Friction-Lock Connector Parts

Friction-Lock Connector	Used with BL2500 Headers	Molex Housing Part Number	Molex Crimp Terminals	Molex Polarizing Keys
0.1" 1 × 10	J1, J3, J9, J11, J12	22-01-2107	08-50-0113	15-04-9209
0.156" 1 × 4	J7, J8	09-50-3041	08-50-0108	15-04-0219
0.156" 1 × 2	J2, J10	09-50-3021		