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Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
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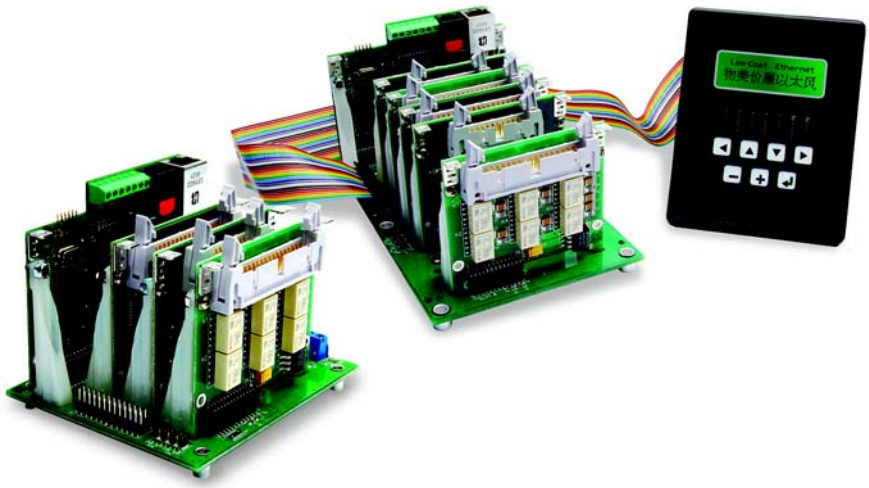
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

PRODUCT MANUAL



Smart Star (SR9000)

Modular C-Programmable Control System

User's Manual

019–0107 • 090519–L

Smart Star (SR9000) User's Manual

Part Number 019-0107 • 090519–L • Printed in U.S.A.

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PART I. CPU/BACKPLANE

1. INTRODUCTION

Chapter 1 introduces the Smart Star embedded control system and describes the features associated with the backplane chassis and the CPU Card. The Tool Kit containing the hardware essentials to begin using the Smart Star is described, and the software highlights are presented.

The Smart Star is a modular and expandable embedded control system whose configuration of Digital I/O, A/D Converter, D/A Converter, and Relay Cards can be tailored to a large variety of demanding real-time control and data acquisition applications.

The typical Smart Star system consists of a rugged backplane with a built-in voltage regulator, a CPU Card, and one or more I/O cards. The CPU Card plugs into a designated slot on the backplane chassis, which has additional slots available for any combination of I/O cards. A high-performance Rabbit 2000 microprocessor on the CPU Card operates at 22.1 MHz to provide fast data processing.

1.1 Features

- C-programmable to create a custom user interface
- Flexible functionality—modular configuration allows interchanging or replacing individual I/O cards
- Expandable—up to 168 I/O ports
- Choice of two backplanes—with either 3 or 7 slots for I/O cards
- Choice of CPU cards—with or without one RJ-45 10/100-compatible Ethernet port with 10Base-T Ethernet interface
- RS-232 and RS-485 serial ports allow networking to other Smart Star units, single-board computers, or enterprise computing centers
- 128K SRAM and 512K flash memory, optional 512K SRAM
- Real-time clock
- Watchdog supervisor
- Backup battery
- Optional backlit 122 × 32 graphic display/keypad module
- RabbitLink Ethernet gateway available for remote download/debug, Web serving, and e-mail

Table 1 lists the backplanes, CPU cards, and the I/O cards that are available for the Smart Star control system. Appendix A provides detailed specifications for the Smart Star backplanes and the CPU cards.

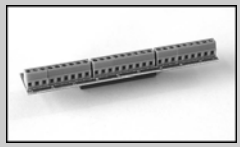
Table 1. Smart Star Backplanes and Cards

Card		Model	Features
Backplane		SR9010	7 I/O card slots, 1 CPU card slot, header connections for optional LCD/keypad module
		SR9050	3 I/O card slots, 1 CPU card slot, header connections for optional LCD/keypad module
CPU		SR9150	Full-featured CPU card ***with*** RJ-45 Ethernet port
		SR9160	Full-featured CPU card ***without*** RJ-45 Ethernet port
I/O Cards	Digital I/O	SR9200	16 digital inputs, 8 digital sinking outputs
		SR9210	8 digital inputs, 16 digital sinking outputs
		SR9220	8 digital inputs, 8 digital sinking outputs
		SR9205	16 digital inputs, 8 digital sourcing outputs
		SR9215	8 digital inputs, 16 digital sourcing outputs
		SR9225	8 digital inputs, 8 digital sourcing outputs
	A/D Converter	SR9300	12-bit A/D converter, 11 channels, 0 V – 10 V
		SR9310	12-bit A/D converter, 11 channels, -10 V – +10 V
		SR9320	12-bit A/D converter, 11 channels, 4 mA – 20 mA
	D/A Converter	SR9400	12-bit D/A converter, 8 channels, 0 V – 10 V
		SR9410	12-bit D/A converter, 8 channels, -10 V – +10 V
		SR9420	12-bit D/A converter, 8 channels, 4 mA – 20 mA
	Relay	SR9500	5 SPST relays and 1 SPDT relay, each protected with onboard snubbers
		SR9510	8 SPDT relays (no snubbers)

1.2 User Connections

Connections to the I/O cards are made via a ribbon cable connector or optional field wiring terminals that are either pluggable or have screw terminals. Three different Field Wiring Terminals (FWTs) are available. Table 2 lists the I/O cards and the Rabbit part numbers for the corresponding FWTs.

Table 2. Guide to FWT Selection

FWT Description	I/O Cards	Rabbit Part Number	
		Pluggable Terminals	Screw Terminals
			
FWT27	Digital I/O Relay (SR9510)	101-0420	101-0514
FWT18	A/D Converter D/A Converter	101-0421	101-0515
FWT18R	Relay (SR9500)	101-0422	101-0516

NOTE: Appendix A, "Field Wiring Terminals," provides further information on FWTs, including their dimensions.

1.3 Optional Add-Ons

The LCD/keypad module is the only available optional add-on. Further details on the LCD/keypad module are provided in Appendix B.

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.

1.4 Development and Evaluation Tools

1.4.1 Tool Kit

The Tool Kit has the hardware essentials that you need to create and use your own Smart Star control system.

The items in the Tool Kit and their use are as follows:

- ***Smart Star (SR9000) Getting Started*** instructions.
- ***Dynamic C*** CD-ROM, with complete product documentation on disk.
- Programming cable, used to connect your PC serial port to the Smart Star CPU Card to write and debug C programs that run on the Smart Star control system.
- FWT27 pluggable field wiring terminal.
- Screwdriver.
- DC power supply, used to power the backplane, which in turn supplies power to the CPU card and the I/O cards. The DC power supply accepts an AC input of 100 V to 240 V at up to 0.6 A, and delivers a DC output up to 1.1 A at 24 V.
- ***Rabbit 2000 Processor Easy Reference*** poster.
- Registration card.

1.4.2 Software

The Smart Star control system is programmed using Rabbit's Dynamic C. A compatible version is included on the Tool Kit CD-ROM.

Rabbit also offers add-on Dynamic C modules containing 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. Visit our Web site at www.rabbit.com or contact your Rabbit sales representative or authorized distributor for further information.

1.5 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 µV/m at 10 m (40 dB relative to 1 µV/m) or 300 µV/m	More restrictive emissions requirement: 30 dB µV/m at 10 m or 100 µV/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 CPU card, I/O cards, and backplane in the Smart Star embedded control system have been tested and were found to be in conformity with the following applicable immunity and emission standards as described in Table 3.

Table 3. CE Compliance of Smart Star Backplanes and Cards

Card		Model	Description		Used for CE Compliance Testing
Backplane		SR9010	7 I/O card slots, 1 CPU card slot, header connections for optional LCD/keypad module*	Full-featured	×
		SR9050	3 I/O card slots, 1 CPU card slot, header connections for optional LCD/keypad module*	Sub-version	
CPU		SR9150	22.1 MHz CPU card ***with*** Ethernet	Full-featured	×
		SR9160	22.1 MHz CPU card ***without*** Ethernet	Sub-version	
I/O Cards	Digital I/O	SR9200	16 inputs, 8 sinking outputs	Full-featured	×
		SR9205	16 inputs, 8 sourcing outputs	Full-featured	×
		SR9210	8 inputs, 16 sinking outputs	Sub-version	
		SR9220	8 inputs, 8 sinking outputs	Sub-version	
	A/D Converter	SR9300	Eleven 12-bit analog inputs (0–10 V)	Sub-version	
		SR9310	Eleven 12-bit analog inputs (±10 V)	Full-featured	×
		SR9320	Eleven 12-bit analog inputs (4–20 mA)	Sub-version	
	Relay	SR9500	5 SPST relays and 1 SPDT relay, each protected with onboard snubbers	Full-featured	×
		SR9510	8 SPDT relays (no snubbers)	Full-featured	×

* No CE compliance testing was done with the LCD/keypad module connected to a Smart Star embedded control system. A system consisting of Smart Star boards and an LCD/keypad module therefore ***cannot*** be considered to be CE-compliant.

The sub-versions of the boards are also CE-compliant. All boards that are CE-compliant have the CE mark.

Several Smart Star boards are not yet CE-compliant. These boards are listed in Table 4.

Table 4. Smart Star Backplanes and Cards Not CE-Compliant

Card	Model	Description	Comments
Backplane	SR9000	7 I/O card slots, 1 CPU card slot	Legacy product
CPU	SR9100	25.8 MHz CPU card	Legacy product
D/A Converter	SR9400	Eight analog outputs (0–10 V)	Passed emissions tests, immunity tests pending
	SR9410	Eight analog outputs (±10 V)	
	SR9420	Eight analog outputs (4–20 mA)	

Immunity

The CE-compliant Smart Star boards meet 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 CE-compliant Smart Star boards meet the following emission standards when used with a Smart Star embedded control system that contains a Rev. C or higher version of the Rabbit 2000 microprocessor with its spectrum spreader turned on and set to the normal mode. This microprocessor is used in all Smart Star CPU boards that carry the CE mark.

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

NOTE: The Smart Star embedded control system satisfied the Class A limits but not the Class B limits. Such equipment need not be restricted in its sale, but the following warning must be included in the instructions for its use.

Warning

This is a class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

Additional shielding or filtering may be needed to meet Class B emissions standards.

1.5.1 Design Guidelines

Note the following requirements for incorporating a Smart Star embedded control system 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 Smart Star embedded control system to outdoor cables, the customer is responsible for providing CE-approved surge/lighting 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 Smart Star embedded control system, it is the responsibility of the end-user to use proper ESD precautions to prevent ESD damage to the Smart Star.

Safety

- All inputs and outputs to and from the Smart Star embedded control system 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 CPU card in the Smart Star embedded control system 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.

1.5.2 Interfacing the Smart Star to Other Devices

Since Smart Star embedded control systems are 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 power supply to the Smart Star backplane, how to install the CPU Card on the backplane, and how to connect the programming cable to the CPU Card. Once you run a sample program to demonstrate that you have connected everything correctly, you will be ready to go on to install I/O cards and finish developing your system.

2.1 Attach the CPU Card to the Backplane

1. Orient the backplane with the **PROCESSOR SLOT** facing away from you as shown in Figure 1.

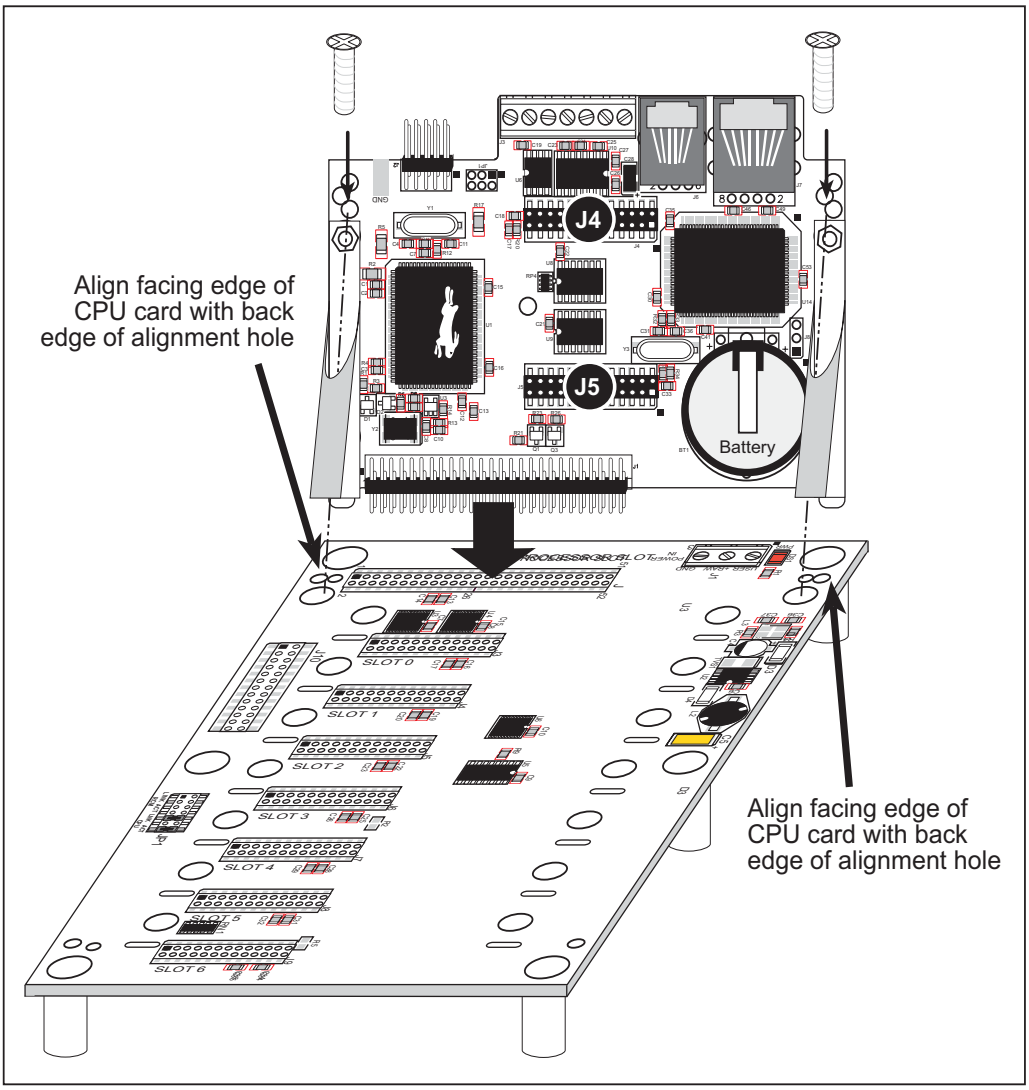


Figure 1. Attach the CPU Card to the Backplane

2. Position the CPU Card above the backplane as shown in Figure 1.
3. Carefully insert the CPU Card header into the **PROCESSOR SLOT** on the backplane and line up the facing edge of the CPU Card with the back edge of the alignment holes on the backplane as shown in Figure 1.

   NOTE: Be careful to line up the pins on the CPU Card with the socket on the backplane when installing the CPU Card. The CPU Card can be damaged once power is applied if the CPU Card is not installed correctly.

4. Use the two 4-40 screws supplied with the CPU Card to anchor the plastic brackets so that they hold the CPU Card firmly in place on the backplane.

2.2 Connect the Power Supply

Connect the power supply to the **POWER IN** connector on the backplane—the red (positive) wire to **+RAW** and the black (negative) wire to **GND**, as shown in Figure 2.

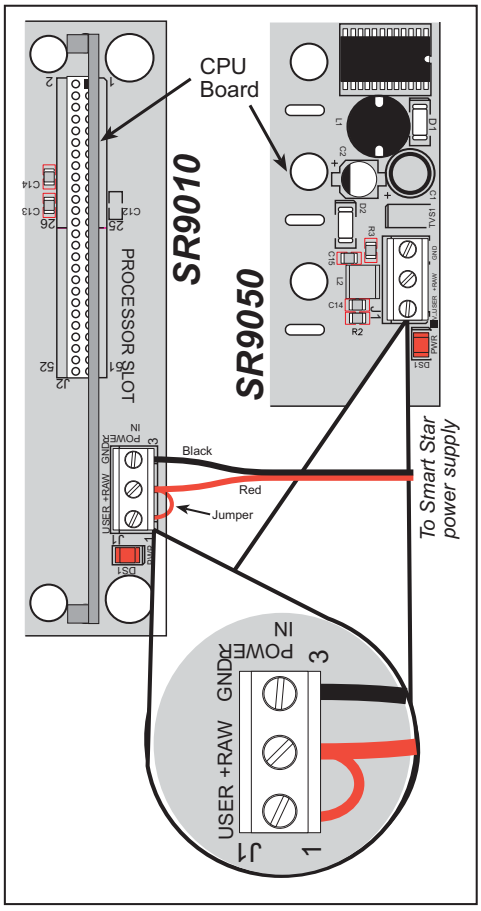


Figure 2. Power Supply Connections (North America)

> **NOTE:** Be careful to hook up the positive and negative leads ***exactly*** as described. Only the +5 V circuitry is protected against reverse polarity.

A **USER** connection is supplied on the backplane to allow an independent power supply to be used for future development. For now, use a wire jumper to connect **USER** to **+RAW** so that they share the same power supply.

Notice to Customers Outside North America

The power supply included with the Smart Star Tool Kit may be used worldwide. Customers outside North America simply need to exchange the line cord and plug from the power supply to their wall outlet with one available locally.

1. To exchange the line cord and plug, first remove the existing line cord. To access the screws, use a screwdriver to gently lift up and remove the plastic insulating cover.

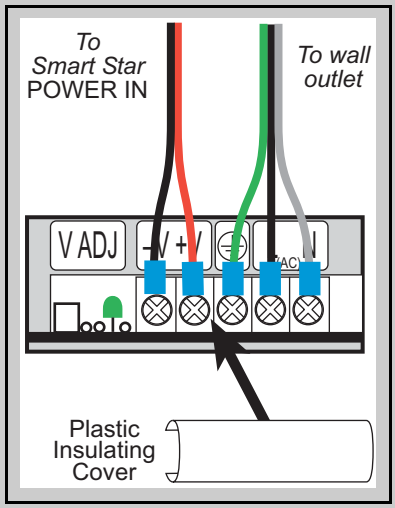


Figure 3. Power Supply Connections (overseas)

2. Unscrew the wires at the ground, **L**, and **N** terminals.
3. Attach the line cord that you obtained locally to the power supply. Be sure to follow any color-coding conventions, for example, green/yellow to ground, brown to **L**, and blue to **N** terminals.
4. Ensure that the wires are attached securely and are not touching each other. Snap on the plastic insulating cover.

> **NOTE:** The power supply included with the Smart Star Tool Kit is intended for development purposes only.

2.3 Programming Cable Connections

1. Connect the programming cable to the CPU Card.

Connect the 10-pin **PROG** connector of the programming cable to header J2 on the CPU Card as shown in Figure 4. Connect the other end of the programming cable to a COM port on your PC. Note that COM1 on the PC is the default COM port in the Dynamic C installation.

NOTE: Be sure to use the programming cable (Part No. 101-0513) supplied with the Smart Star Tool Kit—the programming cable has red shrink wrap around the RS-232 converter section located in the middle of the cable. Programming cables from other Rabbit kits are not designed to work with the Smart Star.

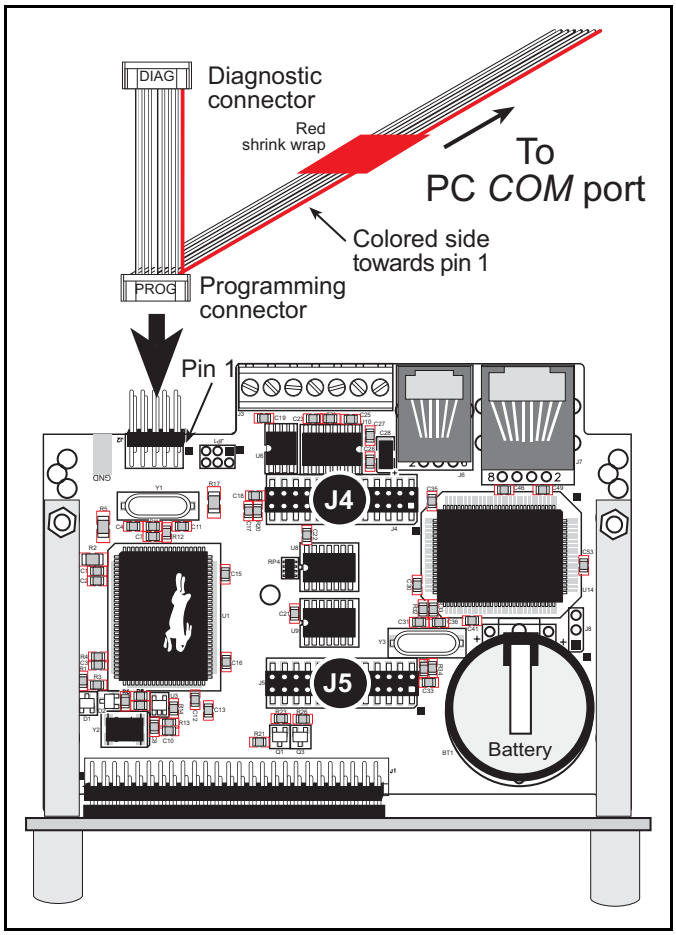


Figure 4. Programming Cable Connections

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

NOTE: Some PCs now come equipped only with a USB port. It may be possible to use an RS-232/USB converter (Part No. 20-151-0178) with the programming cable supplied with the Tool Kit. Note that not all RS-232/USB converters work with Dynamic C.

2. Apply power.

Plug the power supply in to a nearby outlet. The CPU Card is now ready to be used.

> **NOTE:** A hardware RESET is accomplished by unplugging the power supply, then plugging it back in.

To power down the SmartStar, unplug the power supply. You should disconnect power before making any circuit adjustments or changing any connections to the SmartStar.

2.4 Installing Dynamic C

If you have not yet installed Dynamic C version 7.06P3 (or a later version), do so now by inserting the Dynamic C CD from the Smart Star Tool 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 **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.

2.5 Starting Dynamic C

Once the CPU Card is installed and connected as described above, start Dynamic C by double-clicking on the Dynamic C icon or by double-clicking on **dcrab_XXXX.exe** in the Dynamic C root directory, where **XXXX** are version-specific characters.

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 CPU Card and go through a sequence of steps to cold-boot the CPU Card 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.

2.6 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 and will display a small square bouncing around in a box.

This program does not test the serial ports on the CPU Card, but does ensure that the CPU is basically functional.

2.7 Installing I/O Cards

1. Orient the backplane with the CPU Card already installed and facing towards you as shown in Figure 5.

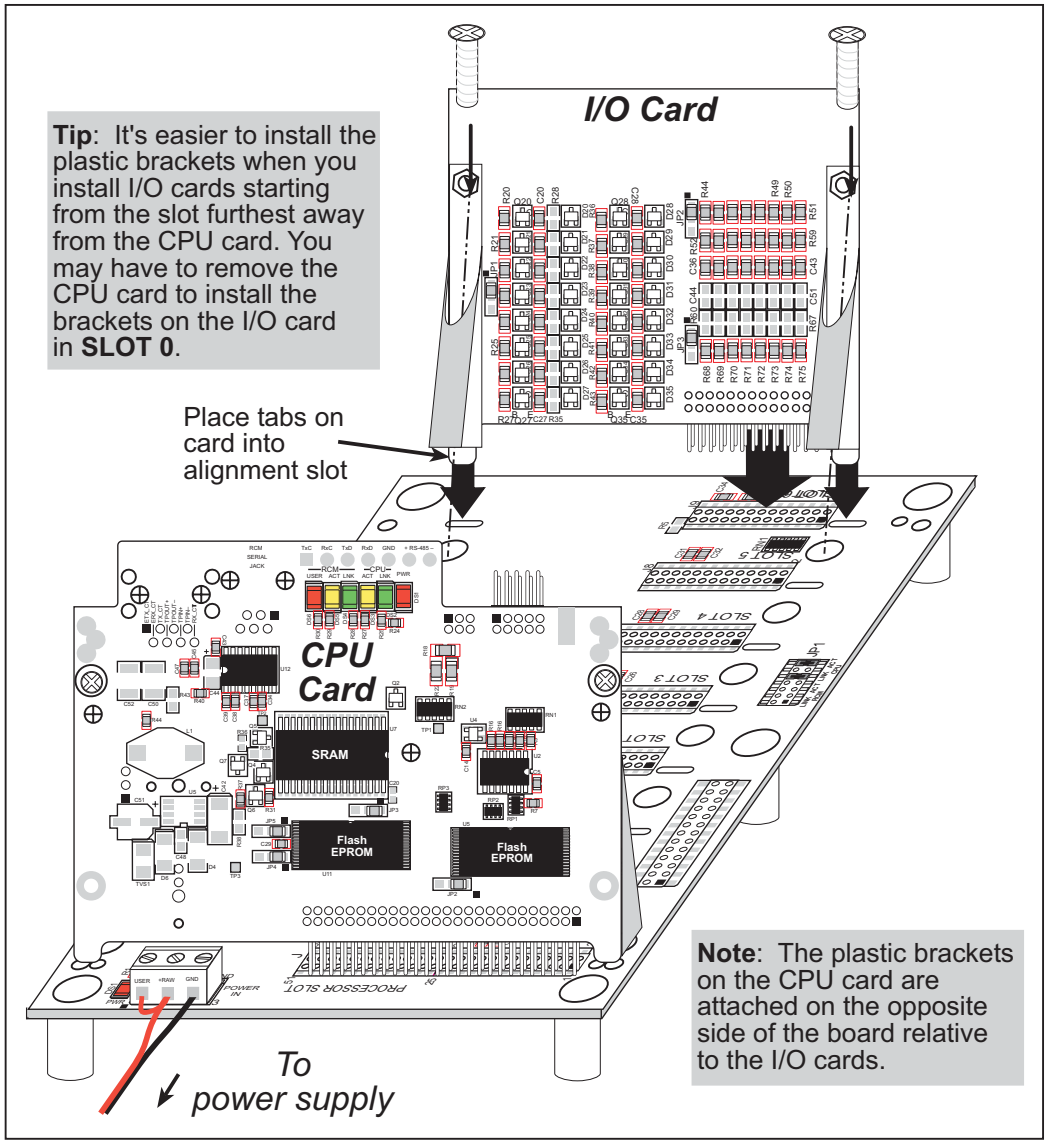


Figure 5. Installing I/O Cards on the Backplane

2. Position the new I/O card above the backplane over any unused slot position (**SLOT 0** to **SLOT 6**) as shown in Figure 5. Note the slot number and the type of I/O card since Dynamic C addresses the I/O cards by slot number.
3. Carefully insert the I/O card header into the slot on the backplane and line up the tabs on the I/O cards with the slots on the backplane as shown in Figure 5.
4. Use the two 4-40 screws supplied with the I/O card to anchor the plastic brackets on the CPU Card or the I/O card firmly on the backplane. Tighten the screws as needed using a Phillips screwdriver whose shaft is at least 3" (7 cm) long, but is no thicker than 0.16" (4 mm).