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Understanding Embedded - Microcontroller, Microprocessor, FPGA Modules

Embedded - Microcontroller, Microprocessor, and FPGA Modules are fundamental components in modern electronic systems, offering a wide range of functionalities and capabilities. Microcontrollers are compact integrated circuits designed to execute specific control tasks within an embedded system. They typically include a processor, memory, and input/output peripherals on a single chip. Microprocessors, on the other hand, are more powerful processing units used in complex computing tasks, often requiring external memory and peripherals. FPGAs (Field Programmable Gate Arrays) are highly flexible devices that can be configured by the user to perform specific logic functions, making them invaluable in applications requiring customization and adaptability.

Applications of Embedded - Microcontroller,

Details	
Product Status	Obsolete
Module/Board Type	MPU Core
Core Processor	Rabbit 2000
Co-Processor	-
Speed	22.1MHz
Flash Size	256KB
RAM Size	128KB
Connector Type	2 IDC Headers 2x13
Size / Dimension	1.6" x 2.3" (41mm x 58mm)
Operating Temperature	0°C ~ 70°C
Purchase URL	https://www.e-xfl.com/product-detail/digi-international/20-101-0454

2.1.3 Connect Power

When all other connections have been made, you can connect power to the RCM2200 Prototyping Board.

First, prepare the AC adapter for the country where it will be used by selecting the plug. The RCM2200 Development Kit presently includes Canada/Japan/U.S., Australia/N.Z., U.K., and European style plugs. Snap in the top of the plug assembly into the slot at the top of the AC adapter as shown in Figure 3, then press down on the spring-loaded clip below the plug assembly to allow the plug assembly to click into place.

Connect the AC adapter to 3-pin header J5 on the Prototyping Board as shown in Figure 3 below. The connector may be attached either way as long as it is not offset to one side.

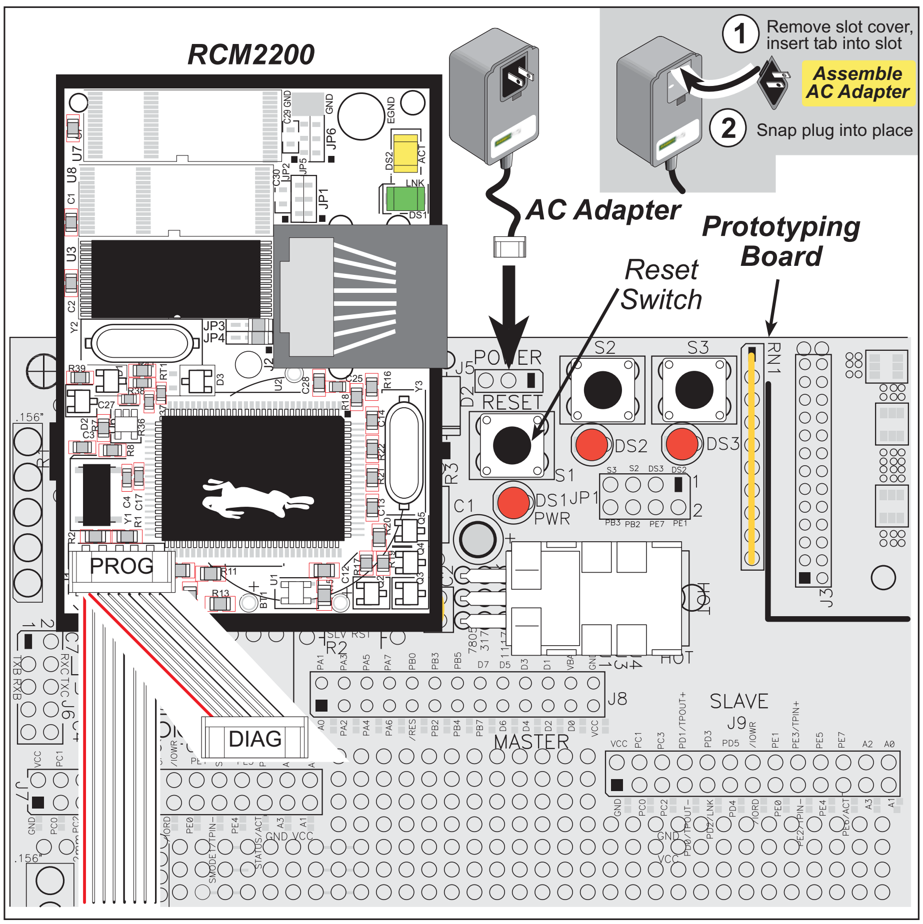


Figure 3. Power Supply Connections

Plug in the AC adapter. The power LED on the Prototyping Board should light up. The RCM2200 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.

3. Running Sample Programs

To develop and debug programs for the RCM2200 (and for all other Rabbit hardware), you must install and use Dynamic C. This chapter provides a tour of the sample programs for the RCM2200.

3.1 Sample Programs

To help familiarize you with the RCM2200 modules, several sample Dynamic C programs have been included. Loading, executing and studying these programs will give you a solid hands-on overview of the RC M2200's capabilities, as well as a quick start with Dynamic C as an application development tool. These programs are intended to serve as tutorials, but then can also be used as starting points or building blocks for your own applications.

> **NOTE:** It is assumed in this section that you have at least an elementary grasp of ANSI C. If you do not, see the introductory pages of the ***Dynamic C User's Manual*** for a suggested reading list.

Each sample program has comments that describe the purpose and function of the program.

Before running any of these sample program, make sure that your RCM2200 is connected to the Prototyping Board and to your PC as described in Section 2.1, "Connections." To run a sample program, open it with the **File** menu (if it is not already open), then compile and run it by pressing **F9** or by selecting **Run** in the **Run** menu.

Sample programs are provided in the Dynamic C **`SAMPLES`** folder. Two folders contain sample programs that illustrate features unique to the RCM2200.

- **`RCM2200`**—Demonstrates the basic operation and the Ethernet functionality of the RCM2200.
- **`TCPIP`**—Demonstrates more advanced TCP/IP programming for Rabbit's Ethernet-enabled Rabbit-based boards.

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

tion of how Dynamic C handles multitasking with costatements and cofunctions, see Chapter 5, “Multitasking with Dynamic C,” and Chapter 6, “The Virtual Driver,” in the ***Dynamic C User’s Manual***.

3.1.4.3 TOGGLELED.C

One of Dynamic C’s unique and powerful aspects is its ability to efficiently multitask using *cofunctions* and *costatements*. This simple application demonstrates how these program elements work.

This sample program uses two costatements to set up and manage the two tasks. Costatements must be contained in a loop that will “tap” each of them at regular intervals. This program:

1. Initializes the pins of Port A as outputs.
2. Sets all the pins of Port A high, turning off the attached LEDs.
3. Sets the toggled LED status variable **`vswitch`** to 0 (LED off).
4. Starts an endless loop using a **`while(1)`** expression, and within that loop:
    - Executes a costatement that flashes LED DS3;
    - Executes a costatement that checks the state of switch S2 and toggles the state of **`vswitch`** if it is pressed;
    - Turns LED DS2 on or off, according to the state of **`vswitch`**.

    These steps repeat as long as the program is allowed to run.

The first costatement is a compressed version of **`FLASHLED.c`**, with slightly different flash timing. It also uses the library function **`DelayMs()`** to deliver more accurate timing than the simple delay loops of the previous program.

The second costatement does more than check the status of S2. Switch contacts often “bounce” open and closed several times when the switch is actuated, and each bounce can be interpreted by fast digital logic as an independent press. To clean up this input, the code in the second costatement “debounces” the switch signal by waiting 50 milliseconds and checking the state of the switch again. If it is detected as being closed both times, the program considers it a valid switch press and toggles **`vswitch`**.

Unlike most C statements, the two costatements are not executed in their entirety on each iteration of the **`while(1)`** loop. Instead, the list of statements within each costatement is initiated on the first loop, and then executed one “slice” at a time on each successive interation. This mode of operation is known as a *state machine*, a powerful concept that permits a single processor to efficiently handle a number of independent tasks.

The ability of Dynamic C to manage state machine programs enables you to create very powerful and efficient embedded systems with much greater ease than other programming methods.

More Information

See the entries for the **`DelayMs()`** function, as well as Section 5, “Multitasking with Dynamic C,” in the ***Dynamic C User’s Manual***.

The RJ-45 connector is shielded to minimize EMI effects to/from the Ethernet signals. Rabbit recommends that an equivalent RJ-45 connector be used on the user board if the customer wishes to have an RJ-45 connector on the user board.

> **NOTE:** The RCM2210 is available without the LEDs and the RJ-45 connector if you plan to use your own RJ-45 connector on your user board.

4.2.3 Programming Port

The RCM2200 has a 10-pin program header labeled J1. The programming port uses the Rabbit 2000's Serial Port A for communication. Dynamic C uses the programming port to download and debug programs.

The programming port is also used for the following operations.

- Cold-boot the Rabbit 2000 after a reset.
- Remotely download and debug a program over an Ethernet connection using the RabbitLink EG2110.
- Fast copy designated portions of flash memory from one Rabbit-based board (the master) to another (the slave) using the Rabbit Cloning Board.

Alternate Uses of the Serial Programming Port

All three clocked Serial Port A signals are available as

- a synchronous serial port
- an asynchronous serial port, with the clock line usable as a general CMOS input

The serial programming port may also be used as a serial port via the **DIAG** connector on the serial programming cable.

In addition to Serial Port A, the Rabbit 2000 startup-mode (SMODE0, SMODE1), status, and reset pins are available on the serial programming port.

The two startup mode pins determine what happens after a reset—the Rabbit 2000 is either cold-booted or the program begins executing at address 0x0000. These two SMODE pins can be used as general inputs once the cold boot is complete.

The status pin is used by Dynamic C to determine whether a Rabbit microprocessor is present. The status output has three different programmable functions:

1. It can be driven low on the first op code fetch cycle.
2. It can be driven low during an interrupt acknowledge cycle.
3. It can also serve as a general-purpose CMOS output.

The /RESET_IN pin is an external input that is used to reset the Rabbit 2000 and the onboard peripheral circuits on the RabbitCore module. The serial programming port can be used to force a hard reset on the RabbitCore module by asserting the /RESET_IN signal.

Refer to the ***Rabbit 2000 Microprocessor User's Manual*** for more information.

4.3 Serial Programming Cable

The programming cable is used to connect the RCM2200's programming port to a PC serial COM port. The programming cable converts the RS-232 voltage levels used by the PC serial port to the TTL voltage levels used by the Rabbit 2000.

When the **PROG** connector on the programming cable is connected to the RCM2200's programming header, programs can be downloaded and debugged over the serial interface.

The **DIAG** connector of the programming cable may be used on the RCM2200's programming header with the RCM2200 operating in the Run Mode. This allows the programming port to be used as a regular serial port.

4.3.1 Changing Between Program Mode and Run Mode

The RCM2200 is automatically in Program Mode when the **PROG** connector on the programming cable is attached to the RCM2200, and is automatically in Run Mode when no programming cable is attached. When the Rabbit 2000 is reset, the operating mode is determined by the status of the SMODE pins. When the programming cable's **PROG** connector is attached, the SMODE pins are pulled high, placing the Rabbit 2000 in the Program Mode. When the programming cable's **PROG** connector is not attached, the SMODE pins are pulled low, causing the Rabbit 2000 to operate in the Run Mode.

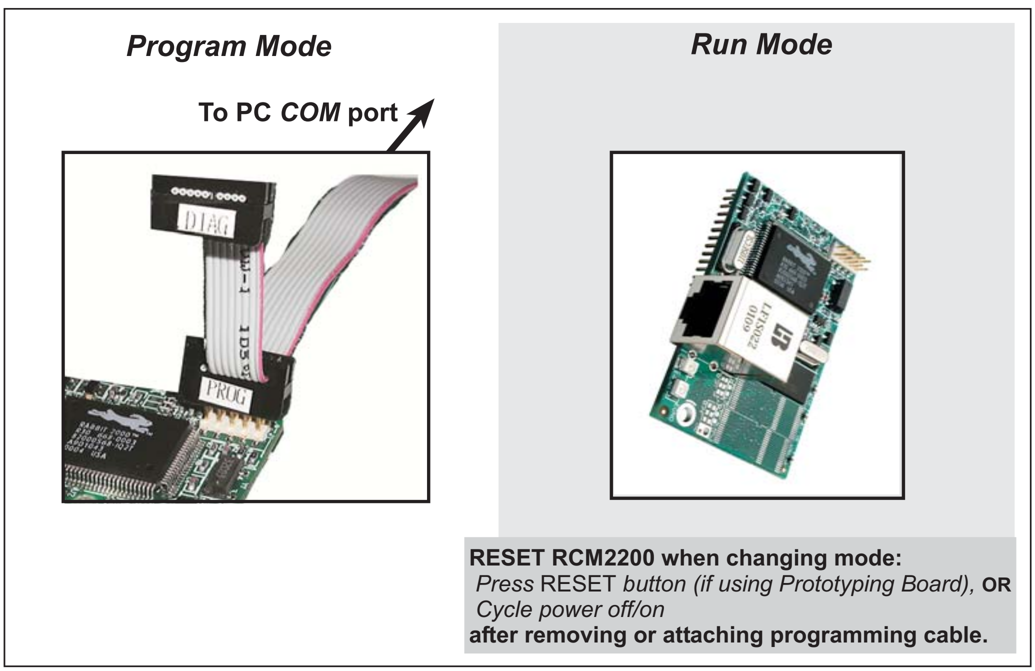


Figure 8. Switching Between Program Mode and Run Mode

A program "runs" in either mode, but can only be downloaded and debugged when the RCM2200 module is in the Program Mode.

Refer to the ***Rabbit 2000 Microprocessor User's Manual*** for more information on the programming port and the programming cable.

5. Software Reference

Dynamic C is an integrated development system for writing embedded software. It runs on an IBM-compatible PC and is designed for use with Rabbit single-board computers and other single-board computers based on the Rabbit microprocessor. Chapter 4 provides the libraries and function calls related to the RCM2200.

5.1 More About Dynamic C

Dynamic C has been in use worldwide since 1989. Dynamic C is specially designed for programming embedded systems, and features quick compile and interactive debugging. A complete reference 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 static RAM included on the RCM2200. The flash memory and SRAM options are selected with the **Options > Project Options > Compiler** menu.

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:** An application can be developed in RAM, but cannot run standalone from RAM after the programming cable is disconnected. All standalone applications can only run from flash memory.

> **NOTE:** Do not depend on the flash memory sector size or type. Due to the volatility of the flash memory market, the RCM2200 and Dynamic C were designed to accommodate flash devices with various sector sizes.

RCM2250 and RCM2260 RabbitCore modules have two 256K flash memories. By default, Dynamic C will use only the first flash memory for program code in these RCM2250 and RCM2260 RabbitCore modules. Uncomment he BIOS `USE_2NDFLASH_CODE` macro to allow the second flash memory to hold any program code that is in excess of the available memory in the first flash.

5.3 Serial Communication Drivers

Library files included with Dynamic C provide a full range of serial communications support. The **`RS232.LIB`** library provides a set of circular-buffer-based serial functions. The **`PACKET.LIB`** library provides packet-based serial functions where packets can be delimited by the 9th bit, by transmission gaps, or with user-defined special characters. Both libraries provide blocking functions, which do not return until they are finished transmitting or receiving, and nonblocking functions, which must be called repeatedly until they are finished. For more information, see the ***Dynamic C User's Manual*** and Technical Note 213, ***Rabbit 2000 Serial Port Software***.

5.4 TCP/IP Drivers

The TCP/IP drivers are located in the **`TCPIP`** directory. Complete information on these libraries and the TCP/IP functions is provided in the ***Dynamic C TCP/IP User's Manual***.

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 RCM2200'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 RCM2200 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 RCM2200 does not need to be the PC with the Ethernet card.

3. Apply Power

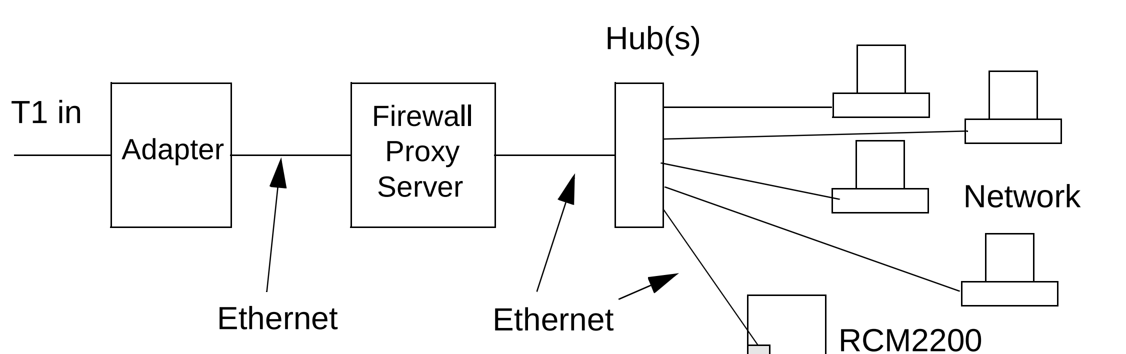
Plug in the AC adapter. The RCM2200 is now ready to be used.

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 RCM2200 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, except they are 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 RCM2200 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 RCM2200 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 RCM2200 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.

6.3 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 (216.103.126.0) is used to identify the local network. The highest address (216.103.126.255) 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.

6.5 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 RCM2200 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 XP you can run the **`ipconfig`** 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 RCM2200 from the Internet, you can place the RCM2200 on the internal network using a private address assigned either statically or through DHCP.

APPENDIX A. RABBITCORE RCM2200 SPECIFICATIONS

Appendix A provides the specifications for the RCM2200, and describes the conformal coating.

It is recommended that you allow for an “exclusion zone” of 0.04" (1 mm) around the RCM2200 in all directions when the RCM2200 is incorporated into an assembly that includes other printed circuit boards. An “exclusion zone” of 0.16" (4 mm) is recommended below the RCM2200 when the RCM2200 is plugged into another assembly using the shortest connectors for headers J4 and J5. Figure A-2 shows this “exclusion zone.”

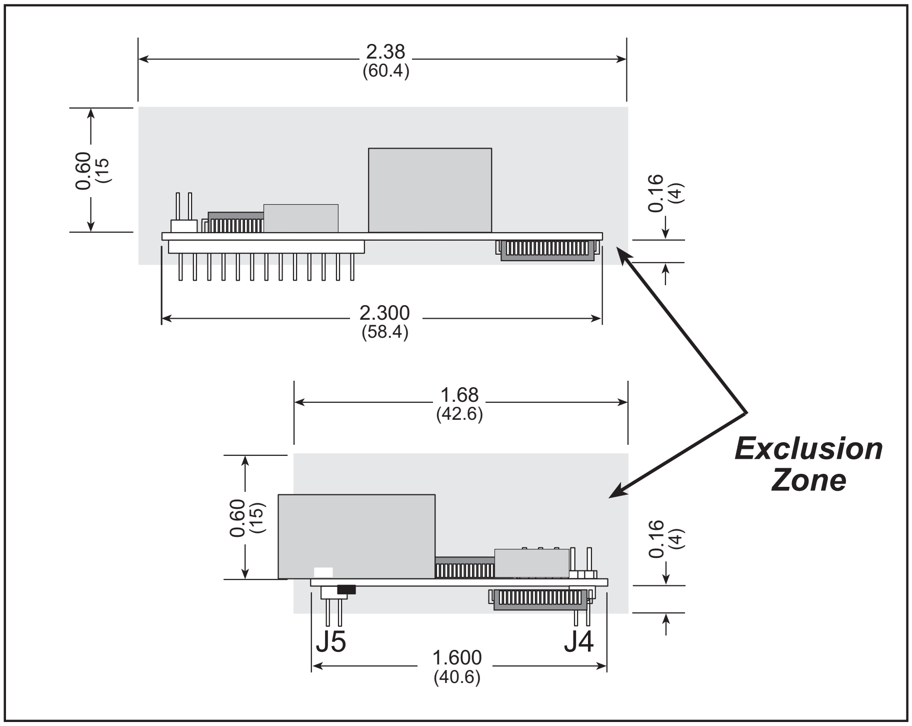


Figure A-2. RCM2200 “Exclusion Zone”

Table A-1 lists the electrical, mechanical, and environmental specifications for the RCM2200.

Table A-1. RabbitCore RCM2200 Specifications

Parameter	RCM2200	RCM2210	RCM2250	RCM2260
Microprocessor	Rabbit 2000® at 22.1 MHz			
Ethernet Port (10/100-compatible with 10Base-T interface)	RJ-45, 2 LEDs	Raw signals only	RJ-45, 2 LEDs	Raw signals only
Flash Memory	One 256K		Two 256K	Two 256K
SRAM	128K		512K	512K
Backup Battery	Connection for user-supplied backup battery (to support RTC and SRAM)			
General-Purpose I/O	26 parallel I/0 lines grouped in five 8-bit ports (shared with serial ports): • 16 configurable I/O • 7 fixed inputs • 3 fixed outputs			
Additional Inputs	2 startup mode, reset			
Additional Outputs	Status, reset			
Memory, I/O Interface	4 address lines, 8 data lines, I/O read/write			
Serial Ports	Four 5 V CMOS-compatible ports. Two ports are configurable as clocked ports, one is a dedicated RS-232 programming port.			
Serial Rate	Maximum burst rate = CLK/32 Maximum sustained rate = CLK/64			
Slave Interface	A slave port allows the RCM2200 to be used as an intelligent peripheral device slaved to a master processor, which may either be another Rabbit 2000 or any other type of processor			
Real-Time Clock	Yes			
Timers	Five 8-bit timers cascadable in pairs, one 10-bit timer with 2 match registers that each have an interrupt			
Watchdog/Supervisor	Yes			
Power	4.75 V to 5.25 V DC, 134 mA			
Operating Temperature	–40°C to +70°C			
Humidity	5% to 95%, noncondensing			
Connectors	Two IDC headers 2 × 13, 2 mm pitch			
Board Size	1.60" × 2.30" × 0.86" (41 mm × 59 mm × 22 mm)			

A.6 Conformal Coating

The areas around the 32 kHz real-time clock crystal oscillator has had the Dow Corning silicone-based 1-2620 conformal coating applied. The conformally coated area is shown in Figure A-6. The conformal coating protects these high-impedance circuits from the effects of moisture and contaminants over time.

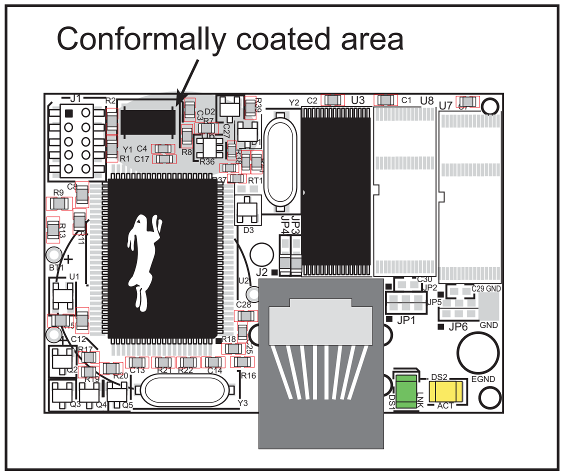


Figure A-6. RCM2200 Areas Receiving Conformal Coating

Any components in the conformally coated area may be replaced using standard soldering procedures for surface-mounted components. A new conformal coating should then be applied to offer continuing protection against the effects of moisture and contaminants.

> **NOTE:** For more information on conformal coatings, refer to Technical Note TN303, ***Conformal Coatings***.

Appendix B. Prototyping Board

Appendix B describes the features and accessories of the Prototyping Board, and explains the use of the Prototyping Board to demonstrate the RCM2200 and to build prototypes of your own circuits.

B.3 Power Supply

The RCM2200 requires a regulated 5 V ± 0.25 V DC power source to operate. Depending on the amount of current required by the application, different regulators can be used to supply this voltage.

The Prototyping Board has an onboard 7805 or equivalent linear regulator that is easy to use. Its major drawback is its inefficiency, which is directly proportional to the voltage drop across it. The voltage drop creates heat and wastes power.

A switching power supply may be used in applications where better efficiency is desirable. The LM2575 is an example of an easy-to-use switcher. This part greatly reduces the heat dissipation of the regulator. The drawback in using a switcher is the increased cost.

The Prototyping Board itself is protected against reverse polarity by a Shottky diode at D2 as shown in Figure B-3.

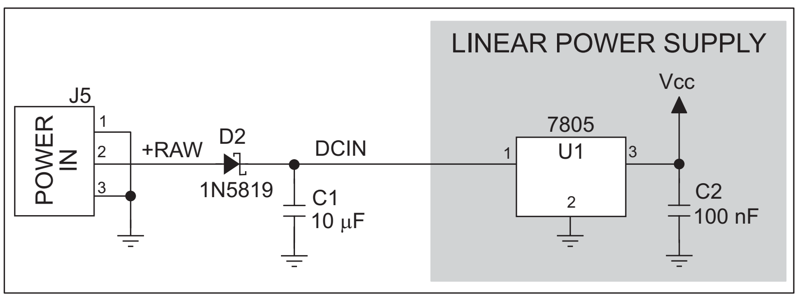


Figure B-3. Prototyping Board Power Supply

B.4 Using the Prototyping Board

The Prototyping Board is actually both a demonstration board and a prototyping board. As a demonstration board, it can be used to demonstrate the functionality of the RCM2200 right out of the box without any modifications to either board. There are no jumpers or dip switches to configure or misconfigure on the Prototyping Board so that the initial setup is very straightforward.

The Prototyping Board comes with the basic components necessary to demonstrate the operation of the RCM2200. Two LEDs (DS2 and DS3) are connected to PE1 and PE7, and two switches (S2 and S3) are connected to PB2 and PB3 to demonstrate the interface to the Rabbit 2000 microprocessor. Reset switch S1 is the hardware reset for the RCM2200.

D.2 Keypad and LCD Connections

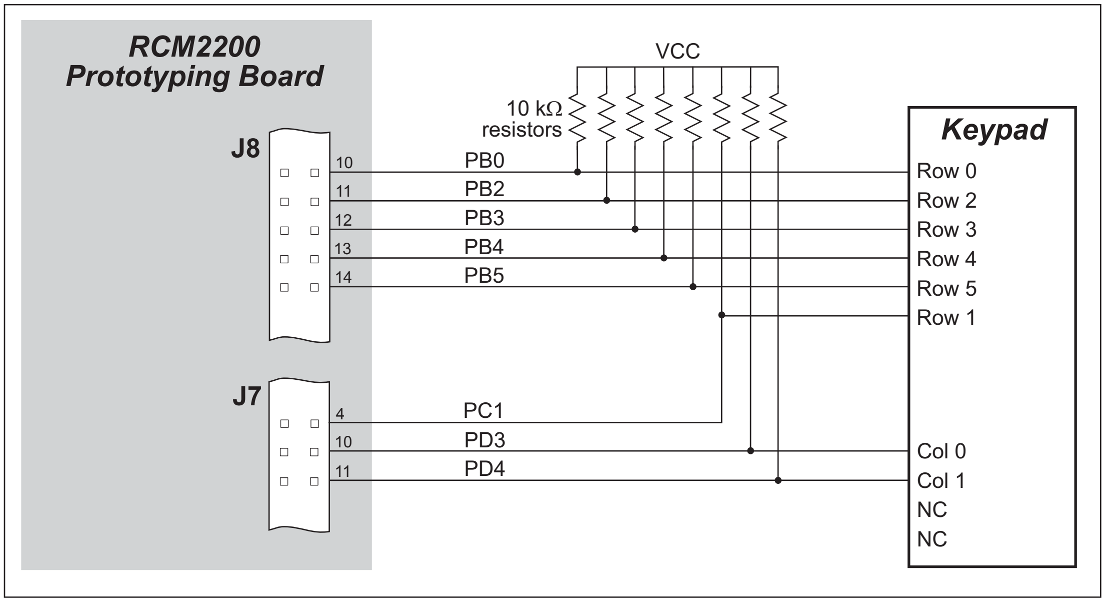


Figure D-2. Sample Keypad Connections

Sample Program: **`KEYLCD.C`** in **`SAMPLES\RCM2200`**.

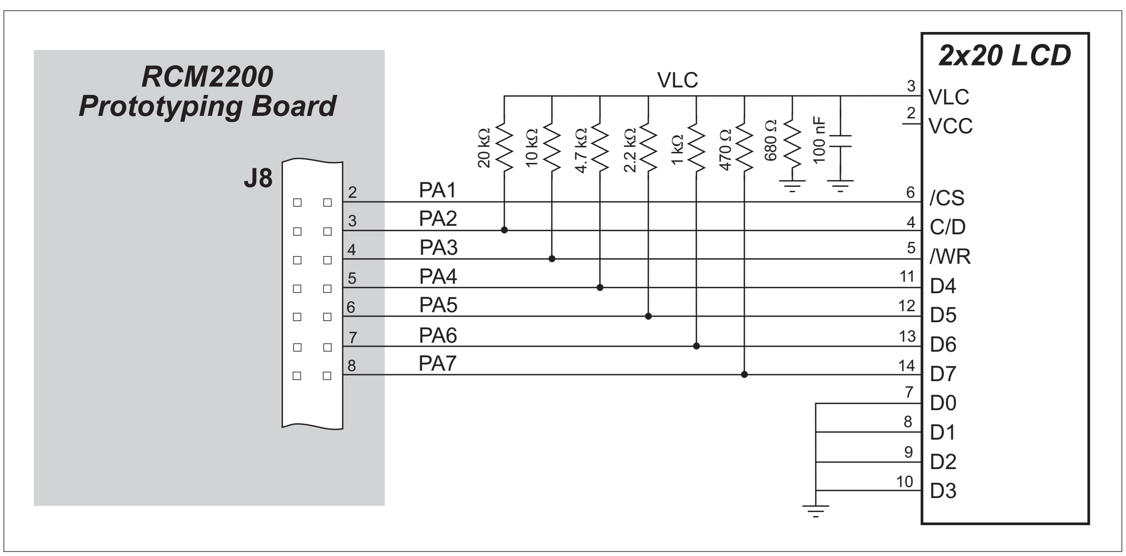


Figure D-3. Sample LCD Connections

Sample Program: **`KEYLCD.C`** in **`SAMPLES\RCM2200`**.

D.3 External Memory

The sample circuit can be used with an external 64K memory device. Larger SRAMs can be written to using this scheme by using other available Rabbit 2000 ports (parallel ports A to E) as address lines.

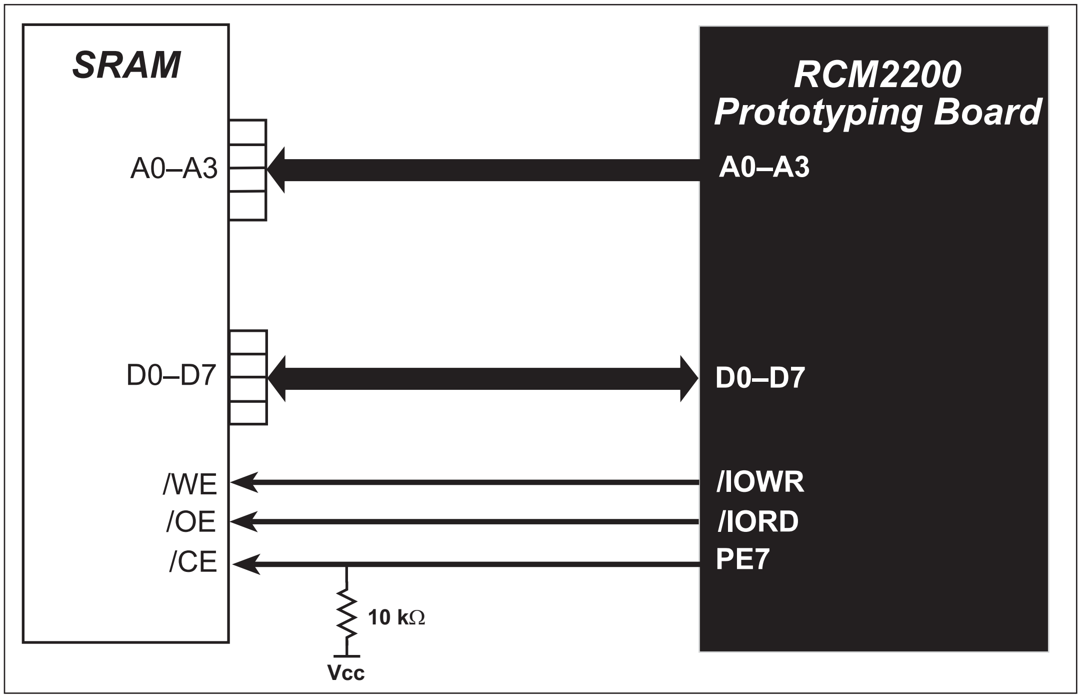


Figure D-4. Sample External Memory Connections

Sample Program: **`EXTSRAM.C`** in **`SAMPLES\RCM2200`**.