Welcome to E-XFL.COM

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	18.432MHz
Flash Size	256KB
RAM Size	128KB
Connector Type	2 IDC Headers 2x20
Size / Dimension	1.9" x 2.3" (48.3mm x 58.4mm)
Operating Temperature	-40°C ~ 85°C
Purchase URL	https://www.e-xfl.com/product-detail/digi-international/20-101-0383

- External reset input
- Reset output
- Five 8-bit timers, two 10-bit timers; five timers are cascadable in pairs
- 256K flash EPROM, 512K SRAM
- Real-time clock
- Watchdog supervisor
- Provision for customer-supplied backup battery via connections on header J2
- Four CMOS-compatible serial ports: maximum asynchronous baud rate of 806,400 bps, maximum synchronous baud rate of 6.45 Mbps. Two ports are configurable as clocked ports.

Appendix A, "Specifications," provides detailed specifications for the RCM2000.

Three versions of the RCM2000 are available. Their standard features are summarized in Table 1.

Table 1. RCM2000 Models and Features

Model	Features
RCM2000	Full-featured RCM2000 module with 25.8 MHz clock, 256K flash memory, and 512K SRAM
RCM2010	RCM2000 with 25.8 MHz clock and 128K SRAM
RCM2020	RCM2000 with 18.432 MHz clock and 128K SRAM

1.2 Advantages of Using the RCM2000

- Fast design time for your project since the basic core has already been designed and built.
- Competitive pricing compared with purchasing and assembling the individual components.
- Easy programming, including production installation of a program.
- Generous memory size allows large C programs with tens of thousands of lines of code, and substantial data storage.

1.4 How to Use This Manual

This user's manual is intended to give users detailed information on the RCM2000 module. It does not contain detailed information on the Dynamic C development environment.

1.4.1 Additional Product Information

In addition to the product-specific information contained in the ***RabbitCore RCM2000 User's Manual*** (this 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 RCM3100 modules:

- ***Dynamic C User's Manual***
- ***Dynamic C Function Reference Manual***
- ***Rabbit 2000 Microprocessor User's Manual***

1.4.2 Online Documentation

The online documentation is installed along with Dynamic C, and an icon for the documentation menu is placed on the workstation's desktop. Double-click this icon to reach the menu. If the icon is missing, use your browser to find and load **default.htm** in the **docs** folder, found in the Dynamic C installation folder.

The latest versions of all documents are always available for free, unregistered download from our Web sites as well.

2.2 Run a Sample Program

Once the RCM2000 is connected as described in the preceding pages, start Dynamic C by double-clicking on the Dynamic C icon on your desktop or in your **Start** menu. Dynamic C uses the serial port specified during installation.

If you are using a USB port to connect your computer to the RCM2000 module, choose **Options > Project Options** and select "Use USB to Serial Converter" under the **Communications** tab, then click **OK**.

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), then compile and run it by pressing **F9** or by selecting **Run** in the **Run** menu. The **STDIO** window will open and will display a small square bouncing around in a box.

2.2.1 Troubleshooting

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

- Check that the RCM2000 is powered correctly — the red power LED on the Prototyping Board should be lit when the RCM2000 is mounted on the Prototyping Board and the AC adapter is plugged in.
- Check both ends of the programming cable to ensure that they are firmly plugged into the PC and the **PROG** connector, not the **DIAG** connector, is plugged in to the programming port on the RCM2000 with the marked (colored) edge of the programming cable towards pin 1 of the programming header.
- Ensure that the RCM2000 module is firmly and correctly installed in its connectors on the Prototyping Board.
- Dynamic C uses the COM port specified during installation. 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 COM port used by the programming cable.

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.

4.2 Memory I/O Interface

Thirteen of the Rabbit 2000 address lines (A0–A12) and all the data lines (D0–D7) are available as outputs on the RCM2000. I/0 write (/IOWR), I/0 read (/IORD), buffer enable (/BUFEN), and Watchdog Output (/WDO) are also available for interfacing to external devices.

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 output.

4.2.1 Additional I/0

Although, the output clock is available on the PCLK pin, the output clock is disabled in software starting with Dynamic C v 7.02 and later. This reduces radiated emissions. The primary function of PCLK is as a peripheral clock or a peripheral clock ÷ 2, but PCLK can instead be used as a digital output. See Section 5.2.1, "PCLK Output," for more information.

Two status mode pins, SMODE0 and SMODE1, are available as inputs. The logic state of these two pins determines the startup procedure after a reset. /RES_IN is an external input used to reset the Rabbit 2000 microprocessor and RCM2000 memory. /RES_OUT is an output from the reset circuitry that can be used to reset other peripheral devices.

4.3 Serial Communication

The RCM2000 does not have an RS-232 or an RS-485 transceiver directly on the board. However, the Prototyping Board does support a industry standard RS-232 transceiver chip. See Appendix B, "Prototyping Board," for more information.

4.3.1 Serial Ports

There are four serial ports designated as Serial Ports A, B, C, and D. All four serial ports can operate in an asynchronous mode up to the baud rate of the system clock divided by 32. An asynchronous port can handle 7 or 8 data bits. A 9th bit address scheme, where an additional bit is sent to mark the first byte of a message, is also supported. Serial Ports A and B can be operated alternately in the clocked serial mode. In this mode, a clock line synchronously clocks the data in or out. Either of the two communicating devices can supply the clock. When the Rabbit provides the clock, the baud rate can be up to 1/4 of the system clock frequency, or more than 6.45 Mbps for a 25.8 MHz clock speed.

4.5 Other Hardware

4.5.1 Clock Doubler

The RCM2000 takes advantage of the Rabbit 2000 microprocessor's internal clock doubler. A built-in clock doubler allows half-frequency crystals to be used to reduce radiated emissions. The 25.8 MHz (RCM 2000 and RCM2010) and 18.4 MHz (RCM 2020) frequencies are generated using 12.9 MHz and 9.2 MHz crystals. The clock doubler is disabled automatically in the BIOS for crystals with a frequency above 12.9 MHz.

The clock doubler can be disabled if 25.8 MHz or 18.4 MHz clock speeds are not required. Disabling the Rabbit 2000 microprocessor's internal clock will reduce power consumption and further reduce radiated emissions. The clock doubler is disabled with a simple configuration macro as shown below.

1. Select the "Defines" tab from the Dynamic C **Options > Project Options** menu.
2. Add the line **CLOCK_DOUBLED=0** to always disable the clock doubler.

   The clock doubler is enabled by default, and usually no entry is needed. If you need to specify that the clock doubler is always enabled, add the line **CLOCK_DOUBLED=1** to always enable the clock doubler. The clock speed will be doubled as long as the crystal frequency is less than or equal to 26.7264 MHz.
3. Click **OK** to save the macro. The clock doubler will now remain off whenever you are in the project file where you defined the macro.

Change the serial baud rate to 57,600 bps when the RCM2000 is operated at 12.9 MHz or 9.2 MHz.

4.5.2 Spectrum Spreader

RCM2000 RabbitCore modules that have a Rabbit 2000 microprocessor labeled ***IQ4T*** (or higher) are equipped with a Rabbit 2000 microprocessor that has a spectrum spreader, which helps to mitigate EMI problems. By default, the spectrum spreader is on automatically for RCM2000 modules that carry the ***IQ4T*** (or higher) marking when used with Dynamic C 7.30 or later versions, but the spectrum spreader may also be turned off or set to a stronger setting. The means for doing so is through a simple configuration macro as shown below.

1. Select the "Defines" tab from the Dynamic C **Options > Project Options** menu.
2. Normal spreading is the default, and usually no entry is needed. If you need to specify normal spreading, add the line

   ```
   ENABLE_SPREADER=1
   ```

   For strong spreading, add the line

   ```
   ENABLE_SPREADER=2
   ```

   To disable the spectrum spreader, add the line

   ```
   ENABLE_SPREADER=0
   ```

   NOTE: The strong spectrum-spreading setting is usually not necessary for the RCM2000.
3. Click **OK** to save the macro. The spectrum spreader will now remain off whenever you are in the project file where you defined the macro.

There is no spectrum spreader functionality for RCM2000 RabbitCore modules that have a Rabbit 2000 microprocessor labeled ***IQ1T***, ***IQ2T***, or ***IQ3T***, or when using any RCM2000 with a version of Dynamic C prior to 7.30.

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 Upgrading Dynamic C

Dynamic C patches that focus on bug fixes are available from time to time. Check the Web site www.rabbit.com/support/ for the latest patches, workarounds, and bug fixes.

The default installation of a patch or bug fix is to install the file in a directory (folder) different from that of the original Dynamic C installation. Rabbit recommends using a different directory so that you can verify the operation of the patch without overwriting the existing Dynamic C installation. If you have made any changes to the BIOS or to libraries, or if you have programs in the old directory (folder), make these same changes to the BIOS or libraries in the new directory containing the patch. Do ***not*** simply copy over an entire file since you may overwrite a bug fix; of course, you may copy over any programs you have written. Once you are sure the new patch works entirely to your satisfaction, you may retire the existing installation, but keep it available to handle legacy applications.

5.4.1 Extras

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.

Starting with Dynamic C version 9.60, Dynamic C includes the popular µC/OS-II real-time operating system, point-to-point protocol (PPP), FAT file system, RabbitWeb, and other select libraries. 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.

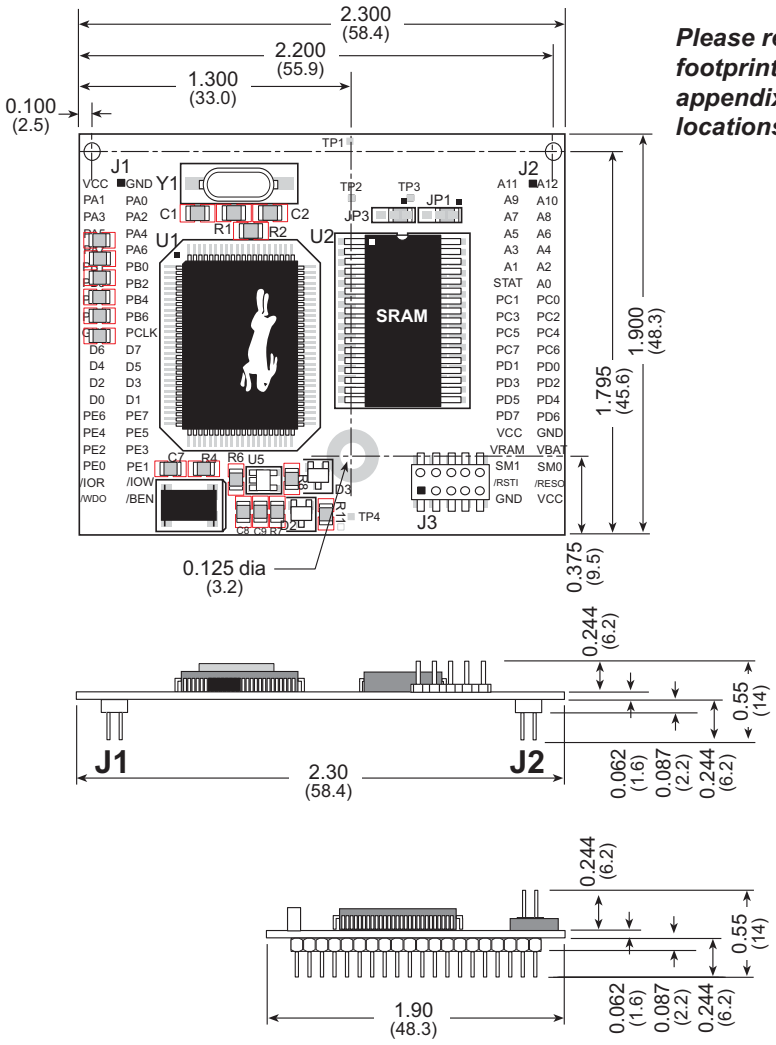
Visit our Web site at www.rabbit.com for further information and complete documentation.

APPENDIX A. SPECIFICATIONS

Appendix A provides the specifications for the RCM2000, and describes the conformal coating.

A.1 Electrical and Mechanical Specifications

Figure A-1 shows the mechanical dimensions for the RCM2000.



Please refer to the RCM2000 footprint diagram later in this appendix for precise header locations.

Figure A-1. RCM2000 Dimensions

NOTE: All measurements are in inches followed by millimeters enclosed in parentheses. All dimensions have a manufacturing tolerance of ±0.01" (0.25 mm).

Table A-1 lists the electrical, mechanical, and environmental specifications for the RCM2000.

Table A-1. RCM2000 Specifications

Parameter	RCM2000	RCM2010	RCM2020
Microprocessor	Rabbit 2000® at 25.8 MHz		Rabbit 2000® at 18.432 MHz
Flash EPROM	256K (supports 128K–512K)		
SRAM	512K	128K	
Backup Battery	Connection for user-supplied backup battery (to support RTC and SRAM)		
General-Purpose I/O	40 parallel I/0 lines grouped in five 8-bit ports (and shared with serial ports): • 26 configurable I/O • 8 fixed inputs • 6 fixed outputs		
Additional Inputs	2 startup mode (for master/slave), reset in		
Additional Outputs	Status, clock, watchdog, reset out		
Memory, I/O Interface	13 address lines, 8 data lines, I/O read/write, buffer enable		
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 RCM2000 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, 130 mA		4.75 V to 5.25 V DC, 98 mA
Standby Current	10 µA (typical)		
Operating Temperature	–40°C to +85°C		
Humidity	5% to 95%, noncondensing		
Connectors	Two IDC headers 2 × 20, 2 mm pitch		
Board Size	1.90" × 2.30" × 0.55" (48.3 mm × 58.4 mm × 14 mm)		

A.1.1 Headers

The RCM2000 uses headers at J1, J2, and J3 for physical connection to other boards. J1 and J2 are 2 × 20 SMT headers with a 2 mm pin spacing. J3 is a 2 × 5 header with a 2 mm pin spacing.

Figure A-3 shows the layout of another board for the RCM2000 to be plugged in to. These reference design values are relative to the mounting hole or to the header connectors.

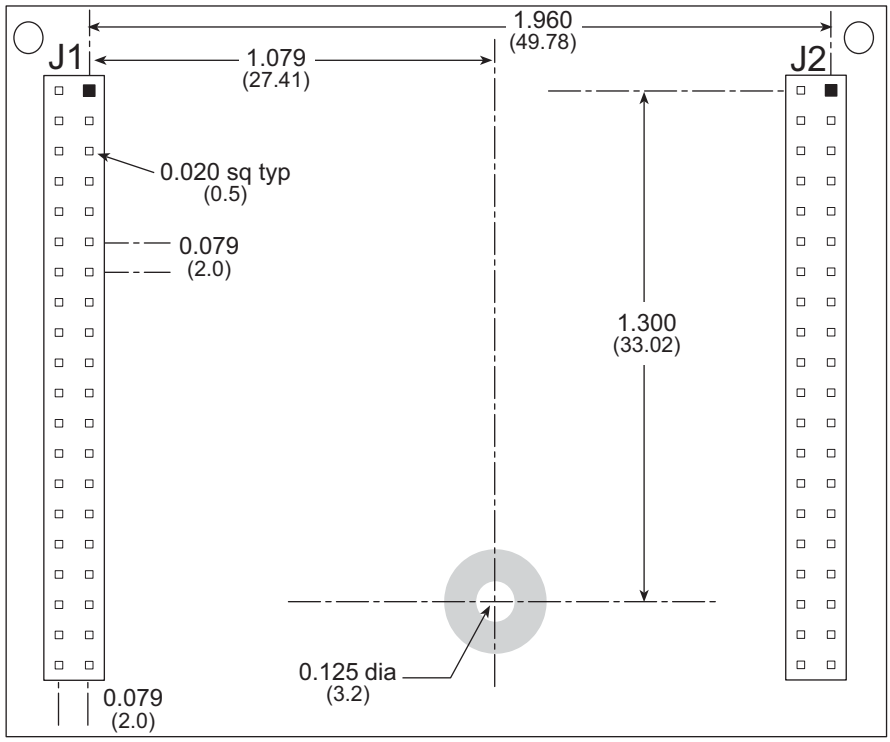


Figure A-3. User Board Footprint for RCM2000 (Top View)

NOTE: Two holes were added near the top of the RCM2000 above headers J1 and J2 starting with RCM2000 versions marked 175-0201 on the bottom side. These holes facilitate factory testing and must not be used for mounting or attaching other hardware.

A.2 Bus Loading

You must pay careful attention to bus loading when designing an interface to the RCM2000. This section provides bus loading for external devices.

Table A-2 lists the capacitance for the various RCM2000 I/O ports.

Table A-2. Capacitance of RCM2000 I/O Ports

I/O Ports	Input Capacitance (pF)		Output Capacitance (pF)	
	Typ.	Max.	Typ.	Max.
Parallel Ports A to E	6 pF	12 pF	10 pF	14 pF
Data Lines D0–D7	16 pF	30 pF	24 pF	32 pF
Address Lines A0–A12	—	—	24 pF	32 pF

Table A-3 lists the external capacitive bus loading for the various Rabbit 2000 output ports. Be sure to add the loads for the devices you are using in your custom system and verify that they do not exceed the values in Table A-3.

Table A-3. External Capacitive Bus Loading -40°C to +85°C

Output Port	Clock Speed (MHz)	Maximum External Capacitive Loading (pF)
A[12:1] D[7:1]	25.8	50
A[12:1] D[7:1]	18.4	55 for 90 ns flash 100 for 55 ns flash*
A0 D0	25.8, 18.4	100
PD[3:0]	25.8, 18.4,	100
PA[7:0] PB[7,6] PC[6,4,2,0] PD[7:4] PE[7:0]	25.8, 18.4	90
All data, address, and I/O lines with clock doubler disabled	12.9, 9.2	100

* The RCM2020 operating at 18.4 MHz will typically come with a flash EPROM whose access time is 55 ns. Because of the volatility of the memory market, a 90 ns flash EPROM could be used on the RCM2020.

B.2 Mechanical Dimensions and Layout

Figure B-2 shows the mechanical dimensions and layout for the RCM2000 Prototyping Board.

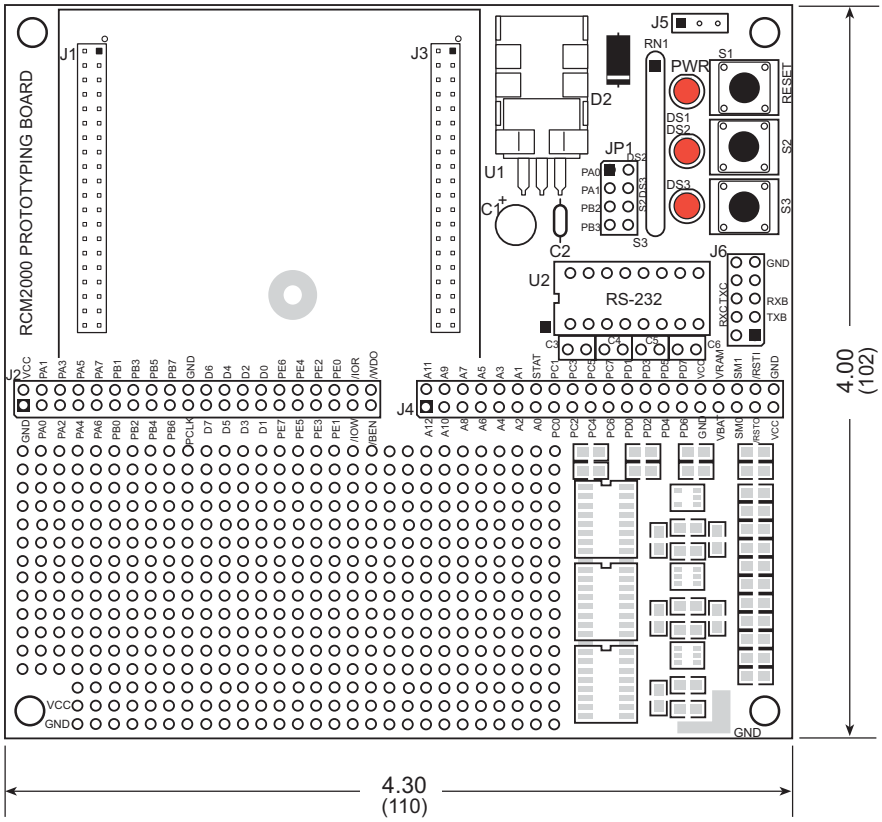


Figure B-2. RCM2000 Prototyping Board Dimensions

Table B-1 lists the electrical, mechanical, and environmental specifications for the Prototyping Board.

Table B-1. Prototyping Board Specifications

Parameter	Specification
Board Size	4.00" × 4.30" × 1.19" (102 mm × 110 mm × 30 mm)
Operating Temperature	–40°C to +70°C
Humidity	5% to 95%, noncondensing
Input Voltage	7.5 V to 25 V DC
Maximum Current Draw (including user-added circuits)	1 A at 12 V and 25°C, 0.7 A at 12 V and 70ºC
Prototyping Area	2" × 3" (51 mm × 76 mm) throughhole, 0.1" spacing
Standoffs/Spacers	4, accept 6-32 × 3/8 screws

C.2 Chip Select Circuit

Figure C-4 shows a schematic of the chip select circuit.

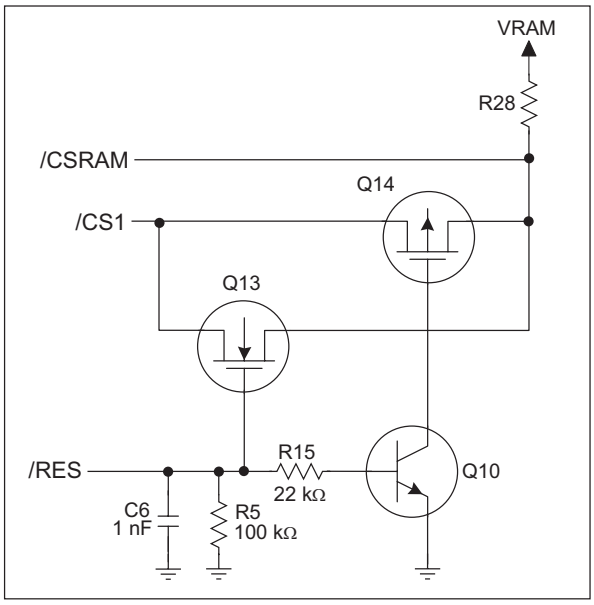


Figure C-4. Chip Select Circuit

The current drain on the battery in a battery-backed circuit must be kept to a minimum. When the RCM2000 is not powered, the battery keeps the SRAM memory contents and the real-time clock (RTC) going. The SRAM has a powerdown mode that greatly reduces power consumption. This powerdown mode is activated by raising the chip select (CS) signal line. Normally the SRAM requires Vcc to operate. However, only 2 V is required for data retention in powerdown mode. Thus, when power is removed from the circuit, the battery voltage needs to be provided to both the SRAM power pin and to the CS signal line. The CS control circuit accomplishes this task for the CS signal line.

In a powered-up condition, the CS control circuit must allow the processor's chip select signal /CS1 to control the SRAM's CS signal /CSRAM. So, with power applied, /CSRAM must be the same signal as /CS1, and with power removed, /CSRAM must be held high (but only needs to be battery voltage high). Q13 and Q14 are MOSFET transistors with opposing polarity. They are both turned on when power is applied to the circuit. They allow the CS signal to pass from the processor to the SRAM so that the processor can periodically access the SRAM. When power is removed from the circuit, the transistors will turn off and isolate /CSRAM from the processor. The isolated /CSRAM line has a 100 kΩ pullup resistor to VRAM (R28). This pullup resistor keeps /CSRAM at the VRAM voltage level (which under no-power conditions is the backup battery's regulated voltage at a little more than 2 V).

Transistors Q13 and Q14 are of opposite polarity so that a rail-to-rail voltages can be passed. When the /CS1 voltage is low, Q13 will conduct. When the /CS1 voltage is high, Q14 will conduct. It takes time for the transistors to turn on, creating a propagation delay. This delay is typically very small, about 10 ns to 15 ns.

D.2 Keypad and LCD Connections

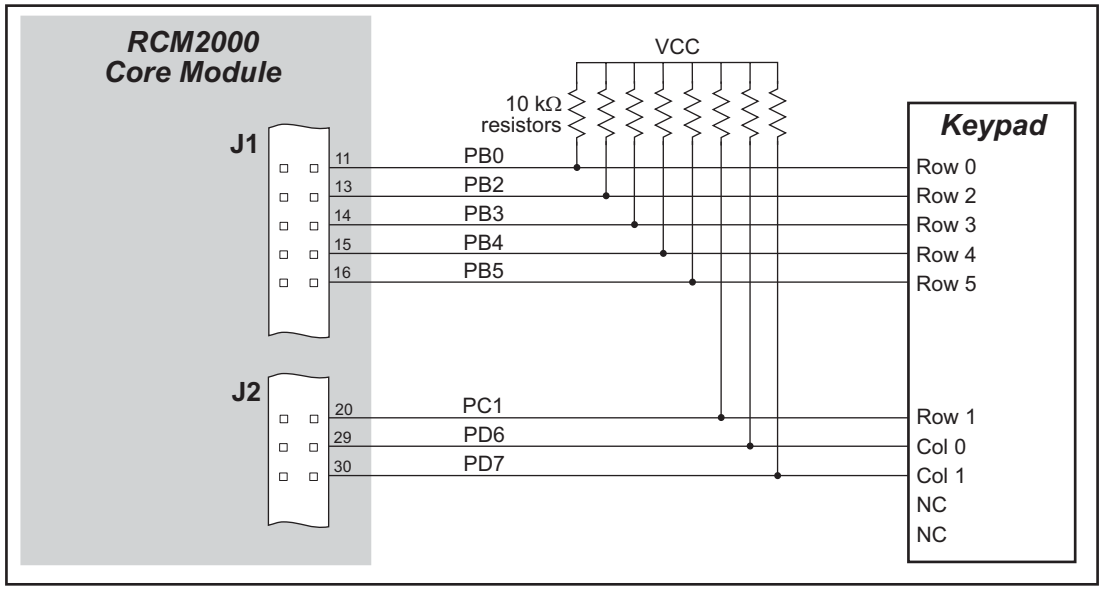


Figure D-2. Sample Keypad Connections

Sample Program: **KEYLCD.C** in **SAMPLES\COREMODULE**.

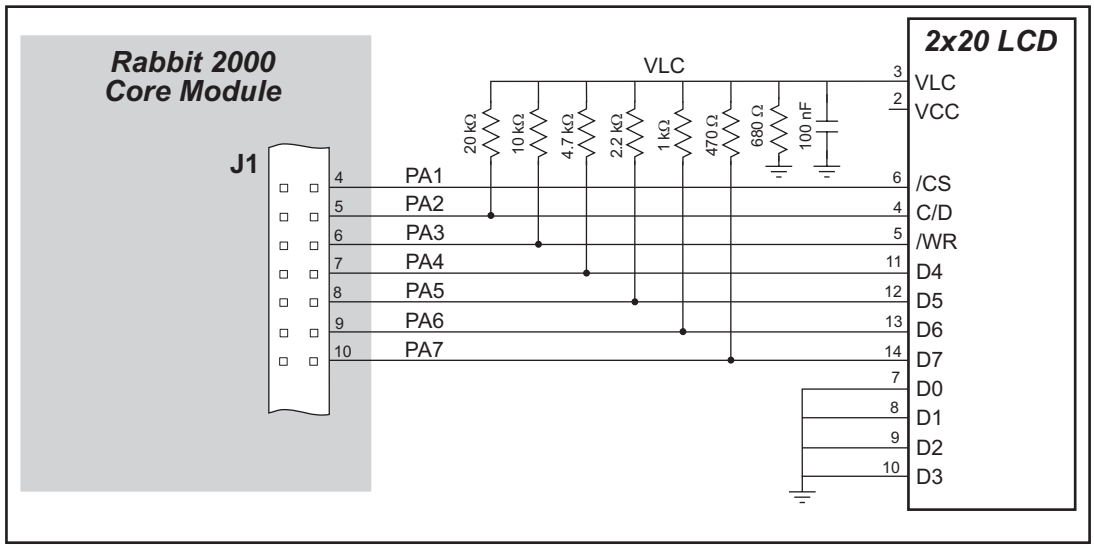


Figure D-3. Sample LCD Connections

Sample Program: **KEYLCD.C** in **SAMPLES\COREMODULE**.

D.3 LCD Connections

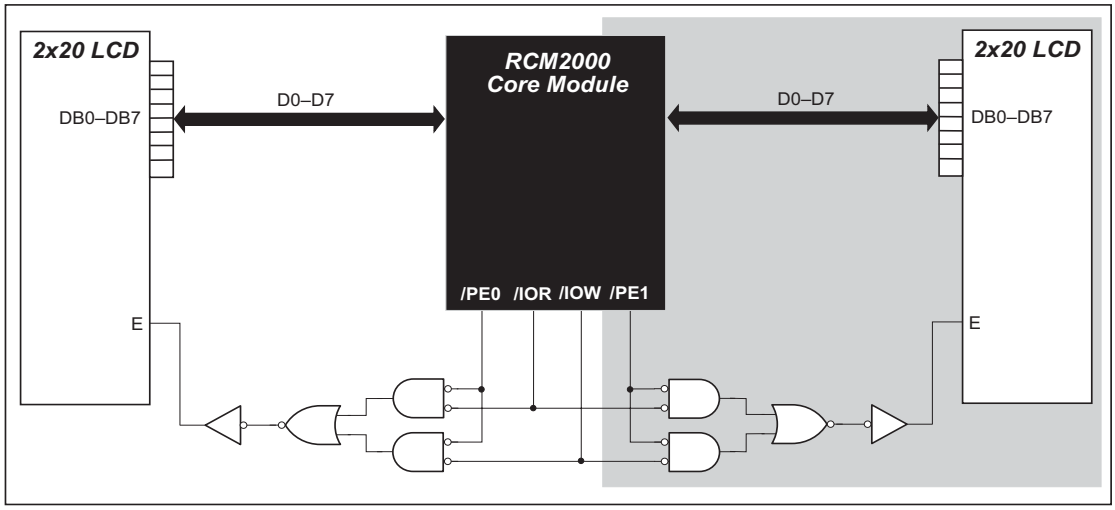


Figure D-4. Sample LCD Connections

Sample Program: **LCD_DEMO.C** in **SAMPLES\COREMODULE**.

The shaded part of the circuit in Figure D-4 can be used to drive a second LCD, but additional software not included in **LCD_DEMO.C** will have to be written.