



RabbitCore RCM2000

C-Programmable Module

User's Manual

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RabbitCore RCM2000 User's Manual

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Z-World, Inc.

2900 Spafford Street
Davis, California 95616-6800
USA

Telephone: (530) 757-3737

Fax: (530) 753-5141

www.zworld.com

Rabbit Semiconductor

2932 Spafford Street
Davis, California 95616-6800
USA

Telephone: (530) 757-8400

Fax: (530) 757-8402

www.rabbitsemiconductor.com

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1. INTRODUCTION

The RabbitCore RCM2000 series is a family of microprocessor modules designed to be the heart of embedded control systems, providing an array of I/O and addressing.

The RCM2000 is a microprocessor core module designed to be the heart of your own controller built around the plug-in module. Data processing is done by a Rabbit 2000 microprocessor operating at 25.8 MHz (RCM2000 and RCM2010).

The RCM2000 has a Rabbit 2000 microprocessor, a static RAM, a flash memory, two quartz crystals (main oscillator and timekeeping), and the circuitry necessary for reset and management of battery backup of the Rabbit 2000's internal real-time clock and the static RAM. Two 40-pin headers bring out the Rabbit 2000 I/O bus, address lines, data lines, parallel ports, and serial ports.

The RCM2000 receives its +5 V power from the user board on which it is mounted. The RCM2000 can interface with all kinds of digital devices through the user board.

The RCM2000 Development Kit comes with a Prototyping Board that can be used to demonstrate the operation of the RCM2000 and to prototype new circuits.

1.1 Features

- Small size: 1.90" × 2.30" (48.3 mm × 58.4 mm)
- Microprocessor: Rabbit 2000 running at 25.8 MHz (RCM2000 and RCM2010)
- 40 CMOS-compatible parallel I/O lines grouped in five 8-bit ports (shared with serial ports)
- 8 data lines (D0–D7)
- 13 address lines (A0–A12)
- I/O read, write, buffer enable
- Status, watchdog and clock outputs
- Two startup mode inputs for master/slave configuration
- 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 Features

| Model | Features |
|--------------|---|
| RCM2000 | Full-featured controller. |
| RCM2010 | RCM2000 with 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.

1.3 Development and Evaluation Tools

1.3.1 Development Kit

The Development Kit has the essentials that you need to design your own a microprocessor-based system, and includes a complete software development system (Dynamic C).

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

- CD-ROM with Dynamic C[®] software, RCM2000, and Rabbit[™] 2000 microprocessor documentation. You may install this software by inserting the disk into your CD-ROM drive. If it doesn't start automatically, click on "setup.exe." This software runs under Windows '95, Windows '98, and Windows NT. We suggest taking the option to load the documentation to your hard disk. The documentation is in both HTML and Adobe PDF format, and may be viewed with a browser.
- RCM2000 (RCM2020 model). This is a complete controller board that includes a Rabbit 2000 processor, 256K of flash memory, 128K of SRAM.
- Prototyping Board. The RCM2000 can be plugged into this board. The Prototyping Board includes a 5 V supply for powering the RCM2000, and various accessories such as pushbutton switches, and LEDs. In addition, you can add your own circuitry using through-hole or surface mount parts in the prototyping space provided.
- Programming cable. The programming cable is used to connect your PC serial port directly to the RCM2000 to write and debug C programs that run on the Rabbit 2000.
- AC adapter. The AC adapter is used to power the Prototyping Board and the RCM2000. The wall transformer is supplied only for Development Kits sold for the North American market. The Prototyping Board can also be powered from any DC voltage source between 7.5 V and 25 V. The linear regulator becomes rather hot for voltages above 15 V.

1.3.2 Documentation

- Our documentation is provided in paperless form on the CD-ROM included in the Development Kit. (A paper copy of the “Getting Started” page *is* included.) Most documents, including this comprehensive *RabbitCore RCM2000 User’s Manual*, are provided in two formats: HTML and PDF. HTML documents can be viewed with an Internet browser, either *Netscape Navigator* or *Internet Explorer*. HTML documents are very convenient because all the documents are hyperlinked together, and it is easy to navigate from one place to another. PDF documents can be viewed using the Adobe Acrobat reader, which is automatically invoked from the browser. The PDF format is best suited for documents requiring high resolution, such as schematics, or if you want to print the document. Don’t print a hard copy from the HTML version because the HTML version has no page numbers and the cross-references and table of contents links only work if viewed on line. The PDF versions contain page number references to allow navigation when reading a paper version of the manual. To view the online documentation with a browser, open the file `default.htm` in the `docs` folder.



2. SUBSYSTEMS

Chapter 2 describes the principal subsystems for the RCM2000.

- Programming Cable
- RCM2000 Digital Inputs and Outputs
- Serial Communication
- Memory

2.1 Programming Cable

The RCM2000 is automatically in program mode when the **PROG** connector on the programming cable is attached, and is automatically in run mode when no programming cable is attached.

The **DIAG** connector of the programming cable may be used on header J3 of the RCM2000 with the board operating in the run mode. This allows the programming port to be used as an application port. See Appendix E, “Programming Cable,” for more information.

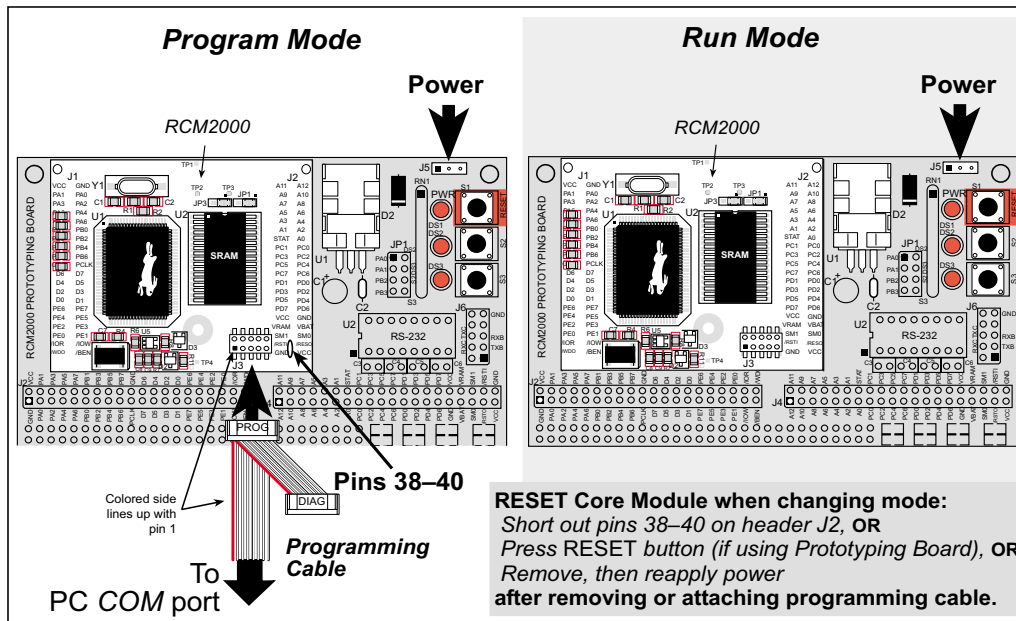


Figure 1. RCM2000 Program Mode and Run Mode Setup

2.1.1 Detailed Instructions: Changing from Program Mode to Run Mode

1. Disconnect the programming cable from header J3 of the RCM2000.
2. Reset the RCM2000. You may do this as explained in Figure 1. Figure 2 shows the location of the RESET button on the Prototyping Board.

The RCM2000 is now ready to operate in the Run Mode.

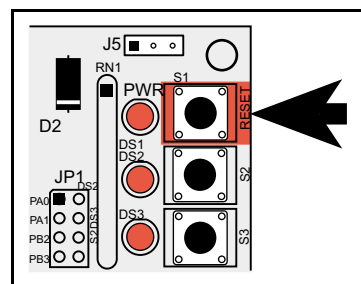


Figure 2. Location of Prototyping Board Reset Button

2.1.2 Detailed Instructions: Changing from Run Mode to Program Mode

3. Attach the **PROG** connector on the programming cable to header J3 on the RCM2000.
4. Reset the RCM2000. You may do this as explained in Figure 1. Figure 2 shows the location of the RESET button on the Prototyping Board.

The RCM2000 is now ready to operate in the Program Mode.

2.2 RCM2000 Digital Inputs and Outputs

Figure 3 shows the subsystems designed into the RCM2000.

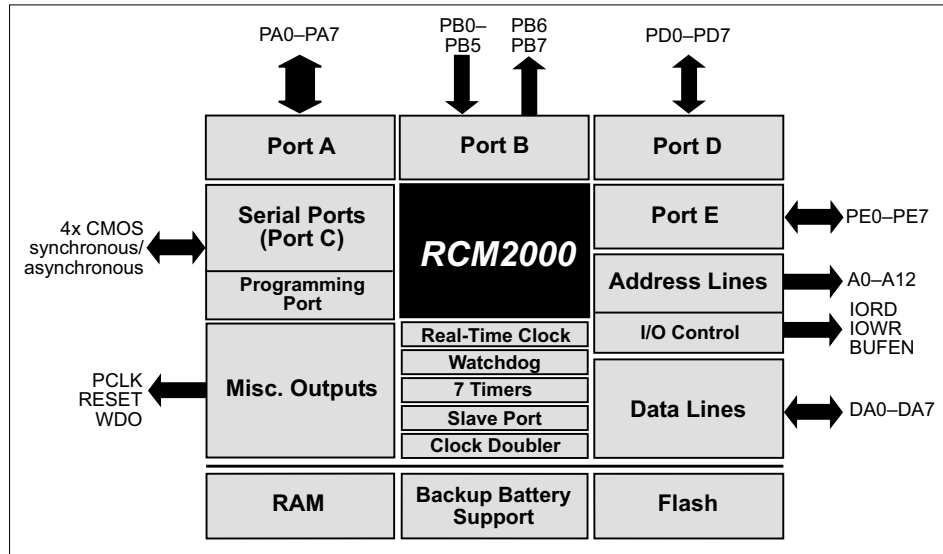


Figure 3. RCM2000 Subsystems

The RCM2000 has 40 parallel I/O lines grouped in five 8-bit ports available on headers J1 and J2. The 24 bidirectional I/O lines are located on pins PA0–PA7, PD0–PD7, and PE0–PE7. The pinouts for headers J1 and J2 are shown in Figure 4.

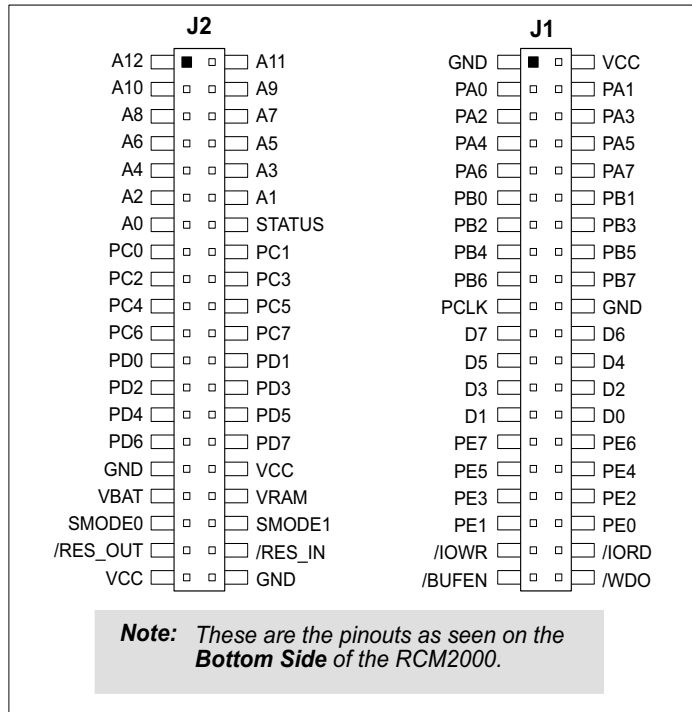


Figure 4. RCM2000 I/O Pins

The ports on the Rabbit 2000 microprocessor used in the RCM2000 are configurable, and so the factory defaults can be reconfigured. Table 2 lists the Rabbit 2000 factory defaults and the alternate configurations.

Table 2. RCM2000 Pinout Configurations

| Pin | Pin Name | Default Use | Alternate Use | Notes | |
|-----------|----------|----------------------------|---|--|--|
| Header J1 | 1, 20 | GND | | | |
| | 2 | VCC | | | |
| | 3–10 | PA[0:7] | Parallel I/O | Slave port data bus SD0–SD7 | |
| | 11 | PB0 | Input | Serial port clock CLKB | |
| | 12 | PB1 | Input | Serial port clock CLKA | CLKA is connected to programming port (header J3, pin 3) |
| | 13 | PB2 | Input | Slave port write /SWR | |
| | 14 | PB3 | Input | Slave port read /SRD | |
| | 15 | PB4 | Input | SA0 | Slave port address lines |
| | 16 | PB5 | Input | SA1 | |
| | 17 | PB6 | Output | | |
| | 18 | PB7 | Output | Slave port attention line /SLAVEATTN | |
| | 19 | PCLK | Output (Internal Clock) | Output | Turned off in software |
| | 21–28 | D[7:0] | Input/Output | | Rabbit 2000 data bus |
| | 29 | PE7 | Bitwise or parallel programmable I/O | I7 output or slave port chip select /SCS | |
| | 30 | PE6 | | I6 output | |
| | 31 | PE5 | | I5 output or INT1B input | |
| | 32 | PE4 | | I4 output or INT0B input | |
| | 33 | PE3 | | I3 output | |
| | 34 | PE2 | | I2 output | |
| | 35 | PE1 | | I1 output or INT1A input | |
| 36 | PE0 | I0 output or INT0A input | | | |
| 37 | /IOWR | Output (I/O write strobe) | | | |
| 38 | /IORD | Output (I/O read strobe) | | | |
| 39 | /BUFEN | Output (I/O buffer enable) | | | |
| 40 | /WDO | Output (Watchdog output) | May also be used to output a 30 μ s pulse | Outputs a pulse when the internal watchdog times out | |

Table 2. RCM2000 Pinout Configurations (continued)

| Pin | Pin Name | Default Use | Alternate Use | Notes | |
|-----------|----------------|---|---|---------------------------------|---|
| Header J2 | 1–13 | A[12:0] | Output | Rabbit 2000 address bus | |
| | 14 | STAT | Output (Status) | Output | |
| | 15 | PC0 | Output | TXD | |
| | 16 | PC1 | Input | RXD | |
| | 17 | PC2 | Output | TXC | |
| | 18 | PC3 | Input | RXC | |
| | 19 | PC4 | Output | TXB | |
| | 20 | PC5 | Input | RXB | |
| | 21 | PC6 | Output | TXA | |
| | 22 | PC7 | Input | RXA | |
| | 21 | PC6 | Output | TXA | Connected to programming port |
| | 22 | PC7 | Input | RXA | |
| | 23–26 | PD[0:3] | Bitwise or parallel programmable I/O, can be driven or open-drain output | | 16 mA sourcing and sinking current at full AC switching speed |
| | 27 | PD4 | | ATXB output | |
| | 28 | PD5 | | ARXB input | |
| | 29 | PD6 | | ATXA output | |
| | 30 | PD7 | | ARXA input | |
| | 31, 40 | GND | | | |
| | 32, 39 | VCC | | | |
| | 33 | VBATR | 3 V battery input | | |
| | 34 | VRAM | 2.1 V output | | 100 k Ω minimum load |
| 35–36 | SMODE0, SMODE1 | (0,0)—start executing at address zero | | No programming cable attached | |
| | | SMODE0 = 1, SMODE1 = 1 Cold boot from asynchronous serial port A at 2400 bps (programming cable connected) | (0,1)—cold boot from slave port (1,0)—cold boot from clocked serial port A | With programming cable attached | |
| 37 | /RES_OUT | Reset Output | | | |
| 38 | /RES_IN | Reset Input | | | |

As shown in Table 2, pins PA0–PA7 can be used to allow the Rabbit 2000 to be a slave to another processor. PE0, PE1, PE4, and PE5 can be used as external interrupts INT0A, INT1A, INT0B, and INT1B. Pins PB0 and PB1 can be used to access the clock on Serial Port B and Serial Port A of the Rabbit microprocessor. Pins PD4 and PD6 can be programmed to be optional serial outputs for Serial Ports B and A. PD5 and PD7 can be used as alternate serial inputs by Serial Ports B and A.

2.2.1 Dedicated Inputs

PB0 and PB1 are designated as inputs because the Rabbit 2000 is operating in an asynchronous mode. Four of the input-only pins are located on PB2–PB5. When Port C is used as a parallel port, PC1, PC3, PC5, and PC7 are also inputs only. All the inputs are pulled up with 47 kΩ resistors. Figure 5 shows the locations of these pullup resistors.

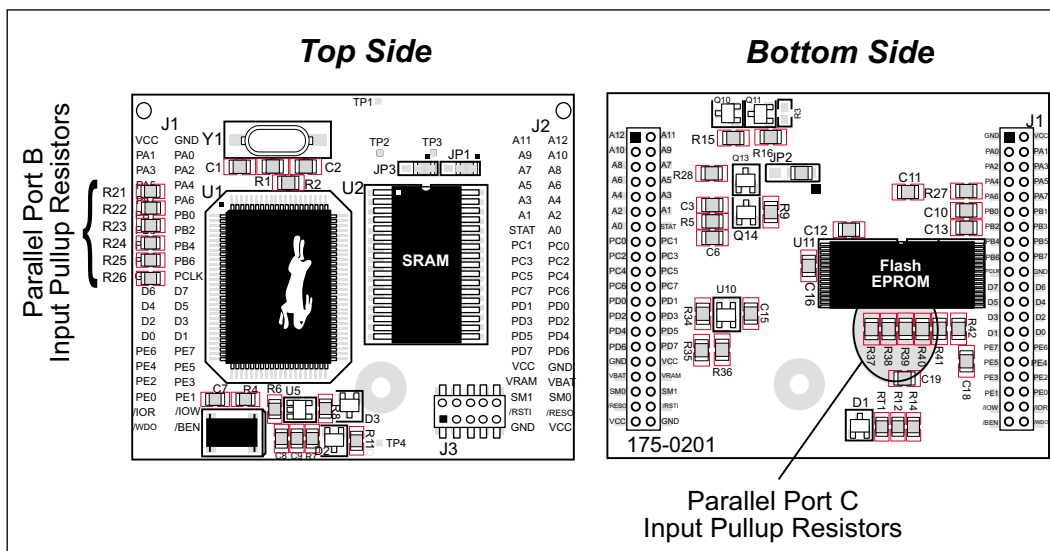


Figure 5. Locations of Digital Input Pullup Resistors

NOTE: All the digital input pullup resistors are located on the bottom side of RCM2000 boards marked 175-0168

PB2–PB5 can instead be used for the slave port. PB2 and PB3 are slave write and slave read strobes, while PB4 and PB5 serve as slave address lines SA0 and SA1, and are used to access the slave registers (SD0–SD7), which is the alternate assignment for Parallel Port A. Parallel Port C pins PC1, PC3, PC5, and PC7 are inputs only can alternately be selectively enabled to serve as the serial data inputs for Serial Ports D, C, B, and A.

2.2.2 Dedicated Outputs

Two of the output-only pins are located on PB6–PB7. PB7 can also be used with the slave port as the /SLAVEATTN output. This configuration signifies that the slave is requesting attention from the master. When Port C is used as a parallel port, PC0, PC2, PC4 and PC6 are outputs only. These pins can alternately serve as the serial data outputs for Serial Ports D, C, B, and A.

2.3 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/O write (/IOWR), I/O 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.

2.3.1 Additional I/O

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 $\div 2$, but PCLK can instead be used as a digital output. See Section 3.2.1, “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.

2.4 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.

2.4.1 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.

2.4.2 Programming Port

Serial Port A has special features that allow it to cold-boot the system after reset. Serial Port A is also the port that is used for software development under Dynamic C.

The RCM2000 has a 10-pin program header labeled J3. The Rabbit 2000 startup-mode pins (SMODE0, SMODE1) are presented to the programming port so that an externally connected device can force the RCM2000 to start up in an external bootstrap mode. The *Rabbit 2000 Microprocessor User's Manual* provides more information related to the bootstrap mode.

The programming port is used to start the RCM2000 in a mode where it will download a program from the port and then execute the program. The programming port transmits information to and from a PC while a program is being debugged.

The RCM2000 can be reset from the programming port via the /RESET_IN line.

The Rabbit 2000 status pin is also presented to the programming port. The status pin is an output that can be used to send a general digital signal.

The clock line for Serial Port A is presented to the programming port, which makes fast serial communication possible.

2.5 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 change to the BIOS as described below.

1. Open the BIOS source code file, **RABBITBIOS.C** in the **BIOS** directory.
2. Change the line

```
#define CLOCK_DOUBLED 1    // set to 1 to double the clock if XTAL<=12.9MHz,  
to read as follows.
```

```
#define CLOCK_DOUBLED 0    // set to 1 to double the clock if XTAL<=12.9MHz,
```

3. Change the serial baud rate to 57,600 bps when the RCM2000 is operated at 12.9 MHz or 9.2 MHz.
4. Save the change using **File > Save**.

2.6 Memory

2.6.1 SRAM

The RCM2000 is designed to accept 32K to 512K of SRAM packaged in an SOIC case.

The existing standard models of the RCM2000 come with 128K or 512K of SRAM.

Figure 6 shows the locations and the jumper settings for the jumpers at JP1 used to set the SRAM size. The “jumpers” are 0 Ω surface-mounted resistors.

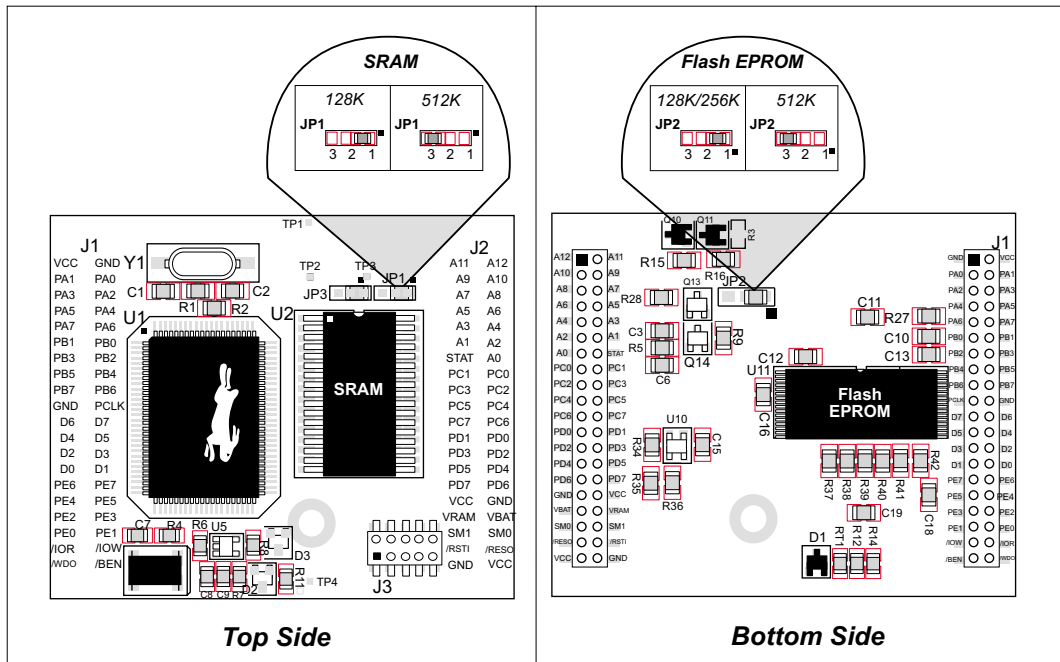


Figure 6. RCM2000 Jumper Settings for SRAM and Flash EPROM Size

2.6.2 Flash EPROM

The RCM2000 is also designed to accept 128K to 512K of flash EPROM packaged in a TSOP case.

The existing standard models of the RCM2000 come with 256K of flash EPROM.

Figure 6 shows the locations and the jumper settings for the jumpers at JP2 used to set the flash EPROM size. The “jumpers” are 0 Ω surface-mounted resistors.

NOTE: Z-World recommends that any customer applications should not be constrained by the sector size of the flash EPROM since it may be necessary to change the sector size in the future.

A Flash Memory Bank Select jumper configuration option exists at JP3 with 0 Ω surface-mounted resistors. This provision allows the code space in the flash memory to be split in half so that one flash memory chip can emulate the two flash memory chips found on some Z-World single-board computers.

NOTE: Only the Normal Mode (pins 1–2 connected at JP2), which corresponds to using the full code space, is supported at the present time.

2.6.3 Dynamic C BIOS Source Files

The Dynamic C BIOS source files handle different standard RAM and flash EPROM sizes automatically.

3. SOFTWARE REFERENCE

Dynamic C Premier is an integrated development system for writing embedded software. It runs on an IBM-compatible PC and is designed for use with Z-World single-board computers and other single-board computers based on the Rabbit microprocessor. Chapter 3 provides the libraries, function calls, and sample programs related to the RCM2000.

3.1 More About Dynamic C

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

Dynamic C for Rabbit[™] processors uses the standard Rabbit programming interface. This is a 10-pin connector that connects to the Rabbit serial port A. It is possible to reset and cold-boot a Rabbit processor via the programming port. No software needs to be present in the target system. More details are available in the *Rabbit 2000 Microprocessor User's Manual*.

Dynamic C cold-boots the target system and compiles the BIOS. The BIOS is a basic program of a few thousand bytes in length that provides the debugging and communication facilities that Dynamic C needs. Once the BIOS has been compiled, the user can compile his own program and test it. If the BIOS fails because the program stops running, a new cold boot and BIOS compile can be done at any time.

The BIOS can be customized by using `#define` options.

Dynamic C does not use `include` files, rather it has libraries that are used for the same purpose, that is, to supply function prototypes to programs before they are compiled. See Section 4.24, "Modules," in the *Dynamic C Premier User's Manual* for more information.

Dynamic C supports assembly language, either as separate functions or as fragments embedded in C programs. Interrupt routines may be written in Dynamic C or in assembly language.

3.1.1 Operating System Framework

Dynamic C does not include an operating system in the usual sense of a complex software system that is resident in memory. The user has complete control of what is loaded as a part of his program, other than those routines that support loading and debugging (which are inactive at embedded run time). However, certain routines are very basic and normally should always be present and active.

- Periodic interrupt routine. This interrupt routine is driven by the Rabbit periodic interrupt facility, and when enabled creates an interrupt every 16 ticks of the 32.768 kHz oscillator, or every 488 μ s. This routine drives three long global variables that keep track of the time: **SEC_TIMER**, **MS_TIMER**, and **TICK_TIMER** that respectively count seconds, milliseconds, and 488 μ s ticks. These variables are needed by virtually all functions that measure time. The **SEC_TIMER** is set to seconds elapsed since 1 Jan 1980, and thus also keeps track of the time and date. The periodic interrupt routine must be disabled when the microprocessor enters sleep mode and the processor clock is operating at 32.768 kHz. The interrupt routine cannot complete at this slow speed before the next tick of the periodic interrupt. In this situation, the hardware real-time clock can be read directly to provide the time.
- Watchdog support routines. Although the Rabbit watchdog can be disabled, this is not recommended since the watchdog is an essential facility for recovering when a program stops running.

3.1.2 Using Dynamic C

You have a choice of doing your software development in the flash memory or in the static RAM. There are 256K bytes of flash and 128K SRAM memory. The advantage of working in RAM is to save wear on the flash, which is limited to about 100,000 writes.

NOTE: Note that an application can be developed in RAM, but cannot run standalone from RAM after the programming cable is disconnected. All applications can only run from flash.

NOTE: Do not depend on the flash sector size remaining constant on all boards. Due to the volatility of the flash market, the RCM2000 and Dynamic C were designed to accommodate flash devices with various sector sizes.

When using flash EPROM, the compile to a file is followed by a download to the flash EPROM. The disadvantage of using flash EPROM is that interrupts must be disabled for approximately 5 ms whenever a break point is set in the program. This can crash fast interrupt routines that are running while you stop at a break point or single-step the program. Flash EPROM or RAM is selected with the Dynamic C **Options > Compiler** menu.

3.2 I/O

The RCM2000 was designed to interface with other systems, and so there are no drivers written specifically for this purpose. The general Dynamic C read and write functions allow you to customize the parallel I/O to meet your specific needs. For example, use

```
WrPortI(PEDDR, &PEDDRShadow, 0x00);
```

to set all the port E bits as inputs, or use

```
WrPortI(PEDDR, &PEDDRShadow, 0xFF);
```

to set all the port E bits as outputs.

The sample programs in the Dynamic C **SAMPLES** directory provide further examples.

3.2.1 PCLK Output

The PCLK output is controlled by bits 7 and 6 of the Global Output Register (GOCR) on the Rabbit 2000 microprocessor, and so can be enabled or disabled in software. Starting with Dynamic C v 7.02, the PCLK output is disabled by default at compile time to minimize radiated emissions; the PCLK output is enabled in earlier versions of Dynamic C.

Use the following code to set the PCLK output as needed.

PCLK output driven with peripheral clock:

```
WrPortI(GOCR, &GOCRShadow, (GOCRShadow&~0xc0));
```

PCLK output driven with peripheral clock ÷ 2:

```
WrPortI(GOCR, &GOCRShadow, ((GOCRShadow&~0xc0) | 0x40));
```

PCLK output off (low):

```
WrPortI(GOCR, &GOCRShadow, ((GOCRShadow&~0xc0) | 0x80));
```

PCLK output on (high):

```
WrPortI(GOCR, &GOCRShadow, (GOCRShadow | 0xc0));
```

3.3 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 Premier User's Manual* and Technical Note 213, *Rabbit 2000 Serial Port Software*.



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.

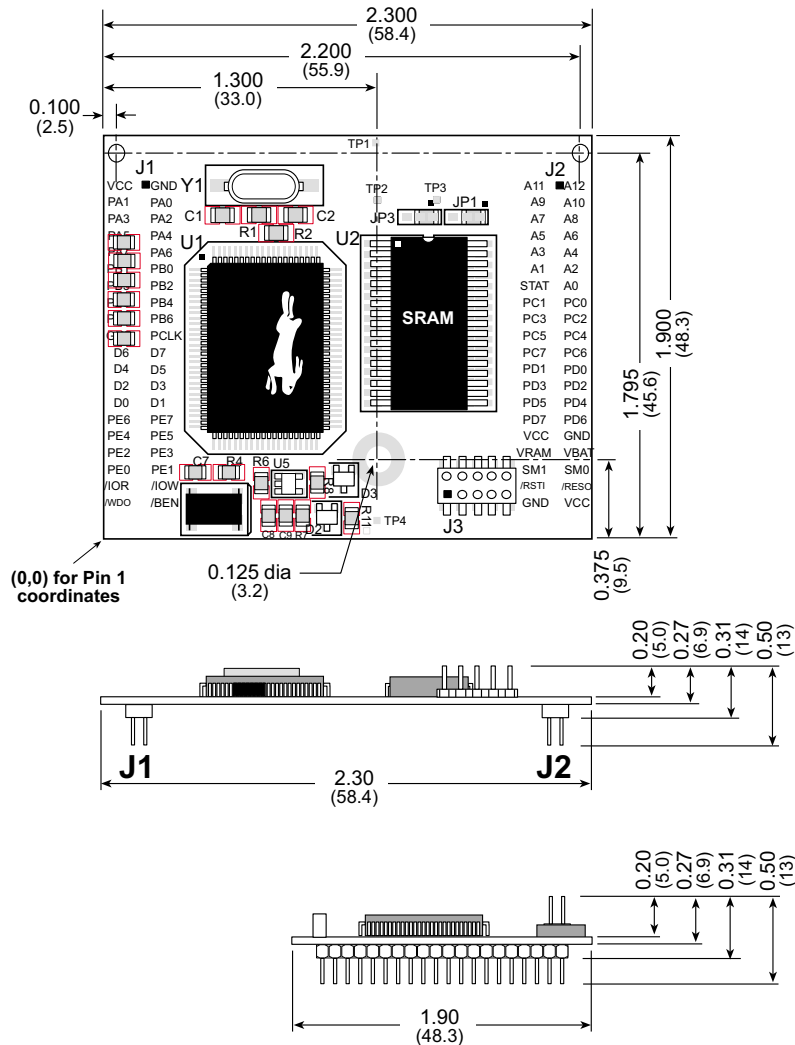


Figure A-1. RCM2000 Dimensions

Table A-1 provides the pin 1 locations for the RCM2000 headers viewed from the top side (as in Figure A-1).

Table A-1. RCM2000 Header Pin 1 Locations

| Header | Description | Pin 1 (x,y) Coordinates (Inches) |
|--------|--------------------|----------------------------------|
| J1 | RCM2000 subsystems | (0.221, 1.675) |
| J2 | RCM2000 subsystems | (2.181, 1.675) |
| J3 | Programming port | (1.600, 0.214) |

Table A-2 lists the electrical, mechanical, and environmental specifications for the RCM2000.

Table A-2. RCM2000 Specifications

| Parameter | Specification |
|--|--|
| Board Size | 1.90" × 2.30" × 0.50" (48.3 mm × 58.4 mm × 12.7 mm) |
| Operating Temperature | −40°C to +85°C |
| Storage Temperature | −55°C to +125°C |
| Humidity | 5% to 95%, noncondensing |
| Input Voltage | 4.75 V to 5.25 V DC |
| Current | 54 mA at 9.216 MHz, 5 V DC 70 mA at 12.9024 MHz, 5 V DC 88 mA at 18.432 MHz, 5 V DC 120 mA at 25.8048 MHz, 5 V DC |
| Standby Current | 10 µA (typical) |
| General-Purpose I/O | 40 parallel I/O lines grouped in five 8-bit ports: 24 bidirectional, 10 inputs only, 6 outputs only |
| Memory, I/O Interface | 13 address lines, 8 data lines, I/O read/write, buffer enable, status, clock |
| Additional Digital Inputs | 2 startup mode (for master/slave), reset in |
| Additional Digital Outputs | Watchdog output, reset out |
| Microprocessor | Rabbit 2000 |
| Clock | 25.8048 MHz (18.432 MHz option) |
| SRAM | 512K (supports 32K–512K) |
| Flash EPROM | 256K (supports 128K–512K) |
| Timers | Five 8-bit timers cascadable in pairs, one 10-bit timer with 2 match registers that each have an interrupt |
| Serial Ports | Four CMOS-compatible ports. Two ports are configurable as clocked ports, one is configurable as RS-232 programming port. |
| Serial Rate | CMOS maximum asynchronous 806,400 bps maximum synchronous 6.45 Mbps |
| Watchdog/Supervisor | Yes |
| Time/Date Clock | Yes |
| Socket Strip (for connection to headers J1 and J2) | Pinrex 2x20, 2 mm pitch (PS2S-2X20GOB) |

Table A-2. RCM2000 Specifications (continued)

| Parameter | Specification |
|--|---|
| Recommended Standoff (to attach RabbitCore 2000 to user board) | 9/32" (7.14) with 4-40 screw |
| Backup Battery | Provision for user-supplied backup battery (2.8 V to 3.3 V) via connections on header J2 |

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-2 shows the layout of another board for the RCM2000 to be plugged in to. These values are relative to the header connectors.

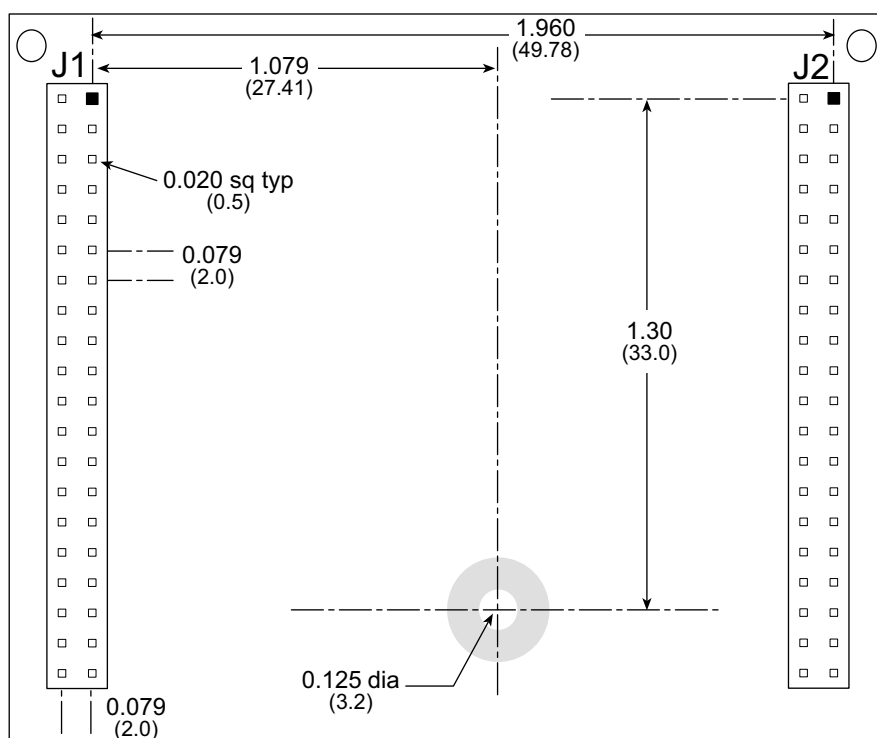


Figure A-2. J1 and J2 Header Layout (Top View)

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-3 lists the capacitance for the various RCM2000 I/O ports.

Table A-3. 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-4 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-4.

Table A-4. 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.

The values from the table above are derived using 55 ns (25.8 MHz version) and 90 ns (18.4 MHz version) memory access times. External capacitive loading can be improved by 10 pF for commercial temperature ranges, but do not exceed 100 pF. See the AC timing specifications in the *Rabbit 2000 Microprocessor User's Manual* for more information.

Figure A-3 shows a typical timing diagram for the Rabbit 2000 microprocessor memory read and write cycles.

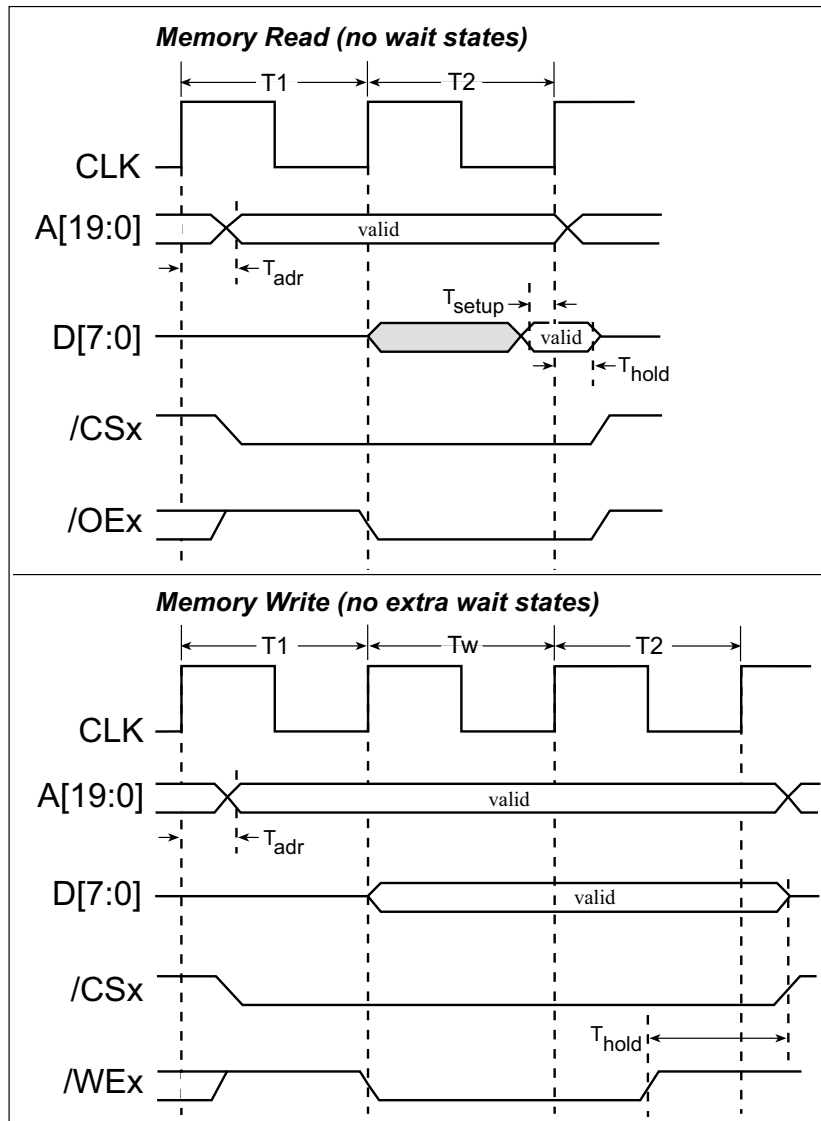


Figure A-3. Memory Read and Write Cycles

T_{adr} is the time required for the address output to reach 0.8 V. This time depends on the bus loading. A0 has a stronger driver and can handle larger capacitive loads than the other address lines. T_{setup} is the data setup time relative to the clock. T_{setup} is specified from 30%/70% of the V_{DD} voltage level. Add 1.5 ns to T_{adr} for each 10 pF of additional bus loading above 70 pF.

A.3 Rabbit 2000 DC Characteristics

Table A-5 outlines the DC characteristics for the Rabbit 2000 at 5.0 V over the recommended operating temperature range from $T_a = -40^\circ\text{C}$ to $+85^\circ\text{C}$, $V_{DD} = 4.5\text{ V}$ to 5.5 V .

Table A-5. 5.0 Volt DC Characteristics

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|----------|--------------------------------|--|---------------------|-----|---------------------|---------------|
| I_{IH} | Input Leakage High | $V_{IN} = V_{DD}$, $V_{DD} = 5.5\text{ V}$ | | | 10 | μA |
| I_{IL} | Input Leakage Low (no pull-up) | $V_{IN} = V_{SS}$, $V_{DD} = 5.5\text{ V}$ | -10 | | | μA |
| I_{OZ} | Output Leakage (no pull-up) | $V_{IN} = V_{DD}$ or V_{SS} , $V_{DD} = 5.5\text{ V}$ | -10 | | 10 | μA |
| V_{IL} | CMOS Input Low Voltage | | | | $0.3 \times V_{DD}$ | V |
| V_{IH} | CMOS Input High Voltage | | $0.7 \times V_{DD}$ | | | V |
| V_T | CMOS Switching Threshold | $V_{DD} = 5.0\text{ V}$, 25°C | | 2.4 | | V |
| V_{OL} | CMOS Output Low Voltage | $I_{OL} = \text{See Table A-6}$ (sinking) $V_{DD} = 4.5\text{ V}$ | | 0.2 | 0.4 | V |
| V_{OH} | CMOS Output High Voltage | $I_{OH} = \text{See Table A-6}$ (sourcing) $V_{DD} = 4.5\text{ V}$ | $0.7 \times V_{DD}$ | 4.2 | | V |

A.4 I/O Buffer Sourcing and Sinking Limit

Unless otherwise specified, the Rabbit I/O buffers are capable of sourcing and sinking 8 mA of current per pin at full AC switching speed. Full AC switching assumes a 25.8 MHz CPU clock and capacitive loading on address and data lines of less than 100 pF per pin. Address pin A0 and data pin D0 are rated at 16 mA each. Pins A1–A12 and D1–D7 are each rated at 8 mA. The absolute maximum operating voltage on all I/O is $V_{DD} + 0.5$ V, or 5.5 V.

Table A-6 shows the AC and DC output drive limits of the parallel I/O buffers when the Rabbit 2000 is used in the RabbitCore 2000.

Table A-6. I/O Buffer Sourcing and Sinking Capability

| Pin Name | Output Drive Sourcing [†] /Sinking [†] Limits (mA) | |
|-----------------|--|--|
| | Full AC Switching SRC/SNK | Maximum [‡] DC Output Drive SRC/SNK |
| PA [7:0] | 8/8 | 12/12 |
| PB [7, 1, 0] | 8/8 | 12/12 |
| PC [6, 4, 2, 0] | 8/8 | 12/12 |
| PD [7:4] | 8/8 | 12/12 |
| PD [3:0]** | 16/16 | 12/25 |
| PE [7:0] | 8/8 | 12/12 |

* The maximum DC sourcing current for I/O buffers between V_{DD} pins is 112 mA.

† The maximum DC sinking current for I/O buffers between V_{SS} pins is 150 mA.

‡ The maximum DC output drive on I/O buffers must be adjusted to take into consideration the current demands made by AC switching outputs, capacitive loading on switching outputs, and switching voltage.

The current drawn by all switching and nonswitching I/O must not exceed the limits specified in the first two footnotes.

** The combined sourcing from Port D [7:0] may need to be adjusted so as not to exceed the 112 mA sourcing limit requirement specified in the first footnote.

Some of the values listed are different from those listed in the *Rabbit 2000 Microprocessor User's Manual* to take into account external loading of the Rabbit 2000 while it is part of the RCM2000. Loads that exceed the values listed above need to be buffered.



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 RCM2000 and to build prototypes of your own circuits.

B.1 Mechanical Dimensions and Layout

Figure B-1 shows the mechanical dimensions and layout for the RCM2000 Prototyping Board.

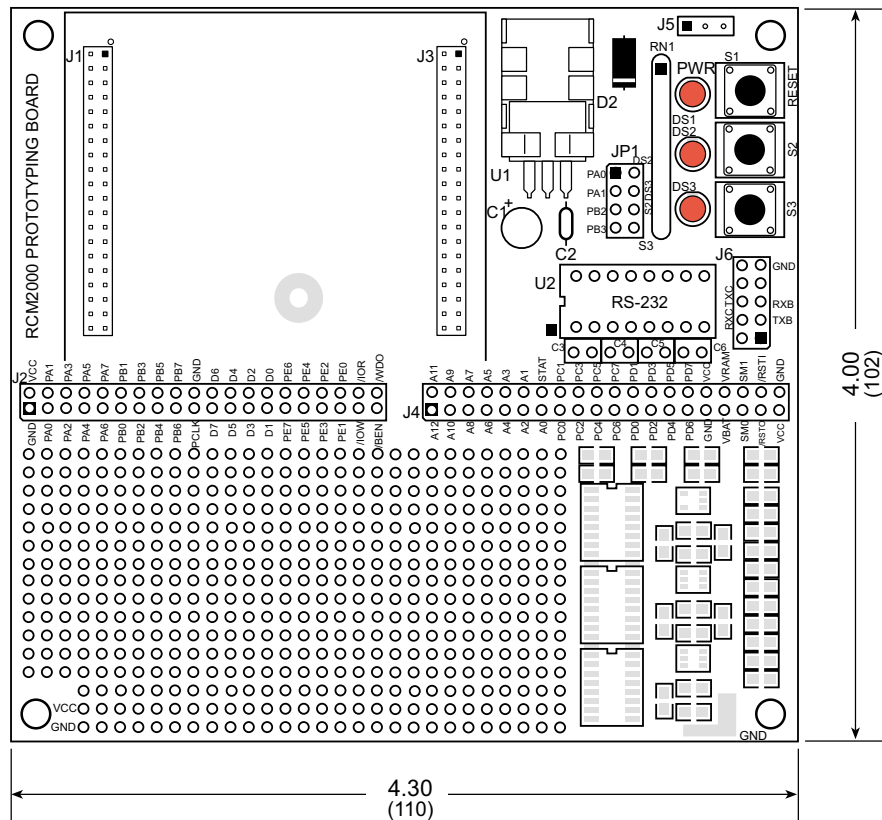


Figure B-1. RCM2000 Prototyping Board Dimensions

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 70°C |
| Prototyping Area | 2" × 3" (51 mm × 76 mm) throughhole, 0.1" spacing |
| Standoffs/Spacers | 4, accept 6-32 x 3/8 screws |

B.2 Power Supply

The RCM2000 requires a regulated 5 V \pm 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 LM340-T5 or equivalent. The LM340-T5 is an inexpensive 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-2.

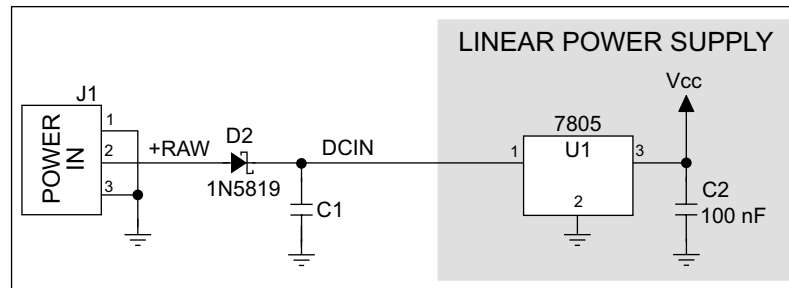


Figure B-2. Prototyping Board Power Supply

Capacitor C1 provides surge current protection for the voltage regulator, and allows the external power supply to be located some distance away.

B.3 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 RCM2000 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 RCM2000. Two LEDs (DS2 and DS3) are connected to PA0 and PA1, 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 RCM2000.

To maximize the availability of RCM2000 resources, the demonstration hardware (LEDs and switches) on the Prototyping Board may be disconnected. This is done by cutting the traces below the silk-screen outline of header JP1 on the bottom side of the Prototyping Board. Figure B-3 shows the four places where cuts should be made. An exacto knife would work nicely to cut the traces. Alternatively, a small standard screwdriver may be carefully and forcefully used to wipe through the PCB traces.

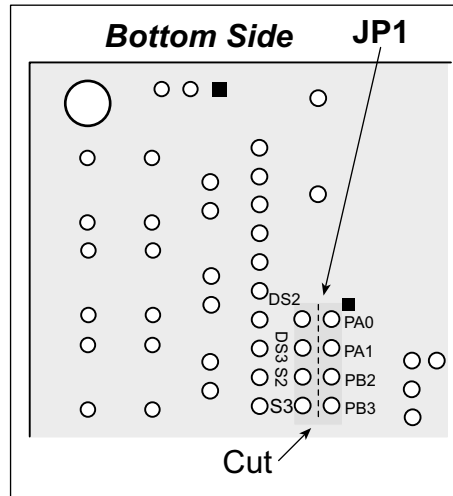


Figure B-3. Where to Cut Traces to Permanently Disable Demonstration Hardware on Prototyping Board

The power LED (PWR) and the RESET switch remain connected. Jumpers across the appropriate pins on header JP1 can be used to reconnect specific demonstration hardware later if needed.

Table B-1. Prototyping Board Jumper Settings

| Header JP2 | |
|------------|------------------|
| Pins | Description |
| 1-2 | PA0 to LED DS2 |
| 3-4 | PA1 to LED DS3 |
| 5-6 | PB2 to Switch S2 |
| 7-8 | PB3 to Switch S3 |

Note that the pinout at location JP1 on the bottom side of the Prototyping Board (shown in Figure B-3) is a mirror image of the top side pinout.

The Prototyping Board provides the user with RCM2000 connection points brought out conveniently to labeled points at headers J2 and J4 on the Prototyping Board. Small to medium circuits can be prototyped using point-to-point wiring with 20 to 30 AWG wire between the prototyping area and the holes at locations J2 and J4. The holes are spaced at 0.1" (2.5 mm),

and 40-pin headers or sockets may be installed at J2 and J4. The pinouts for locations J1 and J3, which correspond to J2 and J4, are shown in Figure B-4.

| J1 | | | J3 | | |
|-------|-----|--------|---------|-----|----------|
| VCC | □ ■ | GND | A11 | □ ■ | A12 |
| PA1 | □ □ | PA0 | A9 | □ □ | A10 |
| PA3 | □ □ | PA2 | A7 | □ □ | A8 |
| PA5 | □ □ | PA4 | A5 | □ □ | A6 |
| PA7 | □ □ | PA6 | A3 | □ □ | A4 |
| PB1 | □ □ | PB0 | A1 | □ □ | A2 |
| PB3 | □ □ | PB2 | STATUS | □ □ | A0 |
| PB5 | □ □ | PB4 | PC1 | □ □ | PC0 |
| PB7 | □ □ | PB6 | PC3 | □ □ | PC2 |
| GND | □ □ | PCLK | PC5 | □ □ | PC4 |
| D6 | □ □ | D7 | PC7 | □ □ | PC6 |
| D4 | □ □ | D5 | PD1 | □ □ | PD0 |
| D2 | □ □ | D3 | PD3 | □ □ | PD2 |
| D0 | □ □ | D1 | PD5 | □ □ | PD4 |
| PE6 | □ □ | PE7 | PD7 | □ □ | PD6 |
| PE4 | □ □ | PE5 | VCC | □ □ | GND |
| PE2 | □ □ | PE3 | VRAM | □ □ | VBAT |
| PE0 | □ □ | PE1 | SMODE1 | □ □ | SMODE0 |
| /IORD | □ □ | /IOWR | /RES_IN | □ □ | /RES_OUT |
| /WDO | □ □ | /BUFEN | GND | □ □ | VCC |

Figure B-4. RCM2000 Prototyping Board Pinout (Top View)

A pair of small holes capable of holding 30 AWG wire appears to the side of each hole pair at locations J2 and J4 for convenience of point-to-point wiring when headers are installed. The signals are those of the adjacent pairs of holes at J2 and J4. These small holes are also provided for the components that may be installed below location J4.

There is an additional 2" × 3" of through-hole prototyping space available on the Prototyping Board. VCC and GND traces run along the edge of the Prototyping Board for easy access. A GND pad is also provided at the lower right for alligator clips or probes.

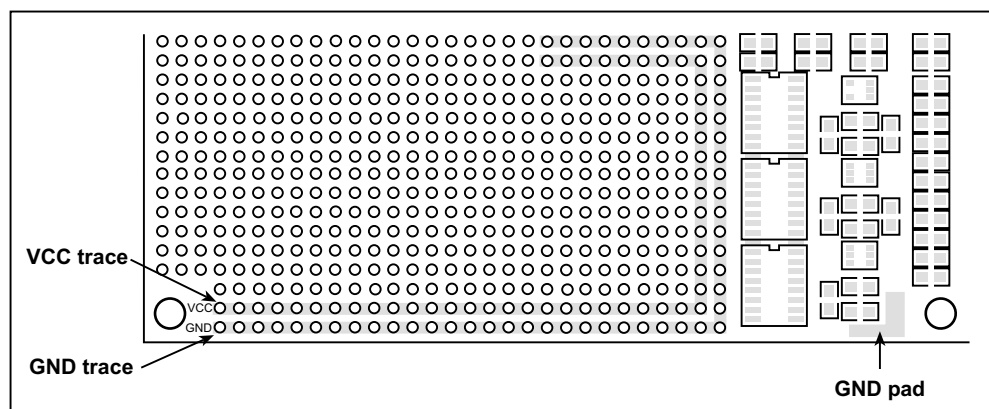


Figure B-5. VCC and GND Traces Along Edge of Prototyping Board

B.3.1 Adding Other Components

There is room on the Prototyping Board for a user-supplied RS-232 transceiver chip at location U2 and a 10-pin header for serial interfacing to external devices at location J6. A Maxim MAX232 transceiver is recommended. When adding the MAX232 transceiver at position U2, you must also add 100 nF charge storage capacitors at positions C3–C6 as shown in Figure B-6.

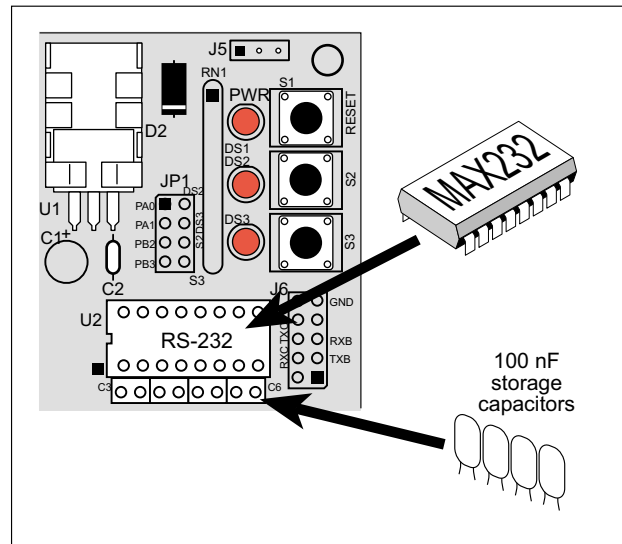


Figure B-6. Location for User-Supplied RS-232 Transceiver and Charge Storage Capacitors

There are two sets of pads that can be used for surface mount prototyping SOIC devices. The silk screen layout separates the rows into six 16-pin devices (three on each side). However, there are pads between the silk screen layouts giving the user two 52-pin (2x26) SOIC layouts with 50 mil pin spacing. There are six sets of pads that can be used for 3- to 6-pin SOT23 packages. There are also 60 sets of pads that can be used for SMT resistors and capacitors in an 0805 SMT package. Each component has every one of its pin pads connected to a hole in which a 30 AWG wire can be soldered (standard wire wrap wire can be soldered in for point-to-point wiring on the Prototyping Board). Because the traces are very thin, carefully determine which set of holes is connected to which surface mount pad.

APPENDIX C. POWER MANAGEMENT

Appendix C describes the RCM2000 power circuitry.

C.1 Power Supplies

The RCM2000 requires a regulated $5\text{ V} \pm 0.25\text{ V}$ DC power source.

An RCM2000 with no loading at the outputs operating at 18.432 MHz typically draws 88 mA, and an RCM2000 operating at 25.8048 MHz typically draws 120 mA. The RCM2000 will consume 13 mA to 15 mA of additional current when the programming cable is used to connect J3 to a PC.

C.1.1 Batteries and External Battery Connections

The RCM2000 does not have a battery, but there is provision for a customer-supplied battery to back up SRAM and keep the internal Rabbit 2000 real-time clock running.

Header J2, shown in Figure C-1, allows access to the external battery. This header makes it possible to connect an external 3 V power supply. This allows the SRAM and the internal Rabbit 2000 real-time clock to retain data with the RCM2000 powered down.

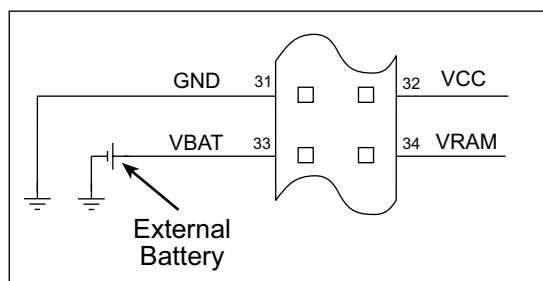


Figure C-1. External Battery Connections at Header J2

A lithium battery with a nominal voltage of 3 V and a minimum capacity of 165 mA·h is recommended. A lithium battery is strongly recommended because of its nearly constant nominal voltage over most of its life.

The drain on the battery by the RCM2000 is typically 10 μA when no other power is supplied. If a 950 mA·h battery is used, the battery can last more than 6 years:

$$\frac{950 \text{ mA}\cdot\text{h}}{10 \mu\text{A}} = 10.8 \text{ years (shelf life = 10 years)}.$$

Since the shelf life of the battery is 10 years, the battery can last for its full shelf life. The actual life in your application will depend on the current drawn by components not on the RCM2000 and the storage capacity of the battery.

C.1.2 Battery-Backup Circuit

The battery-backup circuit serves three purposes:

- It reduces the battery voltage to the SRAM and to the real-time clock, thereby limiting the current consumed by the real-time clock and lengthening the battery life.
- It ensures that current can flow only *out* of the battery to prevent charging the battery.
- A voltage, VOSC, is supplied to U5, which keeps the 32.768 kHz oscillator working when the voltage begins to drop.

VRAM and Vcc are nearly equal (<100 mV, typically 10 mV) when power is supplied to the RCM2000.

Figure C-2 shows the RCM2000 battery-backup circuit.

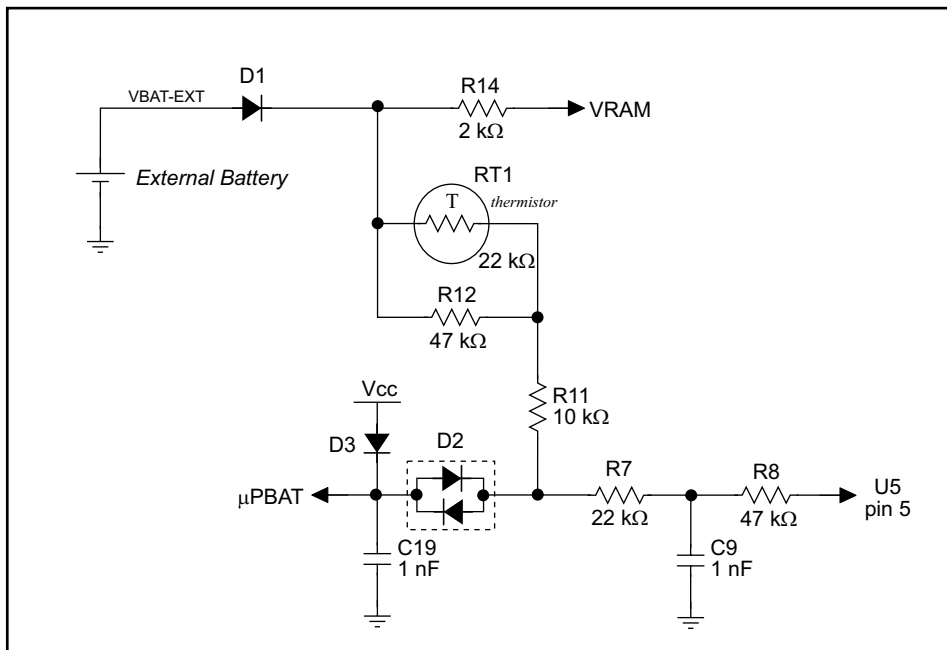


Figure C-2. RCM2000 Battery-Backup Circuit

VRAM is also available on pin 34 of header J2 to facilitate battery backup of the external circuit. Note that the recommended minimum resistive load at VRAM is 100 k Ω , and new battery life calculations should be done to take external loading into account.

C.1.3 Power to VRAM Switch

The VRAM switch, shown in Figure C-3, allows a customer-supplied external battery to provide power when the external power goes off. The switch provides an isolation between Vcc and the battery when Vcc goes low. This prevents the Vcc line from draining the battery.

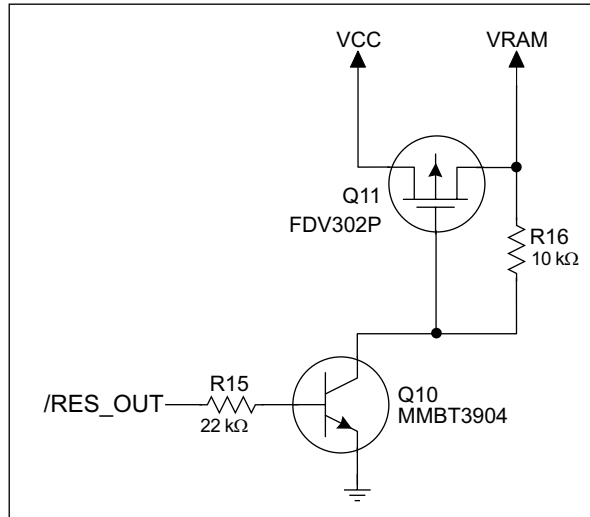


Figure C-3. VRAM Switch

Transistor Q11 is needed to provide a very small voltage drop between Vcc and VRAM (<100 mV, typically 10 mV) so that the processor lines powered by Vcc will not have a significantly different voltage than VRAM.

When the RCM2000 is not resetting (pin 2 on U10 is high), the /RES_OUT line will be high. This turns on Q10, causing its collector to go low. This turns on Q11, allowing VRAM to nearly equal Vcc.

When the RCM2000 is resetting, the /RES_OUT line will go low. This turns off Q10 and Q11, providing an isolation between Vcc and VRAM.

The battery-backup circuit keeps VRAM from dropping below 2 V.

C.1.4 Reset Generator

The RCM2000 uses a reset generator, U10, to reset the Rabbit 2000 microprocessor when the voltage drops below the voltage necessary for reliable operation. The reset occurs between 4.50 V and 4.75 V, typically 4.63 V. The RCM2000 has a reset output, pin 37 on header J3, presented to the headers. The reset generator has a reset input, pin 38 on header J3, that can be used to force the RCM2000 to reset.

C.2 Chip Select Circuit

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

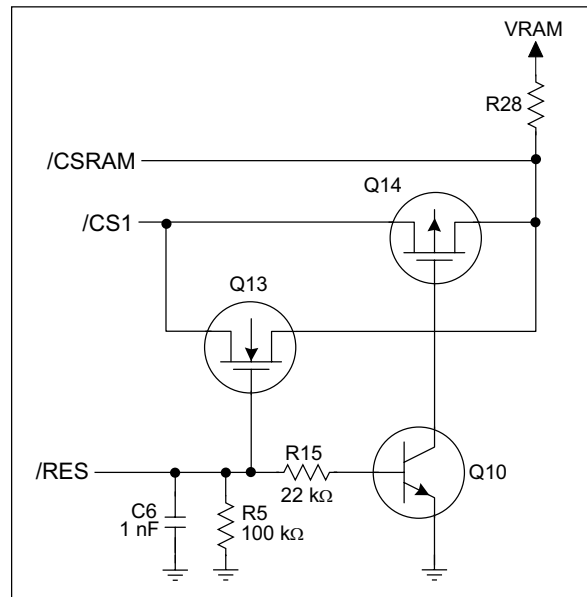


Figure C-4. Chip Select Circuit

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 V_{cc} 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 k Ω 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.



APPENDIX D. SAMPLE CIRCUITS

Appendix D provides these sample circuits that incorporate the RCM2000.

- RS-232/RS-485 Serial Communication
- Keypad and LCD Connections
- LCD Connections
- External Memory
- Simple D/A Converter

D.1 RS-232/RS-485 Serial Communication

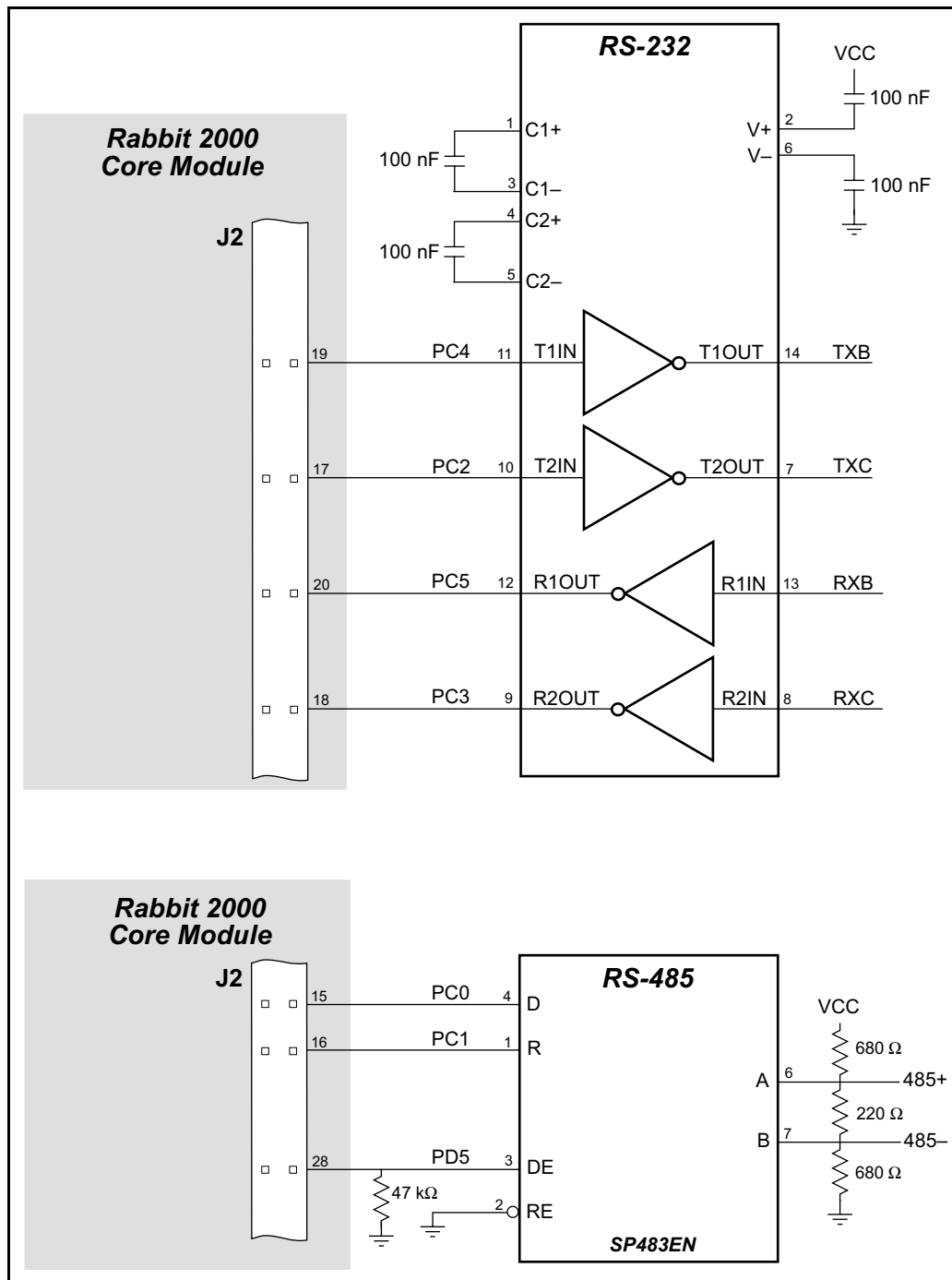


Figure D-1. Sample RS-232 and RS-485 Circuits

Sample Program: PUTS.C in SAMPLES/SERIAL.

D.2 Keypad and LCD Connections

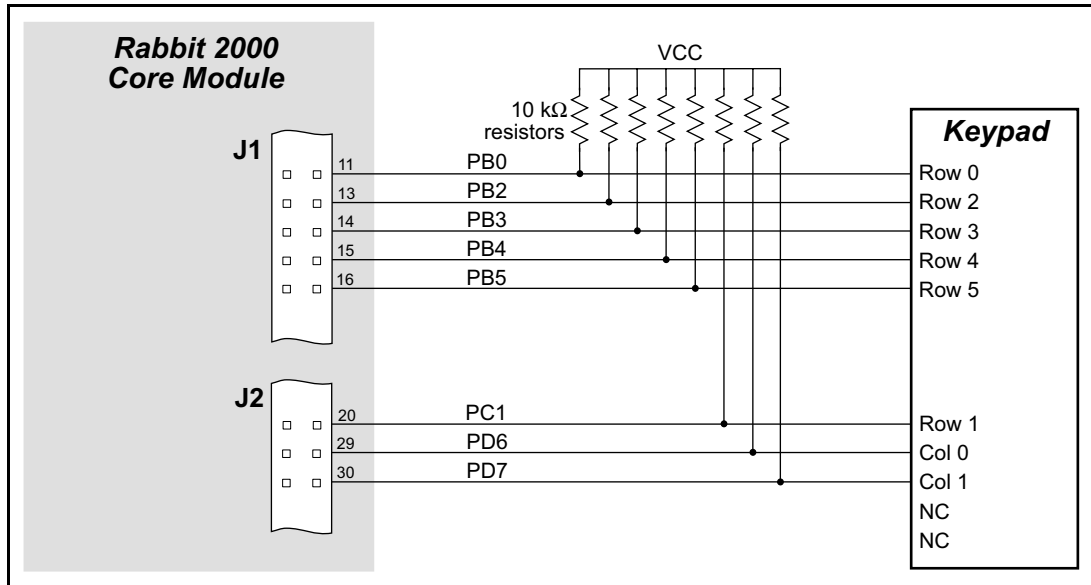


Figure D-2. Sample Keypad Connections

Sample Program: `KEYLCD.C` in `SAMPLES/COREMODULE`.

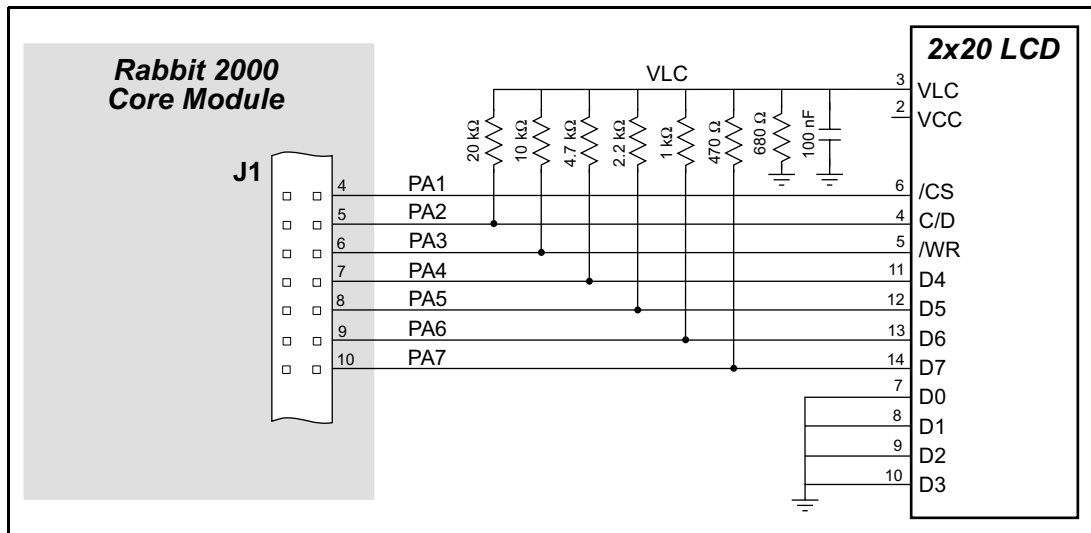


Figure D-3. Sample LCD Connections

Sample Program: `KEYLCD.C` in `SAMPLES/COREMODULE`.

D.3 LCD Connections

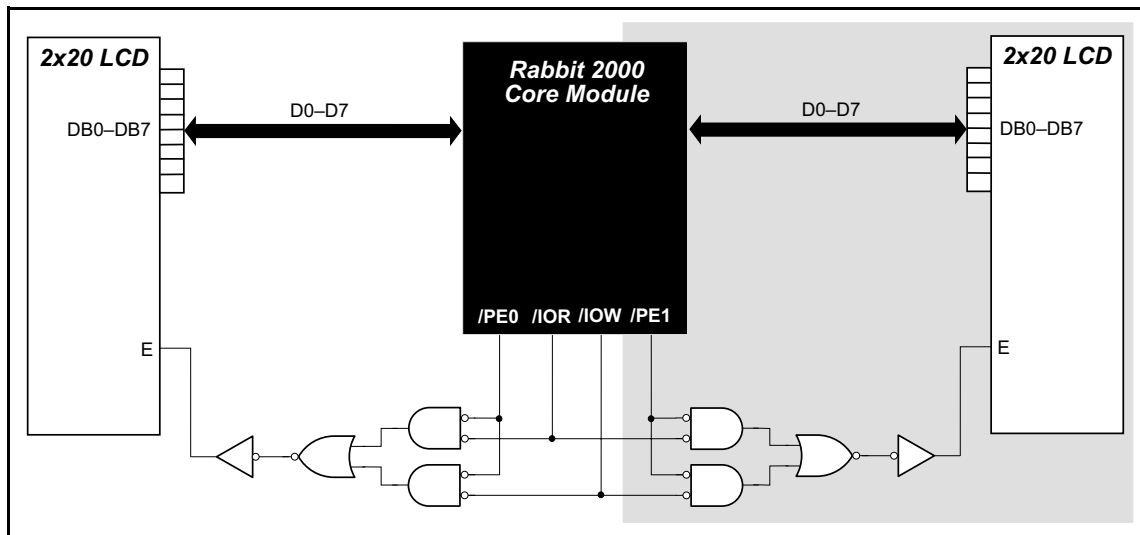


Figure D-4. Sample LCD Connections

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.

D.4 External Memory

The sample circuit can be used with an external 64 Kbit 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.

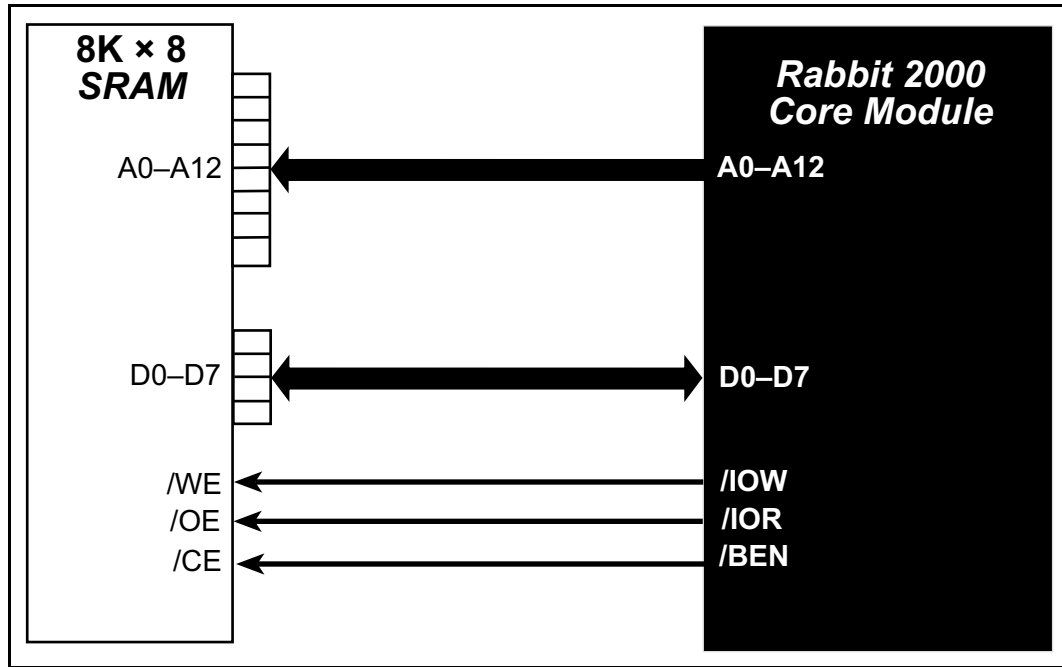


Figure D-5. Sample External Memory Connections

Sample Program: `EXTSRAM.C` in `SAMPLES/COREMODULE`.

D.5 Simple D/A Converter

The output will initially be 0 V to -10.05 V after the first inverting op-amp, and 0 V to +10.05 V after the second inverting op-amp. All lows produce 0 V out, FF produces 10 V out. The output can be scaled by changing the feedback resistors on the op-amps. For example, changing 5.11 k Ω to 2.5 k Ω will produce an output from 0 V to -5 V (first stage) and 0 V to 5 V (second stage). Op-amps with a very low input offset voltage are recommended.

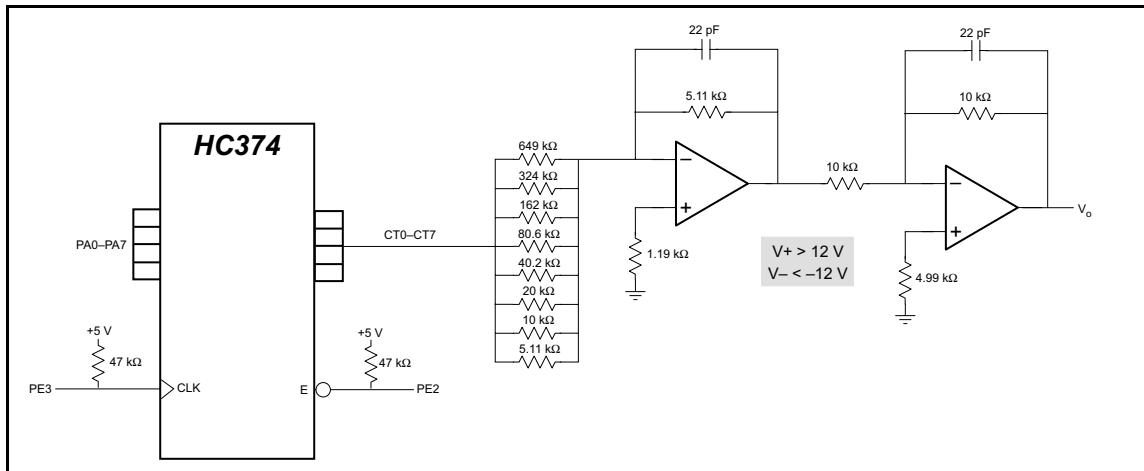


Figure D-6. Sample D/A Converter Connections

A sample program is not available at this time.



APPENDIX E. PROGRAMMING CABLE

Appendix E provides additional information for the Rabbit 2000™ microprocessor when using the **DIAG** and **PROG** connectors on the programming cable. The **PROG** connector is used only when the programming cable is attached to the programming connector (header J3) while a new application is being developed. Otherwise, the **DIAG** connector on the programming cable allows the programming cable to be used as an RS-232 to CMOS level converter for serial communication, which is appropriate for monitoring or debugging an RCM2000 system while it is running.

The programming port, which is shown in Figure E-1, can serve as a convenient communications port for field setup or other occasional communication need (for example, as a diagnostic port). There are several ways that the port can be automatically integrated into software. If the port is simply to perform a setup function, that is, write setup information to flash memory, then the controller can be reset through the programming port and a cold boot performed to start execution of a special program dedicated to this functionality.

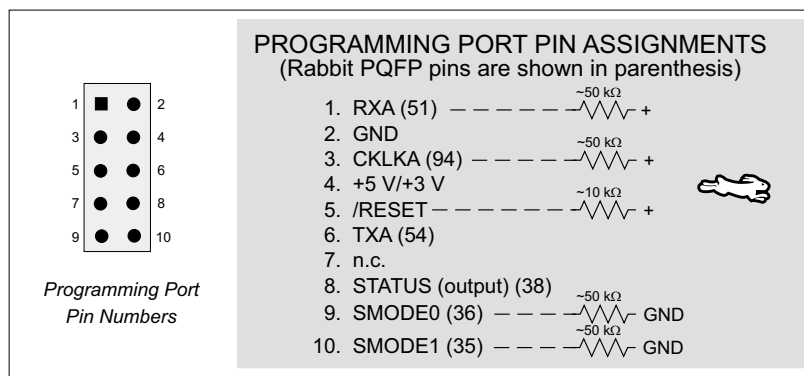


Figure E-1. Programming Port Pin Assignments

When the **PROG** connector is used, the /RESET line can be asserted by manipulating DTR and the STATUS line can be read as DSR on the serial port. The target can be restarted by pulsing reset and then, after a short delay, sending a special character string at 2400 bps. To simply restart the BIOS, the string 80h, 24h, 80h can be sent. When the BIOS is started, it can tell whether the programming cable is connected because the SMODE1 and SMODE0 pins are sensed as being high. This will cause the Rabbit 2000 to enter the bootstrap mode. The Dynamic C programming mode then can have an escape message that will enable the diagnostic serial port function.

Alternatively, the **DIAG** connector can be used to connect the programming port. The /RESET line and the SMODE1 and SMODE0 pins are not connected to this connector. The programming port is then enabled as a diagnostic port by polling the port periodically to see if communication needs to begin or to enable the port and wait for interrupts. The pull-up resistors on RXA and CLKA prevent spurious data reception that might take place if the pins floated.

If the clocked serial mode is used, the serial port can be driven by having two toggling lines that can be driven and one line that can be sensed. This allows a conversation with a device that does not have an asynchronous serial port but that has two output signal lines and one input signal line.

The line TXA (also called PC6) is zero after reset if the cold-boot mode is not enabled. A possible way to detect the presence of a cable on the programming port is for the cable to connect TXA to one of the SMODE pins and then test for the connection by raising PC6 (by configuring it as a general output bit) and reading the SMODE pin after the cold-boot mode has been disabled.

Once you establish that the programming port will never again be needed for programming, it is possible to use the programming port for additional I/O lines. Table E-1 lists the pins available for this alternate configuration.

Table E-1. RCM2000 Programming Port Pinout Configurations

| Pin | Pin Name | Default Use | Alternate Use | Notes |
|-----|----------|---------------|--|-----------------------------------|
| 1 | RXA | Serial Port A | PC6—Input | |
| 2 | GND | | | |
| 3 | CLKA | | PB1—Bitwise or parallel programmable input | |
| 4 | VCC | | | |
| 5 | RESET | | | Connected to reset generator U10 |
| 6 | TXA | Serial Port A | PC7—Output | |
| 8 | STATUS | | Output | |
| 9 | SMODE0 | | Input | Must be low when RCM2000 boots up |
| 10 | SMODE1 | | Input | Must be low when RCM2000 boots up |

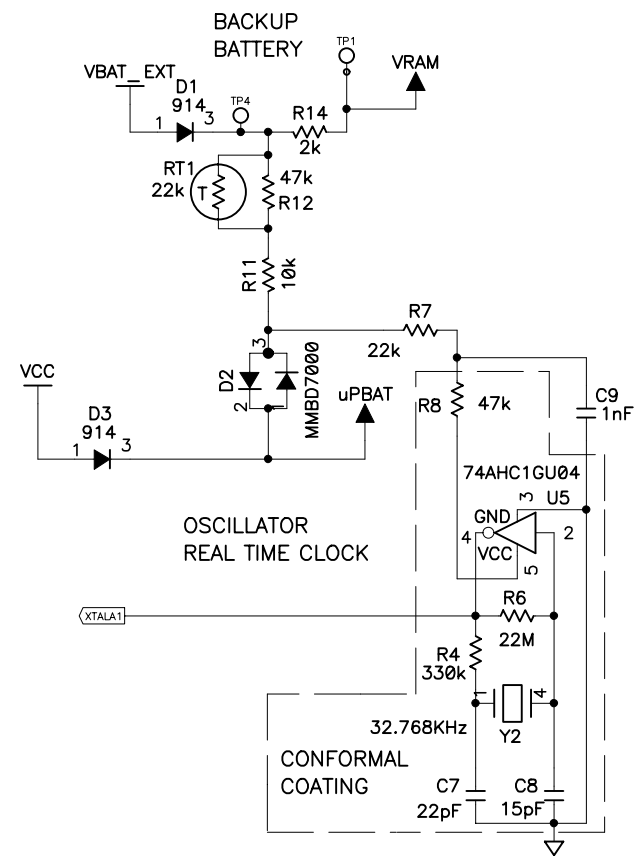


SCHEMATICS

090-0097 RCM2000 Schematic

090-0099 RCM2000 Prototyping Board Schematic

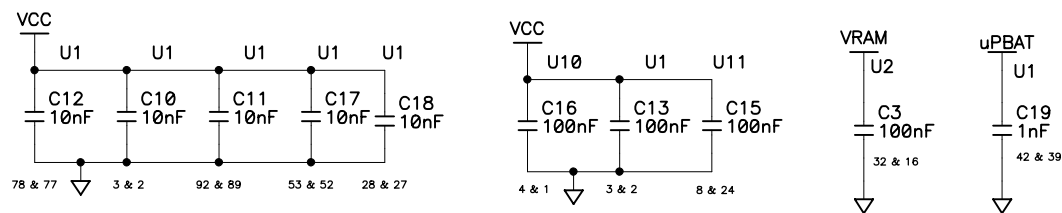
090-0128 Programming Cable Schematic



| REVISION HISTORY | | | REVISION APPROVAL | | | |
|------------------|--------|---|-------------------|---------------|------------------|---------------|
| REV | ECO | DESCRIPTION | PROJECT ENGINEER | APPROVAL DATE | DOCUMENT CONTROL | APPROVAL DATE |
| A | E10937 | INITIAL RELEASE, TRACKS A/W @ REV-B | DM | 04MAY00 | KAH | 03MAY00 |
| B | E11182 | CHANGE R14 FROM 1K TO 1.3K TO CONFORM WITH UL REGULATIONS ON CUREENT LIMITING RESISTORS | RJH | 31AUG00 | KAH | 31AUG00 |
| C | E11620 | CHANGE R14 FROM 1.3K TO 2K. ADDED EXTERNAL 32KHz OSCILLATOR. MODIFIED VBAT CIRCUITRY | | | | |

TABLE A

| REF DES | DEVICE | DEVICE VOLTAGE INFORMATION | | | | | DEVICE: FILTER CAP REF DES(s) |
|---------|-------------|----------------------------|---------------------|-------------------|------|-------------|--|
| | | AGND | GND | VCC | VRAM | NO CONNECTS | |
| U1 | RABBIT 2000 | | 2,27,39 52,77,89 | 3,28,53, 78,92 | 42 | | C13.10 - PIN3, C18,17,12,11 C19 - PIN42 (uPbat) |
| U2 | SRAM* | | 16 | | 32 | | C3 |
| U10 | ETC811 | | 1 | 4 | | | C16 |
| U11 | FLASH* | | 24 | 8 | | | C15 |



STUFFING TABLE

| CIRCUIT | PART | MODEL | | | |
|-------------------|--------------|---------|-----------------------------|-----------------------------|-----------------------------|
| | | RCM2000 | RCM2010 | RCM2020 | |
| SRAM | MAIN | U2 | 512K SRAM | 128K SRAM | 128K SRAM |
| | SRAM SELECT | JP1 | ZERO ohm ACROSS PINS 2-3 | ZERO ohm ACROSS PINS 1-2 | ZERO ohm ACROSS PINS 1-2 |
| FLASH | MAIN | U11 | 256K FLASH | 256K FLASH | 256K FLASH |
| | FLASH SELECT | JP2 | ZERO ohm ACROSS PINS 1-2 | ZERO ohm ACROSS PINS 1-2 | ZERO ohm ACROSS PINS 1-2 |
| | | JP3 | ZERO ohm ACROSS PINS 1-2 | ZERO ohm ACROSS PINS 1-2 | ZERO ohm ACROSS PINS 1-2 |
| PROCESSOR CRYSTAL | Y1 | | 12.9024MHz | 12.9024MHz | 9.216MHz |

- NOTES: UNLESS OTHERWISE SPECIFIED;
- ALL RESISTOR VALUES ARE IN OHMS, 1/10W, 5%
 - ALL CAPACITORS ARE 50VDC OR HIGHER.
 - THE ORIGINATION SOURCE OF A VOLTAGE IS REPRESENTED BY (VCC), AND ALL REFERENCES TO THAT VOLTAGE ARE REPRESENTED BY (VCC).

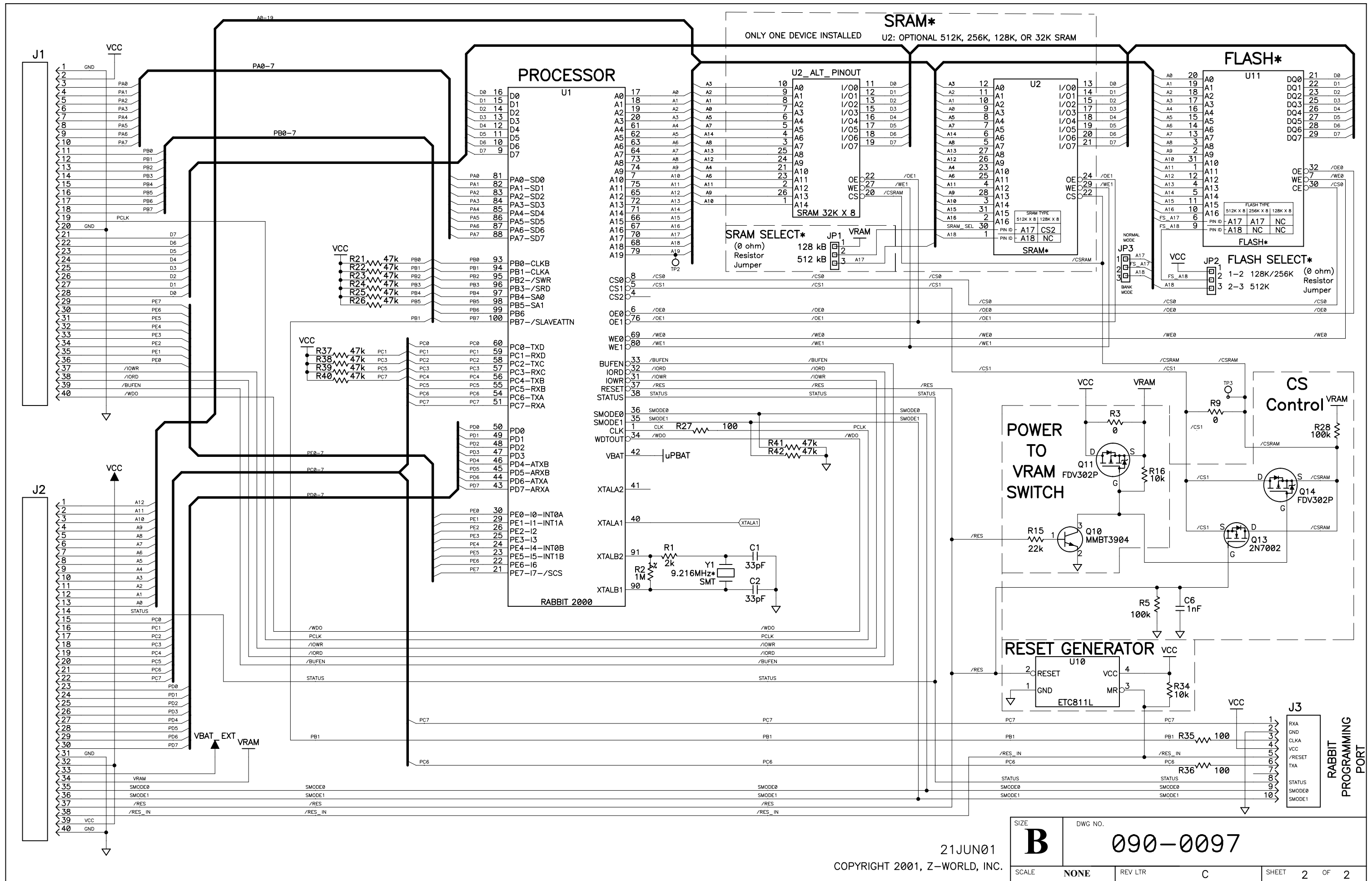
4 OUTLINED CIRCUIT MAY NOT BE STUFFED DEPENDING ON MODEL, SEE STUFFING CHART FOR CLARIFICATION.

- COMPONENT VALUES SHOWN WITH AN ASTERISK (*) FOLLOWING THE VALUE, MAY HAVE DIFFERENT VALUES, OR MAY NOT BE STUFFED DEPENDING ON MODEL. SEE STUFFING CHART FOR CLARIFICATION.

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| | | DRAWN BY: (INITIAL RELEASE) DM | 31JAN00 | SCHEMATIC DIAGRAM RCM2000 SERIES CORE MODULE | |
| | | REVISED BY: KAH | 21JUN01 | | |
| APPROVALS: INITIAL RELEASE | | | | SIZE B DWG NO. 090-0097 | |
| | | PROJECT ENGINEER: DM | 04MAY00 | | |
| | | ENGINEERING MANAGER: --- | --- | | |
| SIGNATURES | | DATE | | SCALE NONE | RELEASE DATE 03MAY00 |
| | | | | SHEET 1 OF 2 | |





ONLY ONE DEVICE INSTALLED U2: OPTIONAL 512K, 256K, 128K, OR 32K SRAM

PROCESSOR

U1

| | |
|----|----|
| D0 | 16 |
| D1 | 15 |
| D2 | 14 |
| D3 | 13 |
| D4 | 12 |
| D5 | 11 |
| D6 | 10 |
| D7 | 9 |

| | |
|-----|----|
| PA8 | 81 |
| PA1 | 82 |
| PA2 | 83 |
| PA3 | 84 |
| PA4 | 85 |
| PA5 | 86 |
| PA6 | 87 |
| PA7 | 88 |

| | |
|-----|-----|
| PB8 | 93 |
| PB1 | 94 |
| PB2 | 95 |
| PB3 | 96 |
| PB4 | 97 |
| PB5 | 98 |
| PB6 | 99 |
| PB7 | 100 |

| | |
|-----|----|
| PC8 | 60 |
| PC1 | 59 |
| PC2 | 58 |
| PC3 | 57 |
| PC4 | 56 |
| PC5 | 55 |
| PC6 | 54 |
| PC7 | 51 |

| | |
|-----|----|
| PD8 | 50 |
| PD1 | 49 |
| PD2 | 48 |
| PD3 | 47 |
| PD4 | 46 |
| PD5 | 45 |
| PD6 | 44 |
| PD7 | 43 |

| | |
|-----|----|
| PE8 | 30 |
| PE1 | 29 |
| PE2 | 26 |
| PE3 | 25 |
| PE4 | 24 |
| PE5 | 23 |
| PE6 | 22 |
| PE7 | 21 |

| | |
|-----|----|
| PC8 | 60 |
| PC1 | 59 |
| PC2 | 58 |
| PC3 | 57 |
| PC4 | 56 |
| PC5 | 55 |
| PC6 | 54 |
| PC7 | 51 |

| | |
|-----|----|
| PD8 | 50 |
| PD1 | 49 |
| PD2 | 48 |
| PD3 | 47 |
| PD4 | 46 |
| PD5 | 45 |
| PD6 | 44 |
| PD7 | 43 |

| | |
|-----|----|
| PE8 | 30 |
| PE1 | 29 |
| PE2 | 26 |
| PE3 | 25 |
| PE4 | 24 |
| PE5 | 23 |
| PE6 | 22 |
| PE7 | 21 |

| | |
|-----|----|
| PC8 | 60 |
| PC1 | 59 |
| PC2 | 58 |
| PC3 | 57 |
| PC4 | 56 |
| PC5 | 55 |
| PC6 | 54 |
| PC7 | 51 |

SRAM SELECT*
(0 ohm) Resistor Jumper

FLASH SELECT*
(0 ohm) Resistor Jumper

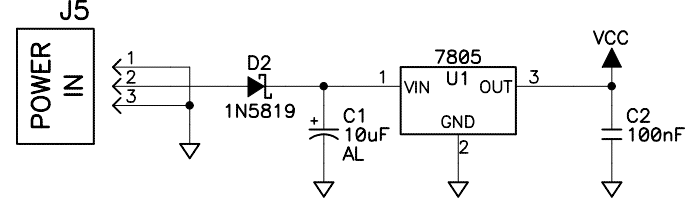
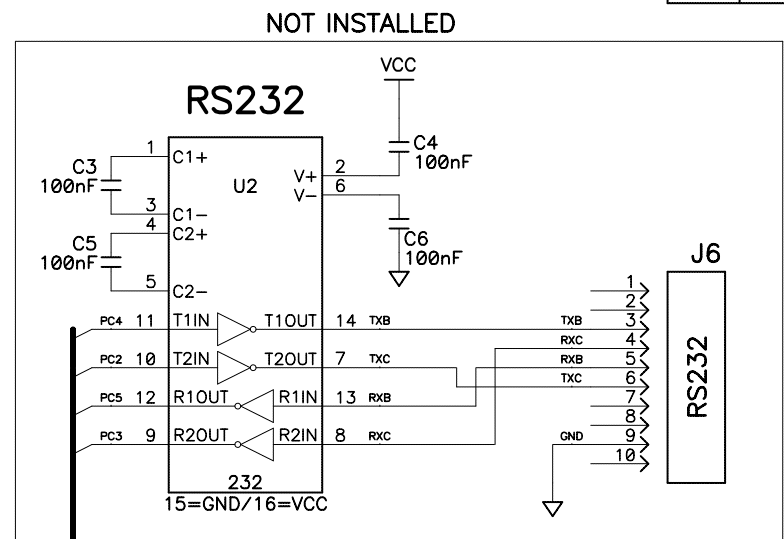
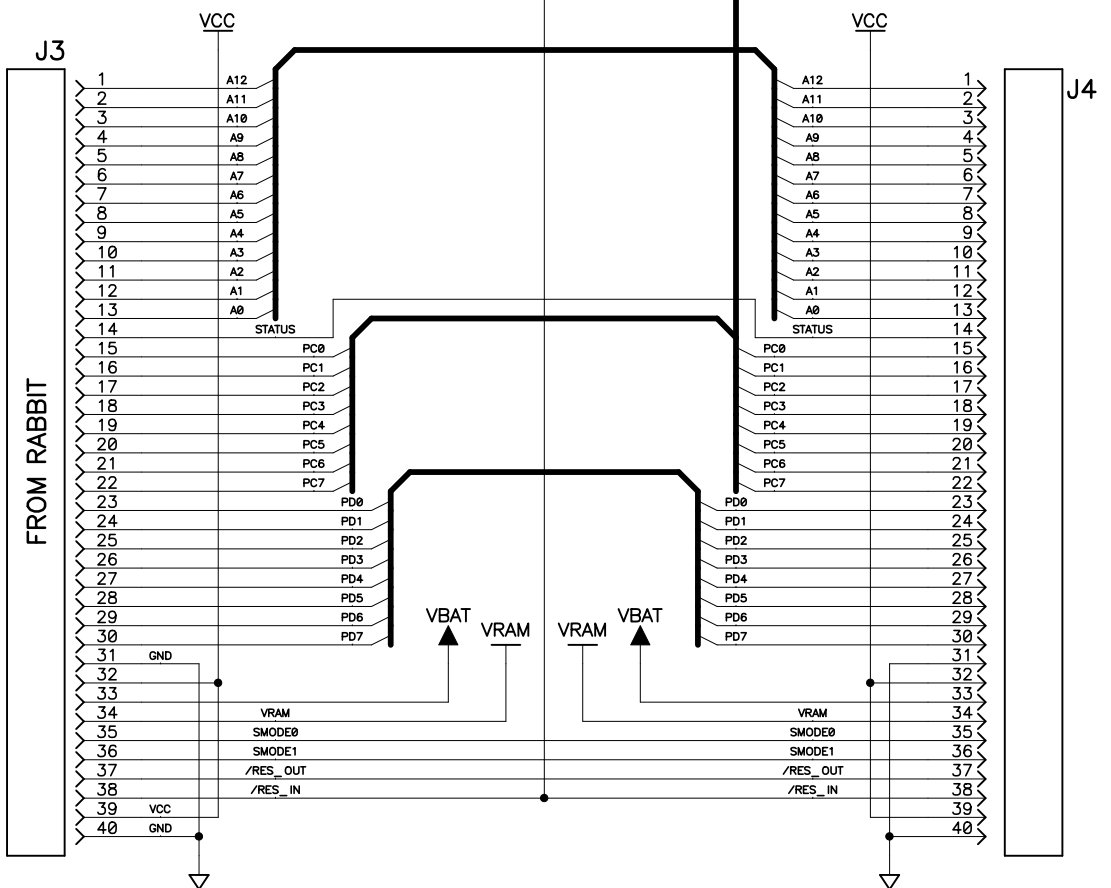
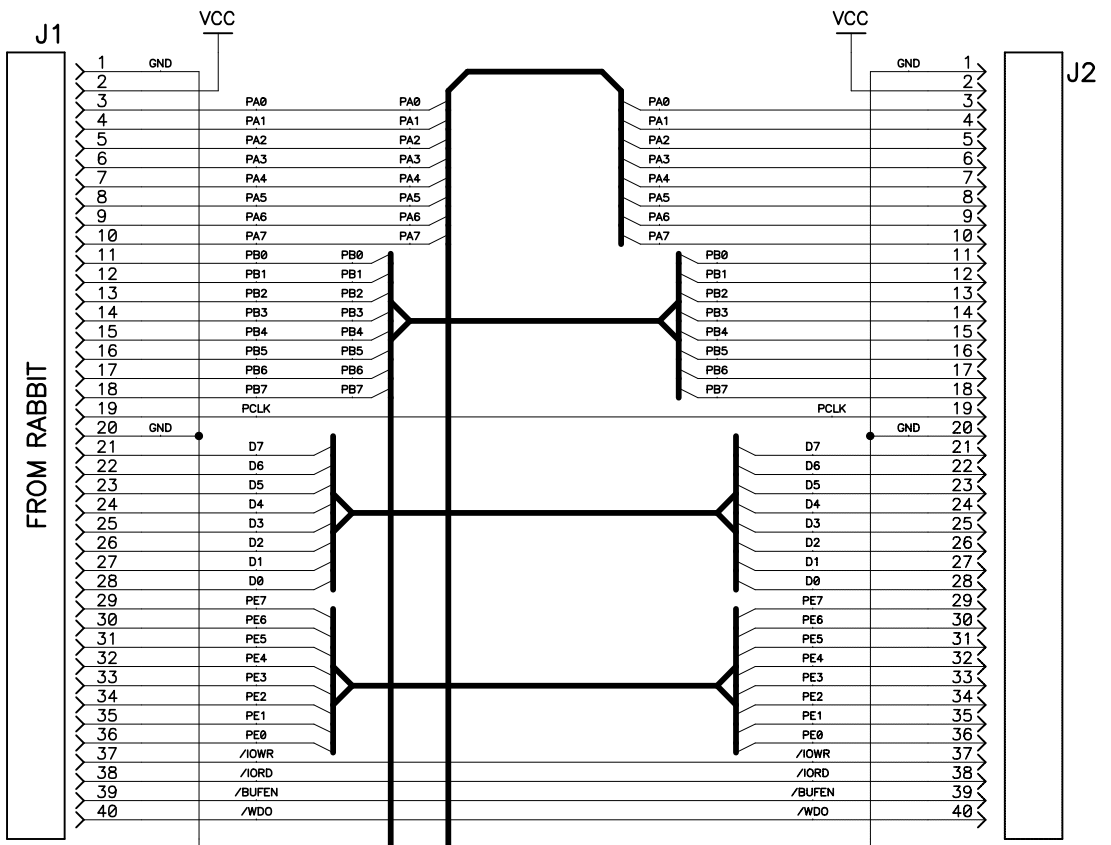
POWER TO VRAM SWITCH

RESET GENERATOR

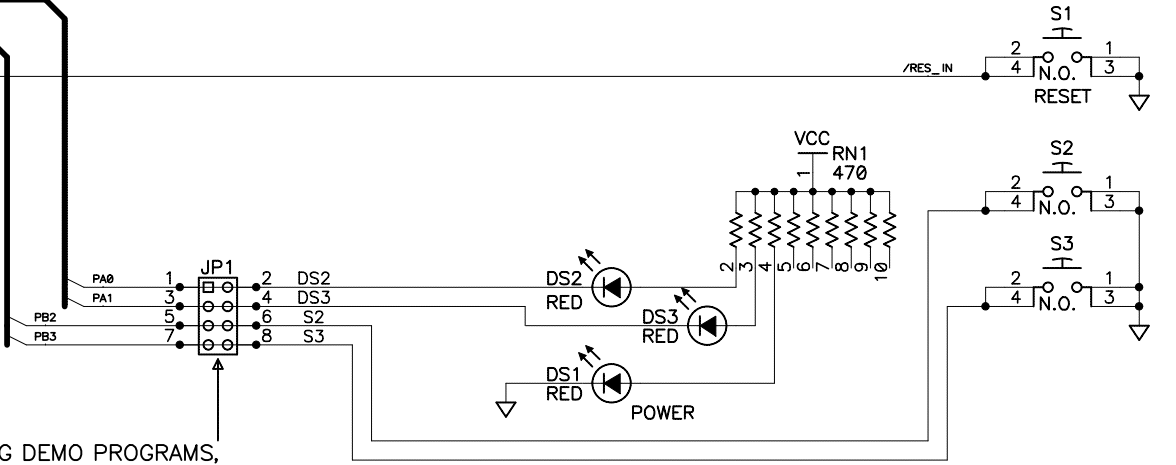
RABBIT PROGRAMMING PORT

21JUN01
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| | | | | | |
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| B | 090-0097 | NONE | C | 2 | 2 |



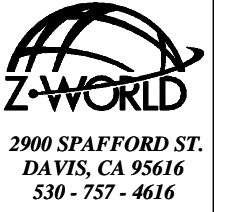
AFTER RUNNING DEMO PROGRAMS,
CAN CUT TRACES IN JP1 TO DISCONNECT
LEDS AND SWITCHES



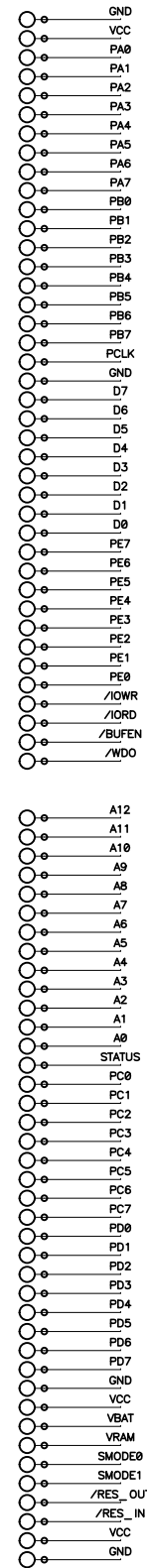
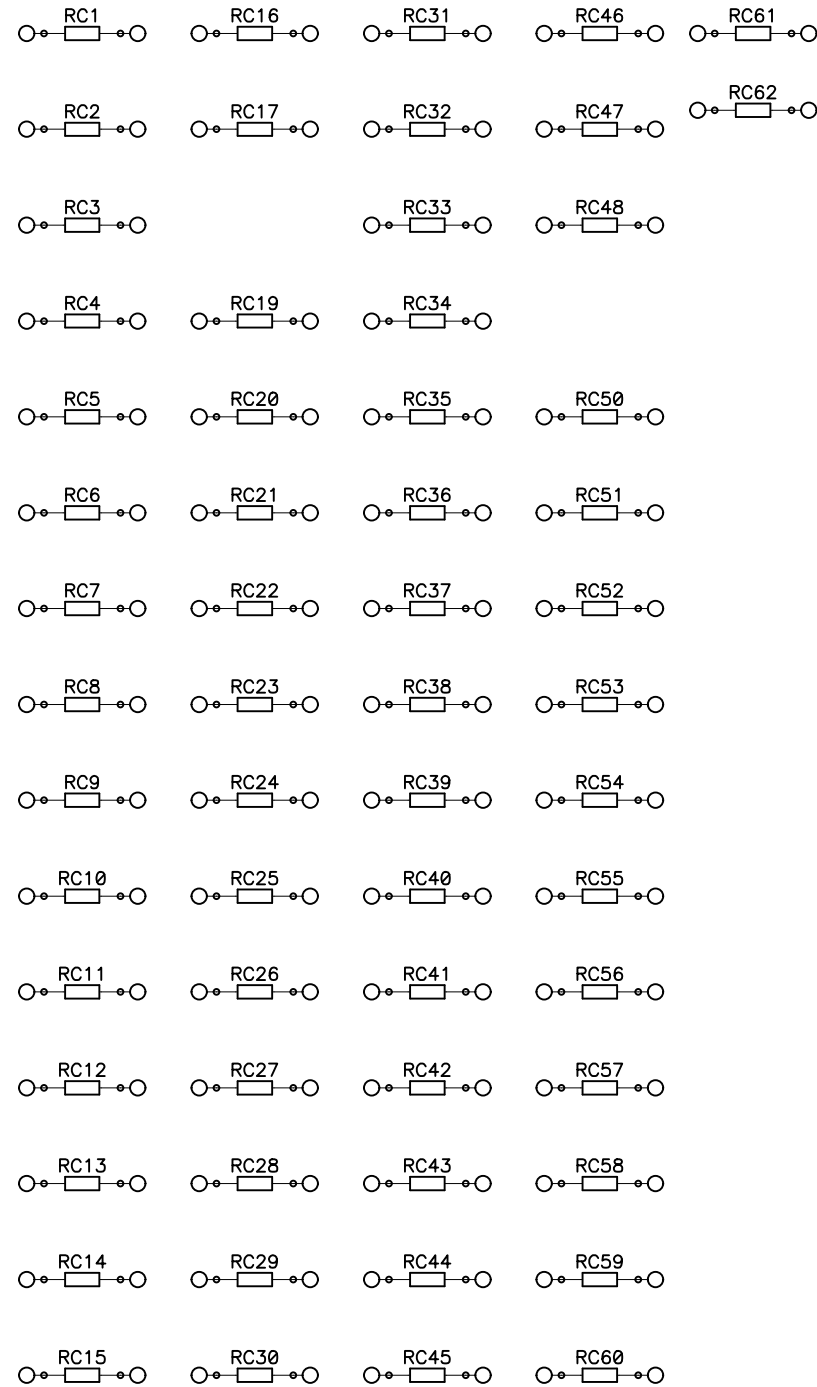
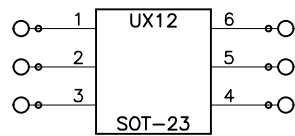
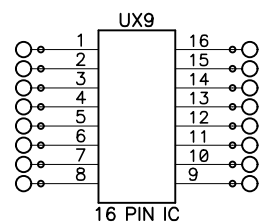
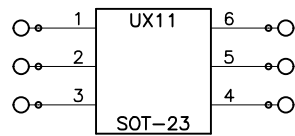
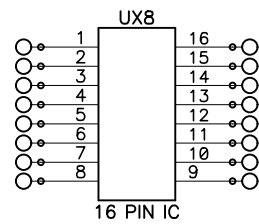
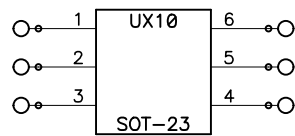
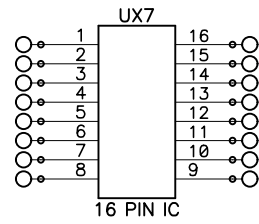
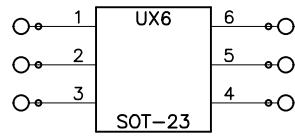
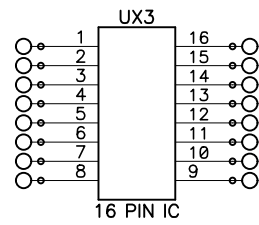
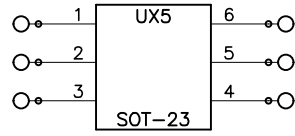
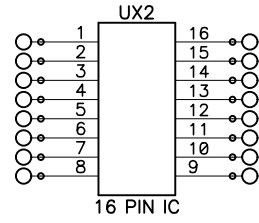
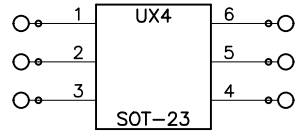
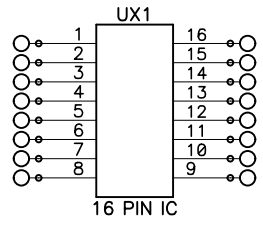
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| REV | ECO | DESCRIPTION | PROJECT ENGINEER | APPROVAL DATE | DOCUMENT CONTROL | APPROVAL DATE |
| A | E11005 | INITIAL RELEASE A/W @ REV-A | | | | |
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| | | REVISED BY: | KAH | RCM2000 SERIES | |
| | | APPROVALS: INITIAL RELEASE | | PROTOTYPING | |
| | | PROJECT ENGINEER: | | BOARD | |
| | | ENGINEERING MANAGER: | | SIZE B | DWG NO. 090-0099 |
| | | SIGNATURES | DATE | SCALE NONE | RELEASE DATE |
| | | | | | SHEET 1 OF 2 |



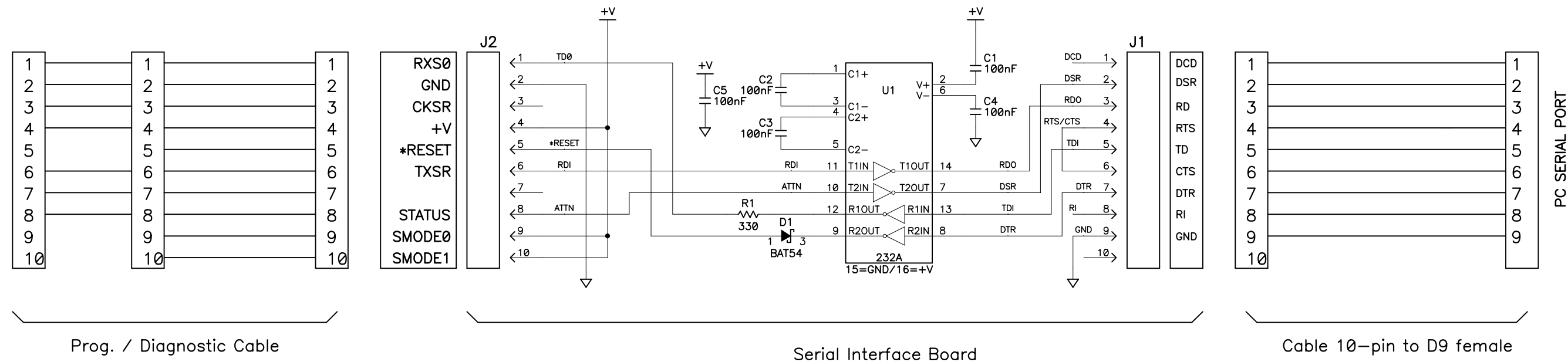
SURFACE MOUNT PROTOTYPING PADS




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| SCALE NONE | REV LTR A |
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|------------------|--------|------------------------------|-------------------|---------------|------------------|---------------|
| REV | ECO | DESCRIPTION | PROJECT ENGINEER | APPROVAL DATE | DOCUMENT CONTROL | APPROVAL DATE |
| A | E11523 | INITIAL RELEASE OF SCHEMATIC | | | | |
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| | DRAWN BY: (INITIAL RELEASE) E. PEAK | 14MAY01 | SCHEMATIC DIAGRAM RABBIT PROG. CABLE | |
| | REVISED BY: | | | |
| | APPROVALS: INITIAL RELEASE | |  2900 SPAFFORD ST. DAVIS, CA 95616 530 - 757 - 4616 | |
| | PROJECT ENGINEER: | | | |
| | ENGINEERING MANAGER: | | | |
| | SIGNATURES | DATE | SIZE B | DWG NO. 090-0128 |
| | | | SCALE NONE | RELEASE DATE |
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