RabbitCore RCM2100

C-Programmable Module with Ethernet

User’s Manual

019–0091 • 011201–E

RabbitCore RCM2100 User's Manual

Part Number 019-0091 • 011201–E • Printed in U.S.A.

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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

TABLE OF CONTENTS

1. Introduction

The RabbitCore RCM2100 series is a family of microprocessor modules designed to be the heart of embedded control systems. In addition to the array of I/O and addressing available on other Z-World products, the RCM2100 series offers an optional integrated Ethernet port. These modules permit LAN and Internet-enabled systems to be built as easily as serial communications-only systems.

The RCM2100 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 22 MHz.

The RCM2100 has a Rabbit 2000 microprocessor, a static RAM, up to two flash memory chips, 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 RCM2100 receives its +5 V power from the user board on which it is mounted. The RCM2100 can interface with all kinds of CMOS-compatible digital devices through the user board.

1.1 RCM2100 Features

- Small size: 2.0" × 3.5" × 0.80"
  (51 mm × 89 mm × 20 mm)
- Microprocessor: Rabbit 2000 running at 22.1 MHz
- 34 CMOS-compatible parallel I/O lines grouped in five 8-bit ports (shared with serial ports)
- 8 data lines (BD0–BD7)
- 13 address lines (BA0–BA12)
- I/0 read, write, buffer enable
- Status, watchdog and clock outputs
- Two startup mode inputs for booting and master/slave configuration
- External reset input
- Reset output
- Five 8-bit timers, two 10-bit timers; five timers are cascadable in pairs
- 2 × 256K flash memory, 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 690,625 bps, maximum synchronous baud rate of 5.52 Mbps. Two ports are configurable as clocked ports.

Appendix A, “RabbitCore RCM2100 Specifications,” provides detailed specifications for the RabbitCore RCM2100 series.

Four versions of the RabbitCore RCM2100 series are available. Their standard features are summarized in Table 1.

Table 1. RCM2100 Series Models

Model	Features
RCM2100	Full-featured module
RCM2110	RCM2100 with 128K SRAM, 256K flash memory
RCM2120	RCM2100 without Ethernet
RCM2130	RCM2110 without Ethernet

1.2 Advantages of the RCM2100 Series

- Fast time to market using a fully engineered, “ready to run” microprocessor core.
- Competitive pricing when compared with the alternative of purchasing and assembling individual components.
- Easy C-language program development and debugging, including rapid production loading of programs.
- Generous memory size allows large programs with tens of thousands of lines of code, and substantial data storage.
- Integrated Ethernet port (on selected models) for network connectivity, royalty-free TCP/IP software.
- Models with and without Ethernet for flexible production options.
- Small size and identical footprint and pinout for all models.

1.3 Development and Evaluation Tools

A complete Development Kit, including a Prototyping Board, accessory components and Dynamic C development software, is available to accompany the RCM2100 module. The Development Kit puts together the essentials you need to design an embedded microprocessor-based system rapidly and efficiently.

See the ***RabbitCore RCM2100 Series Getting Started Manual*** for complete information on the Development Kit.

1.4 How to Use This Manual

This user's manual is intended to give users detailed information on the RCM2100 series modules. It does not contain detailed information on the Dynamic C development environment or the TCP/IP software support for the integrated Ethernet port. Most users will want more detailed information on some or all of these topics in order to put the RCM2100 module to effective use.

1.4.1 Additional Product Information

Introductory information about the RabbitCore RCM2100 series and its associated Development Kit and Prototyping Board will be found in the printed ***RabbitCore RCM2100 Getting Started Manual,*** which is also provided on the accompanying CD-ROM in both HTML and Adobe PDF format.

We recommend that any users unfamiliar with Z-World products, or those who will be using the Prototyping Board for initial evaluation and development, begin with at least a read-through of the ***Getting Started*** manual.

1.4.2 Additional Reference Information

In addition to the product-specific information contained in the ***RabbitCore RCM2100 Series Getting Started*** and ***User's 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 RCM2100 series modules:

- ***Dynamic C Premier User's Manual***
- ***An Introduction to TCP/IP***
- ***Dynamic C TCP/IP User's Manual***
- ***Rabbit 2000 Microprocessor User's Manual***

1.4.3 Using Online Documentation

We provide the bulk of our user and reference documentation in two electronic formats, HTML and Adobe PDF. We do this for several reasons.

We believe that providing all users with our complete library of product and reference manuals is a useful convenience. However, printed manuals are expensive to print, stock, and ship. Rather than include and charge for manuals that every user may not want, or provide only product-specific manuals, we choose to provide our complete documentation and reference library in electronic form with every Development Kit and with our Dynamic C development environment.

> **NOTE:** The most current version of Adobe Acrobat Reader can always be downloaded from Adobe's web site at **http://www.adobe.com**. We recommend that you use version 4.0 or later.

Providing this documentation in electronic form saves an enormous amount of paper by not printing copies of manuals that users don't need. It reduces the number of outdated manuals we have to discard from stock as well, and it makes providing a complete library of manuals an almost cost-free option. For one-time or infrequent reference, electronic documents are more convenient than printed ones—after all, they aren't taking up shelf or desk space!

1.4.3.1 Finding Online Documents

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.

1.4.3.2 Printing Electronic Manuals

We recognize that many users prefer printed manuals for some uses. Users can easily print all or parts of those manuals provided in electronic form. The following guidelines may be helpful:

- Print from the Adobe PDF versions of the files, not the HTML versions.
- Print only the sections you will need to refer to more than once.
- Print manuals overnight, when appropriate, to keep from tying up shared resources during the work day.
- If your printer supports duplex printing, print pages double-sided to save paper and increase convenience.
- If you do not have a suitable printer or do not want to print the manual yourself, most retail copy shops (e.g., Kinkos, AlphaGraphics, CopyMax) will print the manual from the PDF file and bind it for a reasonable charge—about what we would have to charge for a printed and bound manual.

2. Hardware Reference

Chapter 2 describes the hardware components and principal hardware subsystems of the RabbitCore RCM2100 series. Appendix A, “RabbitCore RCM2100 Specifications,” provides complete physical and electrical specifications.

2.1 RCM2100 Series Digital Inputs and Outputs

Figure 1 shows the subsystems designed into the RCM2100 series.

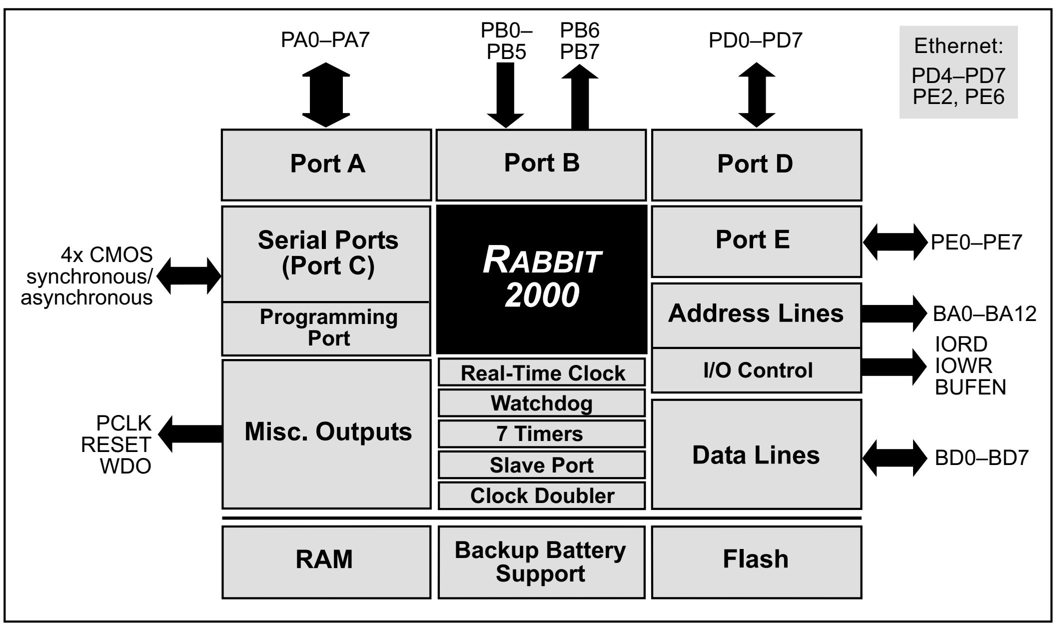


Figure 1. Rabbit Subsystems

The RCM2100 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 2.

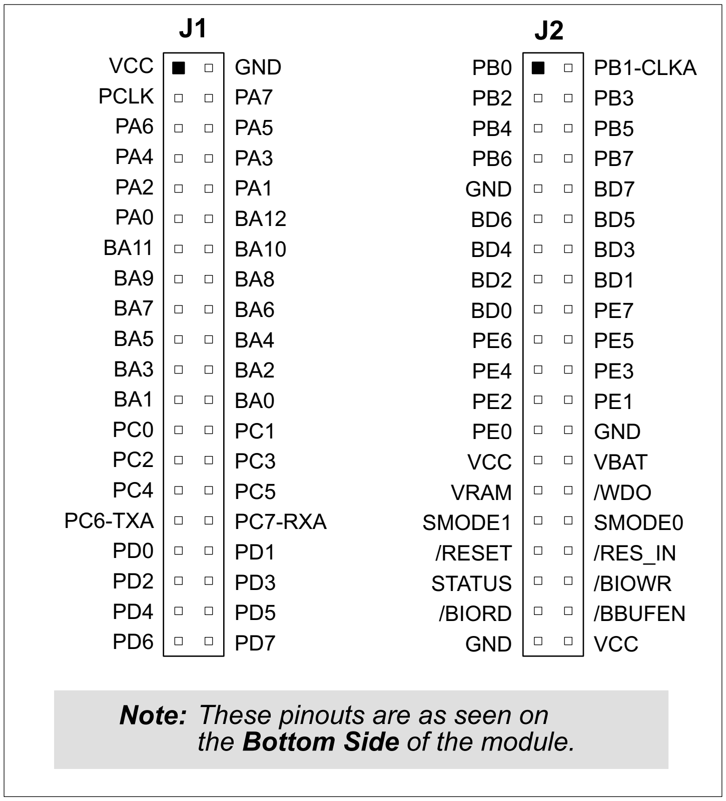


Figure 2. RCM2100 I/O Pinouts

The ports on the Rabbit 2000 microprocessor used in the RCM2100 series are configurable, and so the factory defaults can be reconfigured. Table 1 lists the Rabbit 2000 factory defaults and the alternate configurations.

As shown in Table 1, 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.

The Ethernet-enabled versions of the RCM2100 do not have 0 Ω resistors (jumpers) installed at R21, R24, and R35–R38, which allows PE6, PE2, and PD4–PD7 to connect to the RealTek Ethernet chip that is stuffed on those versions.

Table 1. RCM2100 Pinout Configurations

Pin		Pin Name	Default Use	Alternate Use	Notes
Header J1	1	VCC			
	2	GND			
	3	PCLK	Output (Internal Clock)	Output	Turned off in software
	4–11	PA[7:0]	Parallel I/O	Slave port data bus SD0–SD7	
	12–24	BA[12:0]	Output		Buffered Rabbit 2000 address bus
	25	PC0	Output	TXD	
	26	PC1	Input	RXD	
	27	PC2	Output	TXC	
	28	PC3	Input	RXC	
	29	PC4	Output	TXB	
	30	PC5	Input	RXB	
	31	PC6	Output	TXA	Connected to programming port
	32	PC7	Input	RXA	
	33–36	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
	37	PD4		ATXB output	Ethernet chip RSTDRV
	38	PD5		ARXB input	Ethernet chip BD5
	39	PD6		ATXA output	Ethernet chip BD6
	40	PD7		ARXA input	Ethernet chip BD7

Table 1. RCM2100 Pinout Configurations (continued)

	Pin	Pin Name	Default Use	Alternate Use	Notes
Header J2	1	PB0	Input	Serial port clock CLKB	
	2	PB1	Input	Serial port clock CLKA	CLKA is connected to programming port (header J5, pin 3)
	3	PB2	Input	Slave port write /SWR	
	4	PB3	Input	Slave port read /SRD	
	5	PB4	Input	SA0	Slave port address lines
	6	PB5	Input	SA1	
	7	PB6	Output		
	8	PB7	Output	Slave port attention line /SLAVEATTN	
	9, 26, 39	GND			
	10–17	BD[7:0]	Input/Output		Buffered Rabbit 2000 data bus
	18	PE7	Bitwise or parallel programmable I/O	I7 output or slave port chip select /SCS	
	19	PE6		I6 output	Ethernet chip IOWB
	20	PE5		I5 output or INT1B input	
	21	PE4		I4 output or INT0B input	
	22	PE3		I3 output	
	23	PE2		I2 output	Ethernet chip IORB
	24	PE1		I1 output or INT1A input	
	25	PE0		I0 output or INT0A input	
	27, 40	VCC			
	28	VBAT	3 V battery input		
	29	VRAM	2.1 V output		100 µA maximum current draw
	30	/WDO	Output (Watchdog output)	May also be used to output a 30 µs pulse	Outputs a pulse when the internal watchdog times out

Table 1. RCM2100 Pinout Configurations (continued)

Pin		Pin Name	Default Use	Alternate Use	Notes
Header J2	31–32	SMODE1, SMODE0	(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
	33	/RESET	Reset output		
	34	/RES_IN	Reset input		
	35	STATUS	Output (Status)	Output	
	36	/BIOWR	Output (I/O buffer write strobe)		
	37	/BIORD	Output (I/O buffered strobe)		
	38	/BUFEN	Output (I/O buffer enable)		

2.1.1 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. These pins are 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. When Port C is used as a parallel port, PC1, PC3, PC5, and PC7 are inputs only. These pins can alternately be selectively enabled to serve as the serial data inputs for Serial Ports D, C, B, and A.

2.1.2 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.

2.1.3 Memory I/O Interface

Thirteen of the Rabbit 2000 buffered address lines (A0–A12) and all the buffered data lines (D0–D7) are available as outputs. 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.

The output clock is available on the PCLK pin. 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. PCLK can also be disabled by removing R20 if there is a need to reduce radiated emissions. Removing R20 will disable the PCLK output on pin 3 of header J1. Alternatively, PCLK can be disabled in software using Dynamic C version 7.03 or later.

2.1.4 Additional I/0

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 the RabbitCore RCM2100 memory. /RES_OUT is an output from the reset circuitry that can be used to reset other peripheral devices.

2.2 Serial Communication

The RCM2100 board does not have an RS-232 or an RS-485 transceiver directly on the board. However, an RS-232 or RS-485 interface may be incorporated on the board the RCM2100 is mounted on. For example, the Prototyping Board supports a standard RS-232 transceiver chip.

2.2.1 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 2000 provides the clock, the baud rate can be up to 1/4 of the system clock frequency, or 5.52 Mbps for a 22.1 MHz clock speed.

2.2.2 Ethernet Port

Figure 3 shows the pinout for the RJ-45 Ethernet port (J4). Note that there are two standards for numbering the pins on this connector—the convention used here, and numbering in reverse to that used here.

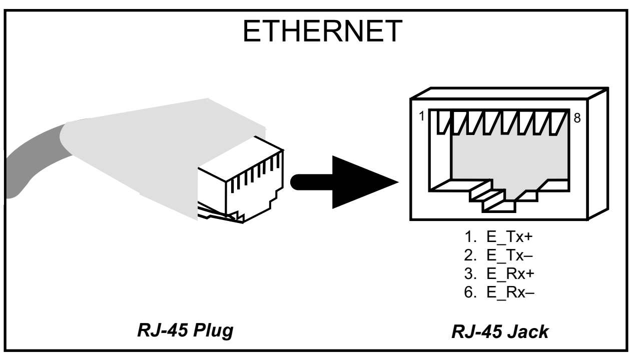


Figure 3. RJ-45 Ethernet Port Pinout

The transformer/connector assembly ground is connected to the RCM2100 printed circuit board digital ground via a 0 Ω resistor "jumper," R5, as shown in Figure 4.

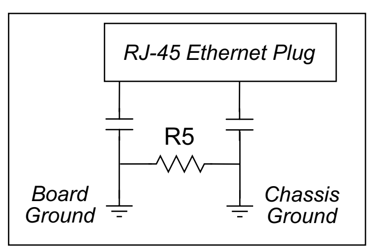


Figure 4. Isolation Resistor R5

The factory default is for the 0 Ω resistor "jumper" at R5 to be installed. In high-noise environments, it may be useful to ground the transformer/connector assembly directly through the chassis ground. This will be especially helpful to minimize EMI problems. Once you have removed the 0 Ω resistor "jumper," R5, use a screw in the position indicated in Figure 5 to attach the RCM2100 board to the chassis ground, thereby grounding the transformer/connector assembly.

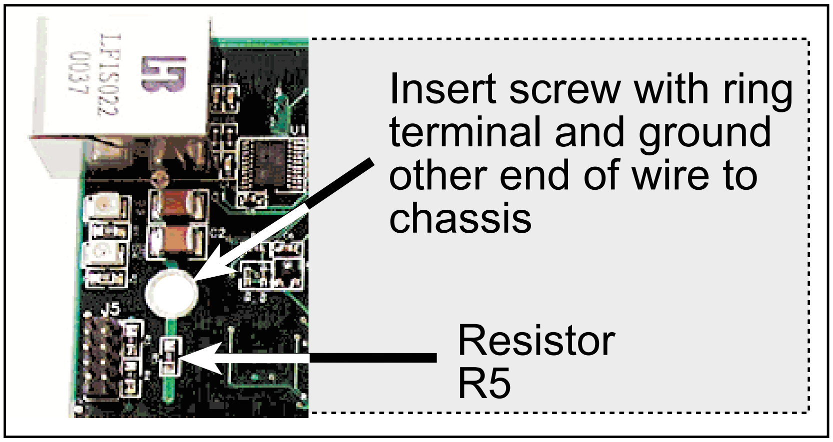


Figure 5. R5 and Chassis Ground Locations

The RCM2100 is available in quantity without the transformer/connector assembly and the **ACT** and **LNK** LEDs (shown to the right of the transformer/connector assembly in Figure 5 above) installed. The Ethernet signals and the LED control signals are then available on header J3 installed on the bottom side of the board, and J3 may then be plugged in to the rest of the system. An Ethernet transformer and LEDs should be included on the board that the modified RCM2100 is plugged into.

NOTE: Contact your Z-World/Rabbit Semiconductor Sales Representative for quantity and pricing information related to this option.

2.2.3 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 RCM2100 has a 10-pin program header labeled J5. The Rabbit 2000 startup-mode pins (SMODE0, SMODE1) are presented to the programming port so that an externally connected device can force the RCM2100 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 RCM2100 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 RCM2100 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.

2.3 Memory

2.3.1 SRAM

The RCM2100 series is designed to accept 32K to 512K of SRAM packaged in an SOIC case.

The existing standard models of the RCM2100 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.

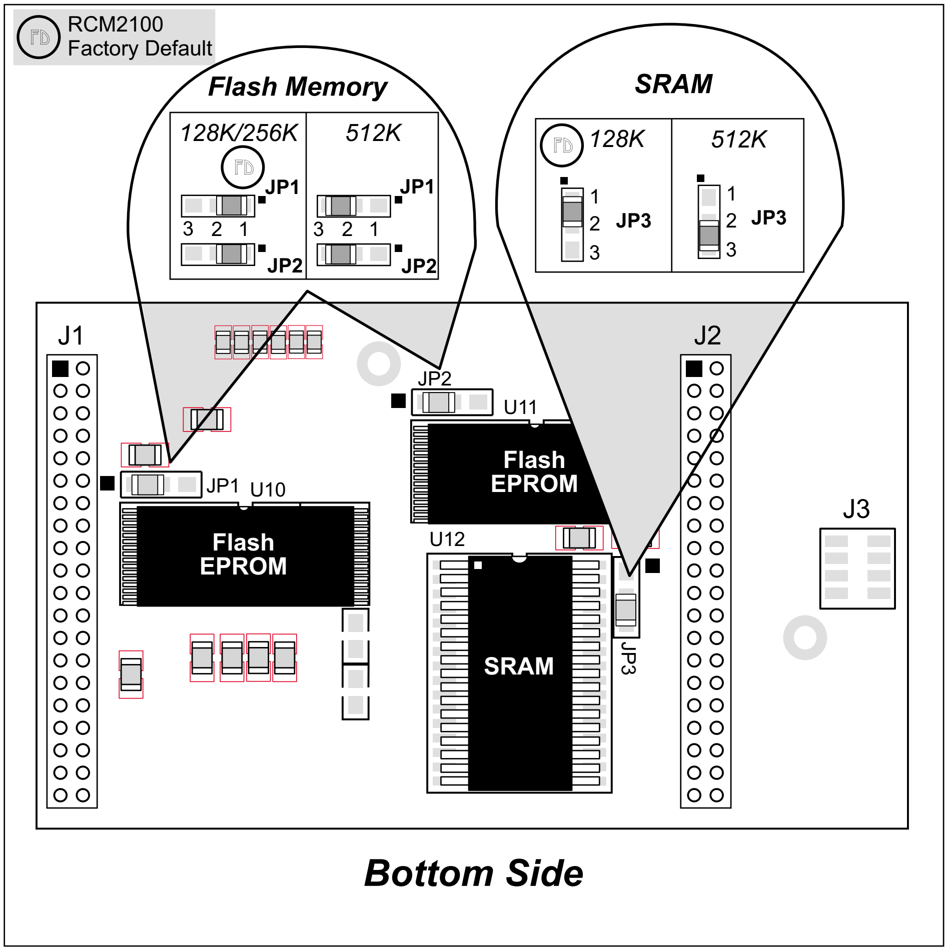


Figure 6. RCM2100 SRAM and Flash Memory Sizes—Jumper Settings

No “jumpers” are used at JP1 for 32K SRAM.

2.3.2 Flash Memory

The RCM2100 is also designed to accept 128K to 512K of flash memory packaged in a TSOP case.

The existing standard models of the RabbitCore RCM2100 come with either one or two 256K flash memory chips installed. Figure 6 shows the locations and the jumper settings for the jumpers at JP2 used to set the flash memory size. The “jumpers” are 0 Ω surface-mounted resistors.

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 JP4 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 two flash memory chips.

> **NOTE:** Only the Normal Mode (pins 1–2 connected at JP5), which corresponds to using the full code space, is supported at the present time.

2.3.3 Dynamic C BIOS Source Files

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

2.4 Other Hardware

2.4.1 Clock Doubler

The RCM2100 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 22.1 MHz frequency is generated using an 11.05 MHz crystal. The clock doubler is disabled automatically in the BIOS for crystals with a frequency above 12.9 MHz.

The clock doubler may be disabled if 22.1 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 RabbitCore RCM2100 series is operated at 11.05 MHz.
4. Save the change using **File > Save**.

2.5 Programming Cable

The RCM2100 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 J5 of the RCM2100 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.

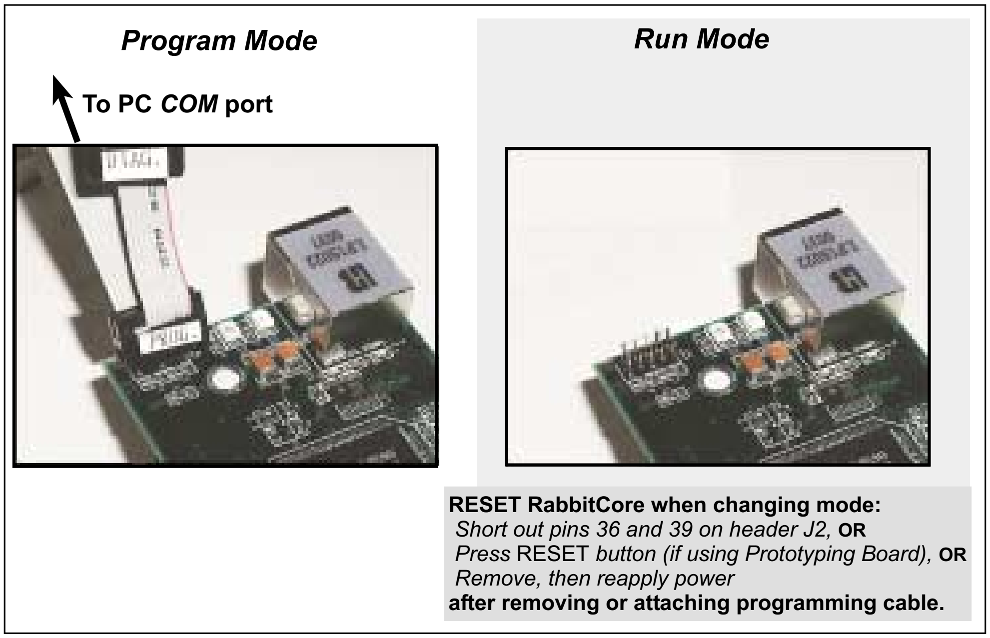


Figure 7. Switching Between Program Mode and Run Mode

2.5.1 Changing from Program Mode to Run Mode

1. Disconnect the programming cable from header J5 of the RCM2100.
2. Reset the RCM2100. You may do this as explained in Figure 7. Figure 8 shows the location of the RESET button on the Prototyping Board.

The RCM2100 is now ready to operate in the Run Mode.

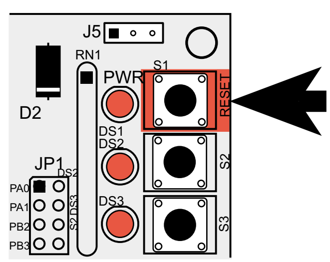


Figure 8. Location of Prototyping Board Reset Button

2.5.2 Changing from Run Mode to Program Mode

1. Attach the programming cable to header J3 on the RCM2100.
2. Reset the RCM2100. You may do this as explained in Figure 7. Figure 8 shows the location of the RESET button on the Prototyping Board.

The RCM2100 is now ready to operate in the Program Mode.

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 controllers and other controllers based on the Rabbit microprocessor. Chapter 3 provides the libraries, function calls, and sample programs related to the RCM2100.

3.1 More About Dynamic C

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

Dynamic C for Rabbit 2000™ processors uses the standard Rabbit programming interface. This is a 10-pin connector that connects to the Rabbit 2000 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 user program stops running, a new cold boot and BIOS compile can be done at any time.

Dynamic C does not use **`include`** files, rather it has libraries that are used for the same purpose, that is, to supply functions and function prototypes to programs before they are compiled.

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 µs. 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 µs ticks. These variables are needed by some 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 sleepy 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.
- The periodic interrupt function also hits the hardware watchdog timer. Software or "virtual" watchdog timers are available in Dynamic C. See the ***Dynamic C Premier User's Manual*** for more information.

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 512K or 256K bytes of flash memory and 512K or 128K bytes of SRAM. 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 memory.

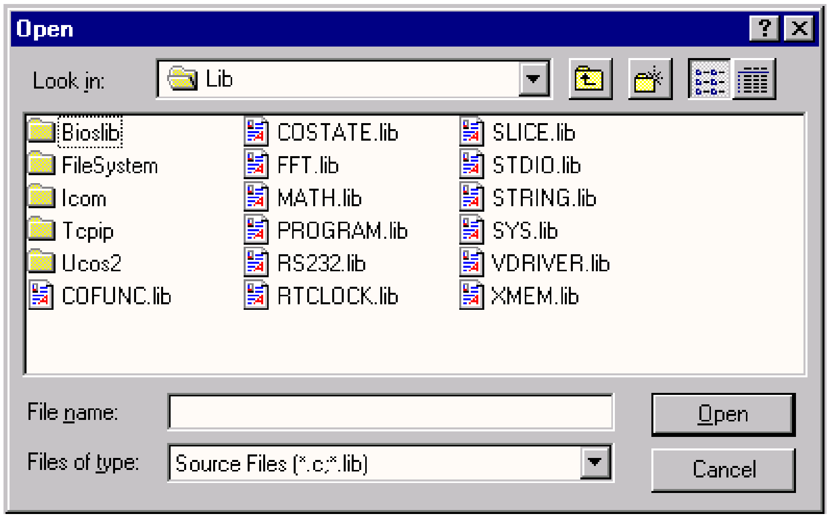
> **NOTE:** Do not depend on the flash memory sector size or type. Due to the volatility of the flash memory market, the RCM2100 and Dynamic C were designed to accommodate flash devices with various sector sizes.

The disadvantage of using flash memory when debugging a program is that interrupts must be disabled for approximately 5 ms to 20 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 memory or RAM is selected with the Dynamic C **Options** > **Compiler** menu.

3.2 Dynamic C Libraries

With Dynamic C running, click **File > Open**, and select **Lib**. The following list of Dynamic C libraries will be displayed.



There is no unique library that is specific to the RCM2100. The functions in the above libraries are described in the ***Dynamic C Premier User's Manual***.

3.2.1 I/O

The RCM2100 was designed to interface with other systems, and so there are no drivers written specifically for the I/O. 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/RCM2100** directory provide further examples.

3.2.1.1 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):

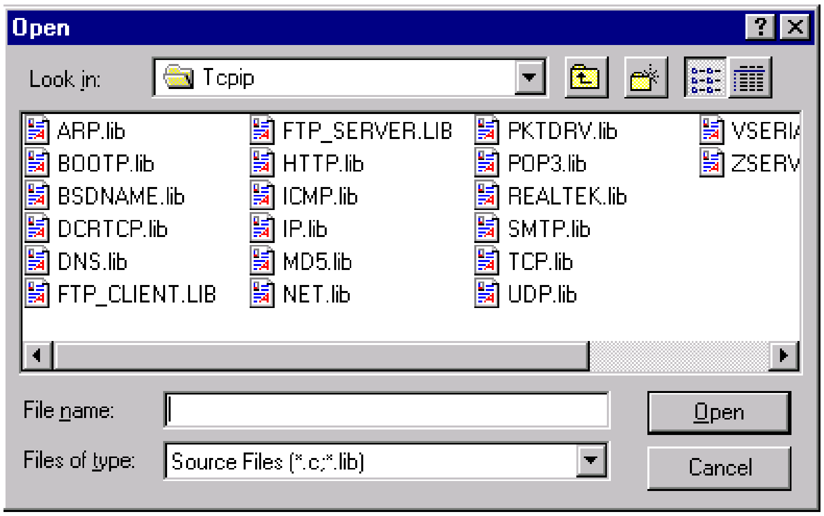
```
WrPortI(GOCR, &GOCRShadow, (GOCRShadow | 0xc0));
```

3.2.2 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***.

3.2.3 TCP/IP Drivers

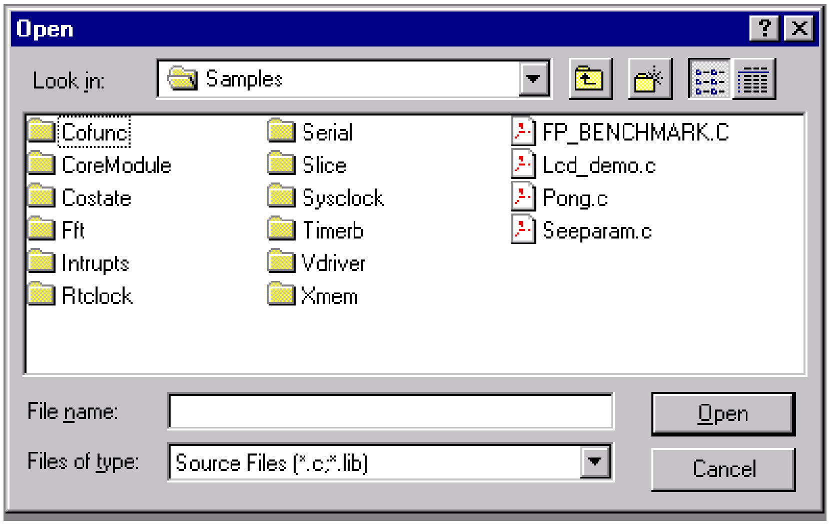
The TCP/IP drivers are located in the **TCPIP** directory.



Complete information on these libraries and the TCP/IP functions is provided in the ***Dynamic C TCP/IP User's Manual***.

3.3 Sample Programs

Sample programs are provided in the Dynamic C **Samples** folder, which is shown below.



The various folders contain specific sample programs that illustrate the use of the corresponding Dynamic C libraries. For example, the sample program **PONG.C** demonstrates the output to the Dynamic C **STDIO** window.

Two folders contain sample programs that illustrate features unique to the RabbitCore RCM2100.

- **RCM2100**—Demonstrates the basic operation and the Ethernet functionality of the RabbitCore RCM2100.
- **TCPIP**—Demonstrates more advanced TCP/IP programming for Z-World's Ethernet-enabled Rabbit-based boards.

Follow the instructions included with the sample program to connect the RabbitCore RCM2100 and the other hardware identified in the instructions.

To run a sample program, open it with the **File** menu (if it is not still open), compile it using the **Compile** menu, and then run it by selecting **Run** in the **Run** menu. The RCM2100 must be in Program Mode (see Section 2.5, "Programming Cable,") and must be connected to a PC using the programming cable.

More complete information on Dynamic C is provided in the ***Dynamic C Premier User's Manual***.

3.4 Upgrading Dynamic C

Dynamic C patches that focus on bug fixes are available from time to time. Check the Web sites

- www.zworld.com/support/supportcenter.html

or

- www.rabbitsemiconductor.com/support.html

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. Z-World 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.

3.4.1 Upgrades

A special edition of Dynamic C, Dynamic C SE, is included on the CD that comes with the RabbitCore RCM2100 Development Kit, and has been customized with all the libraries and features needed to develop and run an application on the RCM2100.

More advanced users who may need upgrades and additional capabilities for other Z-World products in the future are encouraged to consider the standard edition of Dynamic C Premier, which Z-World plans to fully supported with upgrades now and into the future.

APPENDIX A. RABBITCORE RCM2100 SPECIFICATIONS

Appendix A provides the specifications for the RCM2100, and describes the conformal coating.

A.1 Electrical and Mechanical Characteristics

Figure A-1 shows the mechanical dimensions for the RCM2100.

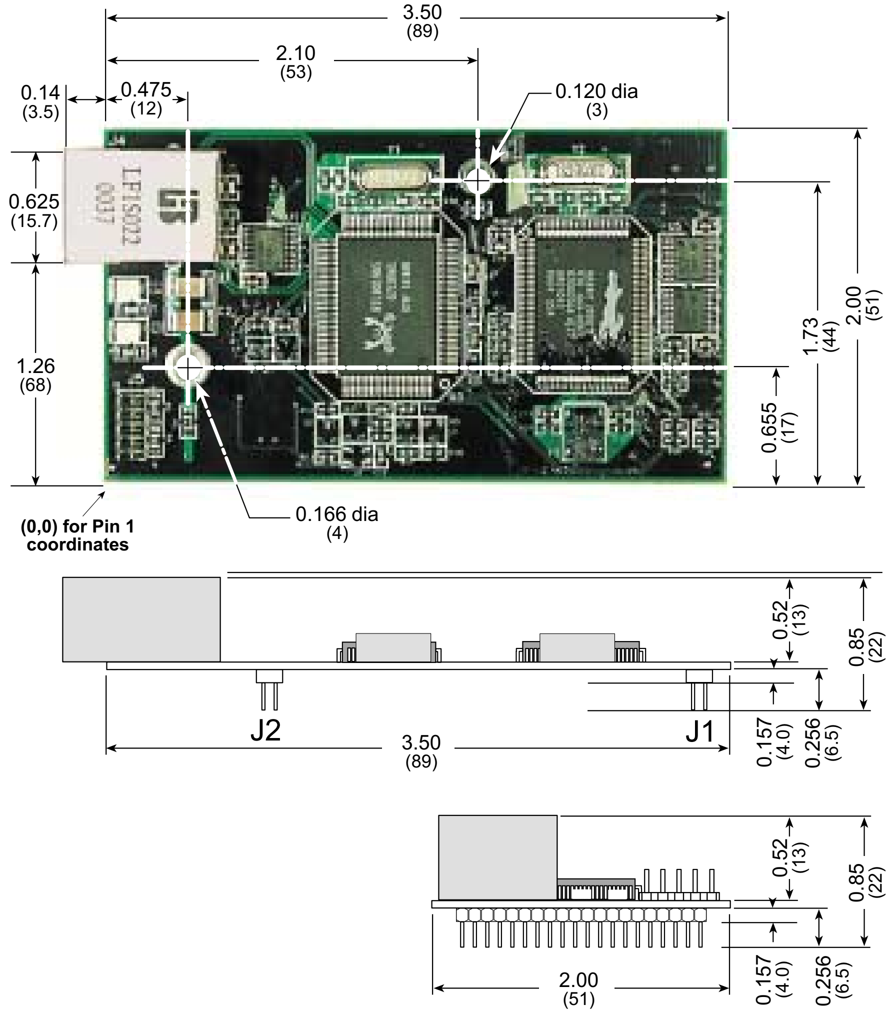


Figure A-1. RCM2100 Dimensions

Table A-1 provides the pin 1 locations for the RCM2100 headers viewed from the top side (as in Figure A-1).

Table A-1. RCM2100 Header Pin 1 Locations

Header	Description	Pin 1 (x,y) Coordinates (Inches)
J1	RCM2100 subsystems	(3.350, 1.731)
J2	RCM2100 subsystems	(0.975, 1.731)
J3	Unisolated Ethernet signals (RCM2110 without RJ-45 jack/transformer)	(0.224, 0.861)

It is recommended that you allow for an “exclusion zone” of 0.25" (6 mm) around the RCM2100 in all directions when the RCM2100 is incorporated into an assembly that includes other components. This “exclusion zone” that you keep free of other components and boards will allow for sufficient air flow, and will help to minimize any electrical or EMI interference between adjacent boards. An “exclusion zone” of 0.12" (3 mm) is recommended below the RCM2100 when the RCM2100 is plugged into another assembly using the shortest connectors for headers J1 and J2 on the RCM2100. Figure A-2 shows this “exclusion zone.”

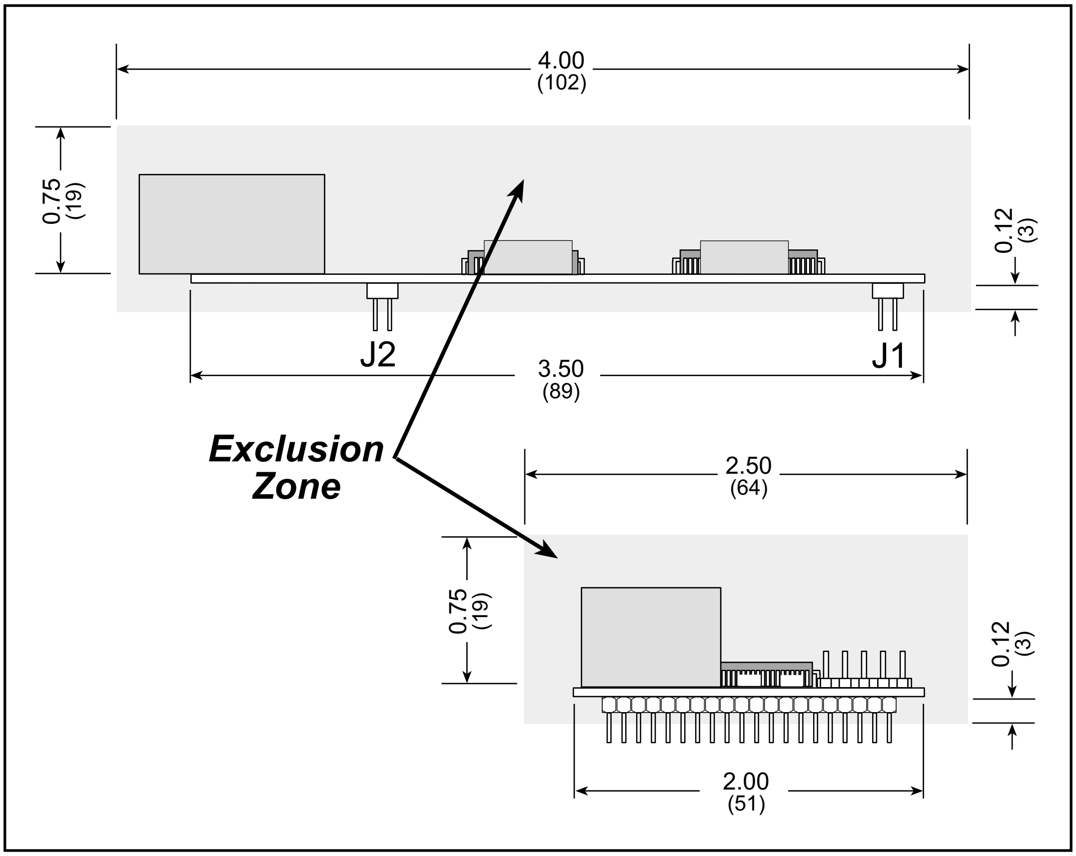


Figure A-2. RCM2100 “Exclusion Zone”

Table A-2 lists the electrical, mechanical, and environmental specifications for the RCM2100.

Table A-2. RCM2100 Specifications

Parameter	Specification
Board Size	2.00" × 3.50" × 0.80" (51 mm × 89 mm × 20 mm)
Operating Temperature	–40°C to +70°C
Humidity	5% to 95%, noncondensing
Input Voltage	4.75 V to 5.25 V DC
Current	140 mA at 22.1 MHz, 5 V DC; 82 mA at 11.05 MHz, 5 V DC
General-Purpose I/O	34 parallel I/0 lines grouped in five 8-bit ports (shared with serial ports): 20 configurable for I/O, 8 fixed inputs, 6 fixed outputs
Memory, I/O Interface	13 address lines, 8 data lines, I/O read/write, buffer enable
Additional Digital Inputs	Startup mode (2 for master/slave), reset in
Additional Digital Outputs	Status, clock, watchdog out, reset out
Ethernet Interface	10base-T
Microprocessor	Rabbit 2000
Clock	22.1 MHz
SRAM	512K × 8, surface mount
Flash Memory	Two 256K × 8, surface mount
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 690,625 bps maximum synchronous 5.52 Mbps
Slave Interface	A slave port allows the RabbitCore RCM2100 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
Watchdog/Supervisor	Yes
Time/Date Clock	Yes
Socket Strip (for connection to headers J1 and J2)	Pinrex 2x20, 2 mm pitch (PS2S-2X20GOB)
Backup Battery	Provision for user-supplied backup battery (2.85 V to 3.15 V) via connections on header J2

A.1.1 Headers

The RCM2100 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 RCM2100 to be plugged in to. These values are relative to the header connectors.

Hole diameters of 0.035 inches are recommended for the user board that the RabbitCore RCM2100 will be plugged into.

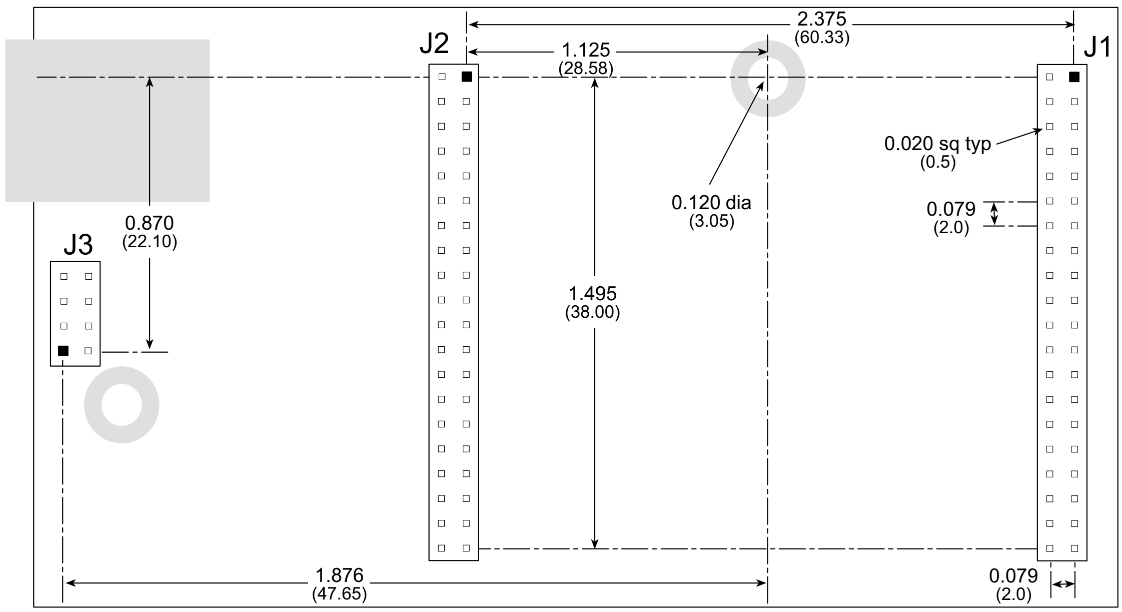


Figure A-3. User Board Footprint for the RCM2100

A.1.2 Physical Mounting

A 9/32” (7 mm) standoff with a 4-40 screw is recommended to attach the RCM2100 to a user board at the hole position shown in Figure A-3. A standoff with a screw may also be used at the hole position close to the RJ-45 Ethernet connector for a second anchor, or you may opt to have a nut and bolt with a wire at this hole position if you removed resistor R5 and elected to ground the RJ-45 Ethernet connector to the chassis.

A.2 Bus Loading

You must pay careful attention to bus loading when designing an interface to the RabbitCore RCM2100. This section provides bus loading information for external devices.

Table A-3 lists the capacitance for the various RCM2100 I/O ports.

Table A-3. Capacitance of RCM2100 I/O Ports

I/O Ports	Input Capacitance		Output Capacitance	
	Typ.	Max.	Typ.	Max.
Parallel Ports A to E	6 pF	12 pF	10 pF	14 pF
Data Lines BD0–BD7	12 pF	18 pF	18 pF	22 pF
Address Lines BA0–BA12	—	—	8 pF	12 pF

Table A-4 lists the external capacitive bus loading for the various RCM2100 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 +70°C

Output Port	Clock Speed (MHz)	Maximum External Capacitive Loading (pF)
A[12:0] D[7:0]	22.1	50
PD[3:0]	22.1	100
PA[7:0] PB[7,6] PC[6,4,2,0] PD[7:4]* PE[7:0]	22.1	90
All data, address, and I/O lines with clock doubler disabled	11.0592	100

* The Parallel Port D outputs (PD[7:4]) are available only on the RCM2120 and the RCM2130 models.

Figure A-4 shows a typical timing diagram for the Rabbit 2000 microprocessor memory read and write cycles.

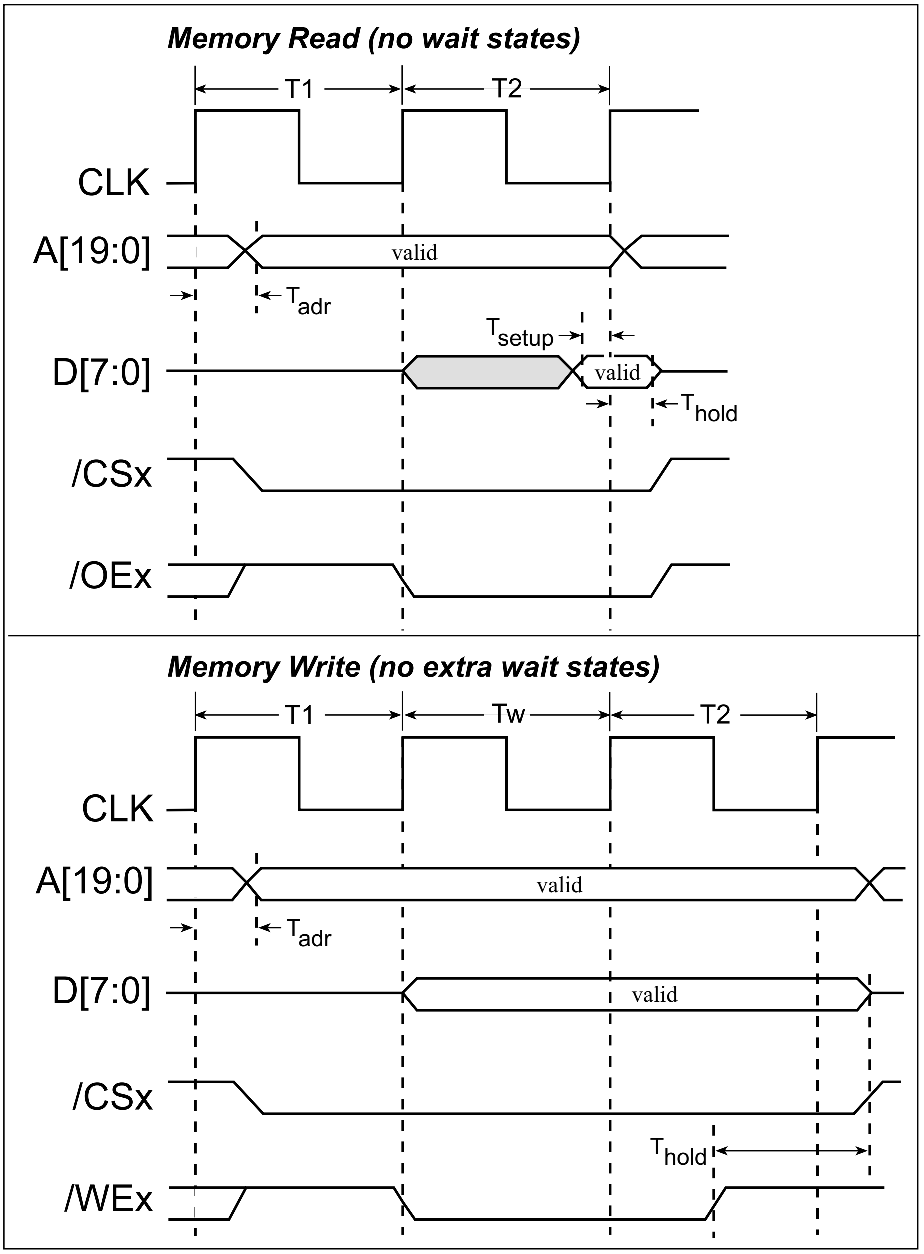


Figure A-4. Memory Read and Write Cycles

T_{adr} is the time required for the address output to reach 0.8 V. This time depends on the bus loading. T_{setup} is the data setup time relative to the clock. Tsetup is specified from 30%/70% of the V_{DD} voltage level.

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°C to +85°C, V_{DD} = 4.5 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 V			10	µA
I_{IL}	Input Leakage Low (no pull-up)	$V_{IN} = V_{SS}$, V_{DD} = 5.5 V	-10			µA
I_{OZ}	Output Leakage (no pull-up)	$V_{IN} = V_{DD}$ or V_{SS}, V_{DD} = 5.5 V	-10		10	µA
V_{IL}	CMOS Input Low Voltage				0.3 x V_{DD}	V
V_{IH}	CMOS Input High Voltage		0.7 x V_{DD}			V
V_T	CMOS Switching Threshold	V_{DD} = 5.0 V, 25°C		2.4		V
V_{OL}	CMOS Output Low Voltage	I_{OL} = See Table A-6 (sinking) V_{DD} = 4.5 V		0.2	0.4	V
V_{OH}	CMOS Output High Voltage	I_{OH} = See Table A-6 (sourcing) V_{DD} = 4.5 V	0.7 x 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 22.1 MHz CPU clock and capacitive loading on address and data lines of less than 100 pF per pin. Pins A0–A12 and D0–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 RCM2100.

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

Pin Name	**Output Drive Sourcing*/Sinking† Limits (mA)**	
Output Port Name	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	25/25
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 my 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.

A.5 Conformal Coating

The areas around the crystal oscillator has had the Dow Corning silicone-based 1-2620 conformal coating applied. The conformally coated area is shown in Figure A-5. The conformal coating protects these high-impedance circuits from the effects of moisture and contaminants over time.

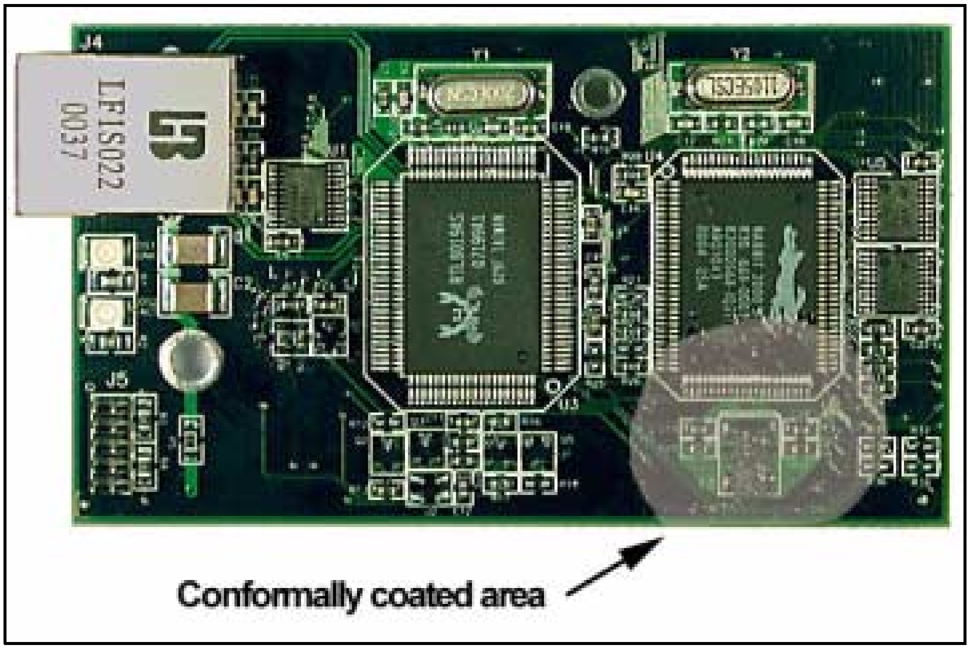


Figure A-5. RCM2100 Areas Receiving Conformal Coating

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

> **NOTE:** For more information on conformal coatings, refer to Rabbit Semiconductor Technical Note 303, ***Conformal Coatings***.

APPENDIX B. PROTOTYPING BOARD

Appendix B describes the features and accessories of the Prototyping Board, and explains the use of the Prototyping Board to demonstrate the RCM2100 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 RCM2100 Prototyping Board.

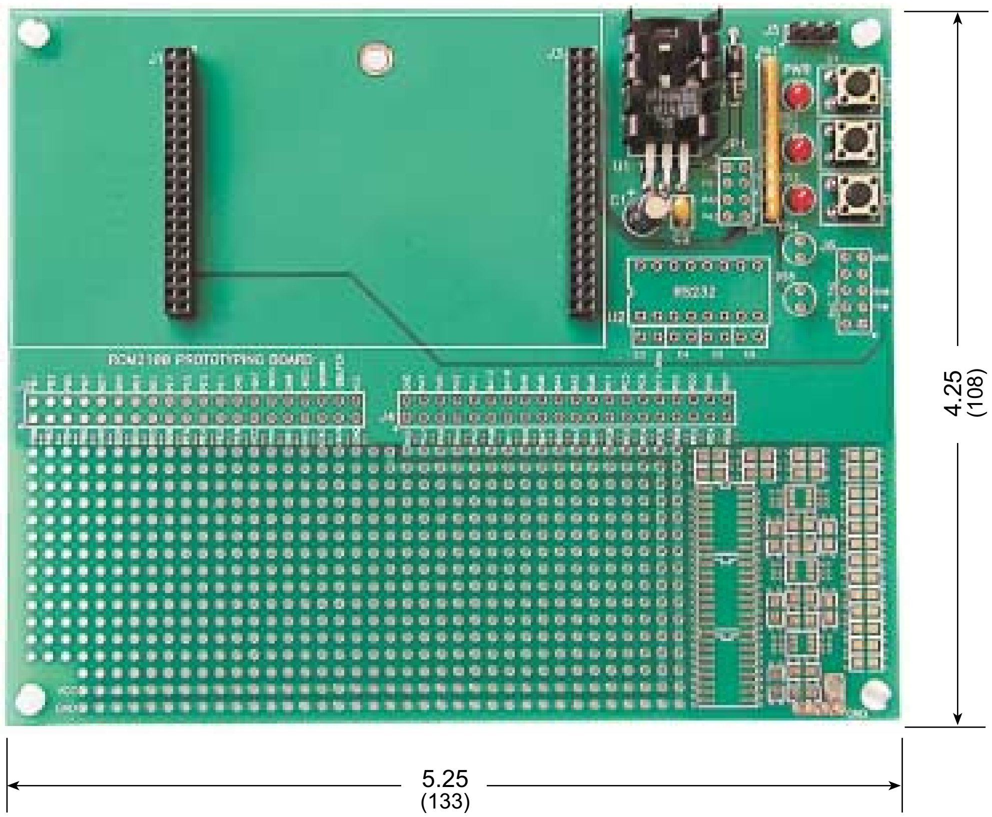


Figure B-1. RCM2100 Prototyping Board Dimensions

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

Table B-1. Prototyping Board Specifications

Parameter	Specification
Board Size	4.25" × 5.25" × 1.00" (108 mm × 133 mm × 25 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	1.7" × 4" (43 mm × 102 mm) throughhole, 0.1" spacing
Standoffs/Spacers	4, accept 6-32 × 3/8 screws

B.2 Power Supply

The RCM2100 requires a regulated 5 V ± 0.25 V DC power source to operate. Depending on the amount of current required by the application, different regulators can be used to supply this voltage.

The Prototyping Board has an onboard 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.

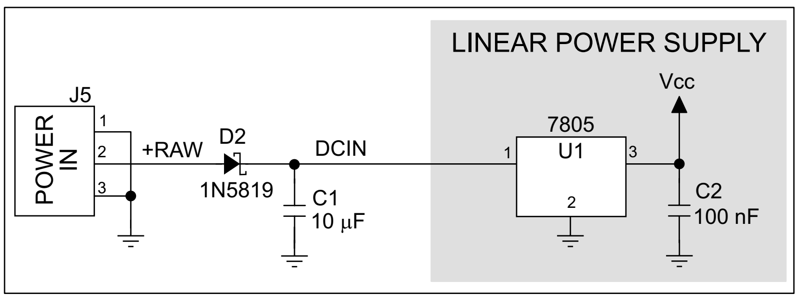


Figure B-2. Prototyping Board Power Supply

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 RCM2100 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 RCM2100. 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 RCM2100.

Two more LEDs, driven by PA2 and PA3, may be added to the Prototyping Board for additional outputs.

To maximize the availability of RCM2100 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.

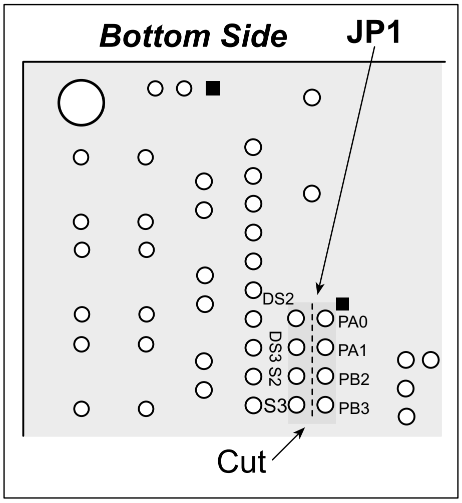


Figure B-3. Where to Cut Traces to Permanently Disable Demonstration Hardware on Prototyping Board

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-2. 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 RCM2100 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.

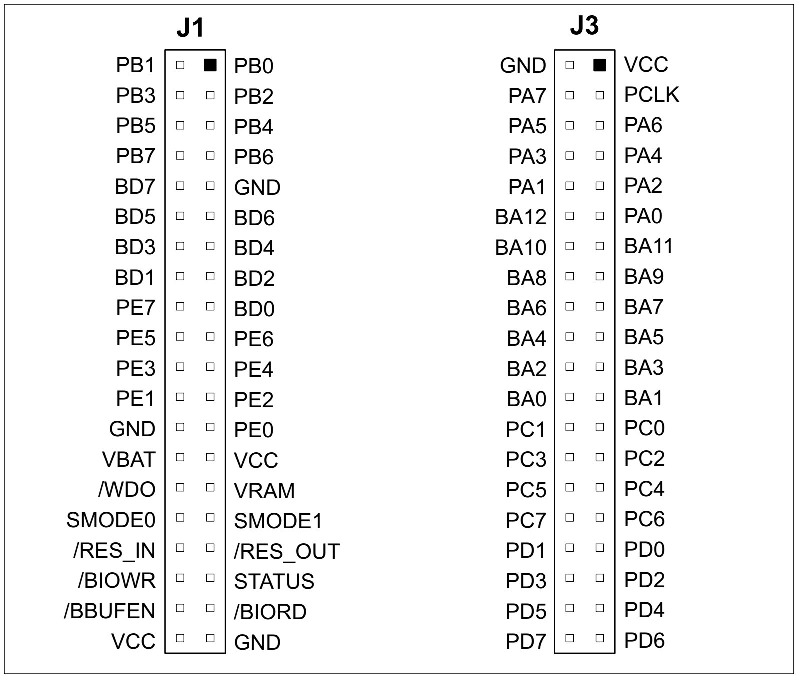


Figure B-4. RCM2100 Prototyping Board Pinout (Top View)

A pair of small holes capable of holding 30 AWG wire appears below each hole pair at locations J2 and J4 for convenience in 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 to the right of the prototyping area.

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.

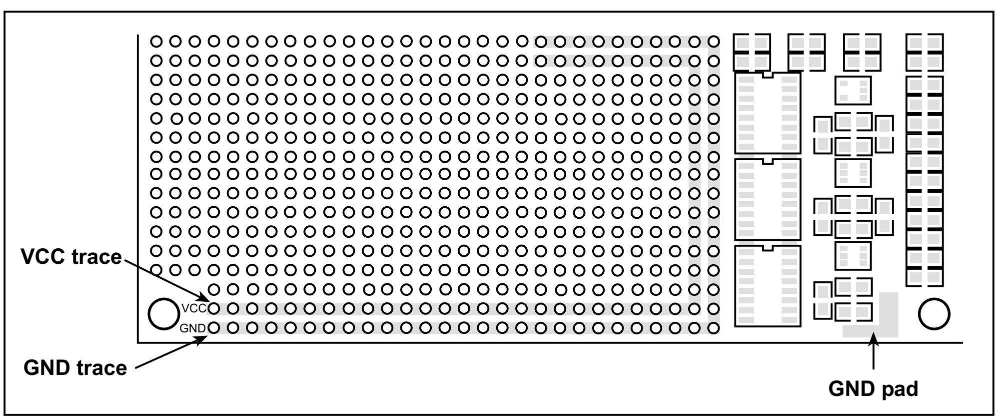


Figure B-5. VCC and GND Traces Along Edge of Prototyping Board

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.

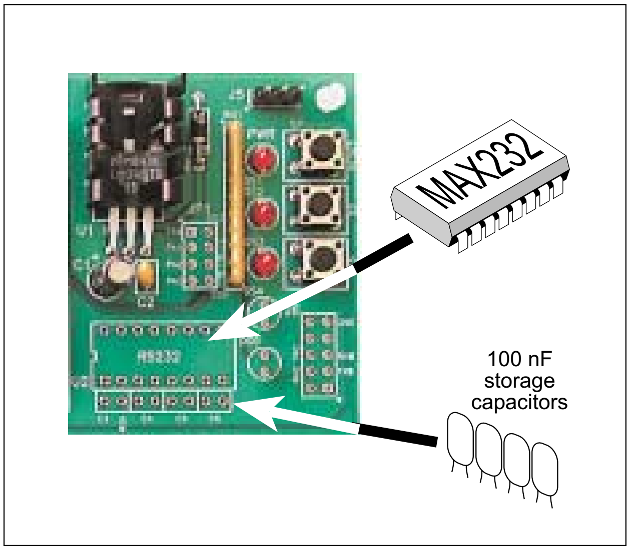


Figure B-6. Location for User-Supplied RS-232 Transceiver and Charge Storage Capacitors

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 (2×26) 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 SUPPLY

Appendix C provides information on the current and power supply requirements of the RCM2100, and some background on the chip select and battery-backup circuits used in power mangement.

C.1 Power Supplies

The RCM2100 requires a regulated 5 V ± 0.25 V DC power source. The RCM2100 design presumes that the voltage regulator is on the user board, and that the power is made available to the RCM2100 board through headers J1 and J2.

An RCM2100 with no loading at the outputs operating at 22.1 MHz typically draws 140 mA. The RCM2100 will consume 13 mA to 15 mA of additional current when the programming cable is used to connect J5 to a PC.

C.1.1 Batteries and External Battery Connections

The RCM2100 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 RCM2100 powered down.

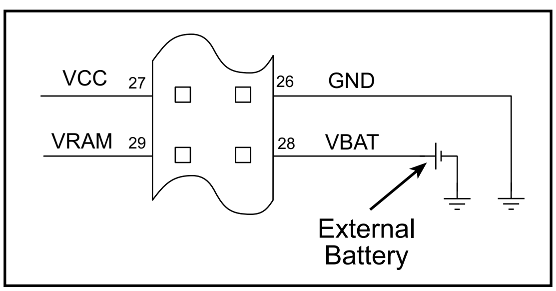


Figure C-1. External Battery Connections at Header J2

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 RCM2100 is typically 16 µA when no other power is supplied. If a 950 mA·h battery is used, the battery can last more than 6 years:

$$\frac{950\ \text{mA·h}}{16\ \mu\text{A}} = 6.8\ \text{years.}$$

The actual life in your application will depend on the current drawn by components not on the RCM2100 and the storage capacity of the battery. Note that the shelf life of a lithium battery is ultimately 10 years.

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 U7, 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 RCM2100.

Figure C-2 shows the RCM2100 battery-backup circuit.

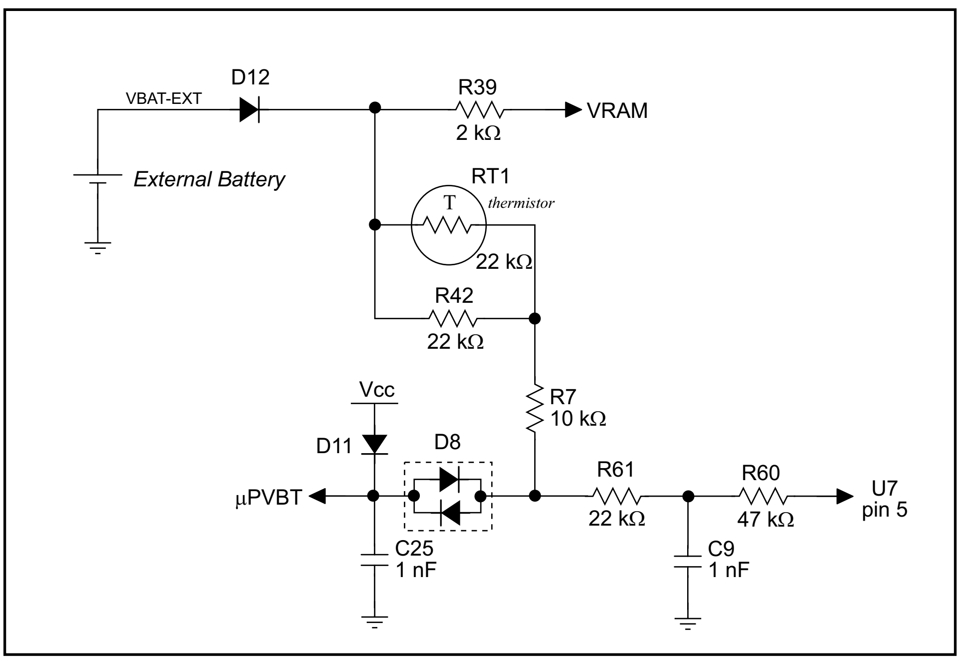


Figure C-2. RCM2100 Battery-Backup Circuit

VRAM is also available on pin 29 of header J2 to facilitate battery backup of the external circuit. Note that the recommended maximum external current draw from VRAM is 100 µA, and new battery-life calculations should be done to take external loading into account.

C.1.2 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.

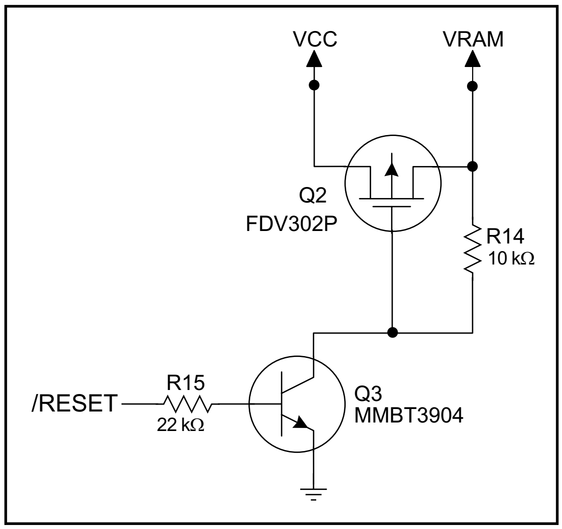


Figure C-3. VRAM Switch

Transistor Q2 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 RCM2100 is not resetting (pin 2 on U3 is high), the /RESET line will be high. This turns on Q3, causing its collector to go low. This turns on Q2, allowing VRAM to nearly equal Vcc.

When the RCM2100 is resetting, the /RESET line will go low. This turns off Q2 and Q3, providing an isolation between Vcc and VRAM.

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

C.1.3 Reset Generator

The RCM2100 uses a reset generator, U2, 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 RCM2100 has a reset output, pin 33 on header J2. The reset generator has a reset input, pin 34 on header J2, that can be used to force the RCM2100 to reset.

C.2 Chip Select Circuit

The RCM2100 has provision for battery backup, which kicks in to keep VRAM from dropping below 2 V.

The current drain on the battery in a battery-backed circuit must be kept to a minimum. When the RCM2100 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.

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

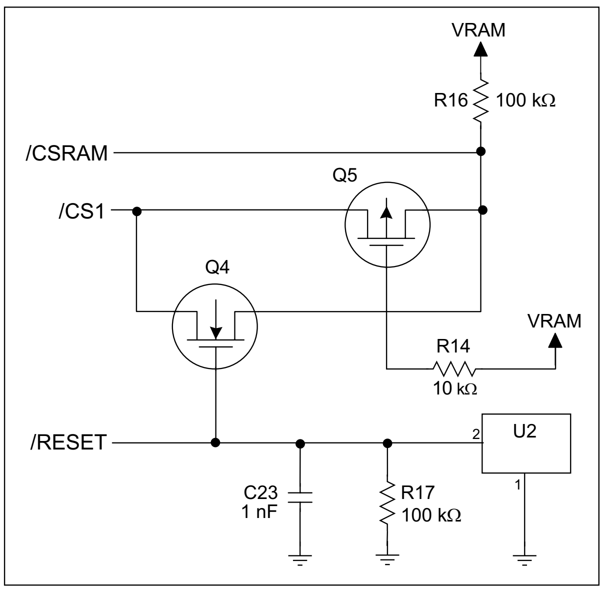


Figure C-4. Chip Select Circuit

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 as high as the battery voltage). Q4 and Q5 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 (R16). This pullup resistor keeps /CSRAM at the VRAM voltage level (which under no power condition is the backup battery's regulated voltage at a little more than 2 V).

Transistors Q4 and Q5 are of opposite polarity so that a rail-to-rail voltages can be passed. When the /CS1 voltage is low, Q4 will conduct. When the /CS1 voltage is high, Q5 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

This appendix details several basic sample circuits that can be used with the RCM2100 series modules.

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

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

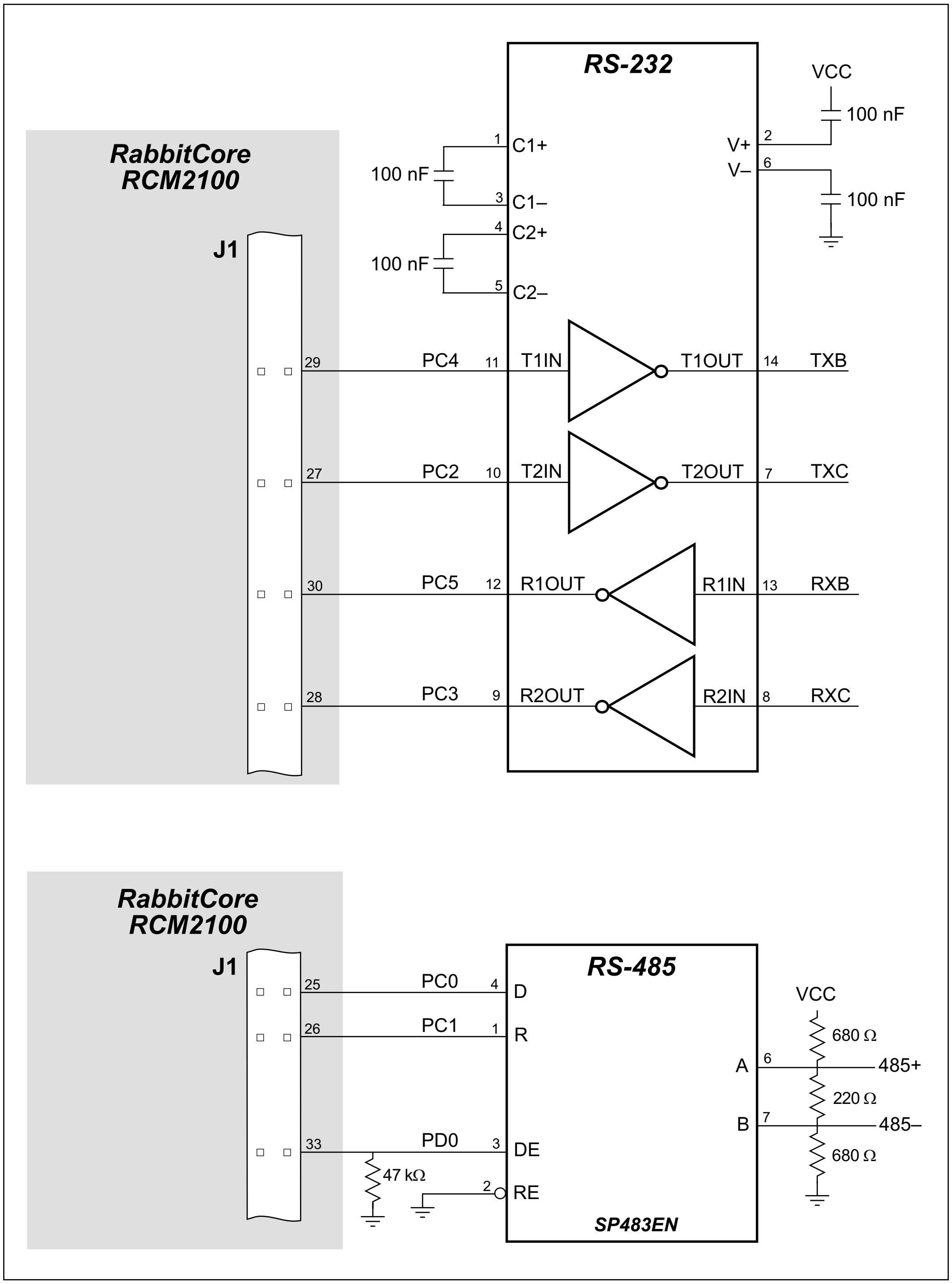


Figure D-1. Sample RS-232 and RS-485 Circuits

Sample Program: **`PUTS.C`** in **`SAMPLES/SERIAL`**.

D.2 Keypad and LCD Connections

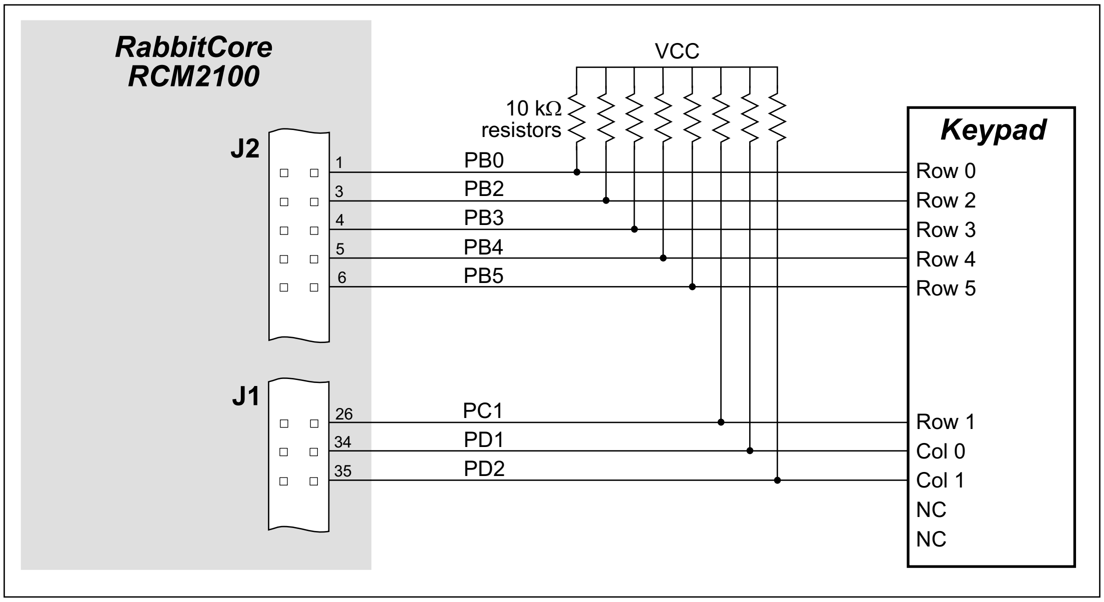


Figure D-2. Sample Keypad Connections

Sample Program: **KEYLCD2.C** in **SAMPLES/RCM2100**.

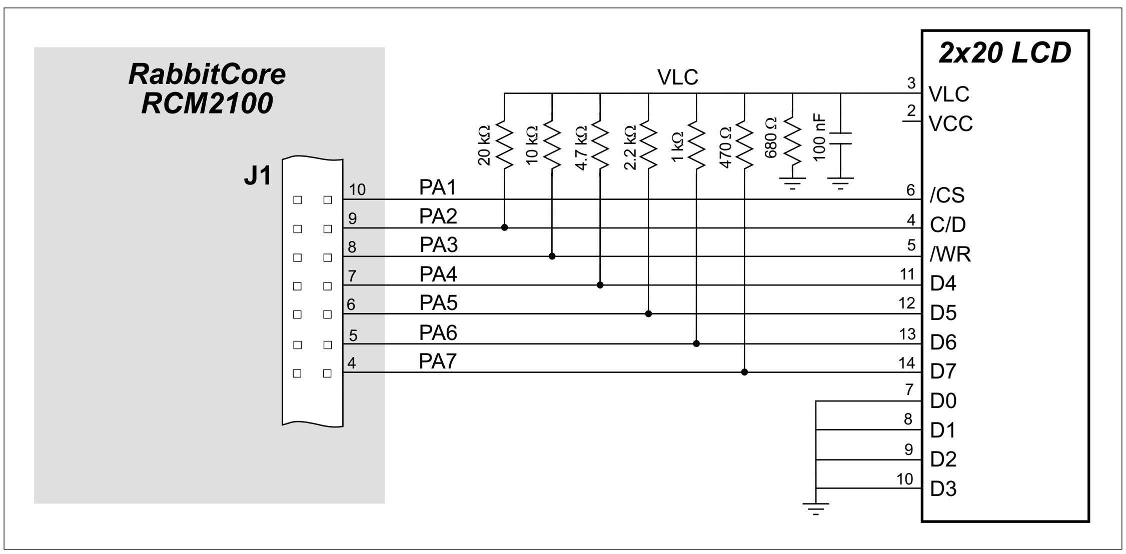


Figure D-3. Sample LCD Connections

Sample Program: **KEYLCD2.C** in **SAMPLES/RCM2100**.

D.3 External Memory

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

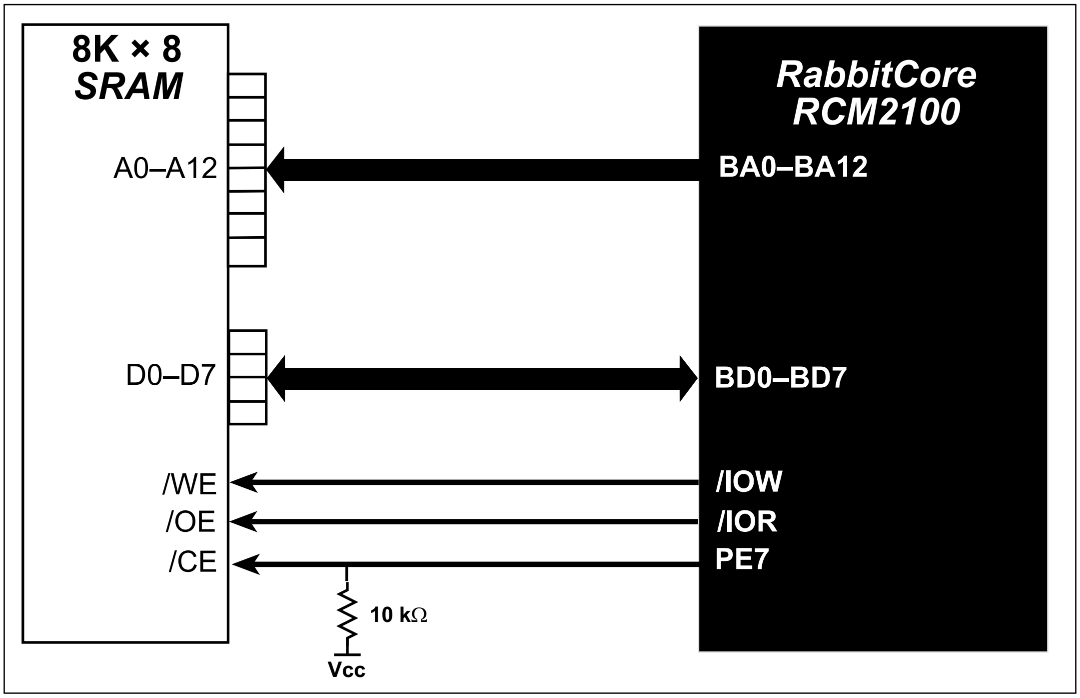


Figure D-4. Sample External Memory Connections

Sample Program: **`EXTSRAM2.C`** in **`SAMPLES/RCM2100`**.

D.4 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 kΩ to 2.5 kΩ will produce an output from 0 V to -5 V. Op-amps with a very low input offset voltage are recommended.

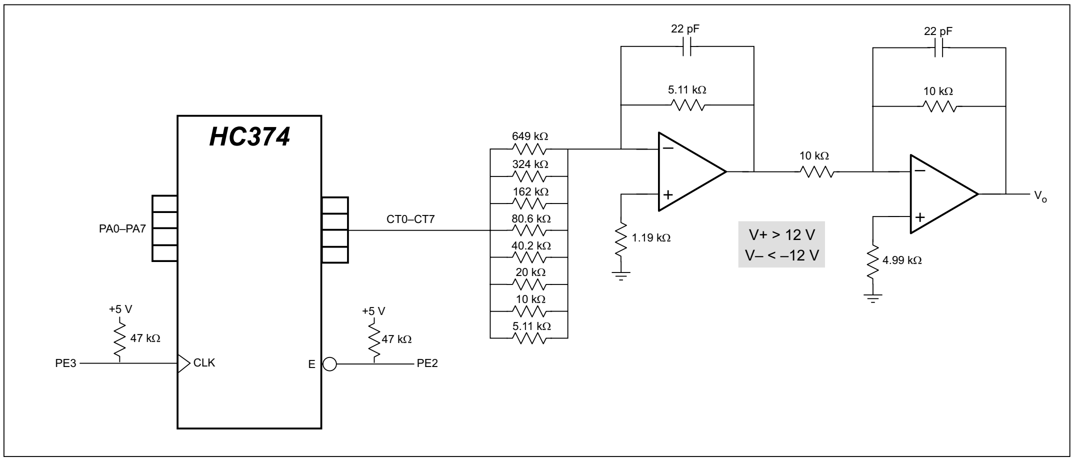


Figure D-5. Sample D/A Converter Connections

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 J5) 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 RCM2100 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.

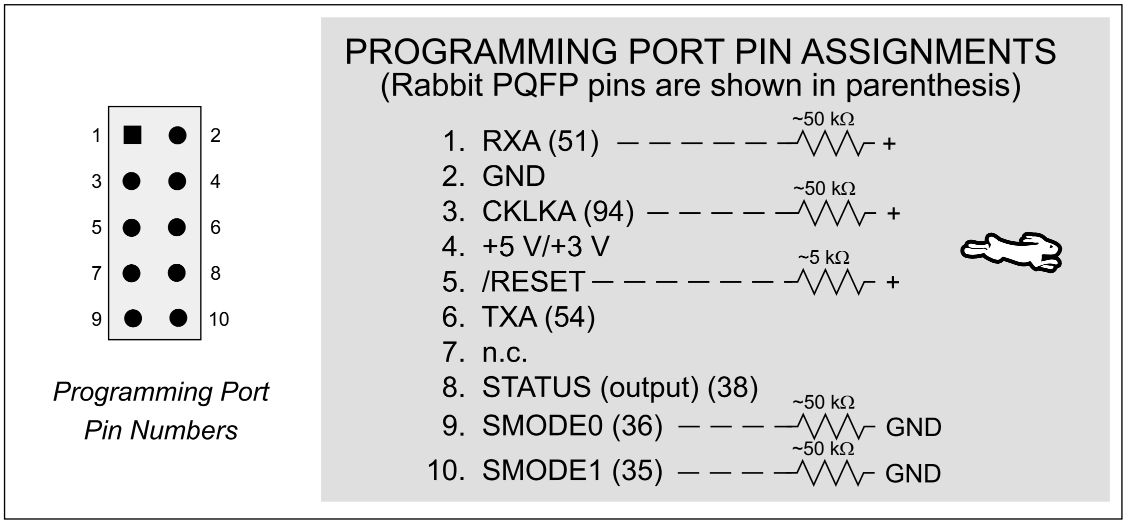


Figure E-1. Programming Port Pin Assignments

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 TXA line (also called PC6) is low 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 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. RCM2100 Programming Port Pinout Configurations

Pin	Pin Name	Default Use	Alternate Use	Notes
1	RXA	Serial Port A	PC7—Input	
2	GND			
3	CLKA		PB1—Bitwise or parallel programmable input	
4	VCC			
5	RESET			Connected to reset generator U2
6	TXA	Serial Port A	PC6—Output	
8	STATUS		Output	
9	SMODE0		Input	Must be low when RCM2100 boots up
10	SMODE1		Input	Must be low when RCM2100 boots up

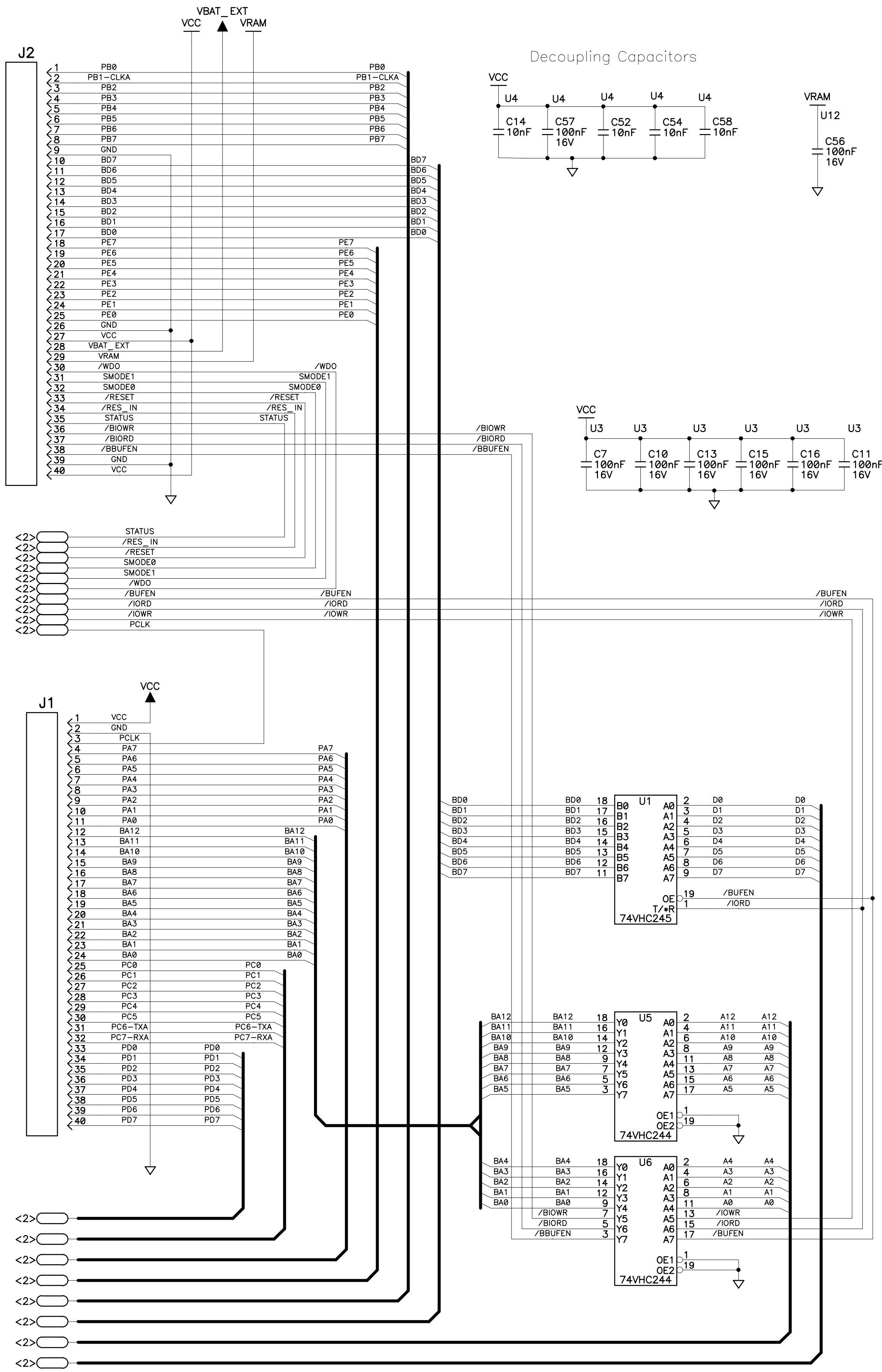
INDEX

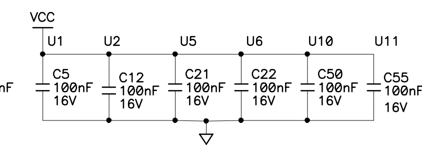
SCHEMATICS

090-0114 RCM2100 Schematic

090-0116 RCM2100 Prototyping Board Schematic

090-0128 Programming Cable Schematic





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A	E11313	INITIAL RELEASE	DM	19Feb01	KIS	3/24/01
B	E11491	CORRECTED FLASH 2 SELECT TO JP2	DM	24Apr01	KIS	4/25/01
C	E11522	CHANGED C8, C9 TO 10pF	DM	14May01	KIS	5/14/01
D	E11580	MODIFIED VBAT CIRCUITRY, ADDED EXTERNAL 32KHz OSC	DM	17AUG01		

NOTES: UNLESS OTHERWISE SPECIFIED;

1. ALL RESISTOR VALUES ARE IN OHMS, 1/16W, 5%
2. ALL CAPACITORS ARE 50VDC OR HIGHER.
3. 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.

5. 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.

TABLE A

REF DES	DEVICE	DEVICE VOLTAGE INFORMATION						DEVICE: FILTER CAP REF DES(s)
		AGND	GND	VCC	VRAM	uPBAT		
U1	74VHC245		10	20				C5
U2	ETC811L		2	4				C12
U3	RTL8019AS		14,28,44 52,83,86	6,17,47 57,70,89				C7,10,12,13,15,16
U4	RABBIT 2000		2,27,39 52,77,89	3,28,53, 78,92		42		C14, 57, 52, 54, 58 C25 – PIN42 (uPBAT)
U5	74VHC244		10	20				C21
U6	74VHC244		10	20				C22
U10	FLASH		24	8				C50
U11	FLASH		24	8				C55
U12	SRAM 512K X 8		15		32			C56
	SRAM 128K X 8		15		32			
	SRAM 32K X 8		14		28			

STUFFING TABLE

CIRCUIT	PART	RCM2100	RCM2110	*RCM2115	RCM2120	RCM2130
SRAM **SRAM select**	U12 JP3	512K 2–3	128K 1–2	128K 1–2	512K 2–3	128K 1–2
FLASH 1 **FLASH 1 select**	U10 JP1	256K 1–2	256K 1–2	256K 1–2	256K 1–2	256K 1–2
FLASH 2 **FLASH 2 select**	U11 JP2	256K 1–2	NOT INSTALLED	NOT INSTALLED	256K 1–2	NOT INSTALLED
ETHERNET OPTION	U3	INSTALLED	INSTALLED	INSTALLED	NOT INSTALLED	NOT INSTALLED
	J3	NOT INSTALLED	NOT INSTALLED	INSTALLED	NOT INSTALLED	NOT INSTALLED
	J4	INSTALLED	INSTALLED	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED
	R1, R2 DS1, DS2	INSTALLED	INSTALLED	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED
	R6, C1, C2, C3, C4	INSTALLED	INSTALLED	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED
	R10, R11, R19 C1, C2, C3 C4, C7, C8 C9, C11, C12 C13, C15, C16	INSTALLED	INSTALLED	INSTALLED	NOT INSTALLED	NOT INSTALLED
	Y1	INSTALLED	INSTALLED	INSTALLED	NOT INSTALLED	NOT INSTALLED
PORTS D-E OPTION	R21, R24, R35 R36, R37, R38	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED	INSTALLED	INSTALLED
INTERRUPT/JUMPER OPTIONS	R12, R18, R25 R58, R59	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED

***Note: RCM2115 only availible for custom orders**

 08/17/01

APPEND THE FOLLOWING DOCUMENTS WHEN CHANGING THIS DOCUMENT:	DRAWING CONTENT:		TITLE	
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	REVISED BY: DM	08/17/01		
	APPROVALS: INITIAL RELEASE			
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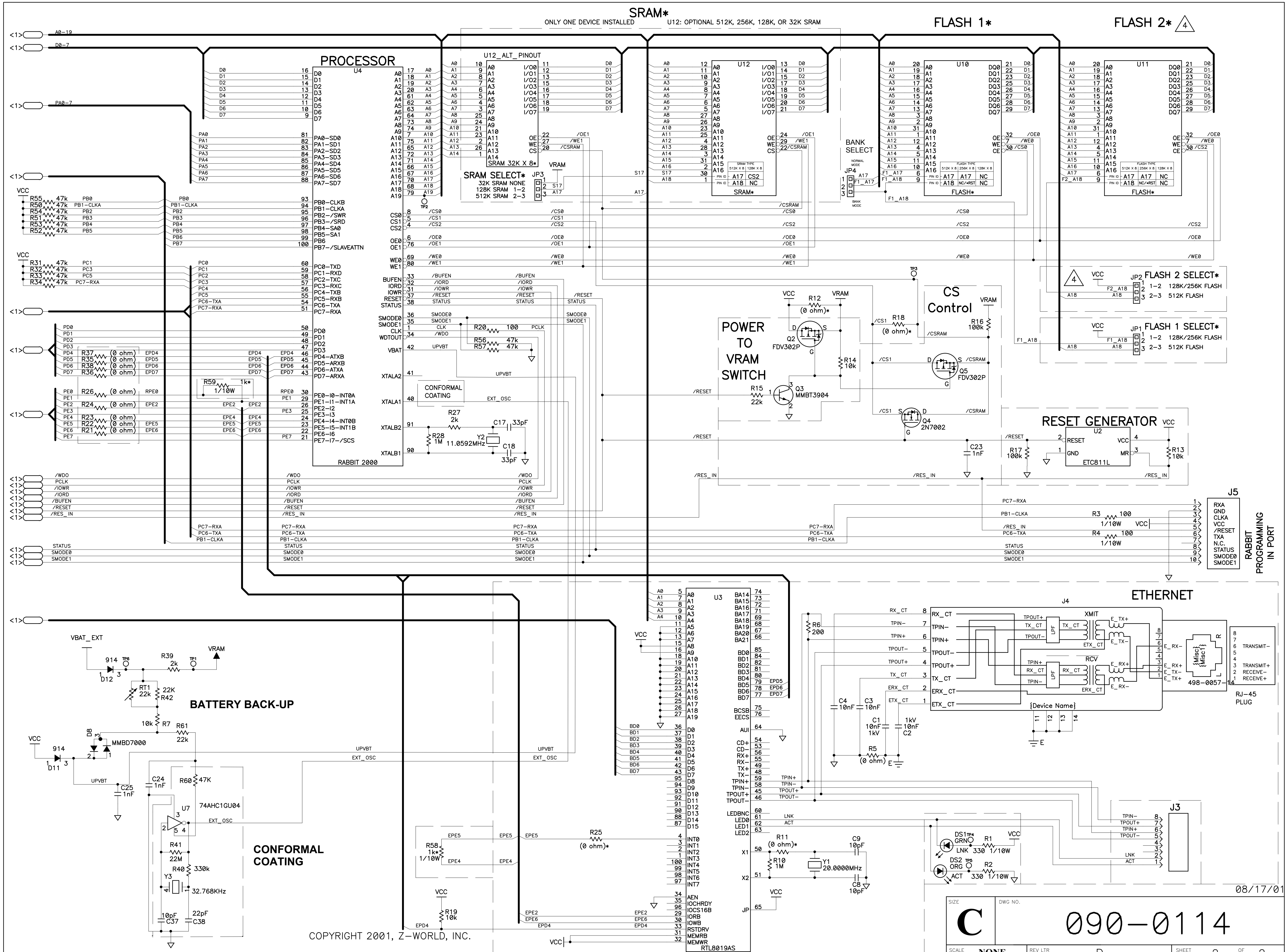
	ENGINEERING MANAGER:			
	SIGNATURES	DATE	SCALE NONE	RELEASE DATE 3/24/01 — SHEET 1 OF 2


SRAM*
ONLY ONE DEVICE INSTALLED
U12: OPTIONAL 512K, 256K, 128K, OR 32K SRAM
FLASH 1*
FLASH 2*
PROCESSOR
U4
RABBIT 2000
U12_ALT_PINOUT
SRAM 32K X 8*
SRAM SELECT*
32K SRAM NONE
128K SRAM 1-2
512K SRAM 2-3
U12
U10
U11
BANK SELECT
FLASH 2 SELECT*
1-2 128K/256K FLASH
2-3 512K FLASH
FLASH 1 SELECT*
1-2 128K/256K FLASH
2-3 512K FLASH
POWER TO VRAM SWITCH
CS Control
Q2 FDV302P
Q3 MMBT3904
Q4 2N7002
Q5 FDV302P
CONFORMAL COATING
Y2 11.0592MHz
RESET GENERATOR
U2 ETC811L
J5
RXA
GND
CLKA
VCC
/RESET
TXA
N.C.
STATUS
SMODE0
SMODE1
RABBIT PROGRAMMING IN PORT
ETHERNET
J4
XMIT
RCV
{Device Name}
498-0057-14
RJ-45 PLUG
TRANSMIT-
TRANSMIT+
RECEIVE-
RECEIVE+
U3
RTL8019AS
Y1 20.0000MHz
J3
DS1 GRN LNK
DS2 ORG ACT
BATTERY BACK-UP
VBAT_EXT
MMBD7000
U7
74AHC1GU04
Y3 32.768KHz
CONFORMAL COATING
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SIZE C
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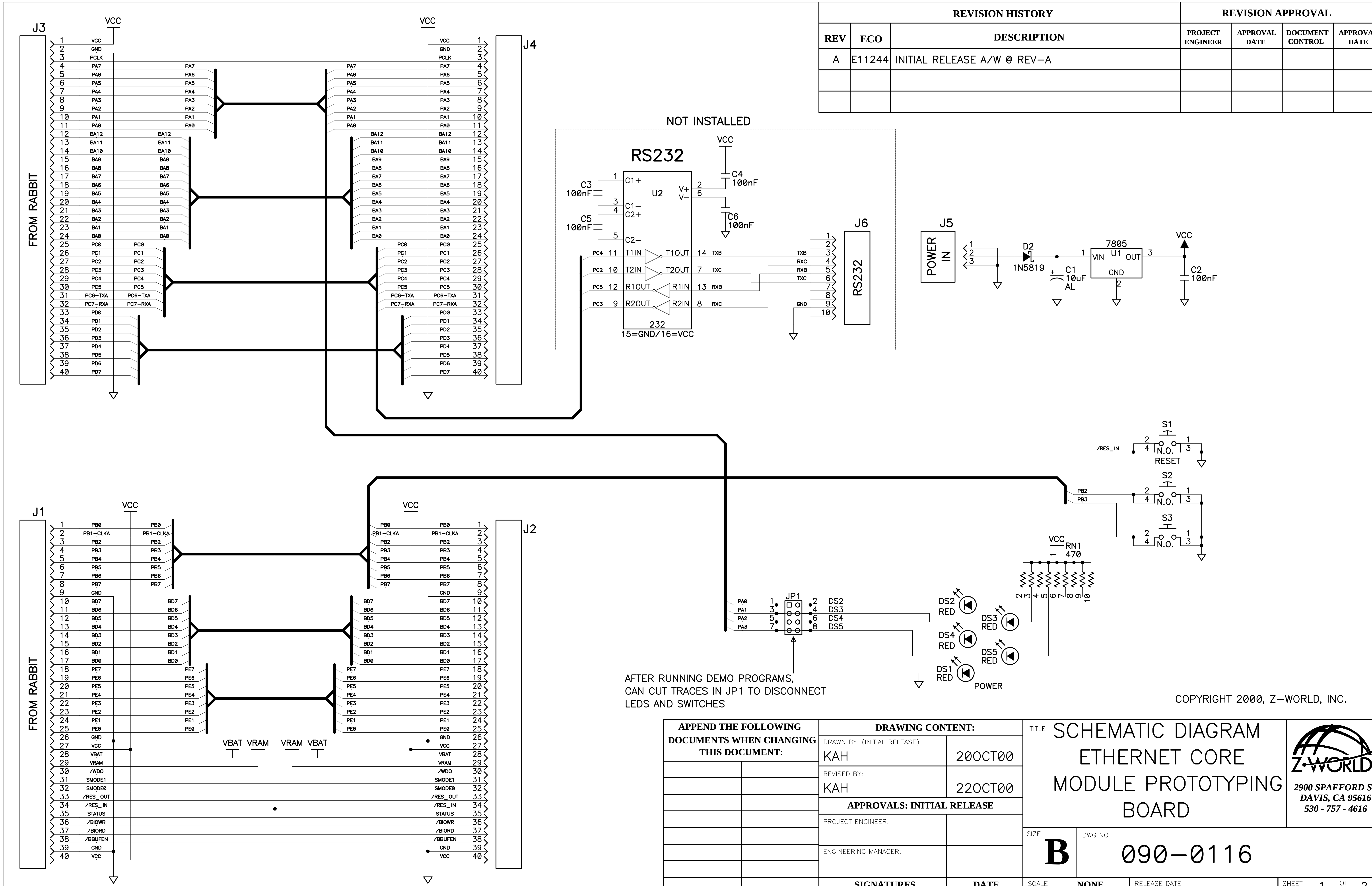
REV LTR D
SHEET 2 OF 2



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	REVISED BY: KAH	22OCT00
	APPROVALS: INITIAL RELEASE	
	PROJECT ENGINEER:	
	ENGINEERING MANAGER:	
	SIGNATURES	DATE

TITLE: SCHEMATIC DIAGRAM ETHERNET CORE MODULE PROTOTYPING BOARD

Z-WORLD
2900 SPAFFORD ST.
DAVIS, CA 95616
530 - 757 - 4616

SIZE	DWG NO.
B	090-0116

SCALE NONE | RELEASE DATE | SHEET 1 OF 2

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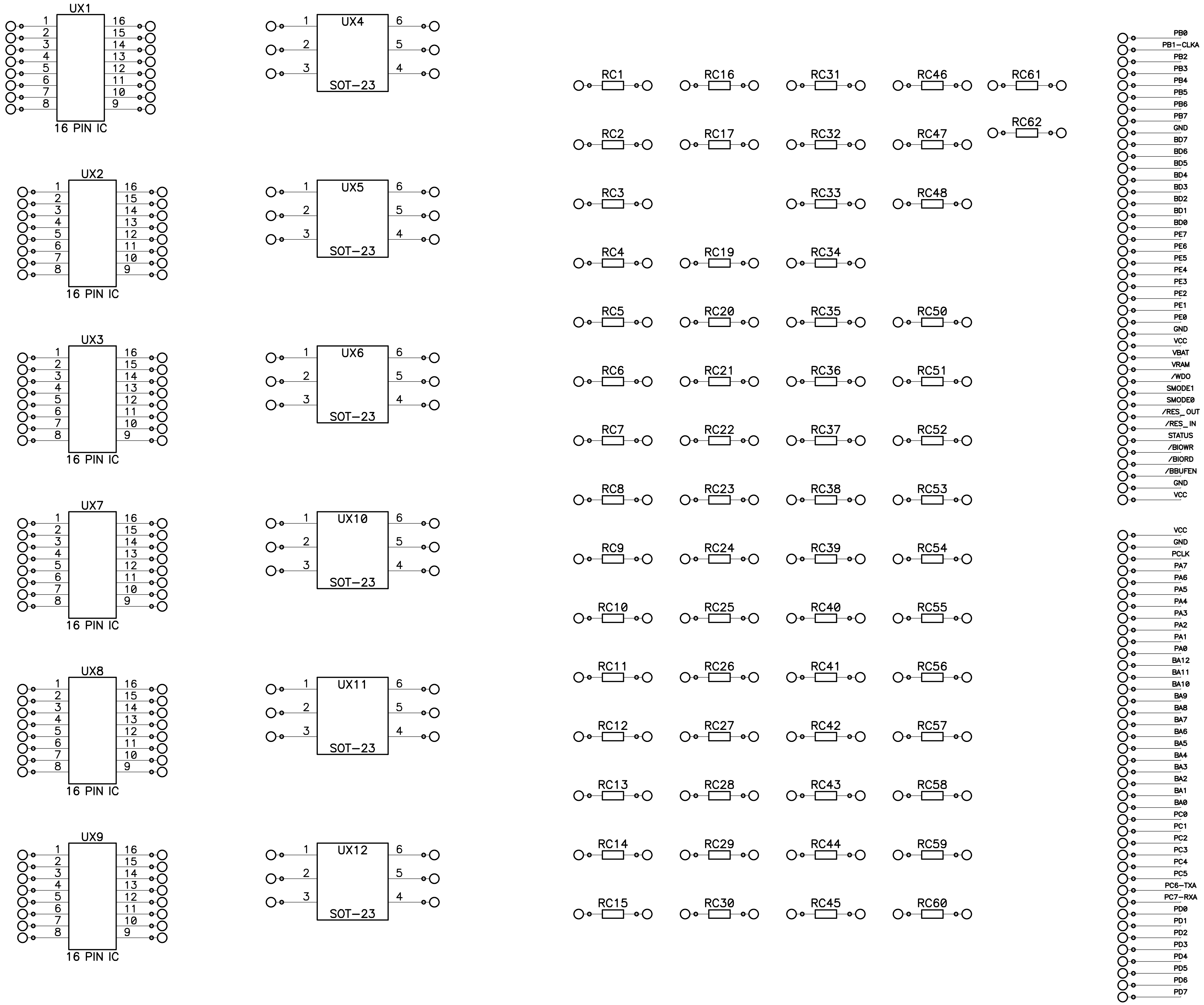

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REVISION HISTORY			REVISION APPROVAL			
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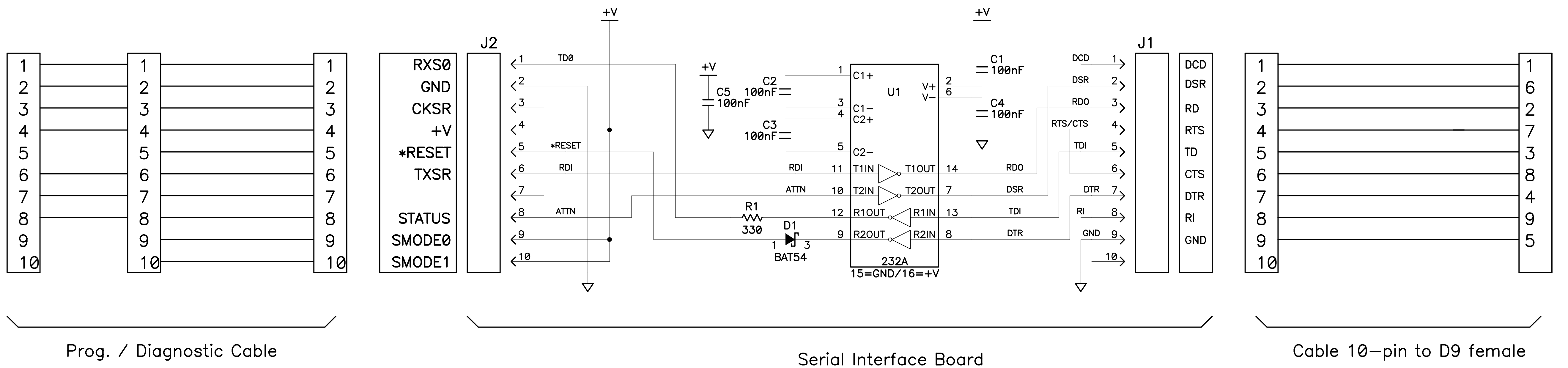
B	E11691	CORRECT DE9 PINOUT				



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		PROJECT ENGINEER:		SIZE B
		ENGINEERING MANAGER:		DWG NO. 090−0128
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