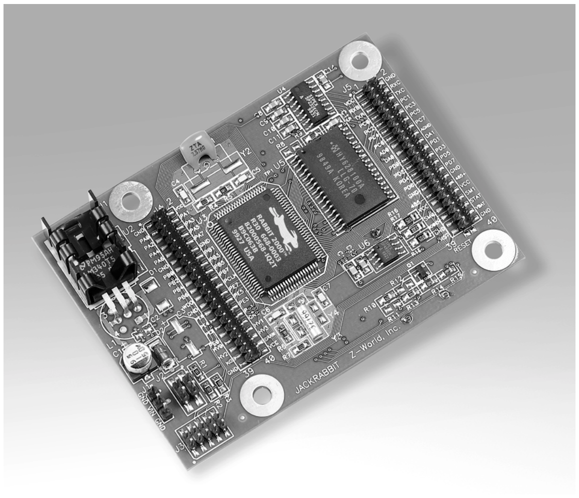
RABBIT™ Semiconductor



Rabbit 2000™ Microprocessor Development Kit

Getting Started

010118 - D

Rabbit 2000 Development Kit Getting Started Manual

Part Number 019-0068 • 010118 - D • Printed in U.S.A.

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Company Address

Rabbit Semiconductor
2932 Spafford Street
Davis, California 95616-6800
USA

Telephone: (530) 757-8400

Facsimile: (530) 757-8402

Web site: http://www.rabbitsemiconductor.com

Table of Contents

About This Manual

This manual provides instructions for installing, testing, configuring, and interconnecting the Rabbit 2000 microprocessor using the Jackrabbit controller and the Jackrabbit Development board.

Assumptions

Assumptions are made regarding the user’s knowledge and experience in the following areas:

- Understanding of the basics of operating a software program and editing files under Windows on a PC.
- Knowledge of basic assembly language and architecture for controllers.

For a full treatment of C, refer to the following texts:

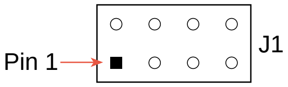
The C Programming Language by Kernighan and Ritchie (published by Prentice-Hall).

and/or

C: A Reference Manual by Harbison and Steel (published by Prentice-Hall).

Pin Number 1

A black square indicates pin 1 of all headers.



Measurements

All diagram and graphic measurements are in inches followed by millimeters enclosed in parenthesis.

1. Introduction

The Rabbit 2000 a a new and powerful microprocessor. Both hardware and software design are easy with the Rabbit.

This kit has the essentials that you need to design your own a microprocessor-based system, and includes a complete software development system (Dynamic C). This Development Kit contains a powerful single-board computer (the Jackrabbit board). With this kit you will be able to write and test complex software. You will be able to prototype circuits that interface to a Rabbit 2000 microprocessor.

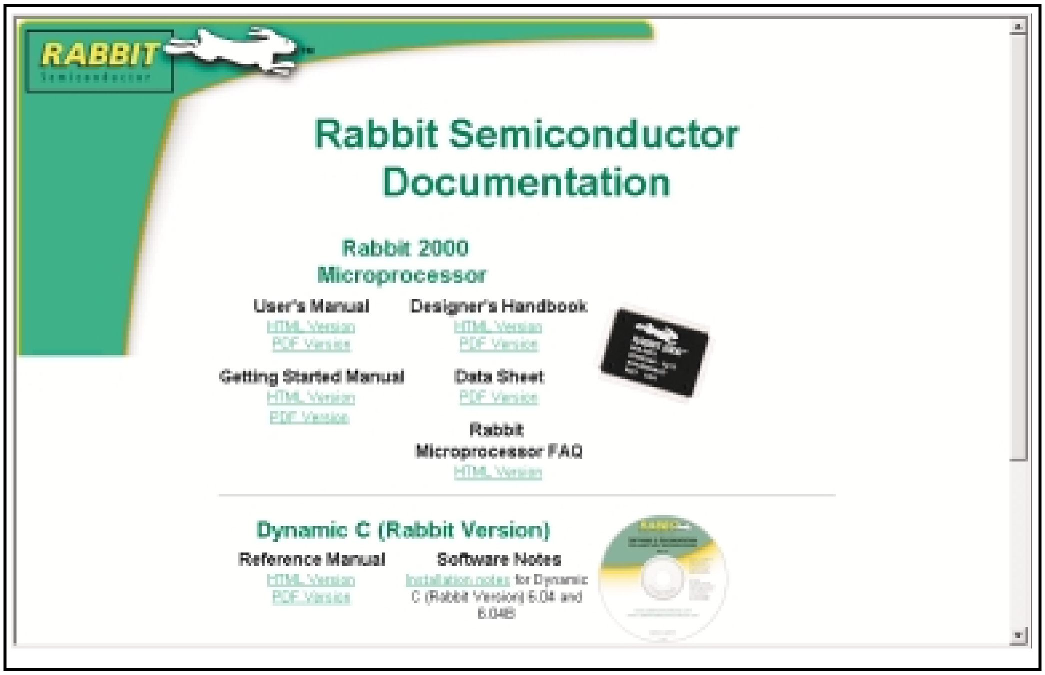
1.1 Kit Contents

The items in the kit and their use is as follows:

- CD-ROM with Dynamic C software and Rabbit 2000 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, '98 and Windows NT. We suggest taking the option to load the documentation to your hard disk. The documentation is in HTML or Adobe PDF format, and may be viewed with a browser.
- Jackrabbit controller board. This is a complete controller board that includes a Rabbit 2000 processor, 128K of flash memory and 128K of RAM (Random Access Memory). You can use this board to demonstrate the use of the Rabbit 2000.
- Prototyping Board. The Jackrabbit board can be plugged into this board. The Prototyping Board includes various accessories such as pushbutton switches, LEDs, and a beeper. In addition, you can add your own circuitry.
- Programming cable. This is a cable that is used to connect your PC serial port to the Jackrabbit board to write and debug C programs that run on the Jackrabbit board.
- Loose parts kit. This bag of parts contains parts that you can solder to the Prototyping Board for various demonstrations.
- Wall transformer. This is used to power the Jackrabbit board. The wall transformer is supplied only for Development Kits sold for the North American market. The Jackrabbit board in the Development Kit can also be powered from any DC voltage source between 9 V and 15 V. Higher voltages can be used, but may make the regulator rather hot.

1.2 Documentation

Our documentation is provided in paperless form on the CD-ROM included in the Development Kit. (A paper copy of this "Getting Started" manual is included.) Most documents 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 hardcopy from the HTML manuals because they have 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. When you open the **`default.htm`** file with your browser, you will see a page similar to that shown below.



Rabbit Semiconductor Documentation

Rabbit 2000 Microprocessor

User's Manual
HTML Version
PDF Version

Designer's Handbook
HTML Version
PDF Version

Getting Started Manual
HTML Version
PDF Version

Data Sheet
PDF Version

Rabbit Microprocessor FAQ
HTML Version

Dynamic C (Rabbit Version)

Reference Manual
HTML Version
PDF Version

Software Notes
Installation notes for Dynamic C (Rabbit Version) 6.04 and 6.04B

1.3 An Overview of Dynamic C for the Rabbit

The Rabbit 2000 is programmed using Z-World’s Dynamic C, an integrated development environment that includes an editor, a C compiler, and a debugger. Library functions provide an easy-to-use interface for the Jackrabbit board included with the Development Kit.

The Jackrabbit board included with the Development Kit is a powerful board that includes a complete Rabbit microprocessor system. A Prototyping Board that includes pushbutton switches, LEDs, and a beeper can be plugged into the Jackrabbit board. By writing programs that run on the Jackrabbit board, you can flash the LEDs, beep the beeper, and otherwise demonstrate the capabilities of the Rabbit. Schematics for both boards are included on the CD-ROM in PDF format.

The Jackrabbit board has a standard Rabbit programming connector, which is a 10-pin, 2 mm header. A programming cable is used to connect a PC serial port (COM port) to the Jackrabbit board. The programming cable has a level converter board in the middle of the cable since the programming connector supports CMOS logic levels, and not the RS-232 levels that are used by PC serial ports. When the programming cable is connected, Dynamic C running on the PC can hard reset the Jackrabbit board and cold boot it. The cold boot includes compiling and downloading a BIOS program that stays resident while you work. If you crash the target, Dynamic C will automatically reboot and recompile the BIOS if it senses that a target communication error occurred.

You have a choice of doing your software development in the flash memory or in the static RAM included on the Jackrabbit board. There are 128K in each memory. Versions of the Jackrabbit board are available that support only 32K of static RAM. If you use one of these boards, you must do development in flash memory. The advantage of working in RAM is to save wear on the flash, which is limited to about 100,000 writes. Note that an application can only be developed in RAM, but cannot run standalone from RAM after the programming cable is disconnected. All applications can only run from flash.

When using flash, the compile to a file is followed by a download to the flash. The disadvantage of using flash 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 breakpoint or single-step the program. Flash or RAM is selected on the **Options-Compiler** menu.

Dynamic C provides a number of debugging features. You can single-step your program, either in C, statement by statement, or in assembly language, instruction by instruction. You can set breakpoints, where the program will stop, on any statement. You can evaluate watch expressions. A watch expression is any C expression that can be evaluated in the context of the program. If the program is at a breakpoint, a watch expression can view any expression using local or external variables. If the program is running and a call to the debugger is included in the user's code (**`runwatch();`**), it is possible to evaluate watch expressions using global variables only while the target program continues to run, slowed down only by the need to refresh a display in response to a **<ctrl-U>** command.

2. Detailed Installation Instructions

Chapter 2 contains detailed instructions for installing the software on your PC and for connecting the Jackrabbit board to your PC in order to run sample programs.

2.1 Software Installation

You will need approximately 10 megabytes of free space on your hard disk. The software can be installed on your C drive or any other convenient drive.

2.2 Getting Hooked Up

Figure 1 below shows an overview of how the serial and power connections are made to Jackrabbit board, the Prototyping Board, and to your PC.

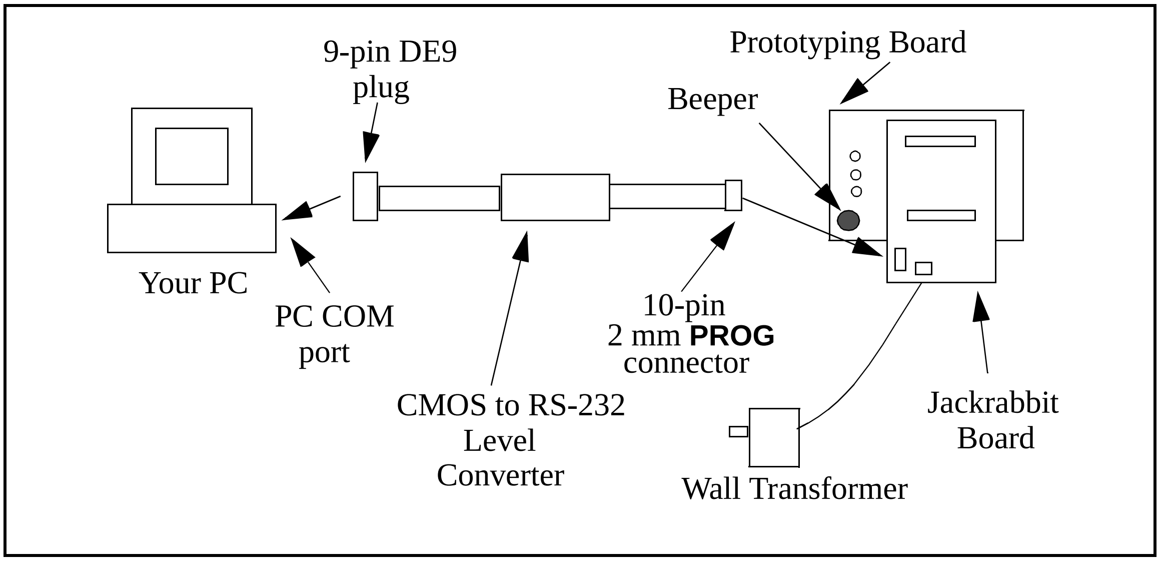


Figure 1. Jackrabbit Hookup Connections

2.2.1 Prototyping Board

To attach the Jackrabbit board to the Prototyping Board, turn the Jackrabbit board over so that the battery is facing up. Plug headers J4 and J5 into the sockets on the Prototyping Board as indicated in Figure 2.

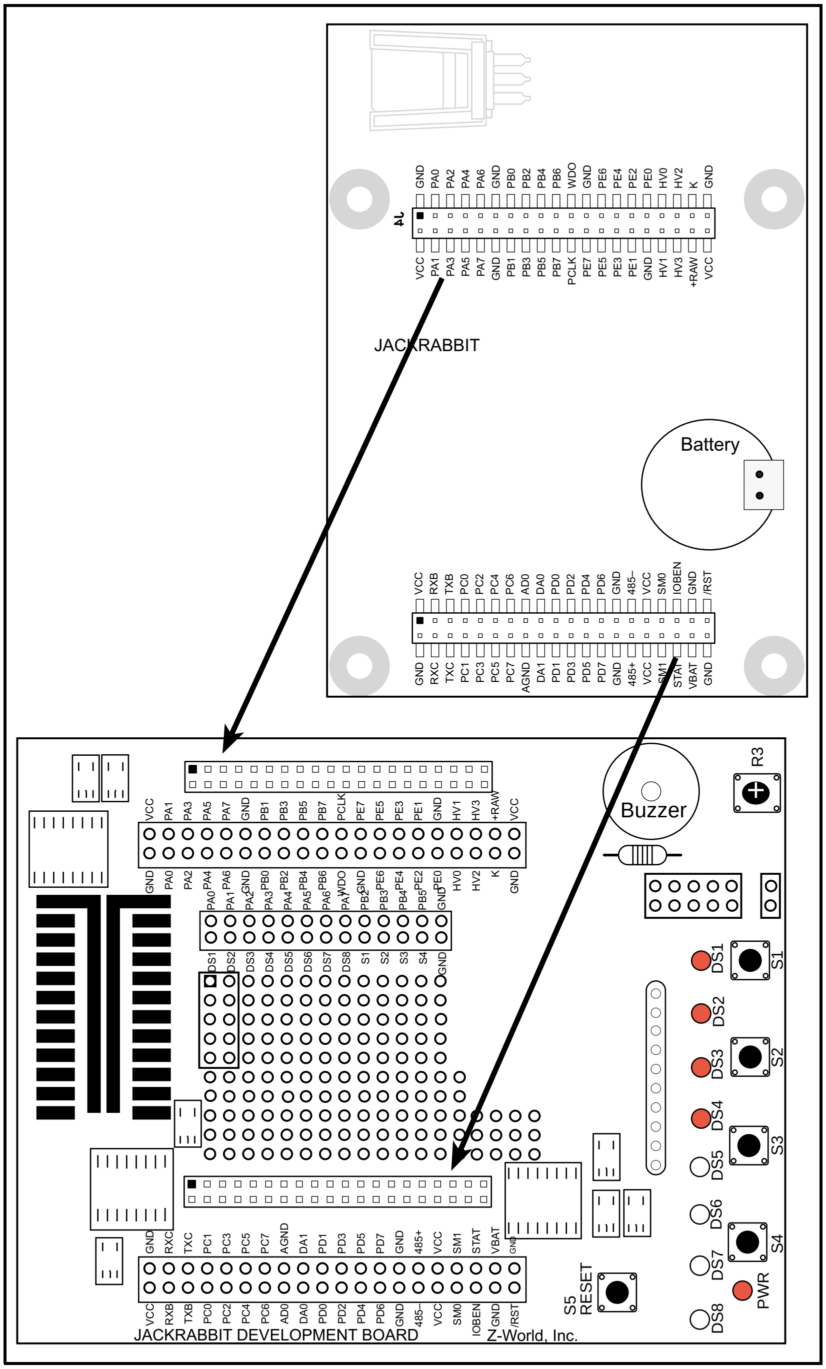

GND PA0 PA2 PA4 PA6 GND PB0 PB2 PB4 PB6 WDO GND PE6 PE4 PE2 PE0 HV0 HV2 K GND
J4
VCC PA1 PA3 PA5 PA7 GND PB1 PB3 PB5 PB7 PCLK PE7 PE5 PE3 PE1 GND HV1 HV3 +RAW VCC
JACKRABBIT
Battery
VCC RXB TXB PC0 PC2 PC4 PC6 AD0 DA0 PD0 PD2 PD4 PD6 GND 485– VCC SM0 IOBEN GND /RST
GND RXC TXC PC1 PC3 PC5 PC7 AGND DA1 PD1 PD3 PD5 PD7 GND 485+ VCC SM1 STAT VBAT GND
R3
Buzzer
VCC PA1 PA3 PA5 PA7 GND PB1 PB3 PB5 PB7 PCLK PE7 PE5 PE3 PE1 GND HV1 HV3 +RAW VCC
GND PA0 PA2 PA4 PA6 GND PB0 PB2 PB4 PB6 WDO GND PE6 PE4 PE2 PE0 HV0 HV2 K GND
PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7 PB2 PB3 PB4 PB5 GND
DS1 DS2 DS3 DS4 DS5 DS6 DS7 DS8 S1 S2 S3 S4 GND
DS1 S1
DS2
DS3 S2
DS4 S3
DS5
DS6 S4
DS7
DS8 PWR
S5 RESET
GND RXC TXC PC1 PC3 PC5 PC7 AGND DA1 PD1 PD3 PD5 PD7 GND 485+ VCC SM1 STAT VBAT GND
VCC RXB TXB PC0 PC2 PC4 PC6 AD0 DA0 PD0 PD2 PD4 PD6 GND 485– VCC SM0 IOBEN GND /RST
JACKRABBIT DEVELOPMENT BOARD
Z-World, Inc.

Figure 2. Attaching Jackrabbit Board to Prototyping Board

2.2.2 Jackrabbit Board

1. Connect the 10-pin **PROG** connector of the programming cable to header J3 on the Jackrabbit board as shown in Figure 3. (If your programming cable has only one unlabeled 10-pin connector, attach that connector to header J3 on the Jackrabbit board.) Connect the other end of the programming cable to a COM port on your PC. Note that COM1 is the default COM port used by Dynamic C.

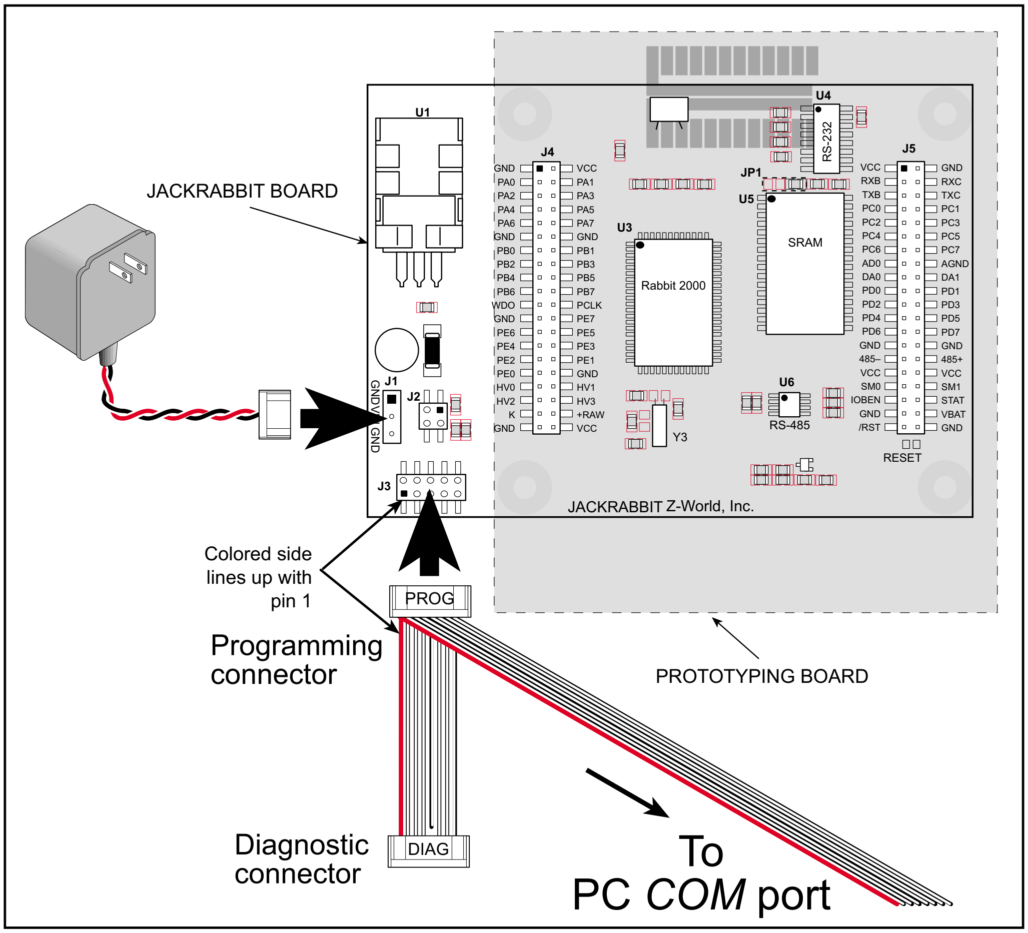


Figure 3. Power and Programming Cable Connections to Jackrabbit Board

2. Hook up the connector from the wall transformer to header J1 on the Jackrabbit board as shown in Figure 3. The orientation of this connector is not important since the VIN (positive) voltage is the middle pin, and GND is available on both ends of the three-pin header J1.

3. Plug in the wall transformer. The Jackrabbit board and the Prototyping Board are ready to be used.

A RESET button is provided on the Prototyping Board (see Figure 2) to allow a harware reset.

2.3 Starting Dynamic C

Once the Jackrabbit board is connected as described in Section 2.2, start Dynamic C by double-clicking on the Dynamic C icon or by double-clicking on **dwc.exe** in the Dynamic C directory.

Dynamic C assumes, by default, that you are using serial port COM1 on your PC. If you are using COM1, then Dynamic C should detect the Jackrabbit board and go through a sequence of steps to cold-boot the Jackrabbit board and to compile the BIOS. If an error message appears, you have probably connected to a different PC serial port such as COM2, COM3, or COM4. You can change the serial port used by Dynamic C with the **OPTIONS** menu, then try to get Dynamic C to recognize the Jackrabbit board by selecting **Recompile BIOS** on the Compile menu. Try the different COM ports in the **OPTIONS** menu until you find the one you are connected to. If you can't get Dynamic C to recognize the target on any port, then the hookup may be wrong or the COM port is not working on your PC.

If you receive the "BIOS successfully compiled …" message after pressing **<ctrl-Y>** or starting Dynamic C, and this message is followed by "Target not responding," it is possible that your PC cannot handle the 115,200 bps baud rate. Try changing the baud rate to 57,600 bps as follows.

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

   ```
   #define USE115KBAUD 1            // set to 0 to use 57600 baud
   ```

   to read as follows.

   ```
   #define USE115KBAUD 0            // set to 0 to use 57600 baud
   ```
3. Locate the **Serial options** dialog in the Dynamic C **Options** menu. Change the baud rate to 57,600 bps, then press **<ctrl-Y>**.

If you receive the "BIOS successfully compiled …" message and do not receive a "Target not responding" message, the target is now ready to compile a user program.

3. Sample Programs

A series of sample programs is provided in the Dynamic C **`Samples/JackRab`** folder. You can load a sample program by using the **File Open** menu in Dynamic C. The sample programs are listed in Table 1.

Table 1. Jackrabbit Sample Programs

`DEMOJR1.C`
`DEMOJR2.C`
`DEMOJR3.C`
`DEMOJR6.C`
`JRIOTEST.C`
`JRIO_COF.C`
`RABDB01.C`
`RABDB02.C`

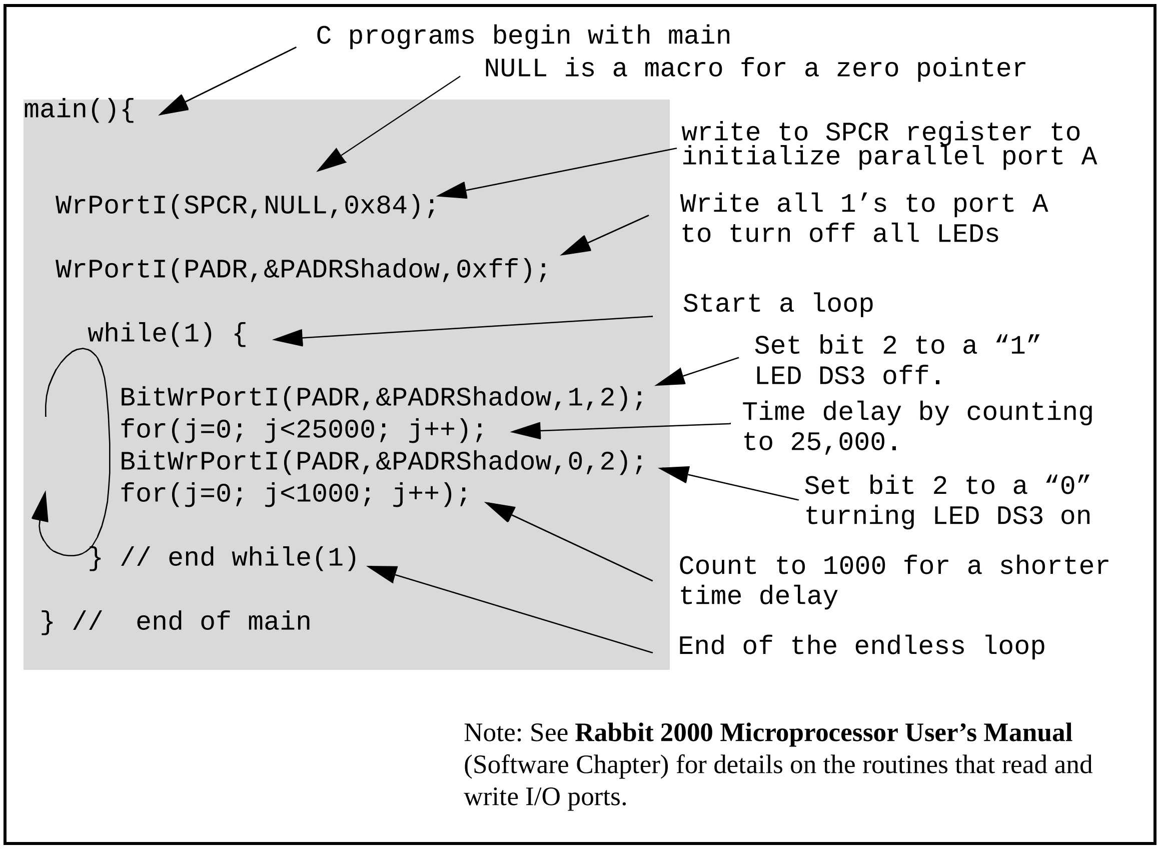
The first five sample programs provide a step-by-step introduction to the Jackrabbit board. Additional sample programs illustrate more advanced topics.

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

3.1 Running Sample Program DEMOJR1.C

This sample program can be used to illustrate some of the functions of Dynamic C.

First, open the file **`DEMOJR1.C`**, which is in the **`Samples/JackRab`** folder. The program will appear in a window, as shown in Figure 4 below (minus some comments). Use the mouse to place the cursor on the function name ***WrPortI*** in the program and type **<ctrl-H>**. This will bring up a documentation box for the function **`WrPortI`**. In general, you can do this with all functions in Dynamic C libraries, including libraries you write yourself. Close the documentation box and continue.



```
main(){

  WrPortI(SPCR,NULL,0x84);

  WrPortI(PADR,&PADRShadow,0xff);

    while(1) {

      BitWrPortI(PADR,&PADRShadow,1,2);
      for(j=0; j<25000; j++);
      BitWrPortI(PADR,&PADRShadow,0,2);
      for(j=0; j<1000; j++);

    } // end while(1)

 } //  end of main
```

C programs begin with main

NULL is a macro for a zero pointer

write to SPCR register to initialize parallel port A

Write all 1’s to port A to turn off all LEDs

Start a loop

Set bit 2 to a “1” LED DS3 off.

Time delay by counting to 25,000.

Set bit 2 to a “0” turning LED DS3 on

Count to 1000 for a shorter time delay

End of the endless loop

Note: See **Rabbit 2000 Microprocessor User’s Manual** (Software Chapter) for details on the routines that read and write I/O ports.

Figure 4. Sample Program DEMOJR1.C

To run the program **`DEMOJR1.C`**, load it with the **File** menu, compile it using the **Compile** menu, and then run it by selecting **Run** in the **Run** menu. The LED on the Development Board should start flashing if everything went well. If this doesn’t work review the following points.

- The target should be ready, which is indicated by the message “BIOS successfully compiled...” If you did not receive this message or you get a communication error, recompile the BIOS by typing **<ctrl-Y>** or select **Recompile BIOS** from the **Compile** menu.

- A message reports that "No Rabbit processor detected" in cases where the Jackrabbit and Prototyping Board are not connected together, the wall transformer is not connected, or is not plugged in. (The red power LED lights whenever power is connected.)
- The programming cable must be connected to the Jackrabbit board. (The colored wire on the programming cable is closest to pin 1 on header J3 on the Jackrabbit board, as shown in Figure 3 on page 7.) The other end of the programming cable must be connected to the PC serial port, possibly, using the 9- to 25-pin adapter if necessary. The COM port specified in the Dynamic C **Options** menu must be the same as the one the programming cable is connected to.
- To check if you have the correct serial port, select **Compile**, then **Compile BIOS**, or type **<ctrl-Y>**. If the "BIOS successfully compiled …" message does not display, try a different serial port using the Dynamic C **Options** menu until you find the one you are plugged into. Don't change anything in this menu except the COM number. The baud rate should be 115,200 bps and the stop bits should be 1.

3.2 Single-Stepping

Compile or re-compile **`DEMOJR1.C`** by clicking the **Compile** button on the task bar. The program will compile and the screen will come up with a highlighted character (green) at the first executable statement of the program. Use the **F8** key to single-step. Each time the **F8** key is pressed, the cursor will advance one statement. When you get to the **`for(j=0, j< ...`** statement, it becomes impractical to single-step further because you would have to press **F8** thousands of times. We will use this statement to illustrate watch expressions.

3.2.1 Watch Expression

Type **<ctrl-W>** or chose **Add/Del Watch Expression** in the **Inspect** menu. A box will come up. Type the lower case letter j and click on *add to top* and *close*. Now continue single-stepping with **F8**. Each time you step, the watch expression (**`j`**) will be evaluated and printed in the watch window. Note how the value of **`j`** advances when the statement **`j++`** is executed.

3.2.2 Break Point

Move the cursor to the start of the statement:

```
        for(j=0; j<1000; j++);
```

To set a break point on this statement, type **F2** or select **Breakpoint** from the **Run** menu. A red highlight will appear on the first character of the statement. To get the program running at full speed, type **F9** or select **Run** on the **Run** menu. The program will advance until it hits the break point. Then the break point will start flashing and show both red and green colors. Note that LED DS3 is now solidly turned on. This is because we have passed the statement turning on LED DS3. Note that **`j`** in the watch window has the value 25000. This is because the loop above terminated when **`j`** reached 25000.

To remove the break point, type **F2** or select **Toggle Breakpoint** on the **Run** menu. To continue program execution, type **F9** or select **Run** from the **Run** menu. Now the LED should be flashing again since the program is running at full speed.

You can set break points while the program is running by positioning the cursor to a statement and using the **F2** key. If the execution thread hits the break point, a break point will take place. You can toggle the break point off with the **F2** key and continue execution with the **F9** key. Try this a few times to get the feel of things.

3.2.3 Editing the Program

Click on the **Edit** box on the task bar. This will set Dynamic C into the edit mode so that you can change the program. Use the **Save as** choice on the **File** menu to save the file with a new name so as not to change the demo program. Save the file as **MYTEST.C**. Now change the number 25000 in the **for (..** statement to 10000. Then use the **F9** key to recompile and run the program. The LED will start flashing, but it will flash much faster than before because you have changed the loop counter terminal value from 25000 to 10000.

3.2.4 Watching Variables Dynamically

Go back to edit mode (select edit) and load the program **DEMOJR2.C** using the **File** menu **Open** command. This program is the same as the first program, except that a variable **k** has been added along with a statement to increment **k** each time around the endless loop. The statement:

```
runwatch();
```

has been added. This is a debugging statement that makes it possible to view variables while the program is running.

Use the **F9** key to compile and run **DEMOJR2.C**. Now type **<ctrl-W>** to open the watch window and add the watch expression **k** to the top of the list of watch expressions. Now type **<ctrl-U>**. Each time you type **<ctrl-U>**, you will see the current value of **k**, which is incrementing about 5 times a second.

As an experiment add another expression to the watch window:

```
k*5
```

Then type **<ctrl-U>** several times to observe the watch expressions **k** and **k*5**.

3.2.5 Summary of Features

So far you have practiced using the following features of Dynamic C.

- Loading, compiling and running a program. When you load a program it appears in an edit window. You can compile by selecting **Compile** on the task bar or from the **Compile** menu. When you compile the program, it is compiled into machine language and downloaded to the target over the serial port. The execution proceeds to the first statement of main where it pauses, waiting for you to command the program to run, which you can do with the **F9** key or by selecting **Run** on the **Run** menu. If want to compile and start the program running with one keystroke, use **F9**, the run command. If the program is not already compiled, the run command will compile it first.
- Single-stepping. This is done with the **F8** key. The **F7** key can also be used for single-stepping. If the **F7** key is used, then descent into subroutines will take place. With the **F8** key the subroutine is executed at full speed when the statement that calls it is stepped over.

- Setting break points. The **F2** key is used to turn on or turn off (toggle) a break point at the cursor position if the program has already been compiled. You can set a break point if the program is paused at a break point. You can also set a break point in a program that is running at full speed. This will cause the program to break if the execution thread hits your break point.
- Watch expressions. A watch expression is a C expression that is evaluated on command in the watch window. An expression is basically any type of C formula that can include operators, variables and function calls, but not statements that require multiple lines such as *for* or *switch*. You can have a list of watch expressions in the watch window. If you are single-stepping, then they are all evaluated on each step. You can also command the watch expression to be evaluated by using the **<ctrl-U>** command. When a watch expression is evaluated at a break point, it is evaluated as if the statement was at the beginning of the function where you are single-stepping. If your program is running you can also evaluate watch expressions with a **<ctrl-U>** if your program has a **runwatch()** command that is frequently executed. In this case, only expressions involving global variables can be evaluated, and the expression is evaluated as if it were in a separate function with no local variables.

3.3 Cooperative Multitasking

Cooperative multitasking is a convenient way to perform several different tasks at the same time. An example would be to step a machine through a sequence of steps and at the same time independently carry on a dialog with the operator via a human interface. Cooperative multitasking differs from a different approach called preemptive multitasking. Dynamic C supports both types of multitasking. In cooperative multitasking each separate task voluntarily surrenders its compute time when it does not need to perform any more activity immediately. In preemptive multitasking control is forcibly removed from the task via an interrupt.

Dynamic C has language extensions to support multitasking. The major C constructs are called *costatements*, *cofunctions*, and *slicing*. These are described more completely in the ***Dynamic C Reference Manual***. The example below, sample program **DEMOJR3.C**, uses costatements. A costatement is a way to perform a sequence of operations that involve pauses or waits for some external event to take place. A complete description of costatements is in the ***Dynamic C Reference Manual***. The **DEMOJR3.C** sample program has two independent tasks. The first task flashes LED DS4 once a second. The second task uses button S1 on the Prototyping Board to toggle the logical value of a virtual switch, **vswitch**, and flash DS1 each time the button is pressed. This task also debounces button S1.

```
int vswitch;             // state of virtual switch controlled by button S1
main(){                  // begin main program
                         // set up parallel port A as output
    WrPortI(SPCR,NULL,0x84);
    WrPortI(PADR,&PADRShadow,0xff);       // turn off all LEDs
    vswitch=0;                            // initialize virtual switch off
(1) while (1) {                           // Endless loop
      BigLoopTop();                     // Begin a big endless loop

    // first task flash LED DS4 every second for 200 milliseconds

(2)   costate {                           // begin a costatement
        BitWrPortI(PADR,&PADRShadow,0,3); // LED DS4 on
(3)     waitfor(DelayMs(200));            // light on for 200 ms
        BitWrPortI(PADR,&PADRShadow,1,3); // LED DS4 off
        waitfor(DelayMs(800));            // light off for 800 ms
(4)   }                                   // end of costatement

    // second task - debounce switch #1 and toggle virtual switch vswitch

    // check button 1 and toggle vswitch on or off

      costate {
(5)     if(BitRdPortI(PBDR,2)) abort;  // if button not down skip out
        waitfor(DelayMs(50));          // wait 50 ms
        if(BitRdPortI(PBDR,2)) abort;  // if button not still down skip out
        vswitch=!vswitch;   // toggle virtual switch- button was down 50 ms
        while (1) {                    // wait for button to be off 200 ms
          waitfor(BitRdPortI(PBDR,2)); // wait for button to go up
          waitfor(DelayMs(200));       // wait for 200 milliseconds
          if(BitRdPortI(PBDR,2)) break;// if button up break
        }                              // end of while(1)
      }                                // end of costatement

    // make LED agree with vswitch if vswitch has changed

(6)   if( (PADRShadow & 1) == vswitch) {
        BitWrPortI(PADR,&PADRShadow,!vswitch,0);
      )
(7) }                              // end of while loop, go back to start
}                                   // end of main, never come here
```

The numbers in the left margin are reference indicators and are not a part of the code. Load and run the program. Note that LED DS4 flashes once per second. Push button S1 several times and note how LED DS1 is toggled.

The flashing of LED DS4 is performed by the costatement starting at the line marked (2). Costatements need to be executed regularly, often at least every 25 ms. To accomplish this, the costatements are enclosed in a *while* loop. The term while loop is used as a handy way to describe a style of real-time programming in which most operations are done in one loop. The while loop starts at (1) and ends at (7). The function **`BigLoopTop()`** is used to collect some operations that are helpful to do once on every pass through the loop. Place the cursor on this function name **`BigLoopTop()`** and hit **<ctrl-H>** to learn more.

The statement at (3) waits for a time delay, in this case 200 ms. The costatement is being executed on each pass through the big loop. When a **`waitfor`** condition is encountered the first time, the current value of **`MS_TIMER`** is saved and then on each subsequent pass the saved value is compared to the current value. If a **`waitfor`** condition is not encountered, then a jump is made to the end of the costatement (4), and on the next pass of the loop, when the execution thread reaches the beginning of the costatement, execution passes directly to the **`waitfor`** statement. Once 200 ms has passed, the statement after the waitfor is executed. The costatement has the property that it can wait for long periods of time, but not use a lot of execution time. Each costatement is a little program with its own statement pointer that advances in response to conditions. On each pass through the big loop, as little as one statement in the costatement is executed, starting at the current position of the costatement's statement pointer. Consult the ***Dynamic C Reference Manual*** for more details.

The second costatement in the program debounces the switch and maintains the variable **`vswitch`**. Debouncing is performed by making sure that the switch is either on or off for a long enough period of time to ensure that high-frequency electrical hash generated when the switch contacts open or close does not affect the state of the switch. The **`abort`** statement is illustrated at (5). If executed, the internal statement pointer is set back to the first statement within the costatement, and a jump to the closing brace of the costatement is made.

At (6) a use for a shadow register is illustrated. A shadow register is used to keep track of the contents of an I/O port that is write only - it can't be read back. If every time a write is made to the port the same bits are set in the shadow register, then the shadow register has the same data as the port register. In this case a test is made to see the state of the LED and make it agree with the state of vswitch. This test is not strictly necessary, the output register could be set every time to agree with vswitch, but it is placed here to illustrate the concept of a shadow register.

To illustrate the use of snooping, use the watch window to observe **`vswitch`** while the program is running. Add the variable **`vswitch`** to the list of watch expressions. Then toggle **`vswitch`** and the LED. Then type **<ctrl-U>** to observe **`vswitch`** again.

3.4 Advantages of Cooperative Multitasking

Cooperative multitasking, as implemented with language extensions, has the advantage of being intuitive. Unlike preemptive multitasking, variables can be shared between different tasks without having to take elaborate precautions. Sharing variables between tasks is the greatest cause of bugs in programs that use preemptive multitasking. It might seem that the biggest problem would be response time because of the big loop time becoming long as the program grows. Our solution for that is a device caused slicing that is further described in the ***Dynamic C Reference Manual***.

4. Software Reference

4.1 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 Reference 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 of a crash, a new cold boot and BIOS compile can be done at any time.

Each type of Rabbit microprocessor system can have a different BIOS, or the BIOS program can be customized by using **`#define`** options. The Jackrabbit board is supplied with one BIOS, and a flash memory and a RAM memory to hold the program. RAM memory is useful for holding a program while debugging is being done because it is more flexible than flash memory.

Dynamic C does not use include files, rather it has libraries which are used for the same purpose, that is, to supply function prototypes to programs before they are compiled. Libraries are much easier to use compared to include files.

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

4.1.1 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 and 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 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 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.

- Watchdog support routines. Although the Rabbit watchdog can be disabled, this is not recommended since the watchdog is an essential facility for recovering from crashes. Very few systems are crash-free in real life.

4.2 I/O Drivers

The Jackrabbit board contains four high-power digital output channels, two D/A converter output channels, and one A/D converter input channel. These I/O channels can be accessed using the functions found in the **`JRIO.LIB`** library.

4.2.1 Initialization

The function **`jrioInit()`** must be called before any other function from the **`JRIO.LIB`** library. This function initializes the digital outputs and sets up the driver for the analog input/outputs. The digital outputs correspond to the Rabbit processor’s port E bits 0–3, and the analog I/O uses timer B; bits 1, 2, and 4 of port D; and bits 6 and 7 of port E.

The function void **`jrioInit()`** initializes the I/O drivers for Jackrabbit. In particular, it sets up parallel port D bits 1, 2, and 4 for analog output, port E bits 0–3 for digital output, and starts up the pulse-width modulation routines for the A/D and D/A channels. Note that these routines can consume up to 20% of the CPU’s processing power; the routines use timer B and the B1 and B2 match registers.

4.2.2 Digital Output

The Jackrabbit board contains four high-power digital output drivers, HV0–HV3, on header J4. These can be turned on and off with the following functions from the library **`JRIO.LIB`**.

HV0, HV1, and HV2 are open-collector sinking outputs, and are able to sink up to 1 A (200 mA for the BL1810 and BL1820) from a 30 V source connected to the K line on header J4. HV3 is a sourcing output that is able to source up to 500 mA (100 mA for the BL1810 and BL1820) from a 30 V source connected to the K line.

Remember to cut the trace between K and Vcc inside the outline for header JP2 on the top side of the Prototyping Board if you are supplying K from a separate power supply. An exacto knife, a precision grinder tool, or a screwdriver may be used to cut through the traces as shown in Figure 5.

Failure to do this could lead to the destruction of the Rabbit 2000 microprocessor and other components once the Jackrabbit is connected to the Prototyping Board.

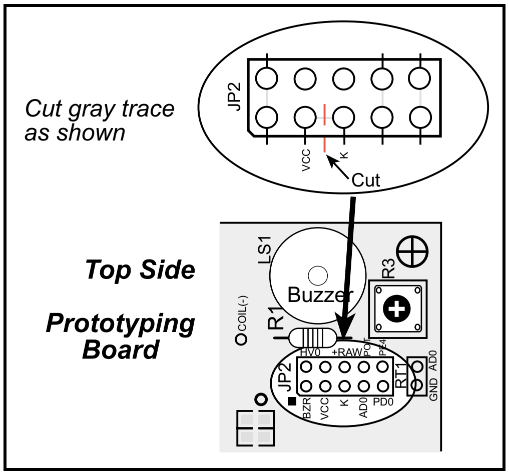


Figure 5. Cut Trace on Prototyping Board When Vcc and K Are Different

`void digOut(int channel, int value)`

sets the state of a digital output bit.

`jrioInit` must be called first.

`channel` is the output channel number (0-3 on the Jackrabbit).

`value` is the output value (0 or 1).

`void digOn(int channel)`

sets the state of a digital output bit to on (1).

`jrioInit` must be called first.

`channel` is the output channel number (0–3 on the Jackrabbit).

`void digOff(int channel)`

sets the state of a digital output bit to off (0).

`jrioInit` must be called first.

`channel` is the output channel number (0–3 on the Jackrabbit).

See the sample program **`JRIOTEST.C`** for an example of using the digital output functions.

4.2.3 Analog Output

The two analog output channels on the Jackrabbit (DA0 and DA1 on header J5) are controlled by a pulse-width modulation (PWM) driver. This requires the use of some fraction of the CPU cycles when the driver is running (up to 20% when both D/A channels are used). A voltage is selected by giving a value from 0 to 1024 to the driver, corresponding roughly to 0.1 V to 3.5 V on DA0. Because of the PWM interrupt frequency, the PWM driver can provide a continuous range of voltage output in the range from 0.1 V to 3.0 V for DA0, and 0.6 V to 3.6 V for DA1. These ranges can be specified with the constants **`PWM_MIN`**, **`PWM_MAX0`**, and **`PWM_MAX1`**. In other words, setting channel DA0 to the value **`PWM_MIN`** will output 0.1 V, and setting it to **`PWM_MAX0`** will output 3.0 V. Similarly, setting DA1 to **`PWM_MIN`** will output 0.6 V, and setting it to **`PWM_MAX1`** will output 3.6 V. Values below **`PWM_MIN`** will be rounded down to 0, and values above **`PWM_MAX0`** (**`PWM_MAX1`** for DA1) will be rounded up to 1024.

The output channels can also be set in an “always on” or “always off” mode, which does not require CPU cycles. The “always on” mode is set by requesting an output value of 1024, and will provide about 3.4 V on channel DA0, and 3.6 V on DA1. The “always off” mode is selected by asking for a value of 0, and provides an output of around 0.1 V on DA0 and 0.0 V on DA1.

See Table 2 for a summary of the possible analog output voltages corresponding to values given in the **anaOut** function.

Table 2. Typical Analog Output Voltages Corresponding to Values in anaOut *Function*

Channel	0	PWM_MIN	PWM_MAX	1024
DA0	0.08 V	0.08 V	2.875 V	3.4 V
DA1	0.004 V	0.63 V	3.6 V	3.6 V

The output value is set using the following function.

```
void anaOut(int channel, int value)
```

sets the state of an analog output channel.

jrioInit must be called first.

channel is the output channel number (0 or 1 on the Jackrabbit).

value is an integer from 0–1024 that corresponds to an output voltage as shown in Table 2.

See the sample program **JRIOTEST.C** for examples of using the **anaOut** function.

Effect of Interrupts on Analog I/O

The stability of the voltage output (and hence the voltage input determination as well) depends on the ability of the driver to respond quickly to interrupt requests. Dynamic C debugging, use of the **printf** function, or any serial communications can disrupt the pulse-width modulation utilized by the driver and cause fluctuations in the voltage outputs. Avoid using serial communications or **printf** statements during portions of your program where the voltage must remain steady. Also be aware that debugging and running Dynamic C in polling mode will cause fluctuations. Finally, be certain to disable the PWM drivers by setting the output values to 0 or 1024 when you are done using them to free up the CPU.

Calibration of Values to Voltages

The analog output channels on the Jackrabbit board can be more accurately calibrated for each individual Jackrabbit board in the following manner (calibration of DA0 is assumed in this example, calibration of DA1 would proceed similarly):

- Set desired channel output to **PWM_MIN**.
- Measure voltage V_{min} on DA0.
- Set desired channel output to **PWM_MAX0**.
- Measure voltage V_{max} on DA0.
- A linear relation between input value and voltage can now be calculated:

$$m = \frac{V_{max} - V_{min}}{\text{PWM\_MAX0} - \text{PWM\_MIN}}$$

$$b = V_{max} - m \times \text{PWM\_MAX0}$$

$$\text{voltage} = m \times \text{value} + b$$

4.2.4 Analog Input

The analog input channel on the Jackrabbit (AD0 on header J5) works by varying analog output channel DA0 until its voltage matches the input voltage on AD0. DA0 obviously cannot be used while an input voltage is being measured, although channel DA0 is still available. The value returned corresponds to the value that DA0 required to match the input voltage (you would call **`anaOut(0,value)`** for DA0 to provide that same voltage). If the value returned is negative, then the function considers the value suspect for some reason (most likely a failure of the DA0 voltage to settle quickly). The value can be taken as is, or another measurement can be done.

`void anaIn(int channel, int *value)`

Analog input for the Jackrabbit analog input channel (AD0).

`jrioInit` must be called first.

`channel` is the input channel number (0 only on the Jackrabbit).

An integer between 0 and 1024 will be returned in **`value`**, corresponding to a voltage obtained if output channel DA0 was set to that value. If a value is found, but the voltage has not appeared to fully settle, the value will be negative (but equal in magnitude to the found voltage) to allow remeasurement if desired.

See sample program **`JRIOTEST.C`** for an example of the use of **`anaIn`**.

Two versions of the analog input function are available: the standard function, listed above, that does not return until the measurement has been made, and a cofunction version that can be called from within a costatement. This cofunction version allows other tasks to be performed while the voltage match is being made. The voltage measurement will take ten calls of the cofunction version to make a measurement.

`void cof_anaIn(int channel, int *value)`

The parameters are identical to those described above for **`anaIn`**.

See sample program **`JRIO_COF.C`** for an example of the use of **`cof_anaIn`**.

4.3 Serial Communication Drivers

The interface to the Rabbit serial library, **`RSERIAL.LIB`**, is designed to provide users with a set of functions that send and receive entire blocks of data without yielding to other tasks, a set of single user cofunctions that send and receive data but yield to other tasks, and a set of circular buffer functions.

The naming convention is **`serXfn`**:

ser - serial

X - the port being used: A, B, C, or D

fn - the function being implemented

For example, **`serBgetc()`** is the serial port B function **`getc()`**, which returns a character.

The Rabbit serial functions are listed in the following groups.

Open and Close Functions

Non-Cofunction Blocking Input Functions

Non-Cofunction Blocking Output Functions

Single-User Cofunction Input Functions

Single-User Cofunction Output Functions

Circular Buffer Functions

4.3.1 Open and Close Functions

The open and close functions enable and disable serial communication over the specified port.

`int serXopen (long baud);`

Currently only 8N1 transmission (8 data bits, no parity, 1 stop bit) is supported. The **`open`** function sets up the interrupt service routine vector.

Parameters

`baud`—desired baud rate in bits per second

Return Value

1—The baud rate set on the Rabbit is the same as the input baud rate.

0—The baud rate set on the rabbit does not match the input baud rate.

`int serXclose ( );`

Disables the serial port interrupt service routine.

Parameters

None.

Return Value

1

4.3.2 Non-Cofunction Blocking Input Functions

These are simple functions that do not use Dynamic C costatements. If no input data are available when called, they return immediately with appropriate status information in their return value. Once they begin to receive characters, they do not yield to other tasks until they complete their operation or until a character-to-character timeout period elapses.

`int serXgetc ( );`

Gets a single character. Always returns immediately, either with the next available input byte, or with –1 if none is available.

Parameters

None

Return Value

An integer with return character in the low byte. No character is represented by a return of –1.

`int serXread (void *data, int length, unsigned long tmout);`

Reads a block of characters. Returns the number of bytes read from an input serial stream. The stream is considered to be ended when all **`length`** bytes have been read or when the timeout period elapses waiting for data to appear in the input buffer.

Parameters

`data`—Destination data structure. The user must ensure data is allocated for at least length bytes.

`length`—The number of bytes to read.

`tmout`—The number of milliseconds to wait for receipt of each byte before timing out.

Return Value

The number of bytes read into data until timed out or until all length bytes have been read.

4.3.3 Non-Cofunction Blocking Output Functions

These are simple functions that do not use Dynamic C costatements. They immediately begin to perform their task, not yielding to other tasks until all characters have been written.

`int serXputc (char c);`

Writes a character to the serial port.

Parameters

`c`—Character to write

Return Value

1 for success, 0 if the character could not be written to the port.

`int serXputs (char *s);`

Calls **`serXwrite (s, strlen (s))`**.

Parameters

`s`—Null-terminated character string source to write to the serial port.

Return Value

The number of characters written.

`int serXwrite (void *data, int length);`

Writes a block of **`length`** bytes to the serial port.

Parameters

`data`—Destination data structure. The user must ensure data is allocated for at least length bytes.

`length`—The number of bytes to read.

Return Value

The number of bytes written to the serial port.

4.3.4 Single-User Cofunction Input Functions

These are Dynamic C cofunctions. If the input buffer they use is locked or becomes full during the course of their operation, they yield to other tasks, but do not return to execute the next statement within their own costatement block until they have completed their operation.

`scofunc int cof_serXgetc ( );`

Reads a single character from the serial port, yielding when not successful, and only returning when a character is successfully read.

Parameters

None

Return Value

An integer with the character read in the low byte.

`scofunc int cof_serXgets(char *s, int length, unsigned long tmout);`

Reads a null-terminated string, completes its execution when a carriage return is read, **`length`** number of characters are read, or the character to character timeout period elapses after the first character is read. It yields to other tasks while the input buffer is locked or becomes empty during its execution, and only returns control to the following statement in its own costatement block when it completes.

Parameters

`data`—Destination data structure. The user must ensure data is allocated for at least length bytes.

`length`—The number of bytes to read.

`tmout`—The number of milliseconds to wait for each character after the first character is read.

Return Value

1—CR or **`length`** bytes read into **`s`**.

0—Function times out before reading CR or **`length`** bytes.

`scofunc int cof_serXread(void *data, int length, unsigned long tmout);`

Reads a block of characters, completes its execution when **`length`** number of characters are read, or the character-to-character timeout period elapses after the first character is read. It yields to other tasks while the input buffer is locked or becomes empty during its execution and only returns control to the following statement in its own costatement block when it completes.

Parameters

`data`—Destination data structure. The user must ensure data is allocated for at least length bytes.

`length`—The number of bytes to read.

`tmout`—The number of milliseconds to wait for each character after the first.

Return Value

The number of bytes read.

4.3.5 Single-User Cofunction Output Functions

These are Dynamic C cofunctions. If the output buffer they use is locked or becomes empty during the course of their operation, they yield to other tasks, but do not return to execute the next statement within their own costatement block until they have completed their operation.

```
scofunc void cof_serXputc (char c);
```

Writes a single character to the serial port, yielding to other tasks when unsuccessful, and returning only when the character is successfully written.

Parameters

`c`—Character to write to the serial port.

Return Value

None

```
scofunc void cof_serXputs(char *s);
```

Writes a null-terminated character string to the serial port, yielding to other tasks when unsuccessful or whenever the buffer is full, returning only when the string is successfully written.

Parameters

`s`—Null-terminated character string written to the serial port.

Return Value

None

```
scofunc void cof_serXwrite (void *data, int length);
```

Writes a block of characters to the serial port, yielding to other tasks when unsuccessful or whenever the buffer is full, returning only when all the data is successfully written.

Parameters

`data`—Source data structure to write to the serial port.

`length`—Number of characters in data to write.

Return Value

None

4.3.6 Circular Buffer Functions

These functions act on or report status of the circular transmit/receive buffers.

Macro definitions are used to establish the buffer sizes:

xINBUFSIZE—read buffer size, where **x** is A, B, C, or D

xOUTBUFSIZE—write buffer size where **x** is A, B, C, or D

The user must define each buffer size for each port being used to be a power of 2 minus 1 with a macro. The size of 2^n - 1 enables masking for fast rollover calculations. If no value or an illegal value is defined, a default size of 31 will be used and a compiler warning will be given. When using cofunctions, smaller buffer sizes can yield more frequently to other tasks, but have the risk of a large input data stream overrunning the buffer and losing data if the other task executes for too long relative to the baud rate.

int serXpeek ( );

Returns the first character in the receive buffer, if any are available, without removing it from the buffer.

Parameters

None

Return Value

An integer with return character in the low byte. No character is represented by a return of –1.

void serXrdFlush ( );

Flushes the serial port receive buffer.

Parameters

None

Return Value

None

void serXwrFlush ( );

Flushes the serial port transmit buffer.

Parameters

None

Return Value

None

`int serXrdFree ( );`

Calculates the free space in the serial port receive buffer.

Parameters

None

Return Value

The number of characters the serial port receive buffer can accept before becoming full.

`int serXwrFree ( );`

Calculates the free space in the serial port transmit buffer.

Parameters

None

Return Value

The number of characters the serial port transmit buffer can accept before becoming full.

`int serXrdUsed ( );`

Calculates the number of characters ready to read from the serial port receive buffer.

Parameters

None

Return Value

The number of characters currently in the serial port receive buffer.

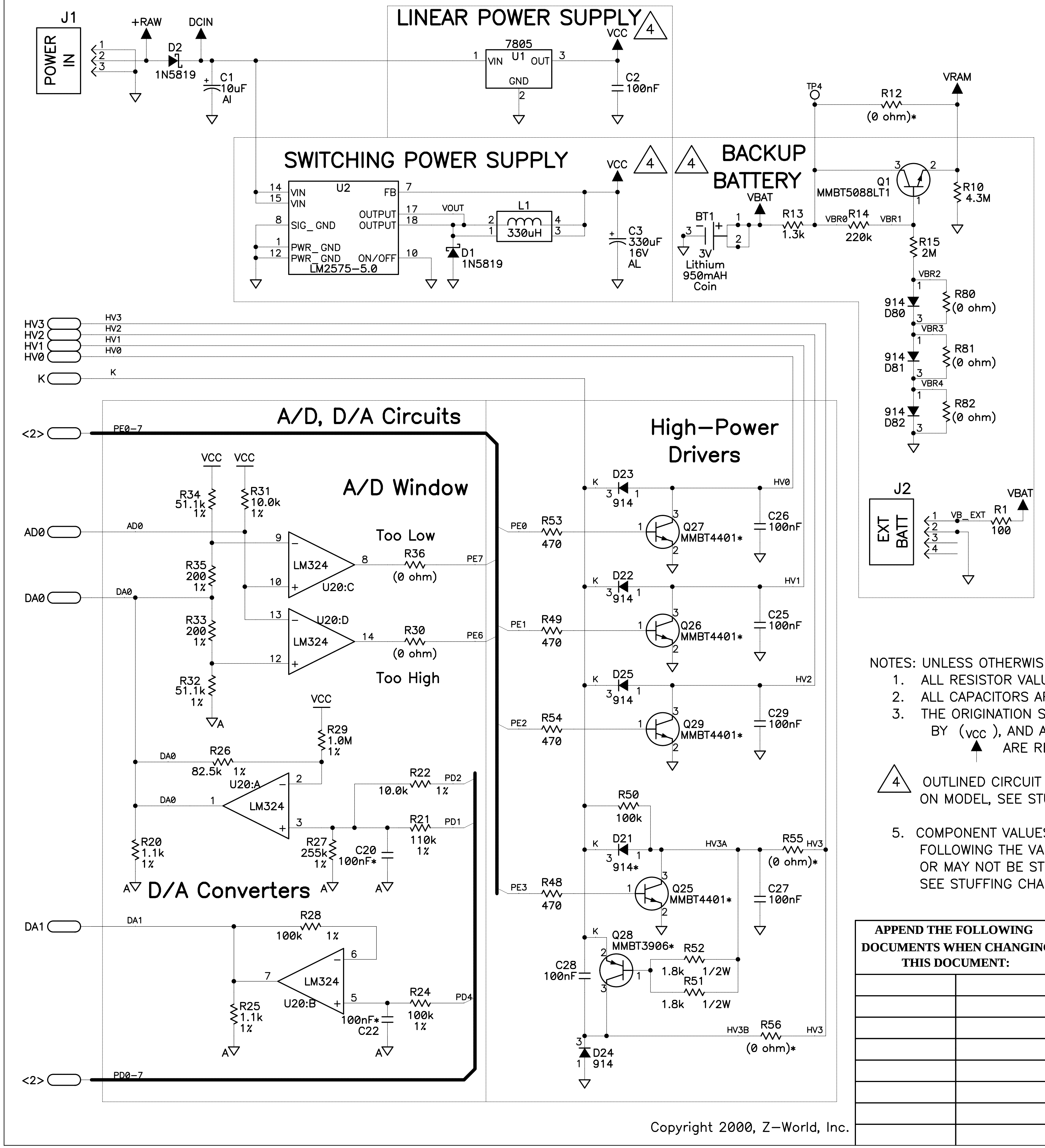
Appendix A. Specifications

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

Table A-1. Jackrabbit Board Specifications

Parameter	Specification
Board Size	3.50" × 2.50" × 0.94" (89 mm × 64 mm × 24 mm)
Humidity	5% to 95%, noncondensing
Input Voltage and Current	7.5 V to 25 V DC, 100 mA typical, 150 mA maximum, linear regulator
Configurable I/O	44—28 independent 16 shared with onboard peripherals 3 additional shared with programming connector when programming/debugging
Analog Inputs	One low-grade A/D input—input range 0 V to 3 V, 10-bit resolution, 8-bit accuracy, average acquisition time 150 ms (165 ms maximum) with 14.7 MHz clock
Analog Outputs	Two filtered and buffered PWM outputs
Digital Outputs	Four high-current, high-voltage outputs—3 sink up to 200 mA and 35 V standoff
Clock	14.74 MHz
SRAM	128K (supports 32K–512K)
Flash EPROM	128K (supports 32K–512K)
Timers	Five 8-bit timers, one 10-bit timer with two match registers, five timers are cascadable
Serial Ports	Four serial ports—two RS-232 or one RS-232 (with CTS/RTS) and one RS-485 One 5 V CMOS-compatible line Two serial ports can be clocked
Serial Rate	Up to 1.84 MHz
Watchdog/Supervisor	Yes
Time/Date Clock	Yes
Backup Battery	Yes, 3 V lithium coin type, 950 mA-h, includes external battery holder

Schematics



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REVISION HISTORY			REVISION APPROVAL			
REV	ECO	DESCRIPTION	PROJECT ENGINEER	APPROVAL DATE	DOCUMENT CONTROL	APPROVAL DATE
F	E10888	SEE ECO FOR HISTORY	RJH	09MAR00	KAH	09MAR00
G	E11008	CHANGE C3 TO LOW ESR TYPE CAP, ADD FLASH SELECT JUMPER JP2, TRACKS A/W @ REV–B	RJH	19APR00	KAH	19APR00
H	E11053	CHANGE U6 FROM 75176B TO SP483EN TO MATCH BOM	RJH	26MAY00	KAH	18MAY00
J	E11182	CHANGE R13 FROM 1K TO 1.3K TO CONFORM WITH UL REGULATIONS ON CUREENT LIMITING RESISTORS				

TABLE A

REF DES	DEVICE	DEVICE VOLTAGE INFORMATION					DEVICE: FILTER CAP REF DES(s)
		AGND	GND	VCC	VRAM	NO CONNECTS	
U1	7805T						
U2	LM2575–5.0					2–6,9,11,13,16,19–24	
U3	RABBIT 2000		2,27,39 52,77,89	3,28,53, 78,92	42		C32 – PIN3, C30,31,33,34 C12 – PIN42 (VRAM)
U4	MAX232A		15	16			C14
U5	SRAM		16		32		C15
U6	SP483EN		5	8			C13
U20	LM324	11		4			C21
U21	ETC811						C24
U22	FLASH		24	8			C35

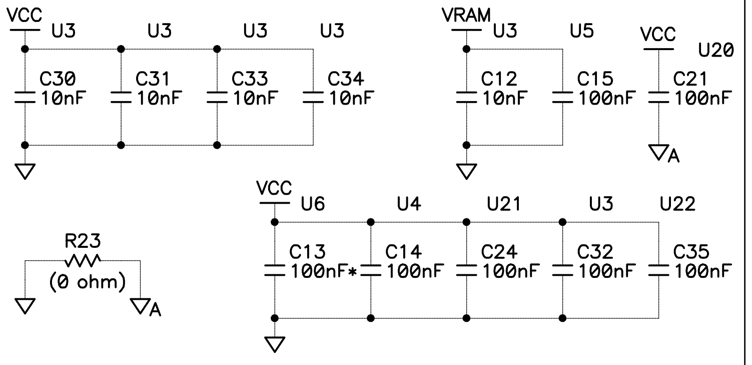
Decoupling Capacitors

NOTES: UNLESS OTHERWISE SPECIFIED;

1. ALL RESISTOR VALUES ARE IN OHMS, 1/10W, 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..



APPEND THE FOLLOWING DOCUMENTS WHEN CHANGING THIS DOCUMENT:

DRAWING CONTENT:

DRAWN BY: (INITIAL RELEASE) JS 27MAY99

REVISED BY: KAH 31AUG00

APPROVALS: INITIAL RELEASE

PROJECT ENGINEER: RJH 21OCT99

ENGINEERING MANAGER:

SIGNATURES DATE

TITLE

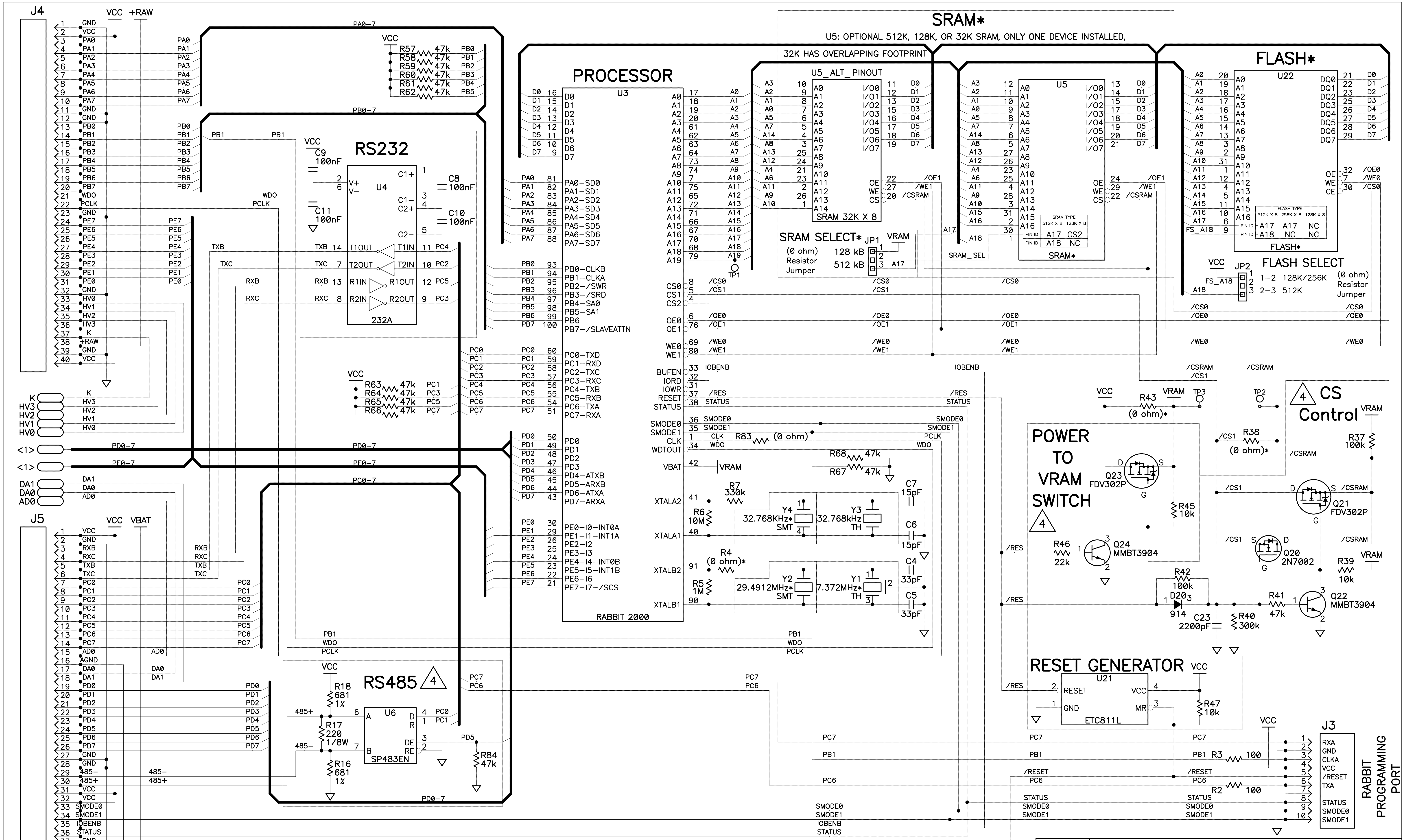
SCHEMATIC DIAGRAM BL1800 SERIES / JACKRABBIT

Z-WORLD

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

SIZE B DWG NO. 090–0092

SCALE NONE RELEASE DATE 21OCT99 SHEET 1 OF 3



B

DWG NO. 090-0092

SCALE NONE

REV LTR J

SHEET 2 OF 3

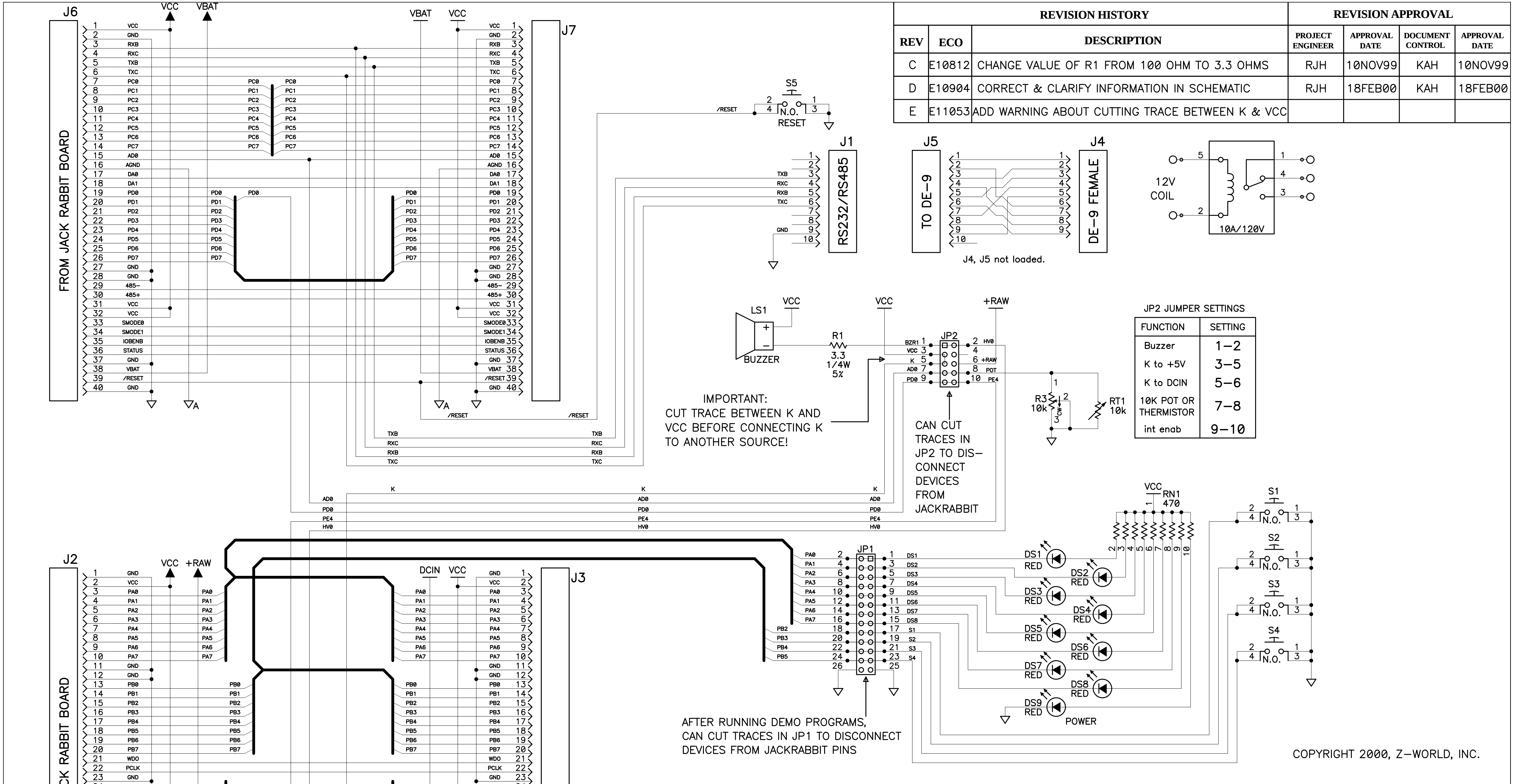
STUFFING TABLE

			MODEL		
CIRCUIT		PART	BL1800	BL1810	BL1820
BACKUP BATTERY	MAIN	BT1	3V Li	3V Li	NOT INSTALLED
		J2	INSTALLED	INSTALLED	NOT INSTALLED
		R1	100 ohm	100 ohm	NOT INSTALLED
		R10	4.3M	4.3M	NOT INSTALLED
		R12	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED
		R13	1.3k	1.3k	NOT INSTALLED
	REGULATOR	Q1	5088 npn	5088 npn	NOT INSTALLED
		R14	220k	220k	NOT INSTALLED
		R15	2M	2M	NOT INSTALLED
	REGULATOR TEMPERATURE COMPENSATION ADJUST	D80	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED
		D81	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED
		D82	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED
		R80	ZERO ohm	ZERO ohm	NOT INSTALLED
		R81	ZERO ohm	ZERO ohm	NOT INSTALLED
		R82	ZERO ohm	ZERO ohm	NOT INSTALLED
CHIP SELECT CONTROL	W/BATTERY BACKUP	C23	2200pF	2200pF	NOT INSTALLED
		D20	914	914	NOT INSTALLED
		Q20	2N7002 n-ch	2N7002 n-ch	NOT INSTALLED
		Q21	FDV302P p-ch	FDV302P p-ch	NOT INSTALLED
		Q22	3904 npn	3904 npn	NOT INSTALLED
		R37	100k	100k	NOT INSTALLED
		R39	10k	10k	NOT INSTALLED
		R40	300k	300k	NOT INSTALLED
		R41	47k	47k	NOT INSTALLED
		R42	100k	100k	NOT INSTALLED
	W/O BATTERY BACKUP	R38	NOT INSTALLED	NOT INSTALLED	ZERO ohm
POWER TO VRAM SWITCH	W/BATTERY BACKUP	Q23	FDV302P p-ch	FDV302P p-ch	NOT INSTALLED
		Q24	3904 npn	3904 npn	NOT INSTALLED
		R45	10k	10k	NOT INSTALLED
		R46	22k	22k	NOT INSTALLED
	W/O BATTERY BACKUP	R43	NOT INSTALLED	NOT INSTALLED	ZERO ohm
POWER SUPPLY	LINEAR	C2	NOT INSTALLED	.1uF	.1uF
		U1	NOT INSTALLED	7805 LIN REG	7805 LIN REG
	SWITCHING	C3	330uF	NOT INSTALLED	NOT INSTALLED
		D1	1N5819	NOT INSTALLED	NOT INSTALLED
		L1	330uH	NOT INSTALLED	NOT INSTALLED
		U2	LM2575-5.0	NOT INSTALLED	NOT INSTALLED

			MODEL		
CIRCUIT		PART	BL1800	BL1810	BL1820
SRAM	MAIN	U5	128K SRAM	128K SRAM	128K SRAM
	SRAM SELECT	JP1	ZERO ohm ACROSS PINS 1-2	ZERO ohm ACROSS PINS 1-2	ZERO ohm ACROSS PINS 1-2
FLASH	MAIN	U22	256K FLASH	128K FLASH	128K FLASH
	FLASH SELECT	JP2	ZERO ohm ACROSS PINS 1-2	ZERO ohm ACROSS PINS 1-2	ZERO ohm ACROSS PINS 1-2
RS485	MAIN	C13	.1uF	.1uF	NOT INSTALLED
		R16	681 ohm	681 ohm	NOT INSTALLED
		R17	220 ohm	220 ohm	NOT INSTALLED
		R18	681 ohm	681 ohm	NOT INSTALLED
		R84	47k	47k	NOT INSTALLED
		U6	SP483EN	SP483EN	NOT INSTALLED
D/A CONV	MAIN	C20	47nF	.1uF	.1uF
		C22	47nF	.1uF	.1uF
HIGH POWER DRIVERS	MAIN	Q25	FMMT619	4401 npn	4401 npn
		Q26	FMMT619	4401 npn	4401 npn
		Q27	FMMT619	4401 npn	4401 npn
		Q28	FMMT720	3906 pnp	3906 pnp
		Q29	FMMT619	4401 npn	4401 npn
	HV3=SINKING	D21	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED
		R55	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED
	HV3=SOURCING	R56	ZERO ohm	ZERO ohm	ZERO ohm
PROCESSOR RTC CRYSTAL		Y3	32.768kHz	32.768kHz	32.768kHz
		Y4	NOT INSTALLED	NOT INSTALLED	NOT INSTALLED
PROCESSOR CRYSTAL		R4	160 ohms	ZERO ohm	ZERO ohm
		Y1	NOT INSTALLED	7.37MHz Resonator	7.37MHz Resonator
		Y2	29.49MHz Crystal	NOT INSTALLED	NOT INSTALLED

SIZE	DWG NO.		
B	090-0092		
SCALE NONE	REV LTR J	SHEET 3	OF 3

REVISION HISTORY			REVISION APPROVAL			
REV	ECO	DESCRIPTION	PROJECT ENGINEER	APPROVAL DATE	DOCUMENT CONTROL	APPROVAL DATE
C	E10812	CHANGE VALUE OF R1 FROM 100 OHM TO 3.3 OHMS	RJH	10NOV99	KAH	10NOV99
D	E10904	CORRECT & CLARIFY INFORMATION IN SCHEMATIC	RJH	18FEB00	KAH	18FEB00
E	E11053	ADD WARNING ABOUT CUTTING TRACE BETWEEN K & VCC				



J6
FROM JACK RABBIT BOARD
J7
VCC
VBAT
GND
RXB
RXC
TXB
TXC
PC0 PC1 PC2 PC3 PC4 PC5 PC6 PC7
AD0
AGND
DA0
DA1
PD0 PD1 PD2 PD3 PD4 PD5 PD6 PD7
485-
485+
SMODE0
SMODE1
IOBENB
STATUS
/RESET
A
S5
N.O.
RESET
J1
RS232/RS485
J5
TO DE-9
J4
DE-9 FEMALE
J4, J5 not loaded.
12V COIL
10A/120V
LS1
BUZZER
R1
3.3
1/4W
5%
JP2
BZR1
K
HV0
+RAW
POT
PE4
R3
10k
CW
RT1
10k
IMPORTANT:
CUT TRACE BETWEEN K AND VCC BEFORE CONNECTING K TO ANOTHER SOURCE!
CAN CUT TRACES IN JP2 TO DIS-CONNECT DEVICES FROM JACKRABBIT
J2
J3
DCIN
JP1
PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7
PB0 PB1 PB2 PB3 PB4 PB5 PB6 PB7
WDO
PCLK
PE7 PE6 PE5 PE4 PE3 PE2 PE1 PE0
HV0 HV1 HV2 HV3
DS1 DS2 DS3 DS4 DS5 DS6 DS7 DS8 DS9
RED
POWER
RN1
470
S1 S2 S3 S4
AFTER RUNNING DEMO PROGRAMS, CAN CUT TRACES IN JP1 TO DISCONNECT DEVICES FROM JACKRABBIT PINS

JP2 JUMPER SETTINGS

FUNCTION	SETTING
Buzzer	1–2
K to +5V	3–5
K to DCIN	5–6
10K POT OR THERMISTOR	7–8
int enab	9–10

APPEND THE FOLLOWING DOCUMENTS WHEN CHANGING THIS DOCUMENT:	DRAWING CONTENT:	
	DRAWN BY: (INITIAL RELEASE) JS	11AUG99
	REVISED BY: KAH	18MAY00
	APPROVALS: INITIAL RELEASE	
	PROJECT ENGINEER: RAH	18OCT99
	ENGINEERING MANAGER:	
	SIGNATURES	DATE

TITLE

SCHEMATIC DIAGRAM BL1800/JACKRABBIT PROTOTYPING BOARD

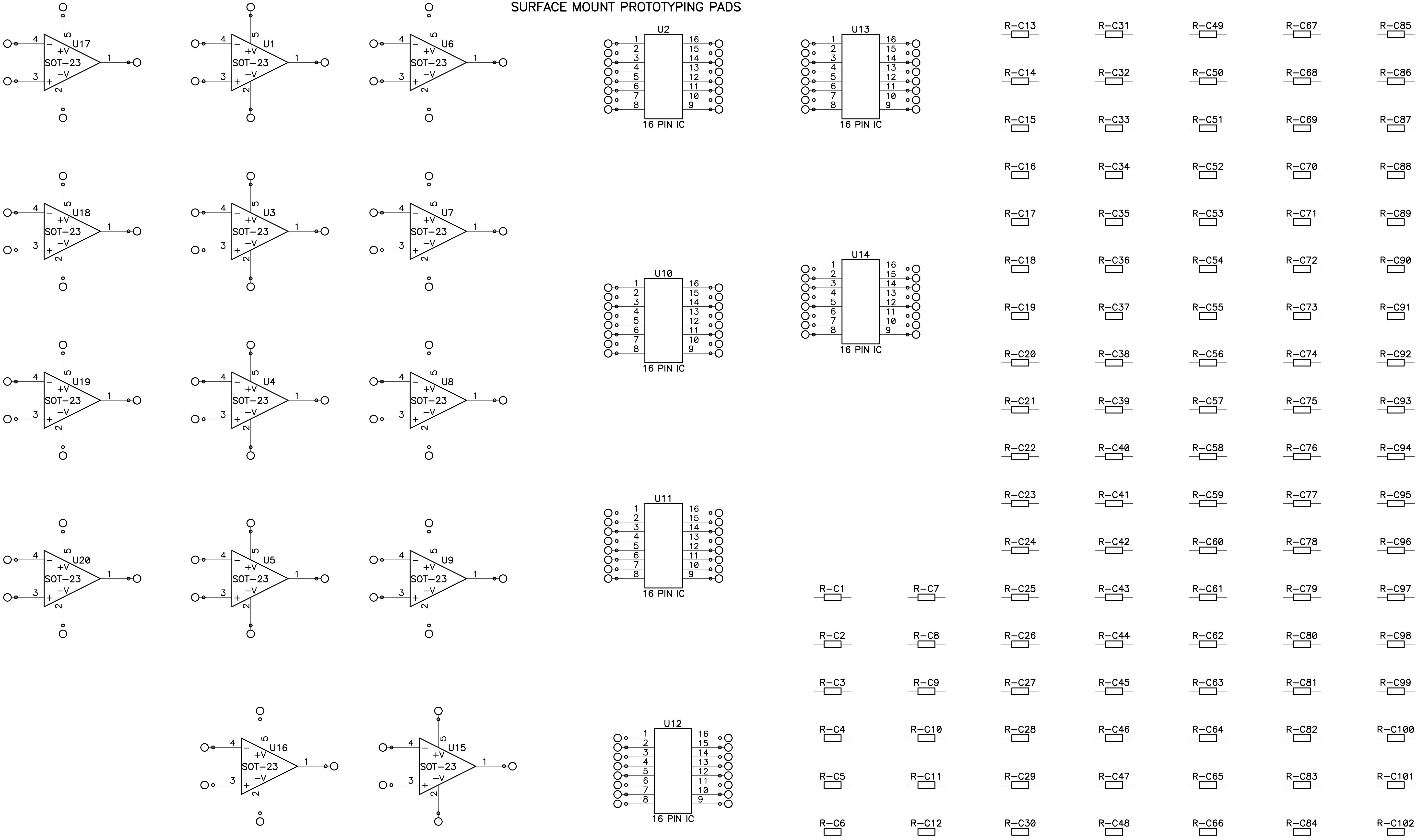
Z-WORLD

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

SIZE	DWG NO.
B	090–0088

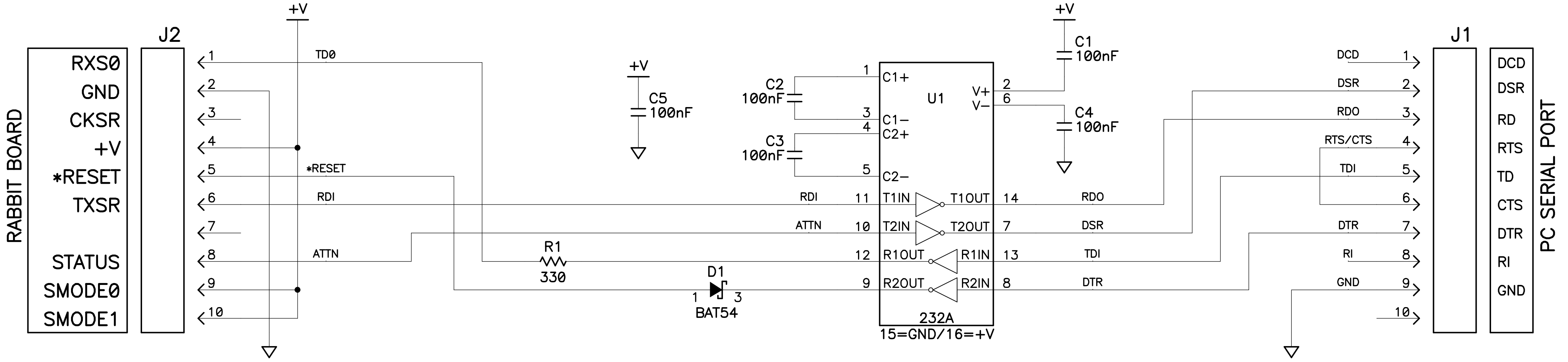
SCALE NONE | RELEASE DATE 18OCT99 | SHEET 1 OF 2

SURFACE MOUNT PROTOTYPING PADS



SIZE B	DWG NO. 090-0088				
SCALE	NONE	REV LTR	E	SHEET 2	OF 2

REVISION HISTORY			REVISION APPROVAL			
REV	ECO	DESCRIPTION	PROJECT ENGINEER	APPROVAL DATE	DOCUMENT CONTROL	APPROVAL DATE
X1	----	Engineering Prototype Release A/W Rev-A	RH	----	----	----
A	E10680	INITIAL RELEASE OF SCHEMATIC, PCB A/W @ REV-B				



NOTES: UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTOR VALUES ARE IN OHMS, 1/10W, 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).

APPEND THE FOLLOWING DOCUMENTS WHEN CHANGING THIS DOCUMENT:		DRAWING CONTENT:	
		DRAWN BY: (INITIAL RELEASE) KAH	15MAR99
		REVISED BY: KAH	13AUG99
		APPROVALS: INITIAL RELEASE	
		PROJECT ENGINEER:	
		ENGINEERING MANAGER:	
		SIGNATURES	DATE

TITLE
SCHEMATIC DIAGRAM
RABBIT SIB

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

SIZE B
DWG NO. 090-0085
SCALE NONE
RELEASE DATE
SHEET 1 OF 1