

RIC320 User's Guide

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RIGEL CORPORATION
P.O. Box 90040, Gainesville, Florida
(352) 373-4629
FAX (352) 373-1786
www.rigelcorp.com
tech@rigelcorp.com

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1 INTRODUCTION

1.1 Hardware Overview

Designed to handle demanding control applications, the RIC320 is optimized for the Dallas Semiconductor DS80C320 or the Siemens SAB C501. The board accepts any 40 pin dip 8051 including the 83C51, 87C51, Intel 8052 BASIC chip, and the DS5000 series.

The RIC320 board features:

- DS80C320 Microcontroller (or a compatible 40 pin dip 8051 chip)
- 32K EPROM
- 32K RAM / optional battery backed RAM
- Optional additional 32K EEPROM / RAM
- 8, 10, or 10 bit with sign A/D converter (ADC10158)
- Real-time clock/calendar (DS1287)
- 2 Serial ports (RS232, RS232 or RS422 or RS485 with networking capabilities)
- Both serial ports terminate on DB9 connectors
- 16 bits TTL I/O
- 16 bits of opto-isolated inputs
- 16 bits of high-voltage/high-current outputs
- Terminal blocks to access the I/O
- Standard 50-pin headers to drive industrial input/output modular boards (Grayhill, Opto 22)
- LCD and keypad interfaces with software drivers in C and Assembly
- Power supplied to the board by way of 2 position terminal blocks
- Power on LED
- Board operates on +5 volts
- Power consumption is less than 150ma fully populated
- Machine screw sockets under all IC's
- 6 layer board with separate ground and VCC planes for industrial noise immunity
- Operating temperature 0 to 70C (optional extended temperature range)

Program the RIC320 using Assembly, Basic, C, and Forth. An integrated assembly language environment with example software programs in C and Assembly come with the RIC320.

1.2 Software Overview

Rigel Corporation offers 2 versions of our Reads51 software. Please select the version that will work best in your system. We recommend new user's select Reads51 Toolchain 4.

1. Reads51 4.x (IDE, SmallC-compatible 8051 compiler, assembler, linker, editor, chip simulator, assembly language debugger, monitor, 95/98/NT)
2. Reads51 version 2.0 (IDE, assembler, editor, debugger, monitor, DOS -- runs in Win 3.1 box)

Reads51, version 4.x, is Rigel Corporation's Integrated Development Environment for the 8051 family of processors. Reads51 constitutes a complete system for developing embedded control applications when used with Rigel Corporation's 8051 boards. Efficient software development and rapid hardware prototyping are combined in a single

integrated development environment. Reads51 v4.x includes an IDE, SmallC-compatible 8051 compiler, assembler, linker, editor, chip simulator, assembly language debugger, and monitor. Reads51 v4.x is written in native 32-bit code to run on Windows95/98 and WindowsNT. Reads51 includes a sophisticated project management system to simplify code reusability and version control. Reads51 supports a full debugger in assembly language. The debugger allows you to step through your code with breakpoints and variable watches as the compiled code runs on the target board, similar to the operation of an in-circuit emulator.

V4 Compiler

The compiler is written to accompany Rigel's educational packages. It is SmallC compatible (integer and char only, one-dimensional arrays, one level of indirection, i.e. pointers). Please refer to books on SmallC for more information.

Running Compiler-Generated Code

The compiler is written for Rigel's 8051 family of boards. Currently the memory map is fixed. It assumes overlapped code and data memory. After building your project, download it to the board and swap the memory (R31JP or R515JC slide switch or R-535J RUN button) so that RAM occupies the lower block. Release the RESET button to run the code.

The Reads51 software has the following distinctive features:

- Project management for organized software development
- Multiple project management with drag and drop module transfers
- Enhanced graphical user interface for easy monitoring
- Stand alone compiler and editor applications connected to Reads51 in a client/server fashion

The 8051 boards are designed to communicate with a PC (IBM PC or compatible) acting as a host. The host-to-board communications are carried out through a serial port (COM1 - COM4).

The monitor program (RROS) includes a monitor system and user-accessible system calls for control and communication support. The RROS monitor may be used to communicate with an ASCII terminal when the PC host is unavailable. The source code of the user-accessible systems calls is provided. These routines as well as all examples in the User's Guide and on the distribution disk may be used or incorporated into applications by the registered buyer without any royalties, fees, or limitations. Rigel Corporation is not responsible for the suitability or correctness of the example software. Refer to the warranty for additional information.

1.3 Example Software

Tutorial source code is provided to experiment with the capabilities of the RIC320 board and READS. Examples are designed to illustrate the features of the 8051 family of microcontrollers, specifically digital and serial input/output, timers and counters, and interrupt logic. Also included are software drivers for the LCD, keypad, and initialization routines for the timer and A/D chips in C and assembly. The example software may be found on the READS disk. Please refer to the comments embedded in the programs for further information.

Users are encouraged to modify the example software in developing their own specific applications. The source code of the user-accessible systems calls, as well as all examples on the distribution disk may be used or incorporated into applications by the registered buyer without any royalties, fees, or limitations. RIGEL Corporation is not responsible for the suitability or correctness of the example software. Refer to warranty for additional information.

2 SOFTWARE SETUP

2.1 System Requirements

Reads51 Version 4.x is designed to work with an IBM PC or compatible, 486 or better, running Windows 95, 98, or Windows NT. The newest version of the software is always available to download off our web site, www.rigelcorp.com. We encourage you to check our web site often to keep up-to-date.

2.2 Software Installation, Reads51

If you receive a CD from Rigel, follow these steps:

1. Place the CD-ROM in your drive.
2. Go to the Rigel Products | 8051 Software | Reads51 | Win95-nt | and click on the SetupReads400.exe file. The program will then install in your system.
3. Follow the standard install directions answering the questions with the appropriate answers

If you download the software from the web, (www.rigelcorp.com)

1. Click on the SetupReads400.exe file. The program will then install in your system.
2. Follow the standard install directions answering the questions with the appropriate answers

2.3 Start up

1. Connect your RIGEL board to the PC host via a serial cable.
2. Connect the board to a well-regulated 5 volt power supply.
3. Check to make sure a jumper is in JP1 the EA# header.
4. Check to make sure the MON switch is in the MON position and the RUN switch is in the PROGRAM position.
5. Check to make sure the correct jumpers are in place.
6. Run the READS51 host driver by selecting **Start | Programs | READS51**. You may also start READS51 by double clicking on the READS51 short cut icon if installed.
7. Specify the serial port (COMM Port) that is connected to the board by opening the **Options | TTY Options** window.
8. Select the Toolchain and Target platform by selecting **Options | Toolchain/Target** and selecting Reads51 Toolchain v4 and the target RROS.
9. Open the TTY window using the menu command **View | TTY Window**.
10. Press RESET on the embedded controller board and observe the prompt in the TTY window.

2.4 Verifying that the Monitor is Loaded

Make sure the TTY window is active, clicking the mouse inside the TTY window to activate it if necessary. Then type the letter '**H**' (case insensitive) to verify that the monitor program is responding. The 'H' command displays the available single-letter commands the monitor will recognize.

The READS monitors use single-letter commands to execute basic functions. Port configurations and data, as well as memory inspection and modifications may be accomplished by the monitor. Most of the single-letter commands are followed by 4 hexadecimal digit addresses or 2 hexadecimal digit data bytes.

The list of monitor commands is displayed with the **H** command while the monitor program is in effect. The **H** command displays the following table.

B xxxx	sets Break point at address xxxx
C xxxx-xxxx	displays Code memory
D xx-xx	displays internal Data ram
D xx=nn	modifies internal Data ram
D xx-xx=nn	fills a block of internal Data ram
G xxxx	Go - starts executing at address xxxx
H	Help - displays monitor commands
K	Kills (removes) break point
L	down Loads Intel hex file into memory
P x	displays data on Port x
P x=nn	modifies data on Port x to nn
R	displays the contents of the Registers
S	displays Special function register addresses
S xx-xx	displays Special function registers
S xx=nn	modifies Special function registers
S xx-xx=nn	fills Special function registers
X xxxx-xxxx	displays eXternal memory
X xxxx=nn	modifies eXternal memory
X xxxx-xxxx=nn	fills eXternal memory

A single-letter command may be followed by up to 3 parameters. The parameters must be entered as hexadecimal numbers. Each 'x' above represents a hexadecimal digit (characters 0..9, A..F). Intermediate spaces are ignored. Alphabetic characters are converted to upper case. The length of the command string must be 16 characters or less. The command syntax is:

Letter [address][-address][=data]<CR>.

2.5 Downloading and Running an Assembly Program

1. Use the use the **Project | Open Project** command to open the project AbsoluteAssembly01.
2. Assemble the program using the **Compile | Build** command.
3. Use the **Compile | Toggle Mode** command to switch to the Run/Debug Mode.
4. Click on the **Compile | Run** command and specify the starting address 8000 (hex).
5. Again the **Compile | Toggle Mode** command to revert back to the Build Mode.

2.6 Downloading and Running a C Program

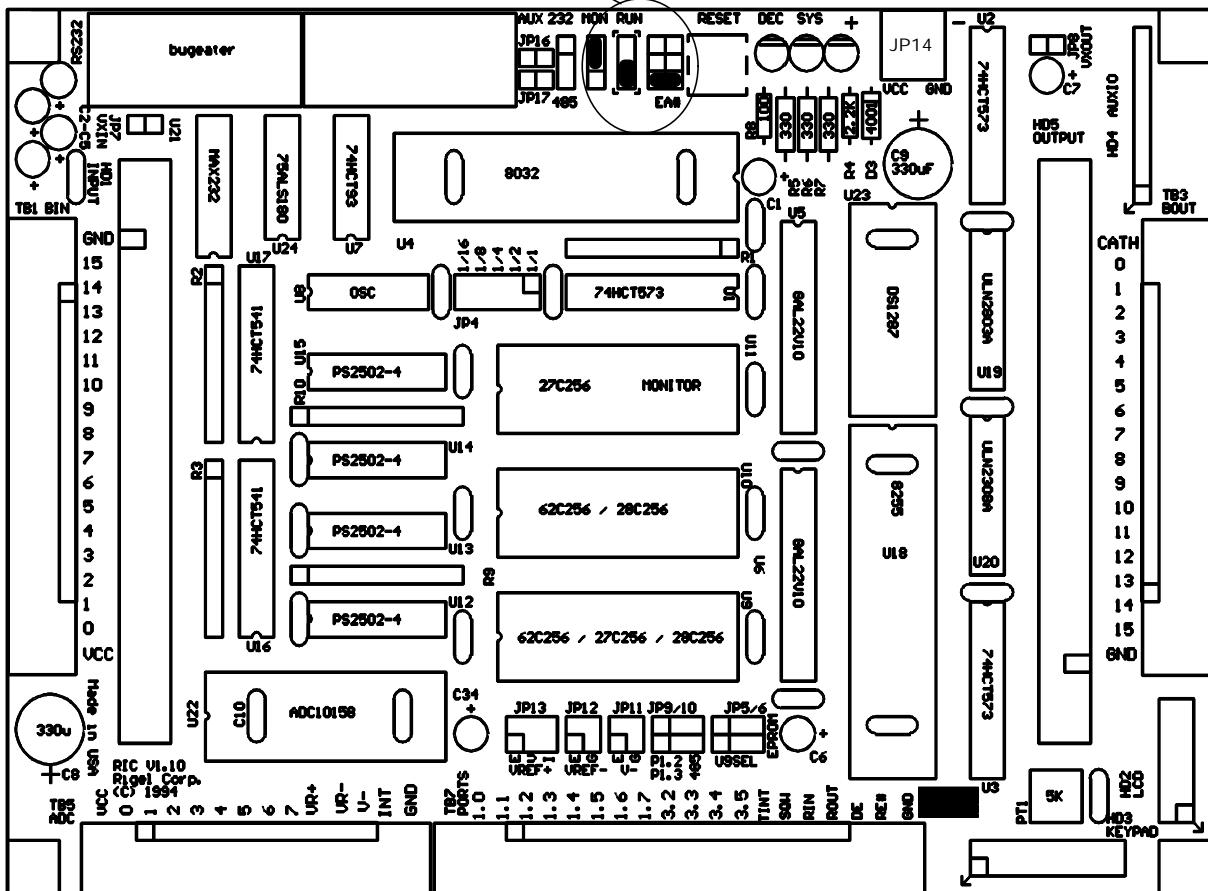
1. Use the **Project | Open Project** command to open the project Hello.
2. Compile the program and download it to the board using the **Compile | Build and Download** command. The project will be compiled and the resultant HEX code will be downloaded to the target board.
3. Press and hold the RESET button on the board. While the RESET button is pressed, flip the MON / RUN switch to the RUN position. This swaps the memory map on the board so that RAM occupies low memory. The HEX code downloaded to RAM executes when you release the RESET button.

3 OPERATING NOTES

3.1 Top Overlay of the Board

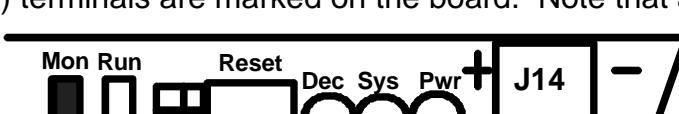
Please refer to this top overlay for location of headers, switches, terminal blocks and jumpers described on the following pages.

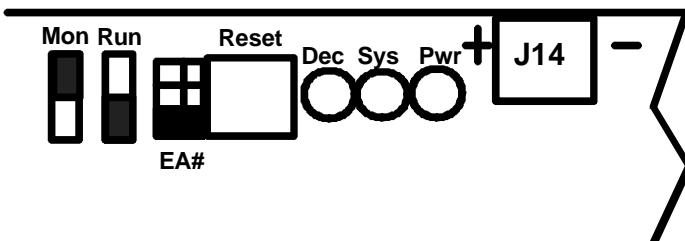
DEFINITION OF SLIDE SWITCHES AND JP1



3.2 Power

Power is brought to the RIC320 board by a two-position screw-type terminal block, JP14. JP14 is located in the top right third of the board. A well regulated (+/- 5%) 5V DC source is required. The (+) and (-) terminals are marked on the board. Note that a diode is placed across the input in reverse. If the power is applied to the RIC320 board in reverse polarity, the diode will short the power supply attempting to prevent damage to the board.





3.3 LEDs

There are three LEDs on the board. A red LED which shows when power is connected to the board. The green LED, marked SYS, will blink on and off when peripheral devices are being used. The yellow LED, marked DEC, is on when the slide switch is in the monitor position, and off when the switch is in the code position.

3.4 Switches

There is one push button and two slide switches on the RIC-320. They are located next to the LEDs. The following sections explain how these switches are used.

3.4.1 RESET

RESET is a momentary push button. The reset button resets the board. The reset input is also available in TB7 (RIN). Grounding RIN has the same effect as pressing the RESET button. A positive-going reset signal is generated by the circuitry. This signal is used to reset the 8255. It is also available on TB7 (ROUT).

3.4.2 RUN

This slide switch selects between the RUN and the PROGRAM modes. In RUN mode U10 occupies the lower half of external memory. In the PROGRAM mode, U11 or U9 (depending on the state of the MON switch) occupies the lower half of memory.

3.4.3 MON

This slide switch selects between the MONITOR (U11) and the CODE (U9) memory. The monitor position selects the EPROM in U11 as the memory block. The code position selects U9 as the memory block. U9 accepts a variety of memory devices. When the slide switch is in the monitor position it allows you to use the READS software for code development and debugging. In the code position the READS debug functions are not available.

3.5 Serial Port Options

3.5.1 Port 0

The primary port (Port 0) is connected to the DB9 marked RS232, and the secondary, to AUX232. The primary port is run by the 8032 serial port. The microcontroller supports the transmit and receive signals. The MAX232 level converter provides the RS232 level voltages. P0 of the RIC320 has a DB-9 female connector used to connect the board to an IBM compatible PC and is located in the far left corner of the board. A minimal serial port is constructed with just 3 lines: transmit, receive, and ground, disregarding all hardware handshake signals. A straight-through modem cable may be used. That is a cable

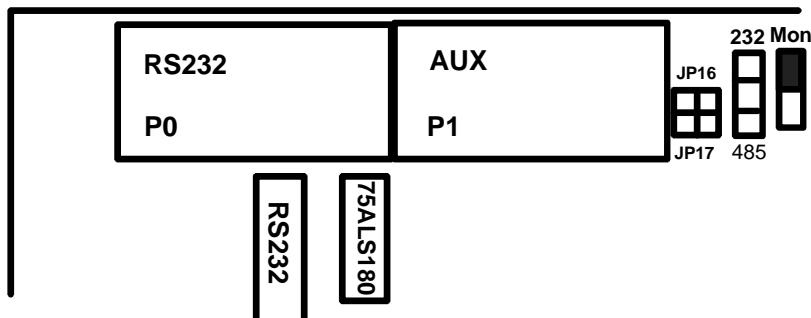
connecting pin 2 of the RIC320 to pin 2 of the host, and similarly pin 3 to pin 3, and pin 5 to pin 5.

3.5.2 Port 1

The auxiliary port is driven by the DS80C320 port 1 which uses port 1 bits 1.2 and 1.3. The jumpers at JP9 and JP10 must be inserted either in the 485 position or in the RS232 position for the port bits to be connected to the serial port driver. The auxiliary port may be configured to be either an RS232, or an RS485, or an RS422 (also called the 4-wire RS485) port. These options are selected by jumpers at JP9 and JP10, and by JP15, JP16, and JP17. The auxiliary port DB9 connector is located to the right of the primary port.

3.5.3 RS422 and RS485 Configurations

When the auxiliary serial port is configured as an RS422 or RS485 port, the transmit and receive enable signals must be provided. The enable signals are called RE# and



DE for receive enable and transmit (data) enable. These signals are supplied to the corresponding posts in terminal block TB 7. Note that RE# is an active low signal, and DE is an active high signal. In the RS422 configuration, both transmit and the receive must continuously be enabled. That is, connect RE# to GND (ground) and DE to VCC (5 volts). In the RS485 configuration, since only two lines (twisted pair) are used for both receiving and transmitting, either RE# or DE should be activated at any given time. It is convenient to connect RE# to DE, so that a low signal enables the receiver, and a high signal enables the transmitter. RE# and DE should then be connected to a control signal, typically a bit of Port 1, also available on terminal block TB7.

Please see Section 4.3 to configure the board for RS422 / RS485.

4 JUMPERS

4.1 Memory Configuration Jumpers

4.1.1 EA#

The memory configuration is determined by jumpers JP1, JP2, and JP3, located between the RESET push button and the slide switches. The jumper JP1 is marked EA#. When inserted, JP1 grounds the External Enable (EA#) pin of the microcontroller. The DS80C320 processor, the 8031, and 80C32 will need the EA# jumper installed. JP1 must be removed to use any internal program memory of the processor, such as the BASIC interpreter on the 8052AH BASIC chip from INTEL, or the internal memory on the 83C52 and 87C52.

4.1.2 JP2 and JP3

The jumpers JP2 and JP3 are located next to JP1. The state of these jumpers is read by the PAL device. In its default configuration, these jumpers are not used. For custom applications, JP2 and JP3 may be used to switch between different memory decoding schemes. For example, between a diagnostics mode and a run mode. The PAL devices must be reprogrammed according to the needs of the specific application in order to use jumpers JP2 and JP3.

4.1.3 U9 Select (JP5/JP6)

JP5/6 is located at the bottom and left of the 8255 chip. The socket for U9 may hold a 32K RAM (62C256), an EEPROM (28C256), or an EPROM (27C256). The jumpers JP5 and JP6 select between EPROM and RAM. Note that the EEPROM option is the same as the RAM option. The jumpers should be inserted horizontally in this header. JP5 and JP6 must be selected together. That is, both JP5 and JP6 must be in the EPROM position (right) or they both must be in the RAM (EEPROM) position (left).

Memory Configuration Jumpers

	EA#	JP2	JP3	JP5	JP6
DeFault Configuration	Inserted	Removed	Removed	Removed	Removed
For Internal Memory on Processor	Removed	Removed	Removed	Selected if U9 is populated	Selected if U9 is populated
U9--RAM	Inserted	Removed	Removed	Left Position	Left Position
U9--EPROM	Inserted	Removed	Removed	Right Position	Right Position
U9--EEPROM	Inserted	Removed	Removed	Left Position	Left Position

4.2 Analog / Digital Convertor Jumpers

4.2.1 Clock Select (JP4)

JP4 is a 2x5 block of headers on the right of the can oscillator. Only one jumper should be inserted in the JP4 block. The ADC clock frequency is derived from the can oscillator in U8. The oscillator frequency is divided by 2, 4, 8, and 16. The ADC clock may be taken from any one of these taps, or directly from the oscillator. Note that the maximum ADC clock frequency is 5 MHz. Thus, using a 24 MHz crystal, the 1/8 tap gives a 3 MHz ADC clock frequency. A 1/4 tap at 24Mhz gives a ADC clock frequency

of 6Mhz which is too high for the ADC, but a 1/4 at 12Mhz gives the ADC clock frequency of 3Mhz.

4.2.2 VREF+ Select (JP13)

JP13 is a 2x3 block of headers in the bottom center of the board above the TB7 row of terminal blocks. VREF+ may be taken from an external reference, VCC, or the ADC internal reference. JP13 provides three settings, marked E, V, and I which correspond to these three options. If the external reference option is selected, the external reference voltage must be supplied through the terminal block TB5. The jumpers should be inserted vertically in this header.

4.2.3 VREF- Select (JP12)

JP12 is a 2x2 block of headers next to JP13. VREF- may be connected to an external reference or to ground. JP12 selects between these two settings (E and G). If the external reference option is selected, the external reference voltage must be supplied through the terminal block TB5. The jumpers should be inserted vertically in this header.

4.2.4 V- Select (JP11)

JP11 is located to the right of JP12. V- may be connected to an external reference or to ground. JP11 selects between these two settings (E and G). If the external reference option is selected, the external reference voltage must be supplied through the terminal block TB5. The jumpers should be inserted vertically in this header.

4.3 Auxiliary Serial Port Jumpers

4.3.1 JP9/JP10

JP9/JP10 are located near the bottom of the board in the center. The auxiliary serial port is driven by port 1 bits 2 and 3. If the auxiliary serial port is not used, the jumpers JP9 and JP10 should be left open. The bits P1.2 and P1.3 are then available on the terminal block TB7. If the auxiliary serial port is to be used, place jumpers in JP9 and JP10. The jumpers should be inserted horizontally in this header to choose the option you prefer. Place the jumpers in the right position, marked 485, to select RS422 or RS485 communications. The left position selects RS232 operation.

4.3.2 JP15

JP15 is located at top of the board to the left of the MON slide switch. It is marked 232 at the top and 485 on the bottom. JP15 also selects between RS232 and RS422/485 operation. A jumper must be placed here to select between the two when using the auxiliary port. Put a jumper in the upper position for 232 and lower position for 485 or 422

4.3.2 JP16 and JP17

JP16 and 17 are located to the right of the DB9 connectors. The jumpers JP16 and JP17 are inserted for RS485 operation. RS485 uses the same twisted pair to both transmit and receive data. The Data Enable (transmit enable) or Receive Enable signals (DE and RE#) need to be provided through the terminal block TB7. Note that DE is active high and RE# is active low. Typically, these two lines are jointly connected to a port bit, for example P1.4. If the jumpers JP16 and JP17 are not inserted, the auxiliary port runs in the RS422 (sometimes called the 4-wire RS485) mode. In this protocol, the transmit and receive signals are carried by separate twisted pairs. If the RS422 mode is selected, the DE and RE# signals should be connected to VCC and GND on TB7 to unconditionally enable both the transmit and receive drivers.

Auxillary Serial Port Jumpers

MODE	JP9	JP10	JP15	JP16	JP17
232	Left Position	Left Position	Upper Position	Removed	Removed
485	Right Position	Right Position	Lower Position	Inserted	Inserted
422	Right Position	Right Position	Lower Position	Inserted	Inserted

4.4 Power Jumpers (JP7/JP8)

JP7 and JP8 are located at the top of the board. JP7 is right below the left DB9, and JP8 is to the right of JP14. The RIC320 is designed to work with industry-standard input/output modules which use 50-pin headers. The ground of the RIC320 is connected to the ground of the modules. The input/output modules may have their own 5 Volt power (VCC). If so, the RIC320 may be powered from this source. Similarly, the input/output modules may be powered from the RIC320. Alternatively, the RIC320 may be supported by a separate 5 Volt supply. In this case, it is desirable to isolate the RIC320 and input/output module VCC signals. The two jumpers JP7 and JP8 are inserted if the input and output module VCC signals are to be connected to the RIC320 VCC. These jumpers are not used unless the RIC320 is to be used with industrial input/output modules.

5 HEADERS

5.1 External Input

The 50-pin lock header HD1 interfaces with industry standard input/output module boards. The header is connected to the 16 inputs to the RIC320. Insert jumper JP7 to tie the VCC signals of the RIC320 and the input module port. Otherwise, remove JP7. All of the inputs to this header are also located on the terminal blocks of TB1 BIN. If not using industry input/output modules it is much more convenient to use the terminal blocks for the inputs. The default RIC320 board is not populated with this header.

5.2 External Output

The 50-pin lock header HD5 interfaces with industry standard input/output module boards. The header is connected to the 16 outputs to the RIC320. Insert jumper JP8 to tie the VCC signals of the RIC320 and the input module port. Otherwise, remove JP8. All of the outputs to this header are also located on the terminal blocks of TB3 BOUT. If not using industry input/output modules it is much more convenient to use the terminal blocks for the outputs. The default RIC320 board is not populated with this header.

5.3 Keypad

HD3 is located in the bottom right corner of the board. Header HD3 is connected to ports A and C of the 8255. Note that the bits 0, 1, and 2 of Port B are also used by the LCD. Strictly speaking, the enable signal (E) of the LCD is the only signal that needs to be dedicated to the LCD. That is bits 0 and 1 may be used as dual purpose bits, supporting both the LCD and the keypad. Using only 5 bits of Port A and the entire Port C, a 5 by 8 matrix-type keypad (40 keys) is supported. If a keypad is not used these 13 bits may be used as general input/output bits.

The Keypad pinout is as follows:

PIN	Function	PIN	Function
1	Port C0	2	VCC
3	Port C1	4	DA0
5	Port C2	6	DA1
7	Port C3	8	DA2
9	Port C4	10	DA3
11	Port C5	12	DA4
13	Port C6	14	DA5
15	Port C7	16	DA6
17	VCC	18	DA7

5.4 LCD

HD2 is located in the bottom right corner of the board. The header HD2 directly interfaces with standard LCD subsystems. These subsystems are available in 16, 20, and 40 character wide displays with 1, 2, or 4 lines. The potentiometer PT1 adjusts the contrast of the display. HD2 is driven by Port A and three bits of Port B of the 8255. If the LCD is not used these 11 bits may be used as general input/output bits.

The LCD pinout is as follows:

PIN	Function	PIN	Function
1	GND	2	VCC
3	to potentiometer	4	RS
5	R/W	6	E
7	DA0	8	DA1
9	DA2	10	DA3
11	DA4	12	DA5
13	DA6	14	DA7

5.5 AUXIO

The auxiliary port HD4, labeled AUXIO, is connected to Port B of the 8255. HD4 is located in the upper right corner of the board.

6 TERMINAL BLOCKS

6.1 Power (JP14)

The 5 Volt supply to the RIC320 is connected to the terminal block JP14. A diode in reverse attempts to protect the board from negative supply currents, such as if the power were to be applied in reverse polarity. VCC and GND also appear in many terminal blocks. Alternatively, the power may be applied to the RIC320 at one of these terminal blocks.

6.2 Buffered Input (TB1)

TB1 is located along the left side of the board. The 16 buffered inputs drive the optoisolators. These are memory mapped into the processors external data memory space at addresses (Base+48h) and (Base+4Ch). The low byte (Base+48h) contains input bits 0 to 7, and the high byte, 8 to 15.

6.3 Buffered Output (TB3)

TB3 is located along the right side of the board. The 16 buffered outputs are connected to open collector drivers. These are memory mapped into the processors external data memory space at addresses (Base+40h) and (Base+44h). The low byte (Base+40h) contains input bits 0 to 7, and the high byte, 8 to 15. When the corresponding bit is set, the open collector drivers are turned on, sinking current.

6.4 Analog-to-Digital Converter (TB5)

TB5 is located on the bottom left side of the board. The analog-to-digital converter input channels 0 to 7 are terminated at terminal block TB5. TB5 also contains the reference voltages VREF+, VREF-, and V-, as well as the ADC interrupt output. If JP11/JP12/JP13 are set to external voltage sources, these references must be supplied through TB5 terminals.

6.5 Ports (TB7)

TB7 is located on the bottom in the center of the board. The processor ports P1.0 to P1.7 and P3.2 to P3.5 are terminated at TB7. This terminal block also contains the timer interrupt (TINT), square wave (SQW) outputs, system reset input (RIN), reset output (ROUT), and the RS485 receive enable (RE#) and data enable (DE) inputs.

7 MEMORY OPTIONS

7.1 Memory Selection

The RIC320 can use up to 64K of memory. This memory is divided into two memory blocks of 32K each. One block of 32K memory is always located in U10. The second 32K block of memory can be located in U9 or U11. These blocks of memory may be interchanged to occupy either the lower half or upper half of memory. See section 7.2 for details.

7.1.1 U10

U10 holds one block of 32K of memory and is located in the center of the board. U10 may use either a 28C256 32K EEPROM, a 62256 32K RAM, or a 32K battery-backed RAM. The pinouts for these chips are the same and they are interchangeable in U10.

U10 may occupy either the lower half or upper half of memory depending on the position of the slide switch RUN. In the RUN mode U10 occupies the lower half of external memory. In the PROGRAM mode U10 occupies the upper half of external memory. The default configuration of the board is with U10 populated with a RAM and the slide switch in the PROGRAM mode.

7.1.2 U9/U11

7.1.2.1 U9/U11 Selection

The second 32K block of memory the RIC320 uses can be located in either U9 or U11. U9 is below and U11 is above U10 in the center of the board. The slide switch MON selects whether U9 or U11 will be used. In the MON position the EPROM in U11 is selected. In the CODE position U9 is selected. With the EPROM in U11 selected, the user may run and debug programs using the READS software and onboard RROS of the EPROM. With U9 selected a user program in U9 may be run.

7.1.2.2 Chip Selection

U11 is configured to only accept EPROMS. U9 may be populated with a variety of 32K devices. The jumpers JP5/6 select which type of device occupies U9. U9 may hold an EPROM (27C256), an EEPROM (28C256), a 32K RAM (62C256), or a 32K battery-backed RAM. Note that the pinouts for the EEPROM and RAM chips are the same and so the EEPROM and RAM option are the same. The jumpers JP5 and JP6 select between EPROM and RAM. JP5 and JP6 must be selected together. That is, both JP5 and JP6 must be in the EPROM position (right) or they both must be in the RAM (EEPROM) position (left).

7.1.2.3 External Memory Position

U9/U11 may occupy either the lower half or upper half of memory depending on the position of the slide switch RUN. In the RUN mode U9/U11 occupies the upper half of external memory. In the PROGRAM mode U9/U11 occupies the lower half of external memory. The default configuration of the board is with U11 populated with an EPROM and the slide switch in the PROGRAM mode. This allows the user access to the debug functions in READS and the RROS of the EPROM.

7.2 Memory Map

The RIC320 uses programmable logic devices to decode the 64K address space. In addition, the two slide switches are read by the devices, allowing the memory map to be altered based on the state of the switches. The default memory map overlaps the external code and data memory spaces and uses two 32K memory devices. Half of the

memory space is occupied by the RAM or EEPROM device U10. The other half is decoded to be either the EPROM U11 or U9. U9 may be EPROM, RAM, battery backed RAM, or EEPROM. In its default configuration, the slide switch RUN selects which device occupies the lower half of memory, whereas the slide switch MON selects whether U11 or U9 is used. The default RIC320 memory map reserves three blocks of 256 bytes for various system use as shown below.

Use	Address
Reserved	FC00h - FCFFh
Memory Mapped Input/Output	FD00h - FDFFh
Reserved	FE00h - FEFFh

Note that these blocks are excluded from the memory space of the processor irrespective of how the RAM and ROM are decoded. The reserved blocks are intended to be used with a network driver such as ARCNET. Currently, only the block FD00h - FDFFh is used. The peripherals of the RIC320 are memory mapped to allow fast data transfers, especially when a fast microcontroller is used. The addresses of the peripheral devices are given in the next section.

7.3 IO Memory Map

The following memory map is used. The addresses are offsets into the base defined by the signal XIOSEL#. The default address is FD00h. The base address may be changed by reprogramming the PAL devices. RIC320 uses 22V10 type GALs. These devices are electrically erasable and programmable to facilitate user modified memory maps to be implemented by reprogramming the GALs.

Device	Address
Timer	FD00h - FD3Fh
XOUTLO	FD40h - FD43h
XOUTHII	FD44h - FD47h
XINLO	FD48h - FD4Bh
XINHI	FD4Ch - FD4Fh
KPLCD	FD50h - FD53h
Port A	FD50h
Port B	FD51h
Port C	FD52h
Control	FD53h
ADC	FD60h - FD63h

With the default GALs, the analog-to-digital converter, for example, is mapped to addresses FD60h to FD63h.

8 PAL EQUATIONS

The PAL equations for U5, and U6 are given below.

8.1 U5 Equations

```
; PALASM Design Description
----- Declaration Segment -----
TITLE    RIC
PATTERN  U5
REVISION 1.1
COMPANY  RIGEL Corp
DATE     07/17/93
CHIP _ric  PALCE22V10
----- PIN Declarations -----
-- inputs --
PIN 1      A8
PIN 2      A9
PIN 3      A10
PIN 4      A11
PIN 5      A12
PIN 6      A13
PIN 7      A14
PIN 8      A15
PIN 9      RD_
PIN 10     WR_
PIN 11     PSEN_
PIN 13     RUN ; 0 for the MONITOR and 1 for the
; RUN mode
PIN 14     RIC ; 0 for the READS and 1 for the RIC
; mode
-- outputs --
PIN 15     HISEL_ ; high memory select
PIN 16     LOSEL_ ; low memory select
PIN 17     MOE_   ; monitor ROM output enable
PIN 18     COE_   ; code ROM output enable
PIN 19     READ_
PIN 20     XIOSEL_ ; memory-mapped I/O select
PIN 21     ARCNET_ ; network register page select
PIN 22     MRSEL_ ; monitor ROM select (address
; range)
PIN 23     LED_ ;
----- Boolean Equation Segment -----
EQUATIONS
HISEL_ = ( /RIC + /A15 ) * ( RIC + /RUN + A15 ) * ( RIC + RUN + /A15
; (/A8+/A9) * A10 * A11 * A12 * A13 * A14 * A15
LOSEL_ = ( /RIC + /A15 ) * ( RIC + /RUN + /A15 ) * ( RIC + RUN + A15 )
+ (/A8+/A9) * A10*A11*A12*A13*A14*A15
MOE_ = ( /RIC + RUN + (PSEN_ + MRSEL_) )
* ( RIC + (RD_ * PSEN_) ) + RIC * RUN
COE_ = ( /RUN + (RD_ * PSEN_) )
* ( RUN + (PSEN_ + /MRSEL_) * RD_ ) + /RIC
READ_ = RD_ * PSEN_
XIOSEL_ = /( A8 * /A9 * A10 * A11 * A12 * A13 * A14 * A15)
ARCNET_ = /( /A8 * A9 * A10 * A11 * A12 * A13 * A14 * A15 )
MRSEL_ = 1 ; this disables MOE_
LED_ = ( /RIC + RUN + (PSEN_ + MRSEL_) ) * ( RIC + (RD_ * PSEN_) )
+ RIC * RUN
```

8.2 U6 Equations

```

; PALASM Design Description
----- Declaration Segment -----
TITLE    RIC
PATTERN  U6
REVISION 1.0
COMPANY  RIGEL Corp
DATE    07/17/93
CHIP _ric  PALCE22V10
----- PIN Declarations -----
; --- i nputs ---
PIN 1      XI0SEL_ ;
PIN 2      A2 ;
PIN 3      A3 ;
PIN 4      A4 ;
PIN 5      A5 ;
PIN 6      A6 ;
PIN 7      A7 ;
PIN 8      RD_ ;
PIN 9      WR_ ;
PIN 10     AUX0 ;
PIN 11     AUX1 ;
PIN 13     RSTIN_ ;

; --- o utputs ---
PIN 14     RSTOUT_ ;
PIN 15     RSTOUT ;
PIN 16     XOUTL0 ;
PIN 17     XOUTH1 ;
PIN 18     XINL0_ ;
PIN 19     XINH1_ ;
PIN 20     ADCSEL_ ;
PIN 21     KPLCD_ ;
PIN 22     TIMER_ ;
PIN 23     LED_ ;

----- Boolean Equation Segment ----- EQUATIONS
RSTOUT_ = RSTIN_
RSTOUT_ = /RSTIN_
TIMER_ = A7+A6 + XI0SEL_
; [0, 3Fh]
XOUTL0 = /(WR_ + A7+ /A6 + A5+A4+A3 + A2 + XI0SEL_ )
; [40h, 43h]
XOUTH1 = /(WR_ + A7+ /A6 + A5+A4+A3 + /A2 + XI0SEL_ )
; [44h, 47h]
XINL0_ = RD_ + A7+ /A6+A5+A4+ /A3 + A2 + XI0SEL_
; [48h, 4Bh]
XINH1_ = RD_ + A7+ /A6+A5+A4+ /A3 + /A2 + XI0SEL_
; [4Ch, 4Fh]

; Keypad/LCD: A0 and A1 are decoded by the 8255
KPLCD_ = A7 + /A6 + A5 + /A4 + A3 + A2 + XI0SEL_
; [50h, 53h]
ADCSEL_ = A7 + /A6 + /A5 + A4 + A3 + A2 + XI0SEL_
; [60h, 63h]
LED_ = XI0SEL_
-----
```

9 8051 FAMILY CHIP MANUFACTURERS

The following is a list of chip manufacturers. There are over a 100 varieties of 8051 processors on the market today. The 8051 family has about a 45% share of the 8-bit processor market. We recommend you get on the manufactureres web sites to download information and data sheets.

Atmel Corporation

www.atmel.com

Dallas Semiconductor

www.dalsemi.com

Intel Corporation

www.intel.com

OKI Semiconductor, Inc

www.okisemi.com

Philips Semiconductors

www.philipsmcu.com

Infineon, (formerly Seimens)

www.infineon.com

Standard Microsystems Corporation

www.smc.com

Silicon Systems

Silicon Systems offers one chip at present, the 73D2910. This is a 8052 compatible that has been optimized for low power portable modem or communication applications.

Please check out our WEB site at www.rigelcorp.com for the latest software updates.

10 PARTS LISTS

The following is a list of components as they appear in the circuit diagrams. Note that the circuit diagrams are presented as a hierarchy. The sheet name indicate which sheet in the hierarchy the component belongs to. The part field gives component names as they appear in the diagrams.

Cross Reference:

Revised: December 5, 1994

Designator	Component	Reference Sheet
C1	2.2uF	DECODE
C2	1uF	SERIAL
C3	1uF	SERIAL
C4	1uF	SERIAL
C5	1uF	SERIAL
C6	22uF	POWER
C7	22uF	POWER
C8	330uF	ADC
C9	330uF	POWER
C10	100nF	ADC
C11	100nF	ADC
C12	100nF	POWER
C13	100nF	POWER
C14	100nF	POWER
C15	100nF	POWER
C16	100nF	POWER
C17	100nF	POWER
C18	100nF	POWER
C19	100nF	POWER
C20	100nF	POWER
C21	100nF	POWER
C22	100nF	POWER
C23	100nF	POWER
C24	100nF	POWER
C25	100nF	POWER
C26	100nF	POWER
C27	100nF	POWER
C28	100nF	POWER
C29	100nF	POWER
C30	100nF	POWER
C31	100nF	POWER
C32	100nF	POWER
C33	100nF	POWER
C34	10uF	ADC
C35	100nF	POWER
C36	100nF	POWER
C37	100nF	POWER

D1	RUN	DECODE
D2	RUN	DECODE
D3	1N4001	POWER
D4	PWR	POWER
HD1	INPUT	XIN
HD2	LCD	LCD.SCH
HD3	KEYPAD	LCD.SCH
HD4	AUXIO	LCD.SCH
HD5	OUTPUTS	XOUT
JP1	EA#	CPU
JP2	AUX0	DECODE
JP3	AUX1	DECODE
JP4	ACLKSEL	CLOCK
JP5	PIN1	MEMORY
JP6	PIN27	MEMORY
JP7	VXIN	XIN
JP8	VXOUT	XOUT
JP9	P1.2	SERIAL
JP10	P1.3	SERIAL
JP11	V-	ADC
JP12	VREF-	ADC
JP13	VREF+	ADC
JP14	PWR	POWER
JP15	TX2	SERIAL
JP16	TX#/RX#	SERIAL
JP17	TX/RX	SERIAL
P1	RS232	SERIAL
P2	AUX	SERIAL
PB1	RESET	DECODE
PT1	5K	LCD.SCH
R1	10K	CPU
R2	10K	XIN
R3	10K	XIN
R4	2.2K	DECODE
R5	330	DECODE
R6	330	DECODE
R7	330	POWER
R8	100	DECODE
R9	470	XIN
R10	470	XIN
S1	RUN/MONITOR	DECODE
S2	RIC/READS	DECODE
TB1	BIN	XIN
TB2	BINAUX	XIN
TB3	BOUT	XOUT
TB4	BOUTAUX	XOUT
TB5	ADC	ADC

TB6	ADCAUX	ADC
TB7	PORTS	TIMER
TB8	PAUX	TIMER
U1	74HC573	CPU
U2	74HC573	XOUT
U3	74HC573	XOUT
U4	8032	CPU
U5	GAL22V10	DECODE
U6	GAL22V10	DECODE
U7	74HCT93	CLOCK
U8	OSC	CLOCK
U9	62256	MEMORY
U10	62256	MEMORY
U11	27256	MEMORY
U12	OPT04	XIN
U13	OPT04	XIN
U14	OPT04	XIN
U15	OPT04	XIN
U16	74HCT541	XIN
U17	74HCT541	XIN
U18	8255	LCD.SCH
U19	ULN2803A	XOUT
U20	ULN2803A	XOUT
U21	MAX232	SERIAL
U22	ADC10158	ADC
U23	DS1287	TIMER
U24	75ALS180	SERIAL

11 LAYOUT AND CIRCUIT DIAGRAMS

