RTC-SIR

Serial-Timer-IR I/O
the RTC microcontroller

Technical Manual

Release 1.0
1/17/90

Micromint, Inc.
115 Timberlachen Circle
Suite 2001
Lake Mary, FL, 32746

Micromint, Inc.
115 Timberlachen Circle
Suite 2001
Lake Mary, FL, 32746

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REV. 10/89

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An Overview of the RTC-SIR Board

The RTC-SIR board was designed to be a companion to the RTC line of microprocessors. It mates piggy-back style, atop any of the RTC microprocessor boards. Two vertical expansion headers connect the boards together providing mechanical and electrical connections between them. Four functions are provided on the RTC-SIR board. A RS-232 compatible serial port, three hardware counter/timers, three eight-bit programmable I/O ports, and both a 40kHz IR (InfraRed) receiver and IR transmitter.

With the optional UART section, an RS-232 compatible serial port is added. The UART (2691) has a built-in baudrate generator and can send and receive data through an RS-232 compatible serial interface or the IR transmitter/receiver. A master oscillator, 3.6864 MHz, feeds the UART for baudrate division. RS-232 conversion is accomplished through the use of a MAX232. This eliminates the normal +/- 12 volts for RS-232, requiring only 5 volts for operation.

The optional counter/timer (8254) is clocked from the same external oscillator as the UART. Timer 2 is dedicated to IR modulation, usually set up for 40 kHz. Timer 0 and timer 1 have gates and outputs available to the user. In addition either timer can create an interrupt. Counter/timer modes include; interrupt on terminal count, gate triggerable one-shot, pulse-rate generator, square-wave generator, software triggered strobe, and gate triggered strobe.

The I/O ports (8255) A and B are byte programable (port C is nibble programable) as inputs or outputs. All 24 I/O lines are brought out to a 26 pin header.

With the optional IR section, 40 kHz modulated IR is demodulated (SHARP GP1U5) into a TTL gate signal and directed to an interrupt or the UART receive input. IR output can be gated by an output bit or the UART serial output. This gating can control the IR transmitter directly or gate a 40 kHz modulation for IR transmission.

DEMO programs contained within this manual are written for the RTC52 microcontroller. The RTC-SIR board, as all RTC expansion boards, is hardware compatible with other RTC microcontrollers. Using the RTC-SIR board with other RTC microcontrollers will require software modifications to the programs presented here. BASIC programs usually require minor syntax changes. Assembly language routines require complete translation using the instruction set of the base processor being used.

VERTICAL-STACKING I/O EXPANSION

The vertical-stacking connectors pass all the necessary I/O control, address, and data signals to each expansion board added to the system. The buffered address/data bus (AD0-AD7), the latched address bus (A0-A7), and the upper four decoded address blocks (8000H, A000H, C000H & E000H) are grouped together. Control lines are bundled separately on a second vertical connector. These two connectors alone provide adequate mechanical stability for the stacking arrangement, but corner mounting holes are provided for #4 x 9/16" spacers.

JP16 (pins 26 / 25 at top, 2 / 1 at bottom)

Even pins (26 … 2)	Odd pins (25 … 1)
Buffered D4	Buffered D3
Buffered D5	Buffered D2
Buffered D6	Buffered D1
Buffered D7	Buffered D0
+5 volts	+5 volts
Latched A4	Latched A3
Latched A5	Latched A2
Latched A6	Latched A1
Latched A7	Latched A0
+5 volts	+5 volts
0C000H	0A000H
0E000H	8000H
+12 volts	*GET

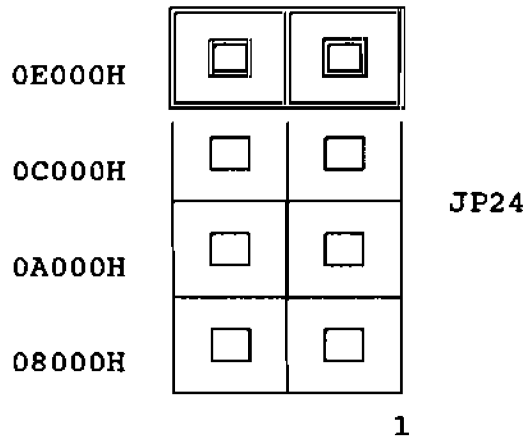
JP15 (pins 26 / 25 at top, 2 / 1 at bottom)

Even pins (26 … 2)	Odd pins (25 … 1)
-12 volts	GND
ALE	GND
*DS	GND
*WR	GND
*RD	GND
*PSEN	GND
T1	*INT1
T0	*INT0
RESET	GND
P1.4	P1.3
P1.5	P1.2
P1.6	P1.1
P1.7	P1.0

JP16 and JP15 bring the expansion bus up to I/O boards which mate atop the RTC series microcontrollers

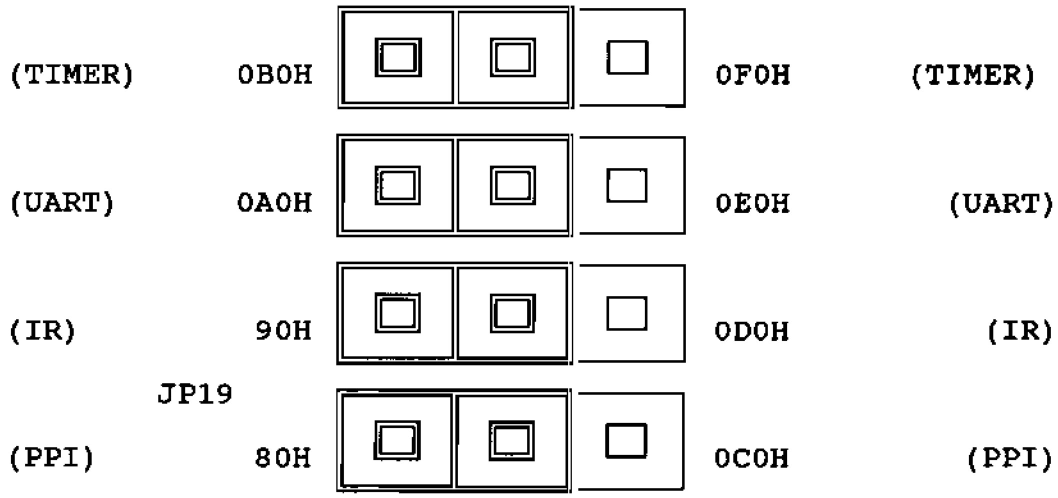
Selecting an Address for the RTC-SIR Board

Each RTC expansion board requires 4K of address space. Four base address options are possible through the jumper selection of JP24.



This example shows 0E000H selected as a base address for this RTC-SIR board.

Two possible offset addresses are available to each function on the RTC-SIR board. The 8255 PPI control is processed through either offset address 80H or 0C0H. The second function, the IR I/O, is enabled at offset address 090H or 0D0H. The UART, the third function, is accessed through offset address A0H or 0E0H. Finally, the timer/counter control is processed through the fourth function at offset address 0B0H or 0F0H.



This example enables offset 80H, 90H, 0A0H, and 0B0H on JP19.

Add the offset to to the base address 0E000H from the previous example to get the actual function address:

PPI	0E000H + 80H = 0E080H
IR	0E000H + 90H = 0E090H
UART	0E000H + 0A0H = 0E0A0H
Counter/Timer	0E000H + 0B0H = 0E0B0H

Using the 8255 TTL I/O (JP17)

The 8255 programmable peripheral interface (PPI) is an efficient and cost-effective way to add TTL (logic level) I/O to any microcontroller system. The PPI adds 24 bits of I/O to the RTC system. The 24 bits are grouped into three 8-bit ports. Ports A & B can be independently programmed as 8-bit input or output ports. The third port, port C, is divided into two 4-bit nibbles (an upper and lower nibble). These nibbles can be programmed independently as 4-bit input or output ports.

The three ports are memory mapped. Referring to JP19 and JP24 we find the base + offset address of the PPI to be E000H + 80H (E080H). Starting with this address, the ports are addressed as follows:

8255 Port	**JP19 + JP24 + 8255 register address = actual address**
Port A	E000H + 80H + 0 = E080H
Port B	E000H + 81H + 1 = E081H
Port C	E000H + 82H + 2 = E082H
Mode Port	E000H + 83H + 3 = E083H

The mode port is a write-only port used to set the PPI for the appropriate configuration. Let's assume we need 12 input bits and 12 output bits. Port A and the upper nibble of port C as inputs and port B and the lower nibble of port C as outputs. Writing a value of 98H to the mode port (E083H) configures the ports. Verify this value in the following chart:

PPI configuration values

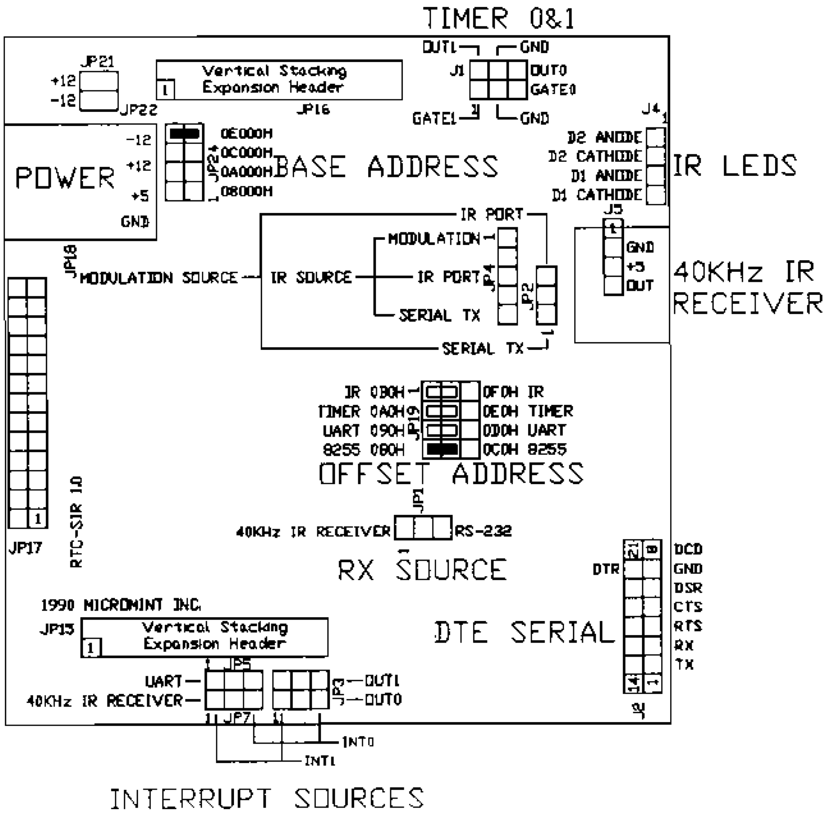
Port A	Port C (upper) (nibble)	Port B	Port C (lower) (nibble)	Value
output	output	output	output	80H
output	output	output	input	81H
output	output	input	output	82H
output	output	input	input	83H
output	input	output	output	88H
output	input	output	input	89H
output	input	input	output	8AH
output	input	input	input	8BH
input	output	output	output	80H
input	output	output	input	91H
input	output	input	output	92H
input	output	input	input	93H
input	**input**	**output**	**output**	**98H**
input	input	output	input	99H
input	input	input	output	9AH
input	input	input	input	9BH

Once the PPI is configured the appropriate ports (A, B & C) can be read from and written to. In this example, reading port A (E080H) will return a value equal to the logic levels applied to the port A pins on JP17. Reading port C (E082H) will return a value equal to the logic levels applied to the upper nibble port C pins on JP17. The value returned for the upper nibble of port C will contain erroneous data in the lower nibble and must be discarded. ANDing the value read with 'F0H' will clear the lower nibble to zero.

Writing 'FFH' to port B (E081H) will set the corresponding bit pins on JP17 to a logic '1'. Writing '00H' to port C (E082H) will clear the corresponding bit pins on JP17 to a logic '0'. In this case the upper nibble is not used and could be any value.

Upon power-up or manual reset, the PPI is configured with all three ports (A, B, & C) as inputs. Once reconfigured, if necessary, for your application, care must be taken not to change the mode. The values at each port will be lost when the mode is changed.

The 8255's port pins are brought out to connector JP17. JP17 is normally populated with a 2 x 13 square-pin header. These port pins can be brought directly up to the RTC-PROTO (prototyping) board. This simplifies the wiring when DIP relays or opto-isolators are needed on the TTL I/O lines. The RTC-OPTO board uses an 8255 for this purpose.



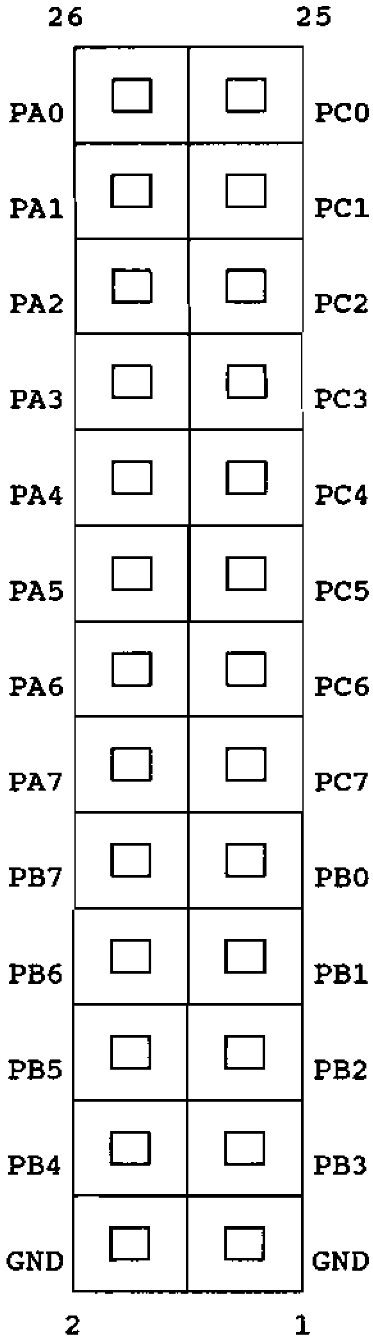
Use these jumper settings when running the following DEMO program.

The following program, written for the RTC52, will allow easy configuration of the I/O ports and testing of your TTL I/O pins on JP17.

```
10      STRING 33,7
20     $(0)="OUTPUT" : $(1)="INPUT" : $(2)="WRITE" : $(3)="READ"
30      INPUT "What is the base address of the RTC-SIR board (0E000H)"B
40      INPUT "What is the offset address of the PPI (080H)"O
50     P=B+O
60     A=1 : B=1 : C=1 : M=9BH
70      PRINT
80      PRINT "Hit MENU Selection #"
90      PRINT "1 - Set Port A from ",$(A)," to ",$(ABS(A-1))
100     PRINT "2 - ",$(A+2)," PORT A"
110     PRINT "3 - Set Port B from ",$(B)," to ",$(ABS(B-1))
120     PRINT "4 - ",$(B+2)," PORT B"
130     PRINT "5 - Set Port C from ",$(C)," to ",$(ABS(C-1))
140     PRINT "6 - ",$(C+2)," PORT C"
150     PRINT "7 - END"
160    G=GET
170    G=GET
180     IF G=0 THEN 170
190    G=G-30H
200     IF ((G<1).OR.(G>7)) THEN 170
210     IF G=7 THEN  END
220     ON G-1 GOTO 240,540,340,610,440,680
230     REM ************************* Adjust Mode Port Value for Port A
240     IF A=1 THEN 290
250    A=1
260    M=M.OR.10H
270     GOSUB 750
280     GOTO 70
290    A=0
300    M=M.AND.8FH
310     GOSUB 750
320     GOTO 70
330     REM ************************* Adjust Mode Port Value for Port B
340     IF B=1 THEN 390
350    B=1
360    M=M.OR.02H
370     GOSUB 750
380     GOTO 70
390    B=0
400    M=M.AND.0FDH
410     GOSUB 750
420     GOTO 70
```

```
430    REM ************************* Adjust Mode Port Value for Port C
440     IF C=1 THEN 490
450    C=1
460    M=M.OR.09H
470     GOSUB 750
480     GOTO 70
490    C=0
500    M=M.AND.0F6H
510     GOSUB 750
520     GOTO 70
530     REM ************************* Read/Write Port A
540     IF A=1 THEN 580
550     INPUT "Enter Value"V
560    XBY(P)=V
570     GOTO 70
580     PHO. XBY(P)
590     GOTO 70
600     REM ************************* Read/Write Port B
610     IF B=1 THEN 650
620     INPUT "Enter Value"V
630    XBY(P+1)=V
640     GOTO 70
650     PHO. XBY(P+1)
660     GOTO 70
670     REM ************************* Read/Write Port C
680     IF C=1 THEN 720
690     INPUT "Enter Value"V
700    XBY(P+2)=V
710     GOTO 70
720     PHO. XBY(P+2)
730     GOTO 70
740     REM ************************* Write Mode Port Value
750    XBY(P+3)=M
760     RETURN
```

Connector JP17 - PPI Port Pin Designation



JP17

Using the 2691 UART

The 2691 Universal Asynchronous Receiver/Transmitter provides a full duplex serial port operating from 50 to 38.4K baud. The internal baud rate generator and programmable data format and mode makes this 24 pin skinny dip UART a real winner. Internal registers are accessed through the base address + offset address, which were selected as 0E000H + 0A0H from JP24 and JP19 in the example above + the register number (0-7).

UART read/write register Name and #		Address
Mode / Mode	0	0E0A0H
Status / Clock Select	1	0E0A1H
none / Command	2	0E0A2H
Receiver / Transmitter	3	0E0A3H
none / Auxiliary Control	4	0E0A4H
Interrupt Status / Interrupt Mask	5	0E0A5H
Cntr Timer MSB / Cntr Timer MSB	6	0E0A6H
Cntr Timer LSB / Cntr Timer LSB	7	0E0A7H

There are two mode registers MR1 and MR2. An MR pointer can point to either MR1 or MR2. The pointer directs reads and writes to the correct MR. It will point to MR2 unless the command register is set to point to MR1. The pointer will remain at MR1 only until it has been accessed once. It will return to MR2 until it is forced again by the command register.

The receiver register accesses a three byte rotating FIFO register. Up to four characters can be received, the fourth is held within the receiver. RXRDY, bit0 of SR (status register), is set upon receipt of a character. FFULL, bit1 of SR, is set when the FIFO is full.

The transmit register loads a character into the transmitter. TXRDY bit2 of SR is set when the holding register is empty because a character has been transfered into the transmit shift register. TXEMT bit3 of SR is set when the transmit shift register has finished sending the last bit and no characters are in the holding register.

The following is a description of the UART registers:

MR1							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
RXRTS	RXSEL	ERROR	PARITY MODE		PARITY	# OF BITS	

bit 7 — 0=receiver does not control the MPO for RTS indication
1=receiver controls the MPI for RTS indication

bit 6 — 0=RXRDY interrupt ISR.3 indicates RXRDY
1=RXRDY interrupt ISR.3 indicates FFULL

bit 5 — 0=character error mode
1=block error mode

bit 4&3 — 00=parity
01=set parity
10=clr parity
11=special wake-up mode

bit 2 — 0=even parity
1=odd parity

bit 1&0 — 00=5 bits/character
01=6 bits/character
10=7 bits/character
11=8 bits/character

MR2							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
CHANNEL MODE		TXRTS	CTSTX	STOP BIT LENGTH			

bit 7&6 — 00=normal operation
01=echo every received character to CPU and transmitter
10=loopback every transmitted character
11=echo every received character to transmitter only

bit 5 — 0=transmitter does not control MPO for RTS indication
1=transmitter controls MPO for RTS indication

bit 4 — 0=CTS on the MPI does not enable the transmitter
1=CTS on the MPI enables the transmitter

bits 3-0

0000=0.563 stop bits	1000=1.563 stop bits
0001=0.625 stop bits	1001=1.625 stop bits
0010=0.688 stop bits	1010=1.688 stop bits
0011=0.750 stop bits	1011=1.750 stop bits
0100=0.813 stop bits	1100=1.813 stop bits
0101=0.875 stop bits	1101=1.875 stop bits
0110=0.938 stop bits	1110=1.938 stop bits
0111=1.000 stop bits	1111=2.000 stop bits

CSR							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
RECEIVER CLOCK SELECT				TRANSMITTER CLOCK SELECT			

bits 7-4 and bits 3-0 when BaudrateSET (ACR.7)=

	BSET=0	BSET=1
0000	=50	75
0001	=110	110
0010	=134.5	134.5
0011	=200	150
0100	=300	300
0101	=600	600
0110	=1200	1200
0111	=1050	2000
1000	=2400	2400
1001	=4800	4800
1010	=7200	1800
1011	=9600	9600
1100	=38.4K	19.2K
1101	=Timer	Timer
1110	=MPI*16	MPI*16
1111	=MPI	MPI

CR							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
MISCELLANEOUS COMMANDS				DISTX	ENTX	DISRX	ENTX

0000=no command
0001=reset MR pointer to MR1
0010=reset receiver
0011=reset transmitter
0100=reset error status
0101=reset break change interrupt
0110=start break
0111=stop break
1000=start counter/timer
1001=stop counter/timer
1010=set MPO
1011=clr MPO
1100=reset MPI change interrupt

SR							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
RECBK	FRAME	PARITY	OVRUN	TXEMT	TXRDY	FFULL	RXRDY

bit 7 0=no break character has been received
1=a break has been received

bit 6 0=no error
1=a framing error has occured

bit 5 0=no error
1=a parity error has occured

bit 4 0=no error
1=an overrun error has occured

bit 3 0=Transmit Holding or Shift Register is not empty
1=Both registers are empty

bit 2 0=Transmit Holding Register has a character
1=Transmit Holding Register is empty

bit 1 0=FIFO is not full
1=FIFO has three characters

bit 0 0=no character in the receiver
1=character waiting in the receiver

ACR							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
BSET	COUNTER/TIMER MODE			PDOWN	MPO PIN FUNCTION		

bit 7 0=use baud rate generator set 1
1=use baud rate generator set 2

bit 6-4 000=counter mode using MPI pin
001=counter mode using MPI/16
010=counter mode using TXC
011=counter mode using XTAL/16
100=timer mode using MPI pin
101=timer mode using MPI/16
110=timer mode using XTAL
111=timer mode using XTAL/16

bit 3 0=power down mode
1=power down disabled

bit 2-0 000=MPO as RTS
001=MPO as counter/timer output
010=MPO equals TXC
011=MPO equals TXC*16
100=MPO equals RXC
101=MPO equals RXC*16
110=inverted TXEMT (SR.2)
111=inverted RXRDY/FFULL (ISR.2)

ISR							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
MPICH	MPICU	none	CTRDY	BKCH	RXRDY	TXEMT	TXRDY

bit 7 0=MPI has not changed
1=MPI has changed

bit 6 0=MPI is low
1=MPI is high

bit 5 not used

bit 4 0=counter has not reached terminal count
1=counter has reached terminal count

bit 3 0=start or stop break has not been received
1=start or stop break has been received

bit 2 0=RXRDY-no character ready FFULL-FIFO not full
1=RXRDY-character ready FFULL-FIFO full

bit 1 0=Transmit Holding or Shift Register not empty
1=Transmit Holding and Shift Register empty

bit 0 0=Transmit Holding Register has character
1=Transmit Holding Register is empty

IMR							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
MPICH	MPICU	none	CTRDY	BKCH	RXRDY	TXEMT	TXRDY

bit 7 0=MPI change interrupt is disabled
1=MPI change interrupt is enabled

bit 6 0=MPI high interrupt is disabled
1=MPI high interrupt ie enabled

bit 5 not used

bit 4 0=terminal count interrupt is disabled
1=terminal count interrupt is enabled

bit 3 0=break change interrupt is disabled
1=break change interrupt is enabled

bit 2 0=RXRDY-ready/FFULL-FIFO full interrupt disabled
1=RXRDY-ready/FFULL-FIFO full interrupt enabled

bit 1 0=Transmit Holding and Shift empty interrupt disabled
1=Transmit Holding and Shift empty interrupt enabled

bit 0 0=Transmit Holding Register empty interrupt disabled
1=Transmit Holding Register empty interrupt enabled

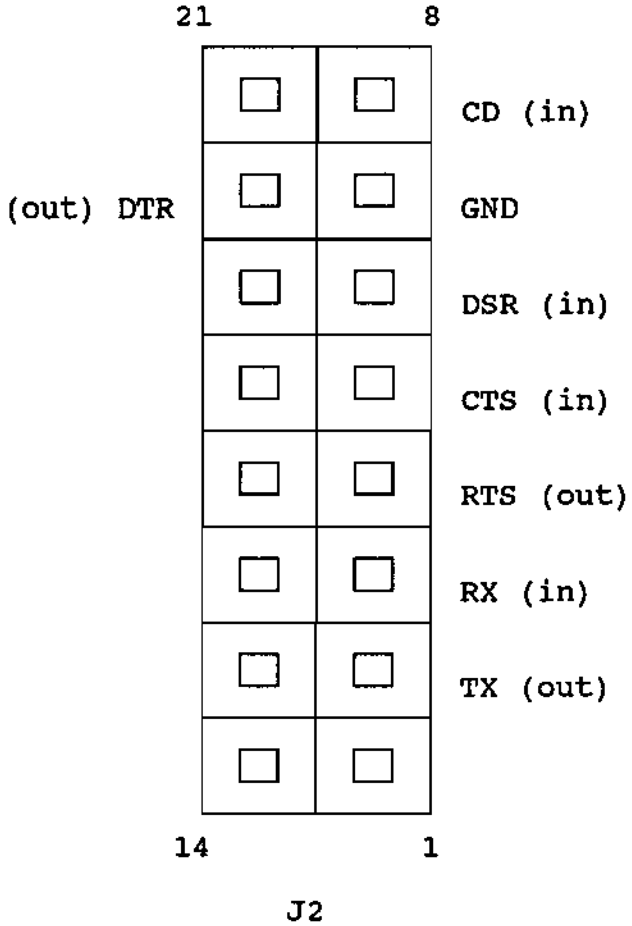
CTUR							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
BIT15	BIT14	BIT13	BIT12	BIT11	BIT10	BIT9	BIT8

This is the MSB of the 16 bit counter/timer.

CTLR							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0

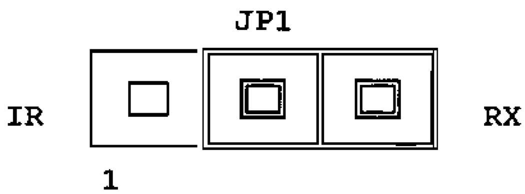
This is the LSB of the 16 bit counter/timer. The minimum value for this register is 0002H.

The TTL serial I/O lines are converted from/to RS-232 by U8 the MAX232. This device has internal charge pumps and an inverter to create the necessary plus and minus voltages for RS-232. RS-232 connections are made through J2, a 2x8 square pin header. Insulation Displacement Connectors (IDC) allow a DB25 to mate with the square pin header directly.



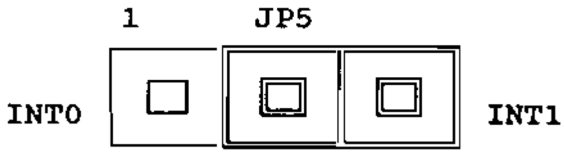
RS-232 level DTE serial communication connections available on J2.
This port is wired for direct connection to an external modem.

TTL serial input can come from one of two sources. The standard serial port or the IR demodulator. Indicate the source for serial reception by enabling one on JP1.

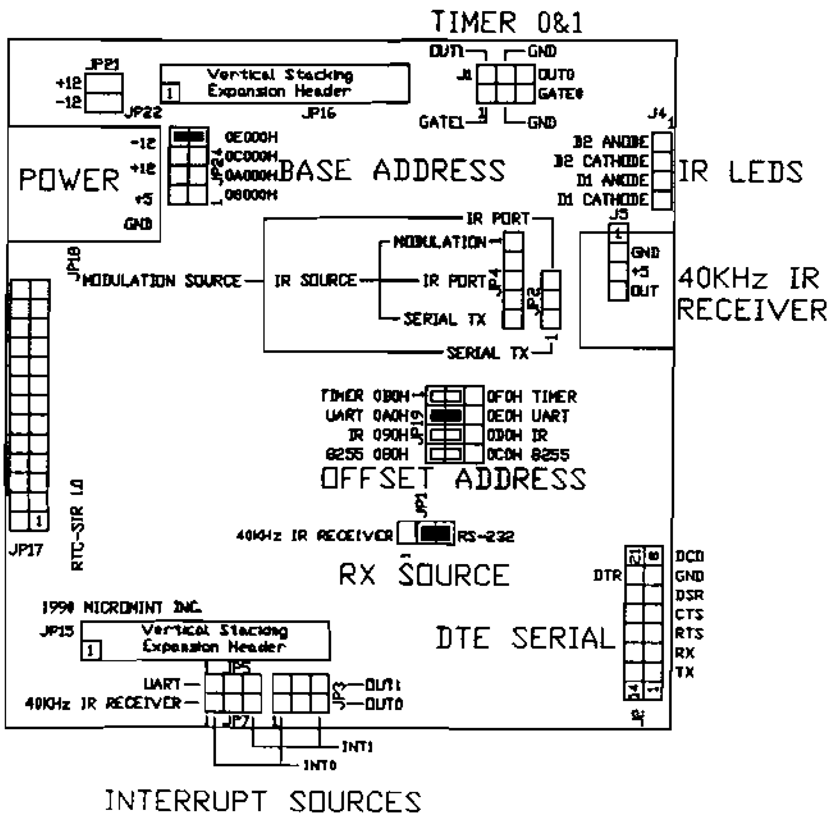


Serial input is selected by JP1, the RX input is shown selected here.

The UART can cause an interrupt to occur from one of its internal sources enabled through the ISR and IMR discussed earlier. The interrupt can be directed to either INT0 or INT1. Indicate your choice on JP5.



Serial interrupt is shown enabling INT1 on JP5.



Use these jumper settings when running the following DEMO program.

Use the following program to initialize the UART and send characters, input through the keyboard, out the serial port. Loopback the TX line, pin 3 on J2, to the RX line, pin 2 on J2, with a piece of wire. Also, loopback RTS and CTS, pins 4 and 5 on J2. The characters sent out the serial port will be channeled back into the serial receiver. The program will display these characters being received on the video display.

```
10      PRINT "YOU MUST LOOP BACK PINS 2 & 3 AND 4 & 5 ON J2"
20      PRINT "   FOR THIS PROGRAM TO WORK"
30      INPUT "Enter the base address of the RTC-SIR board (0E000H)"B
40      INPUT "Enter the offset address of the 2691 (0A0H)"O
50     A=B+O
60     XBY(A+2)=15H :  REM RESET POINTER TO MR1
70     XBY(A)=93H :  REM MR1=8-BITS, NO PARITY, RXRTS
80     XBY(A)=17H :  REM MR2=1-STOP BIT, CTS EN TX
90     XBY(A+1)=44H :  REM CSR=TX @300 BAUD, RX @300 BAUD
100    XBY(A+2)=0A5H :  REM CR=ASSERT RTS, EN RX, EN TX
110    XBY(A+4)=08H :  REM ACR=PWR DOWN OFF
120    XBY(A+5)=0 :  REM ALL INTERRUPTS OFF (JUST POLLING)
130    G=GET
140    G=GET
150     IF G<>0 THEN XBY(A+3)=G :  REM THR=KEYPRESS
160     REM CHECK STATUS REGISTER FOR CHARACTER, IF THERE THEN PRINT IT
170     IF (XBY(A+1).AND.1)=1 THEN  PRINT CHR(XBY(A+3)),
180     GOTO 140
```

This BASIC program does not buffer any data nor can it keep up with any high data rates. Assembly language routines must be custom designed to accommodate your individual requirements.

Using the 8254 Timer/counter

The 8254 programmable interval timer has three 16-bit timers. Counter/timer 2 is dedicated to providing modulation, usually 40 kHz, to the IR transmitter. All counter/timers are clocked from the 3.6864 MHz oscillator. Six modes of operation are available in both binary and BCD counting. Four registers are used to control the counter/timer. The control word register, CWR, and one register for each counter 0-2.

Internal registers are accessed through the base address + offset address which were selected as 0E000H + 0B0H from JP24 and JP19 in the example above + the register number (0-2).

8254 read/write register Name and #		Address
Counter 0	0	0E0B0H
Counter 1	1	0E0B1H
Counter 2	2	0E0B2H
Control Word Register	3	0E0B3H

CWR							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
WHICH COUNTER		READ/WRITE		COUNTER/TIMER MODE			BCD

bits 7&6 00=Select counter 0
01=Select counter 1
10=Select counter 2
11=Read back command (see below for bits 5-0)

bits 5&4 00=Latch the selected counter's count for read back
01=R/W LSB of the count only
10=R/W MSB of the count only
11=R/W LSB then MSB of the count

bits 3-1 000=Mode 0 - Interrupt on terminal count
001=Mode 1 - Hardware retriggerable One-shot
010=Mode 2 - Rate generator
011=Mode 3 - Square wave mode
100=Mode 4 - Software triggered strobe
101=Mode 5 - Hardware triggered strobe
110=none
111=none

bit 0 0=Binary counter - 16 bits
1=BCD counter - 4 decades

The special read back mode set by bits 7&6 of CWR redefines the remaining bits as follows:

(read back mode)			CWR				
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
1	1	COUNT	STATUS	CNTR2	CNTR1	CNTR0	0

bits 7&6 11=Read back mode from above

bit 5 0=latch count of all selected counters bits 3-1
1=do not latch count

bit 4 0=latch status of all selected counters bits 3-1
1=do not latch status

bit 3 0=do not select counter 2
1=select counter 2

bit 2 0=do not select counter 1
1=select counter 1

bit 1 0=do not select counter 0
1=select counter 0

bit 0 none

Any time a counter's status is latched, the latched status is held until the counter is read, ignoring subsequent requests for a status latch. If both status and count have been latched, the first read will return the status, the second and third depending on bits 5&4 of the original R/W mode, will return the latched count and subsequent reads will return unlatched counts.

STATUS BYTE							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
OUTPUT	NULL	READ/WRITE		COUNTER/TIMER MODE			BCD

bit 7 0=Output pin for this counter is low
1=Output pin for this counter is high

bit 6 0=Count is transfered and latched count will be good
1=Count has not been transfered,
latched count will be bogus

The following reflect the values programmed into the CWR for this counter, a reminder of how it is being used

bits 5&4 00=Latch the selected counter's count for read back
01=R/W LSB of the count only
10=R/W MSB of the count only
11=R/W LSB then MSB of the count

bits 3-1 000=Mode 0 - Interrupt on terminal count
001=Mode 1 - Hardware retriggerable One-shot
010=Mode 2 - Rate generator
011=Mode 3 - Square wave mode
100=Mode 4 - Software triggered strobe
101=Mode 5 - Hardware triggered strobe
110=none
111=none

bit 0 0=Binary counter - 16 bits
1=BCD counter - 4 decades

Counter/timer modes

Mode 0 - Interrupt on terminal count. When the control word is written for mode 0, the output of the counter goes low and remains low until the count value is decremented to zero by the CLK input (3.6864 MHz. A low gate input will inhibit counting.

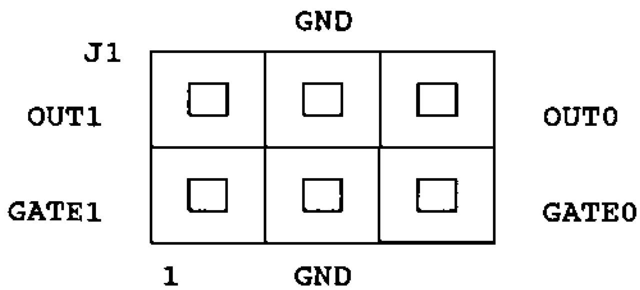
Mode 1 - Hardware retriggerable one-shot. The output will go low on the next rising and falling of the CLK after the gate (trigger) goes high. The output remains high until the count is decremented to zero unless the gate input rises again before the count is zero, retriggering the timer.

Mode 2 - Rate generator. When the control word is written for mode 2, the output of the counter goes high and remains high until the counter is decremented to zero. The output goes low for one CLK time and returns high as the counter is automatically reloaded to continue the cycle. A high on the GATE input enables counting, a low disables it. A low on the GATE during an output pulse immediately reloads the counter.

Mode 3 - Square wave mode. Mode 3 is identical to mode 2 except the output will remain high for half the count and low for half the count providing the initial count is an even number.

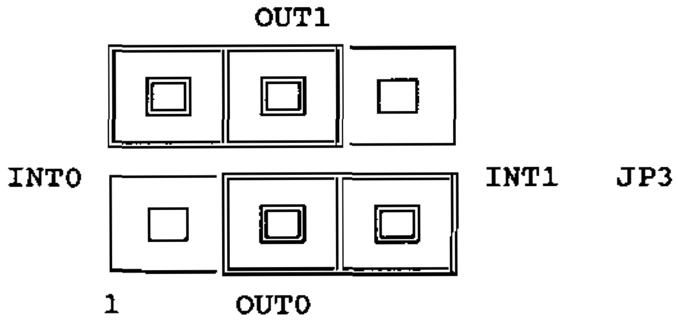
Mode 4 - Software triggered strobe. When the control word is written for mode 4, the output will go high and remain there until the count is decremented to zero. The output will go low for one CLK time and return high. A high on the GATE input will enable counting ,a low will inhibit it. The counting sequence is triggered by writing the initial count.

Mode 5 - Hardware triggered strobe. Mode 4 is identical to mode 4 except the counting sequence is triggered by a rising GATE input. The GATE will not inhibit counting, but a rising GATE will reload the counting sequence.



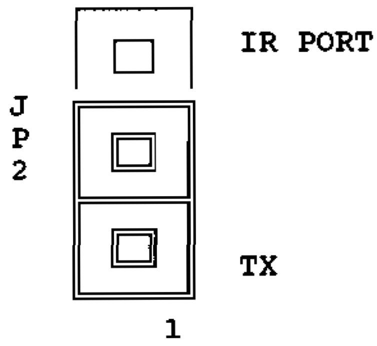
J1 contains user connections for gate and output signals of the Timer/ Counters 0 and 1.

The outputs of Counter/timer 0 and 1 can be the source of an interrupt to the processor. Use JP3 to route the interrupt if necessary for your application.



Select interrupts for Timer/Counter 0 and 1 on JP3. This example shows INT0 selected for Timer/Counter 1 and INT1 selected for Timer/Counter 0.

The gate control of counter/timer 2, usually used for 40 kHz modulation, can come from one of two sources. The GATE can be driven by transmissions from the onboard serial port TX output or from the IR port. Choose the appropriate position of JP2 for your application.



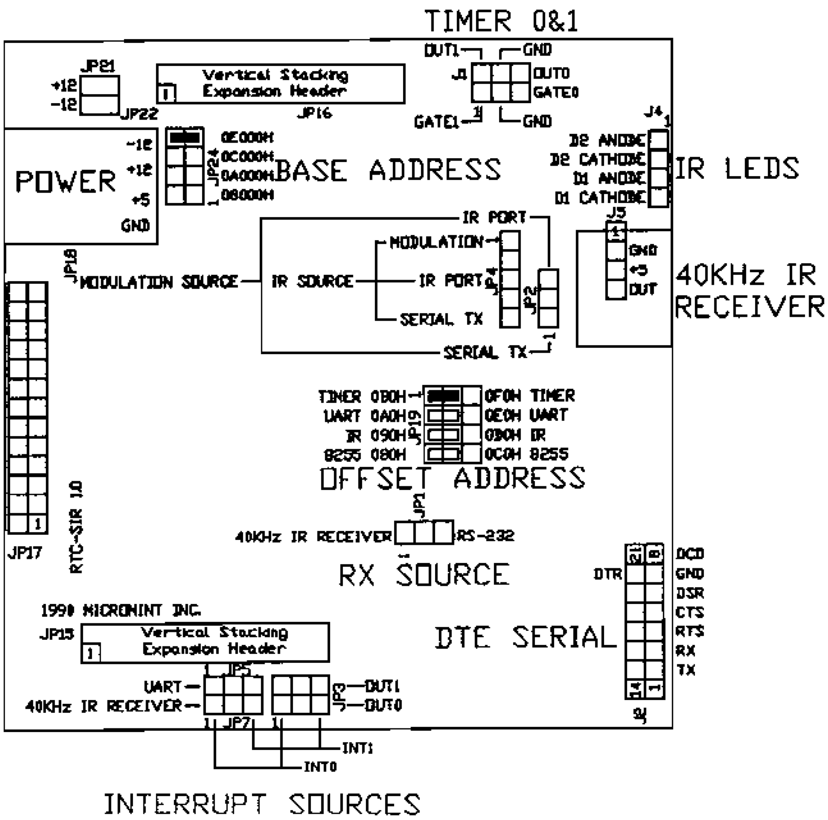
JP2, the gate control for Timer/Counter 2, is shown enabled by the UART's serial transmitter output.

40kHz MODULATION

To set up the 8254 for 40 kHz modulation, use mode 3. Write 0B6H to the CWR and 005CH as 05CH then .. 00H to the counter 2 register.

XBY(0E0B3H)=0B6H
XBY(0E0B2H)=05CH
XBY(0E0B2H)=00H

A high on the gate will enable the 40 kHz output, a low will disable it.



Use these jumper settings when running the following DEMO program.

The following BASIC program will allow you to exercise the 8254's registers.

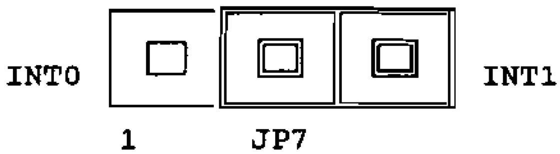
```
10    INPUT "What is the base address of the RTC-SIR board (0E000H)"B
20    INPUT "What is the offset address of the 8254 TIMER (0B0H)"O
30   G=GET
40    PRINT
50    PRINT "8254 Timer Counter"
60    PRINT "1=Write To Counter 0   5=Read from Counter 0"
70    PRINT "2=Write To Counter 1   6=Read from Counter 1"
80    PRINT "3=Write To Counter 2   7=Read from Counter 2"
90    PRINT "4=Write Control Word"
100  G=GET
110   IF (G<31H.OR.G>37H) THEN 100
120   IF G<35H THEN 150
130   PH0. XBY(B+O+G-35H)
140   GOTO 40
150   IF G<34H THEN 360
160   INPUT "Enter... 0=Cntr0 1=Cntr1 2=Cntr2 3=Read Back Command"V1
170  V1=V1.AND.3 : V1=V1*64 :  PH0. "This value shifted =",V1
180   IF V1<>0C0H THEN 280
190   INPUT "Enter... 0=Latch Count of Selected Counters
    1=Don't Latch"V2

200  V2=V2.AND.1 : V2=V2*32 :  PH0. "This value shifted =",V2
210   INPUT "Enter...  0=Latch Status of Selected Counters
     1=Don't Latch"V3

220  V3=V3.AND.1 : V3=V3*16 :  PH0. "This value shifted =",V3
230   INPUT "Enter... 2=Select Cntr2 1=Select Cntr1 0=Select Cntr0"V4
240  V4=V4.AND.3 : V4=2**(V4+1) :  PH0. "This value shifted =",V4
250  X=V1+V2+V3+V4
260   PH0. "This all adds up to ",X
270   GOTO 370
280   INPUT "Enter  0=Cntr Latch 1=r/w lsb 2=r/w msb 3=r/w lsb,msb"V2
290  V2=V2.AND.3 : V2=V2*16 :  PH0. "This value shifted =",V2
300   INPUT "Enter 0=model 1=model 2=mode2 3=mode3 4=mode4 5=mode5"V3
310  V3=V3.AND.7 : V3=V3*2 :  PH0. "This value shifted =",V3
320   INPUT "Enter... 0=binary cntr   1=BCD cntr (4 decades)"V4
330  X=V1+V2+V3+V4
340   PH0. "All this adds up to ",X
350   GOTO 370
360   INPUT "value"X
370  XBY(B+O+G-31H)=X
380   PRINT
390   GOTO 40
```

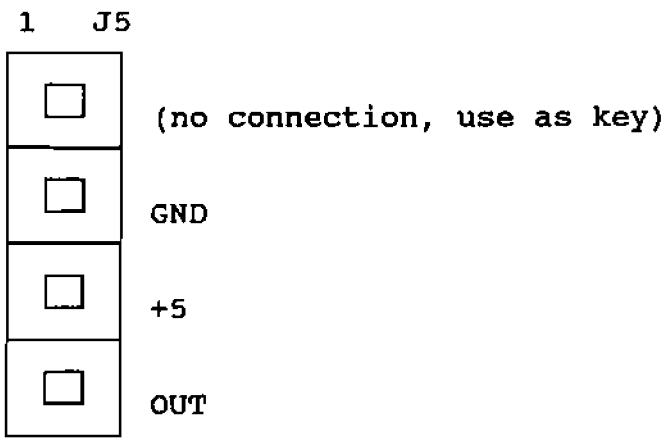
Using the IR Receiver/Demodulator at J5

Hand held audio/video remote controls transmit 40 kHz modulated IR in coded format. The SHARP GP1U5 IR receiver/demodulator outputs a logic high in its idle state. Modulated IR, in the 40 kHz region, is demodulated and output as a logic low as long as the carrier is detected. The IR receiver enable port controls the gated demodulator output. Output can be directed to either an interrupt line or to the RX input of the UART. Standard serial transmissions received from a second RTC-SIR board can be routed into the UART by the appropriate jumper on JP1 (see the section describing the UART for the JP1 diagram). If the RTC-SIR board is the top board on the RTC system, the GP1U5 can be mounted right on the board. If it is mounted directly on the board, the detector will be aimed straight up. Any board mounted above the RTC-SIR will block IR reception.

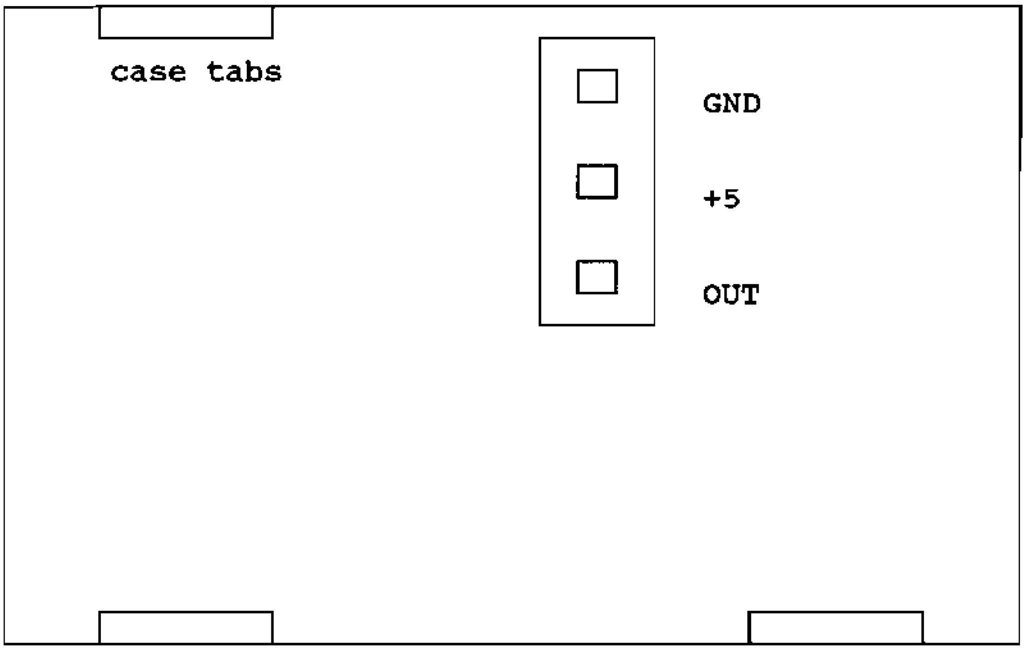


JP7 is shown selecting INT1 for the IR receiver module output

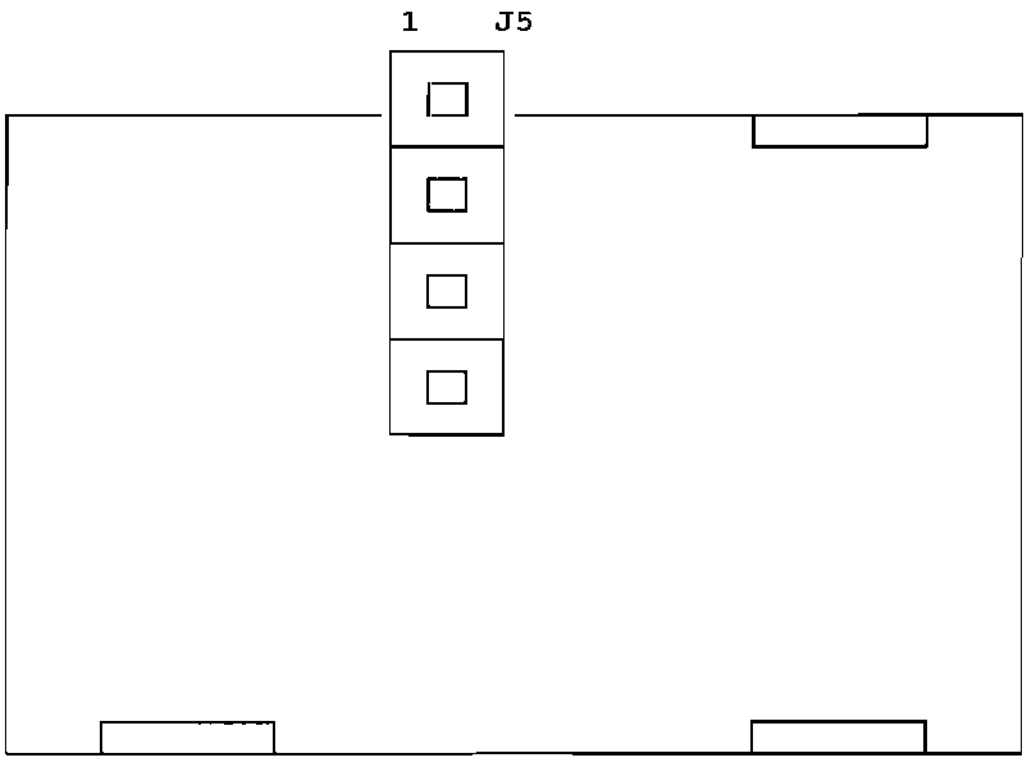
If the RTC system requires an expansion board mounted above the RTC-SIR or if you can not obtain the correct directional position for the IR receiver, you can mount it externally to the RTC-SIR board. A right-angle four-pin header can be soldered into the RTC-SIR board at J5. A short three wire cable can connect the GP1U5 to the header at J5.



These are the connections on J5 necessary for mounting the GP1U5 externally to the RTC-SIR board. Limit the cable length to six inches.



This is the bottom view of the GP1U5 module. Solder a short length of wire to each pin for connection to the RTC-SIR board at J5. Include a case tab in the connection to ground to insure proper shielding, it is not connected internally to circuit ground. Limit the cable length to six inches.

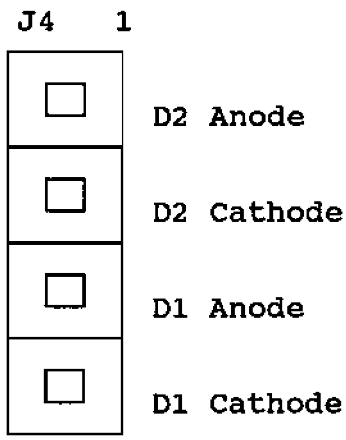


This the top view of the GP1U5 soldered into the RTC-SIR board at J5. The case tabs mecanically stabilize the module and should be soldered along with the three electrical connections J5 pins 2-4.

Using the IR Transmitter at J4

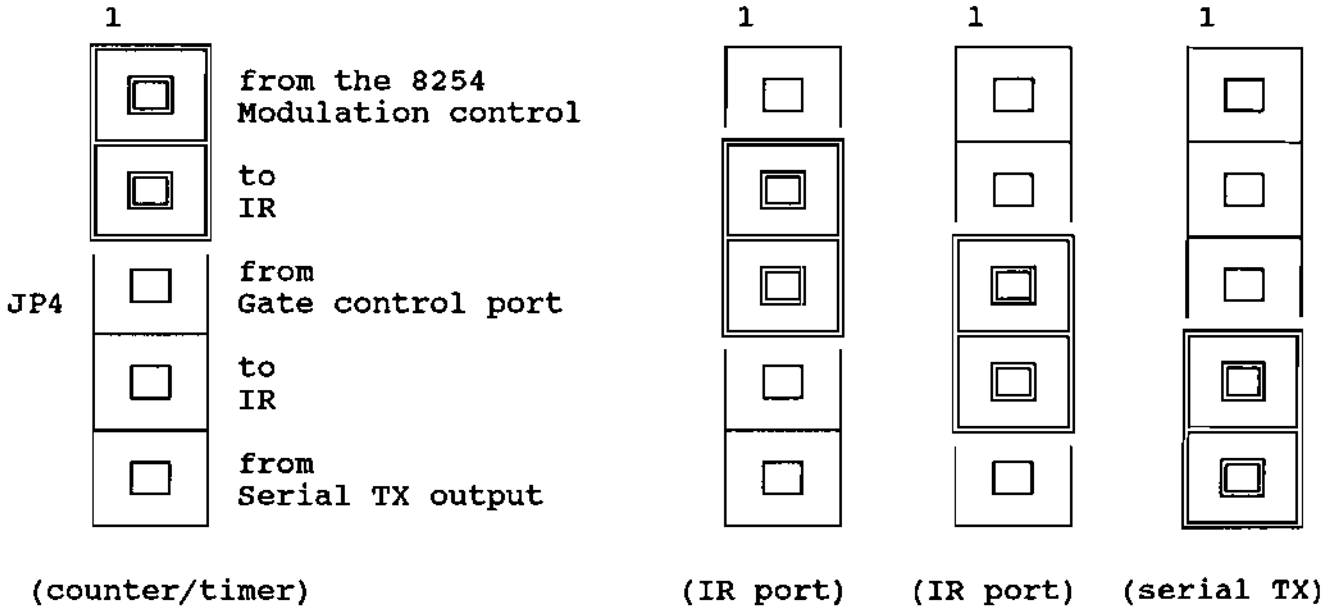
Transmitting IR is accomplished through two IR transmitting LEDs. Control of the IR diodes comes from one of three sources. Simple ON/OFF control comes from the IR control port, TTL serial transmission directly from the UART TX line provides ON/OFF control, and the 8254 can supply a 40 kHz modulation gated from the IR control port or the serial TX line. Since the IR LEDs are not within the visual range, a separate red LED is provided for output verification.

Like the IR receiver the IR LEDs can be mounted directly on the RTC-SIR board or externally. An LED's cathode can be identified by either a flattened edge on the plastic rim around the LED or a marking (i.e. a dot) indicating the cathode lead.



Insert the IR LEDs directly into the mounting holes at J4 or use a right-angle four-pin header to mount the LEDs external to the RTC-SIR board. Since J4 pin 2 and pin 3 are connected together, one of these pins can be used as a key when mounting the LEDs externally. You must use both LEDs because they are connected in series.

Choose the IR control that fits your application. The IR transmitters can be driven by various sources, but only 40 kHz modulation can be detected by the IR receiver on the RTC-SIR board.



The first example shows JP4 enabling the 8254 timer/counter as the source for the IR transmitting LEDs. Use either the second or third jumper setting when controlling the IR from the IR control port. The last example uses the serial TX line to enable the IR transmitter.

To enable the IR receiver, write to the IR receiver port address. To disable the IR receiver, write to the IR receiver port address + 1. The value written to this port will also effect the IR contol port. An even value will disable the control port and an odd value will enable it. This way, both the IR receiver and the IR transmitter can be controlled with one command. If the IR control port is not selected on JP4 or JP2, then the value written will have no effect.

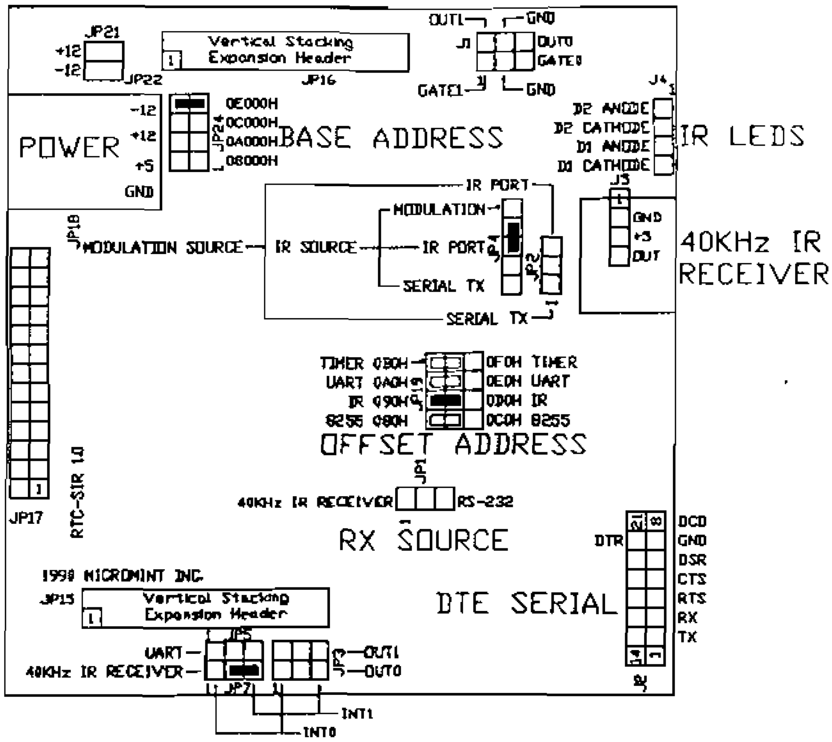
The four possible combinations are as follows:

Enable receiver & transmitter
XBY(0E090H)=odd value

Enable receiver & disable transmitter
XBY(0E090H)=even value

Disable receiver & enable transmitter
XBY(0E091H)=odd value

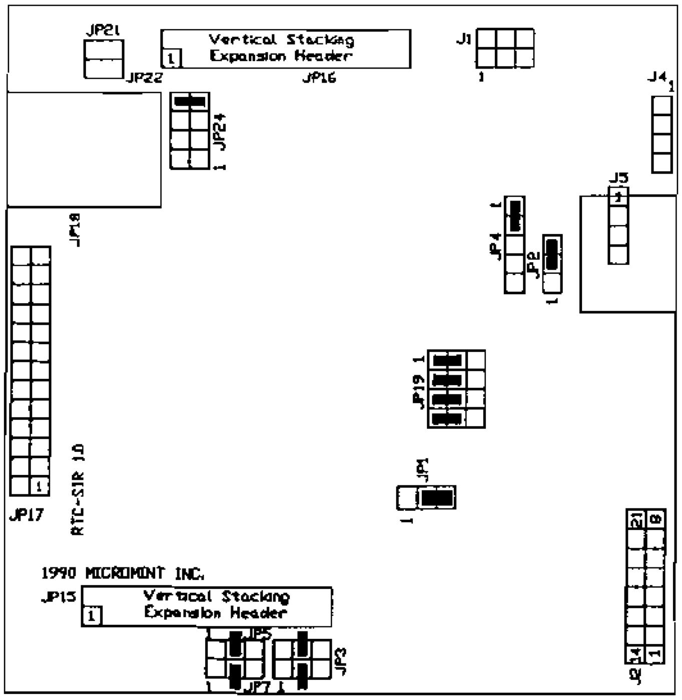
Disable receiver & transmitter
XBY(0E091H)=even value



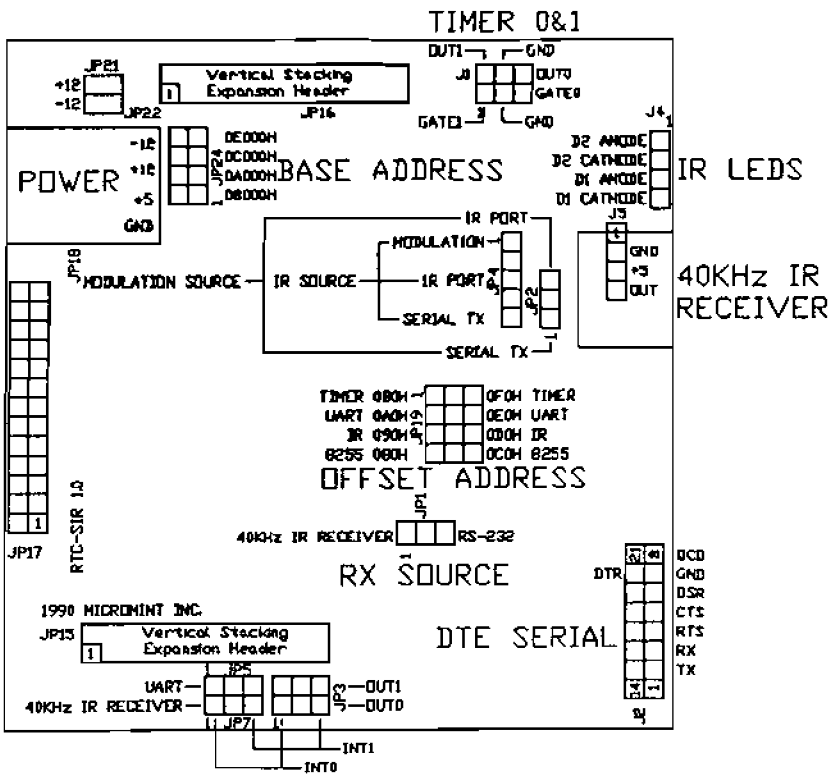
Use these jumper settings when running the following DEMO program.

The following program written in BASIC will allow the IR transmitter to be gated ON/OFF from the appropriate menu choice. It will also indicate when the IR receiver is picking up a 40 kHz modulated IR signal. Setup JP3 for IR port control and JP7 for INT1. The gated IR transmissions, in this case, are not modulated and therefore will not be detected by the IR receiver, unless it is in close proximity and overloads the receiver. Use a hand held TV remote as a source for the IR receiver.

```
10      INPUT "What is the base address of the RTC-SIR board (0E000H)"B
20      INPUT "What is the offset address for the IR port (090H)"O
30      ONEX1 220
40     G=GET
50     G=31H
60      GOTO 120
70     G=GET
80      IF G=0 THEN 70
90      IF (G<30H.OR.G>34H) THEN 70
100     IF G=30H THEN  END
110     PRINT
120     PRINT "  IR Diode      IR Receiver Module"
130     PRINT "1=off   2=on   3=enable   4=disable         0=END"
140     IF G>32H THEN P=G-33H ELSE V=G-31H
150    XBY(B+O+P)=V
160     PRINT
170     PRINT "IR Diode is ",
180     IF V=0 THEN  PRINT "off", ELSE  PRINT "on ",
190     PRINT " and the IR Module is ",
200     IF P=0 THEN  PRINT "enabled" ELSE  PRINT "disabled"
210     GOTO 70
220     PRINT "1",
230     RETI
```



These are the default jumper settings for the RTC-SIR board.



Use this blank layout for marking the jumper settings of your application.