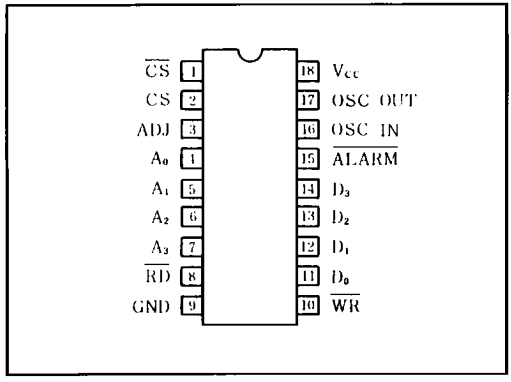
REAL TIME CLOCK

RP5C01

■ GENERAL DESCRIPTION

The RP5C01 bus compatible real-time clock is designed for use with most of the popular microprocessors such as the 8085A, Z-80 and others. Time setting and readout can be readily done in the same manner as writing/readout in and from memory. This RTC device features : counters for complete time-of-day clock alarm, a hundred year calendar, also a 26 × 4-bit RAM providing battery backed up functions and applications as an involatile RAM.

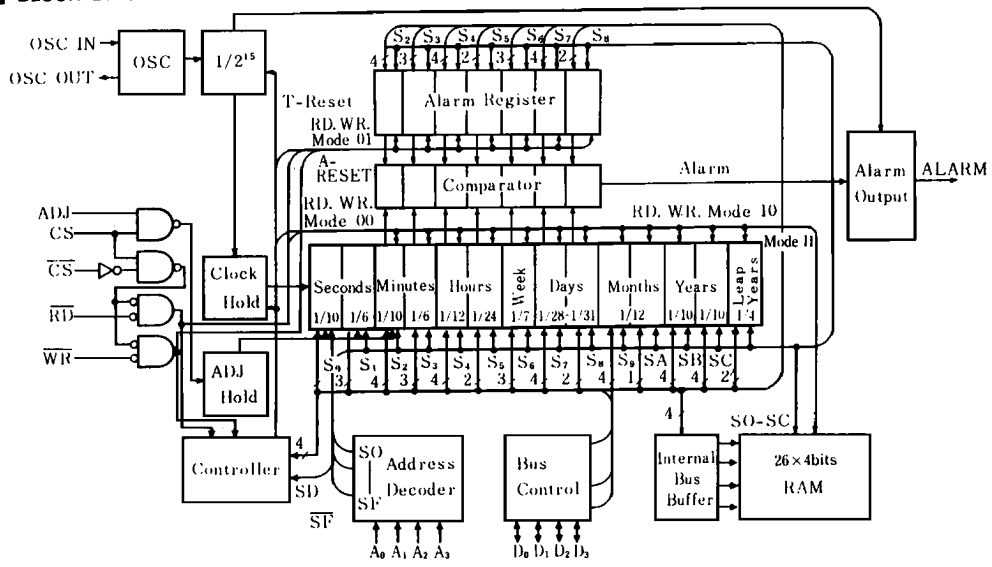
■ PIN CONFIGURATION (Top view)



■ FEATURES

- Direct connection with CPU-Bus
- 4-bit bi-directional bus ; D_0-D_3
- 4-bit address input ; A_0-A_3
- Counters for Time (hour, minute, second) and Calendar (leap year, year, month, date, day of the week) are built in.
- 24 Hours, or 12 Hours am/pm display
- All the clock data is BCD encoded
- ADJ terminal for ±30 seconds adjustment
- Provision for battery-backup
- Self-contained 26 × 4-bit RAM
- Provision for Alarm signal, or 16Hz or 1Hz Timing pulse output.

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Symbol	Parameters	Conditions	Limits	Unit
V_{CC}	Supply Voltage	With respect to GND	−0.3~7	V
V_I	Input Voltage		−0.3~7	V
V_O	Output Voltage		−0.3~7	V
P_d	Power Dissipation	Ta=25℃	700	mW
T_{opr}	Operating Ambient Temperature		0~70	℃
T_{stg}	Storage Temperature		−40~125	℃

■ RECOMMENDED OPERATING CONDITIONS (Unless Noted : Ta=0~70℃)

Symbol	Parameters	Limits			Unit
		Min	Typ	Max	
V_{CC}	Supply Voltage	4.5	5	5.5	V
V_{DH}	Data Hold Voltage	2.2		5.5	V
f_{XT}	Crystal Oscillation Frequency		32.768		kHz

■ ELECTRICAL CHARACTERISTICS

● DC ELECTRICAL CHARACTERISTICS (Unless Noted : Ta=0~70℃, V_{CC}=5V±10%)

Symbol	Parameters	Measuring Conditions	Limits			Unit
			Min	Typ	Max	
V_{IH}	Input High Voltage		2.0		V_{CC}	V
V_{IL}	Input Low Voltage		−0.3		0.8	V
V_{OH}	Output High Voltage	I_{OH}=−400μA	2.4			V
V_{OL}	Output Low Voltage	I_{OL}=2mA			0.4	V
I_I	Input Current	V_I=0~5.5V			±10	μA
I_{LO}	Output Leakage Current				±10	μA
I_{CC1}	Standby Supply Current	f_{XT}=32.768kHz V_{CC}=2.2V			15	μA
I_{CC2}	Operating Supply Current	f_{XT}=32.768kHz V_{CC}=5.0V (N2)			250	μA

(NOTE 1) : Current flow is 'positive' when flowing toward the IC.
(NOTE 2) : When connected to a CPU R/W cycle-time is 10μs.

● AC ELECTRICAL CHARACTERISTICS (Unless Noted : Ta=0~70℃, V_{CC}=5V±5%)

Symbol	Parameters	Measuring Conditions	Limits			Unit
			Min	Typ	Max	
t_{AC}	Address−$\overline{RD}$/$\overline{WR}$ Delay Time		170			ns
t_{CC}	$\overline{RD}$/$\overline{WR}$ Pulse Width		400		10000	ns
t_{CA}	Address Valid Time After $\overline{RD}$/$\overline{WR}$ Pulse Rise		10			ns
t_{RD}	Data Delay Time After $\overline{RD}$ Fall				340	ns
t_{RDH}	Data Hold Time After $\overline{RD}$ Rise		0			ns
t_{WDH}	Data Delay Time After $\overline{WR}$ Fall				40	ns
t_{WD}	Data Hold Time After $\overline{WR}$ Rise		20			ns

SPECIFICATIONS Under $V_{CC}=5V\pm10\%$ are as follows.

- **AC ELECTRICAL CHARACTERISTICS** (Unless Noted : Ta = 0~70℃, $V_{CC}=5V\pm10\%$)

Symbol	Parameters	Measuring Conditions	Limits			Unit
			Min	Typ	Max	
t_{AC}	Adress–$\overline{RD}/\overline{WR}$ Delay Time		170			ns
t_{CC}	$\overline{RD}/\overline{WR}$ Pulse Width		450		10000	ns
t_{CA}	Effective Address Time After $\overline{RD}/\overline{WR}$ Pulse Rise		10			ns
t_{RD}	Data Delay Time After $\overline{RD}$ Fall				400	ns
t_{RDH}	Data Hold Time After $\overline{RD}$ Rise		0			ns
t_{WDL}	Data Delay Time After $\overline{WR}$ Fall				40	ns
t_{WD}	Data Hold Time After $\overline{WR}$ Rise		20			ns

■ PIN DESCRIPTION

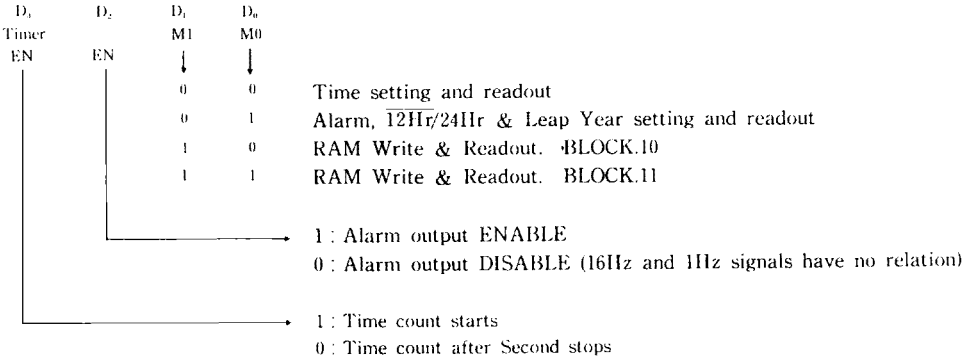
Symbol	Pin No.	Function
$\overline{CS}$, CS	1, 2	Terminals for external interfacing. Valid when CS = H, $\overline{CS}$ = L. CS is connected to the power-down detector of peripheral circiut power supply, and $\overline{CS}$ is connected to the microcomputer.
ADJ	3	This pin provides easy zero setting for the "seconds" independently of the CPU. When ADJ = H in the range of from 0 to 29 secs, the "seconds" are preset at zero and not released in the range of 30 to 59 secs by countup until the full minute expires.
A_0~A_3	4, 5, 6, 7	ADDRESS pin. Connected to ADDRESS bus of CPU.
$\overline{RD}$	8	I/O control input. L when CPU← RP5C01.
GND	9	0 V
$\overline{WR}$	10	I/O control input. L when CPU→RP5C01.
D_0~D_3	11, 12, 13, 14	Bi-directional data bus. Connected to the data bus of CPU.
$\overline{ALARM}$	15	Alarm signal and pulse (16Hz CK or 1HzCK) are put out. Open drain output.
OSC_{IN}, OSC_{OUT}	16, 17	Crystal resonator connecting terminal. 32.768kHz.
V_{CC}	18	+5V power supply.

■ ADDRESS MODES

MODE	MODE 00					MODE 01					10	11
$A_3 \sim A_0$	Contents	D_3	D_2	D_1	D_0	Contents	D_3	D_2	D_1	D_0	Contents	Contents
0	1 Sec Counter						×	×	×	×		
1	10 Sec Counter	×					×	×	×	×		
2	1 Min Counter					Alarm 1 Min Register					block 10	block 11
3	10 Min Counter	×				Alarm 10 Min Register	×					
4	1 Hr Counter					Alarm 1 Hr Register						
5	10 Hr Counter	×	×			Alarm 10 Hr Register	×	×			4bit	4bit
6	Day Counter	×				Alarm Day Register	×				×	×
7	1 Day Counter					Alarm 1 Day Register					13	13
8	10 Day Counter	×	×			Alarm 10 Day Register	×	×				
9	1 Mo Counter						×	×	×	×	RAM	RAM
A	10 Mo Counter	×	×	×		$\overline{12\ Hr}$/24 Hr Selector	×	×	×			
B	1 Yr Counter					Leap Year Counter	×	×				
C	10 Yr Counter						×	×	×	×		
D	MODE Register	Timer EN	Alarm EN	MODE Register M1	M0		Timer EN	Alarm EN	MODE Register M1	M0	As at left	As at left
E	TEST Register	Test 3	Test 2	Test 1	Test 0		Test 3	Test 2	Test 1	Test 0	As at left	As at left
F	RESET Controller and Others	1Hz ON	16Hz ON	Timer RESET	Alarm RESET		1Hz ON	16Hz ON	Timer RESET	Alarm RESET		

× indicates : don't care for WR, always zero for RD.

● MODE REGISTER (A_3, A_2, A_1, A_0) = (1, 1, 0, 1) = D



● LEAP YEAR Counter

Leap year when $D_1 = D_2 = 0$. It counts up simultaneously with Year Counter.

● $\overline{12h}$/24h Selector

24-hour counter when $D_0 = 1$

12-hour counter when $D_0 = 0$

PM when $D_1 = 1$, and AM when $D_1 = 0$ respectively of 10h counter

● RESET Controller 16Hz · 1HzCK Register

(A_3, A_2, A_1, A_0)=(1, 1, 1, 1)=F

$D_0 = 1$: Resetting of all alarm registers

$D_1 = 1$: Resetting of frequency divisions before Second

$D_2 = 0$: 16Hz CK pulse ON

$D_3 = 0$: 1Hz CK pulse ON

● ADDRESS 0~D

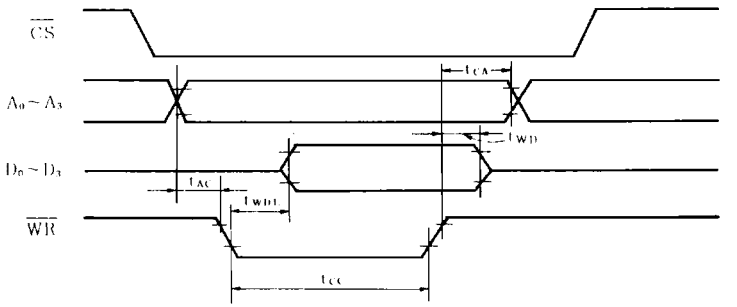
Both READ and WRITE are possible.

● ADRESS E~F

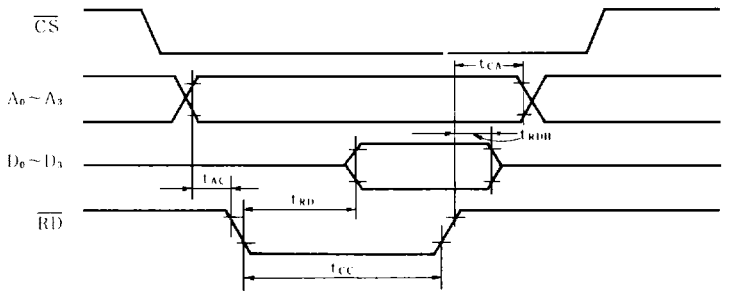
WRITE only is possible.

■ TIMING DIAGRAM

● WRITE CYCLE (CS="H")



READ CYCLE (CS="H")



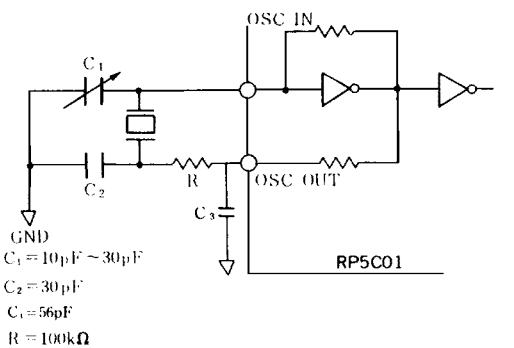
■ APPLICATION NOTES

1. Oscillating Circuit

1-1 When using a crystal oscillating element.

The oscillator circuit is shown in Figure 1. Externally connected parts consist of : a resistor, capacitors and a trimmer capacitor. To adjust the frequency, use the trimmer capacitor (The 16Hz or 1Hz signal output at the $\overline{ALARM}$ pin should be used), for calibration.

When calibrating with the 16Hz signal :
The Address is $(A_3, A_2, A_1, A_0)=(1, 1, 1, 1)$.
The Data is $(1, 0, 0, \times)$.
When calibrating with the 1 Hz signal:
The Address is $(A_3, A_2, A_1, A_0)=(1, 1, 1, 1)$
The Data is $(0, 1, 0, \times)$.



$C_1 = 10pF \sim 30pF$
$C_2 = 30pF$
$C_3 = 56pF$
$R = 100k\Omega$

(The crystal employed is Nippon Dempa Kogyo MX38Tor equivalent)

Fig. 1

1-2 When using an external Clock

The external clock should be connected through the circuits shown in Fig.2(a), and (b). The OSCOUT pin should be left with no connection.

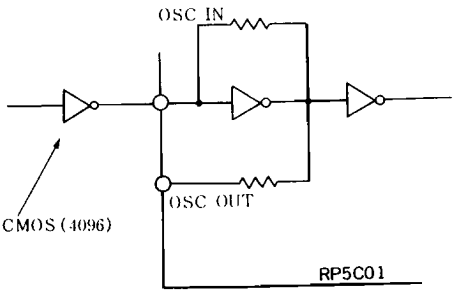


Fig.2 (a) CMOS INVERTER CONNECTION

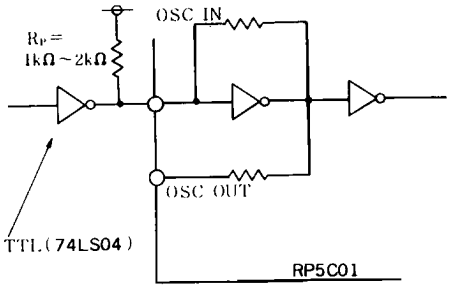


Fig.2 (b) TTL INVERTER CONNECTION

2. Input/Output, and Chip selection Pins.

2-1 Input/Output Pins

In order to stabilize the potential at the Input/Output Pins during 'battery backup' operation, and a pull -down resistor (100~300kΩ), and a pull up resistor (4.7~47kΩ)

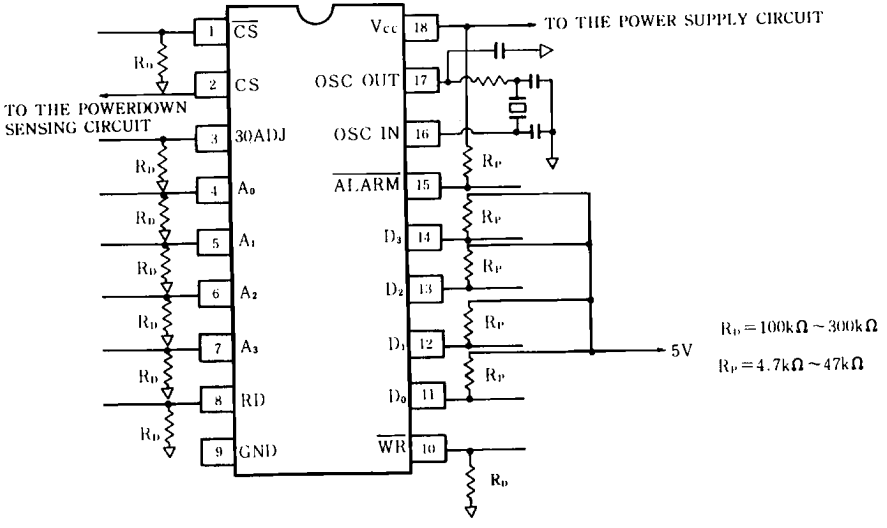


Fig. 3

2-2 Chip selection Pins

There are two chip selection Pins. The CS pin should be connected to the powerdown sensing circuit, and the $\overline{CS}$ pin to the CPU. CS is active "H", whereas $\overline{CS}$ is active "L".

3. Interfacing with typical CPU

3 1 Applicable CPU

CPU	External Circuit
Z 80A	Nil
8085A	74LS74 (NOTE 1)
6800	74LS00, 74LS04

(NOTE 1) Not needed when the X'tal used is below 5MHz

3 2 Standard Interfacing examples.

Examples of Interfacing the RTC with typical CPU (Z80,8085,6800) are presented hereunder.

(1) Z80

The Data Bus, Address Bus, and $\overline{RD}$, $\overline{WR}$ pins are connected to the corresponding pins of the Z 80 (the same symbols are used). The $\overline{CS}$ pin of the RP5C01 should connect with the IORQ pin, or one Bit of the Address Bus (e.g.A_0).

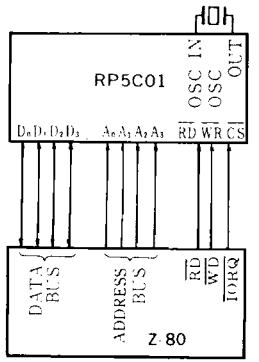
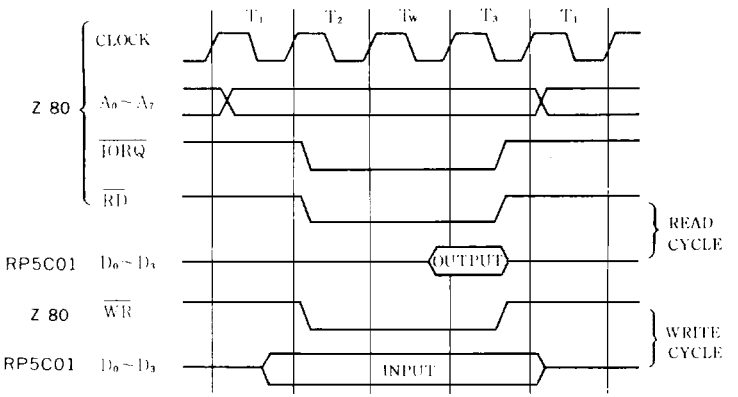


Fig. 4 CONNECTION DIAGRAM WITH Z 80

TIMING CHART



(2) 8085

The Data Bus, Address Bus, and $\overline{RD}$, $\overline{WR}$ pins of the RTC correspond with those of the 8085 (the same symbols are used). The $\overline{CS}$ pin of the RP5C01 should connect with one Bit of the 8085 Address Bus (e.g.pin A_0).

When the crystal oscillator used has a frequency of 6MHz, a 74LS74 (externally connected circuit shown in the dotted line) should be added to provide 1 Wait.

Connection Diagram

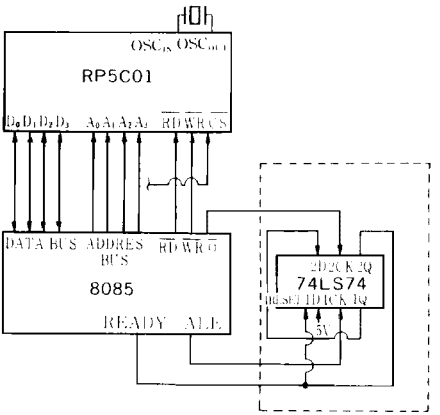
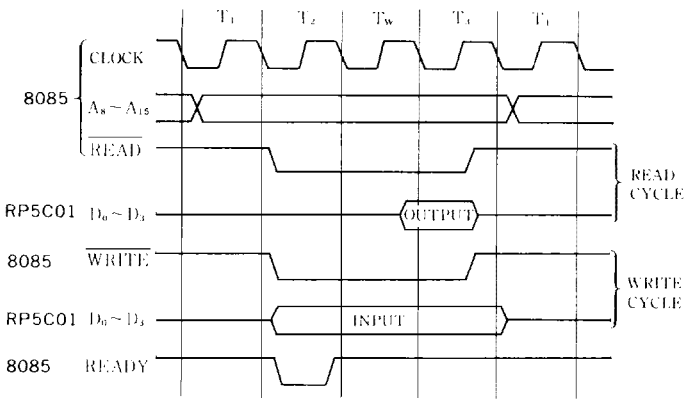


Fig. 5 CONNECTION EXAMPLE WITH 8085

Timing Chart



(3) 6800

The pin connections for the RTC are compatible with the Data Bus, Address Bus of the 6800. (The symbols are the same).

The $\overline{RD}$, $\overline{WR}$, pins of the RP5C01 should be connected to the ϕ_1, and R/W pins of the 6800, but with the addition of the following : two 74LS04 inverters, two input NANDs and two 74LS00.

Besides, the $\overline{CS}$ pin of the RTC should be connected to one Bit of the 6800 Address Bus (e.g.A_0).

Connection Diagram

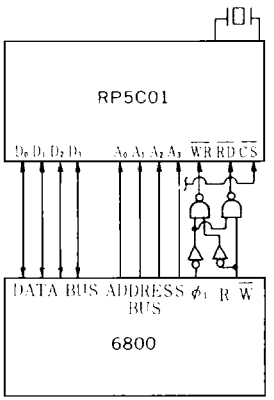
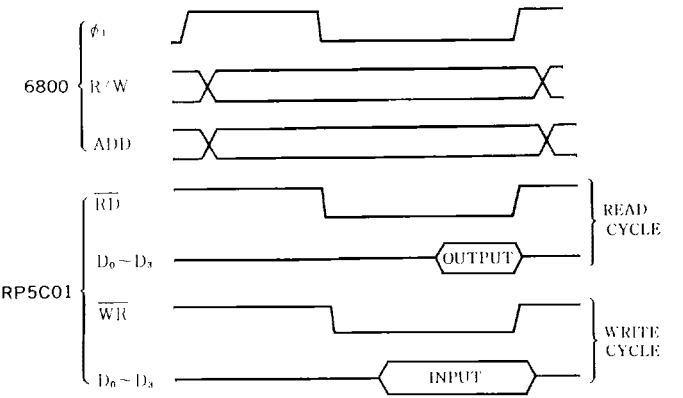


Fig. 6

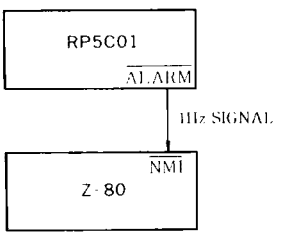
Timing Chart



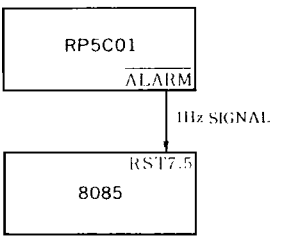
3-3 Interrupt into the CPU

The Data of RP5C01 is read-out by using Interrupt to the CPU at the rate of once every second.

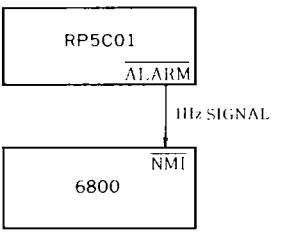
(1) Z80



(2) 8085



(3) 6800



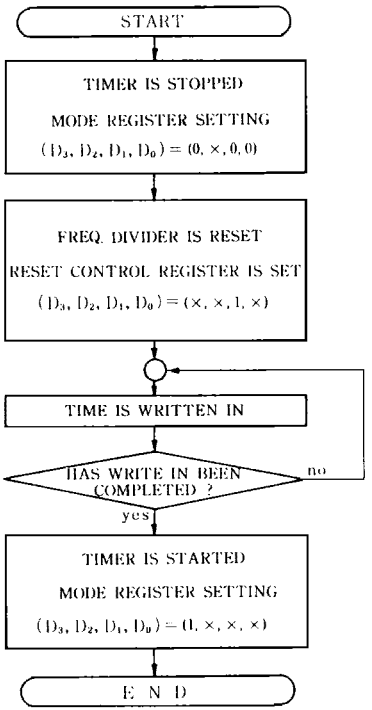
4. Example of a program for setting Time/Alarm

4-1 Flowchart for the time setting operation

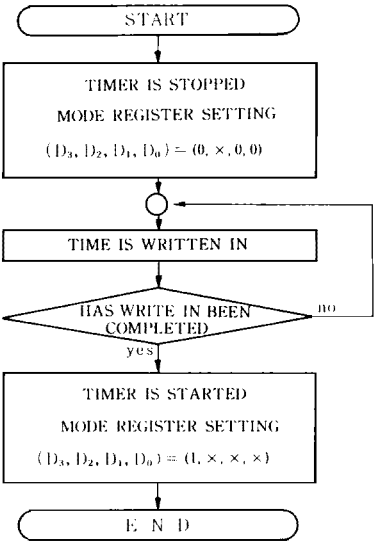
By setting Data (D_3, D_2, D_1, D_0) in the test register (Address (A_3, A_2, A_1, A_0)=(1, 1, 1, 0)), operation of the clock is maintained.

For Time setting, the Timer is stopped, and readout and write-in should be executed within one second.

(1) Timer Setting Program

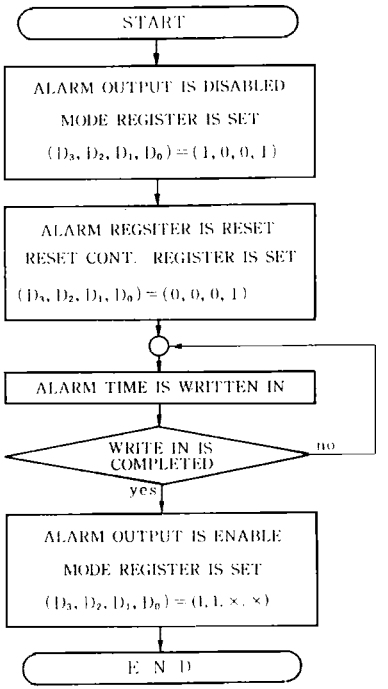


(2) Time Readout Program

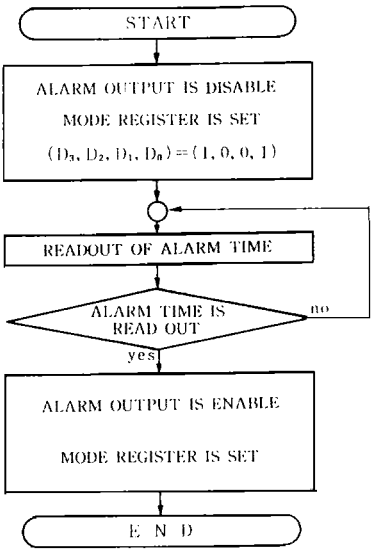


4 2 Alarm Setting Flowchart

(1) Alarm Time Write-in Program



(2) Read-out of Alarm Time

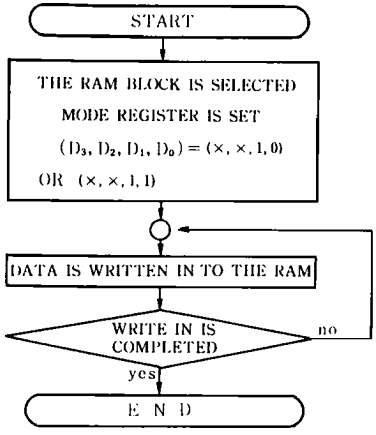


5. Read/Write With RAM Program

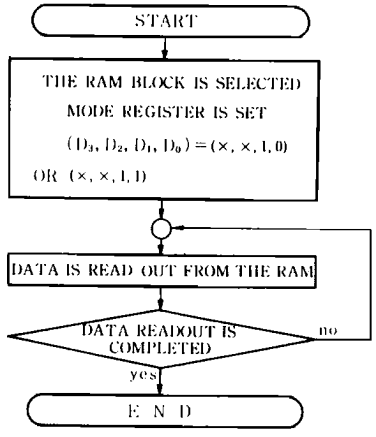
The 26 × 4 Bit User RAM, has provisions for Battery Backup, and can be used as a non-volatile RAM.

The RAM consists of two Blocks (1 Block : 13×4 Bits). A Mode Register enables Selecting the needed Block.

(1) Write-in



(2) Read-out



■ 18 PIN PLASTIC PACKAGE (UNIT : mm)