CHAPTER - III

3. Introduction :

In this chapter we have discussed the architecture of 8085 microprocessor and it is compared with other 8-bit microprocessors. The minimum system around 8085 for the measurement of temperature is described and theoretical treatment of the proportional integration technique is given at the end.

3.1 8085 Microprocessor

8085 is N-channel MOS Technology device manufactured by Intel Corporation. In fig. 3 the functional block diagram of 8085 is given (1).

It has built-in clock generator and a system bus driver controller. It can use the clock freqtency as follows (2).

Microprocessor	Clock Frequency	
	F. min	F. max.
8085 A	500 KHZ	3.125 MHZ
8085 A-2	500 KHZ	5 MHZ

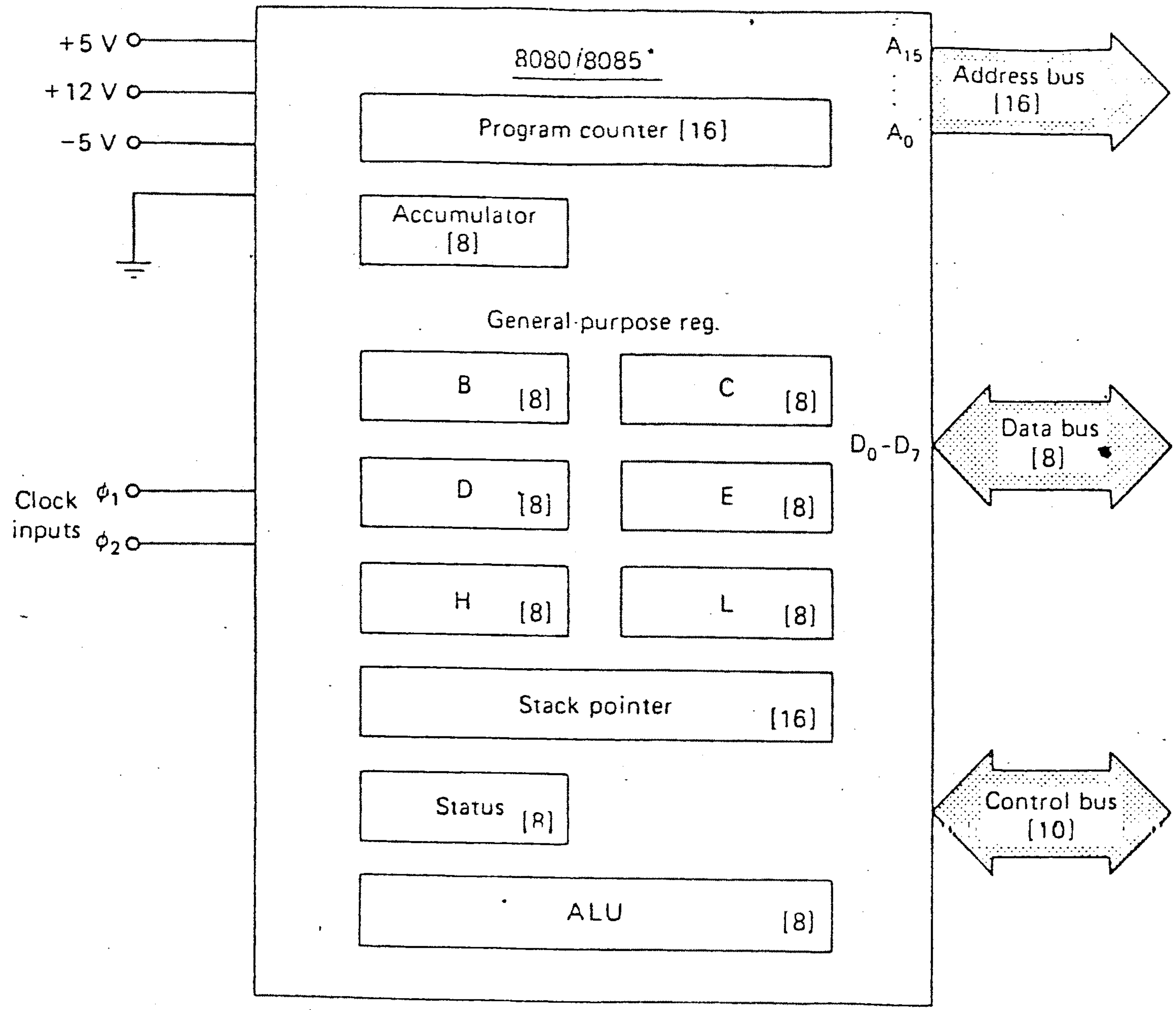


Fig. 3·0 FUNCTIONAL BLOCK DIAGRAM OF 8085 .

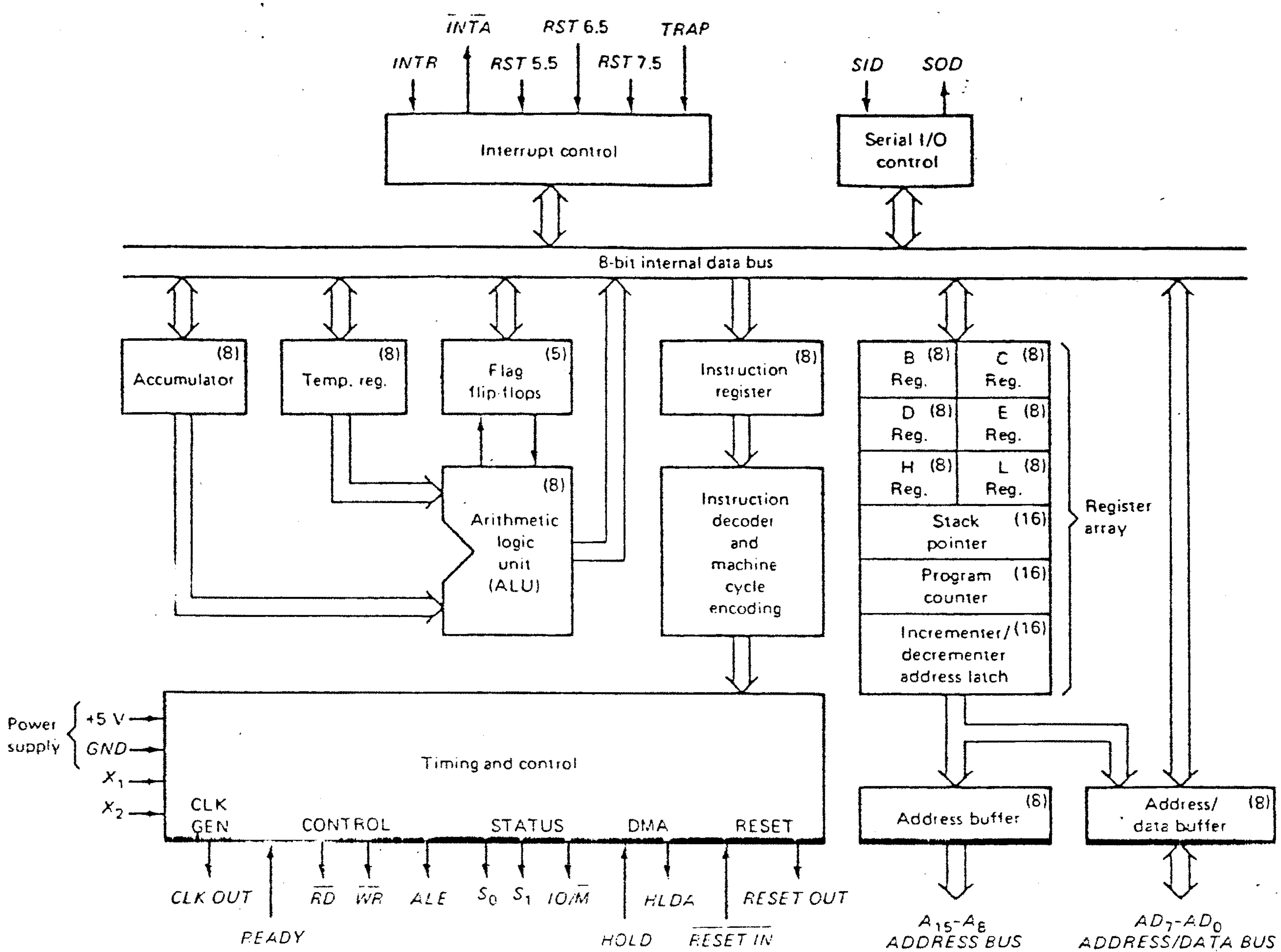


Fig.3·6 b Detail functional block diagram.

The crystal when connected between the pins 1 and 2, determine the frequency of on chip oscillator. The clock frequency is 1/2 the driving frequency of the timing element. The timing elements can be a crystals, LC tank circuit or R-C Network. This is shown in fig. (3.1).

3.2 8085 Processor Signals (3)

A_8 - A_{15} (Address bus)

The 3-state address bus provides the most significant 8-bits of a memory address or the 8-bits of an I/O address.

AD_0 - AD_7 (Address/Data bus) :

The 3-state bi-directional multiplexed address/data bus provides least significant 8-bits of a memory address during the first clock of a machine cycle. It then becomes the data bus during the IInd and IIIrd clock cycles.

ALE (Address latch Enable):

A 3-state output signal present during the 1st clock cycle of a machine cycle, indicating the 8-bit address is present on address/data bus to entre in to memory or peripheral address latch. It also serves as 'status' strobe.

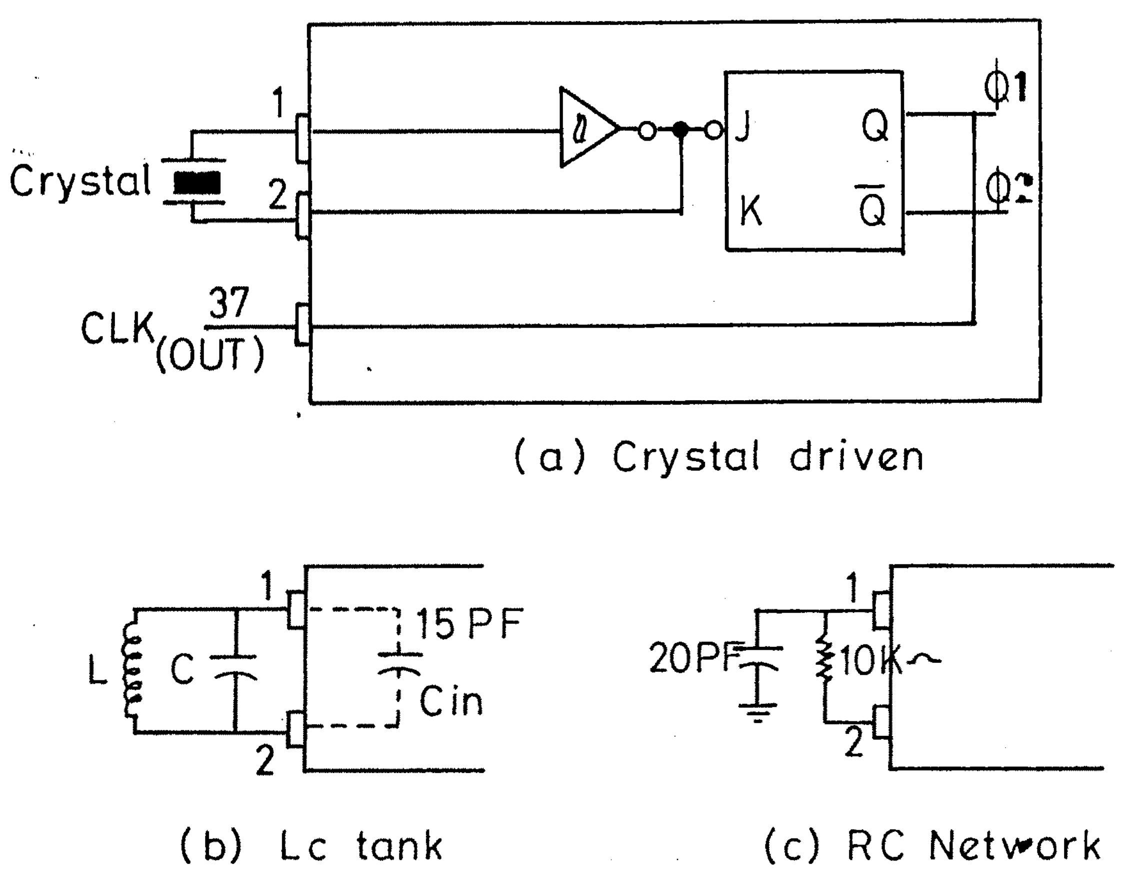

1
Crystal
2
CLK
37
(OUT)
J
K
Q
Q
φ1
φ2
(a) Crystal driven
1
2
L
C
15 PF
Cin
(b) Lc tank
1
2
20PF
10K
(c) RC Network

Fig. 3·1

S_0, S_1 :

These output provides encoded status i.e. type of bus transfer being undertaken.

S_1	S_0	
0	0	HALT
0	1	WRITE
1	0	READ
1	1	FETCH

Io/$\overline{M}$:

A 3-state output that indicates whether the READ/WRITE is to memory or I/o

$\overline{RD}$:

A 3-state output to indicate that selected memory or I/o device is to be read and data bus is available for data transfer.

$\overline{WR}$:

A 3-state output indicates that data on the data bus is to be written into the selected memory or I/o location.

Ready :

An input which, If high during a read or write cycle, indicates that the memory or peripheral is ready to send or receive data. If it is now, the CPU will wait until it goes high before completing the read or write cycle.

INTR :

The processor responds to this asynchronous input at the end of the current instruction cycle or while halted provided

i) The processor is not in the HOLD state and

ii) The internal interrupt enable flip-flop is set (by an EI instruction).

$\overline{\text{INTA}}$

This is an output which is activated instead of $\overline{\text{RD}}$ during the instruction cycle after an INTR is accepted. It can be used to activate an interrupt port for insertion of a RESTART or CALL instruction.

RST 5.5, RST 6.5, RST 7.5 (Restart Interrupts) :

These three maskable inputs have the same timing as INTR except that they cause an internal RESTART instruction to be automatically inserted. The RST 7.5 has the highest priority and RST 5.5 the lowest priority and all have a higher priority than INTR.

TRAP (Trap Interrupt) :

This is a nonmaskable interrupt that causes an internal RESTART instruction to be automatically inserted. It has the highest priority of interrupt.

HOLD :

This asynchronous input request the processor to enter the HOLD state, i.e. to suspend processing operations on completion of the current machine cycle and to put the data bus latch and address buffer in to the high impedance mode. It is also recognized when the processer is in the HALT state. This allows an external device such as the DMA controller or another processor to gain control of the address and data buses. When the hold is acknowledged, the $\overline{RD}$, $\overline{WR}$, $IO/\overline{M}$, and ALE lines are also put in to their high impedance mode.

HLDA :

This output signal appears in response to the HOLD request and indicates that it will relinquish control of buses and control lines in the next clock cycle.

$\overline{\text{RESET IN}}$:

This is an input which resets the programme counter to zero and resets the interrupt enable and hold acknowledge flip-flops.

$\overline{\text{RESET OUT}}$:

This is an output indicating that the processor is being reset. The signal is synchronized to the rprocessor clock.

SID (Serial Input data) :

The data on this input line is loaded in to bit 7 of the accumulator, whenever a RIM instruction is executed.

SOD : (Serial output data):

The output line is set or reset according to the state of bit 7 of the accumulator whenever a SIM instruction is executed.

3.3 Registers :

8085 has GPRS which are B, C, D, E, H, L. These are 8 bit. They can be combined to perform 16-bit operations as BC, DE, HL. These registers are programmable.

Accumulator :

It is an 8-bit register. It always holds one operand in Arithmetic and logical operations. The result of the operation is stored in the accumulator. The data flow from up to memory or I/o is routined via accumulator and vice-versa.

Flags :(4)

There are five flags which are set or Reset according to the data conditions in the accumulator and other register. These flags can also be used for branching operations.

S-Sign Flag :

In arithmetic operations with signed numbers. The bit D_7 indicates the sign. When it is zero (0) the number is considered (+ve) and when it is one the number is (-ve).

Z- Zero Flag :

This flag is set, when the ALU operation results in zero. When the result is not zero this flag is reset.

AC (Auxillary Carry Flag) :

This flag is used internally for BCD operations. In the arithmetic operation when a carry flows from bit D_3 to bit D_4. This flag is set.

P-Parity Flag :

It is used to test for even or odd parity. If the arithmetic or logical operation gives rise to even number of 1^s. Then this Flag is set. It is reset when the number of 1^s is odd.

CY Carry Flag :

If an arithmetic operation results in a carry, the carry flag is set; otherwise it is reset. The carry Flag also serves as a borrow Flag for substraction.

Program Counter (PC) (4) : It is a 16-bit register called the memory pointer. This register is used to sequence the execution of instruction. PC points to the address from which the next byte is to be fetched.

Stack pointer (4) : It is 16-bit register called memory pointer or Stack pointer register. It points to the memory location in the R/W memory called the stack. The stack has to be initialized.

3.4 THE ALU (4) : It consists of the accumulator, the temporqry register, the arithmetic and the logic circuit, and the five flags. The arithmetic and logical operations are carriedout in this unit. The temporary register is used to hold the data during the arithmetic and the logic operations. The other operand is in ACC, and the result goes to ACC. The flags are set or reset depending upon the condition of the result of the operation.

3.5 Timing and the Control Unit (4)

This unit Synchronizes all the microprocessor operqtions with the clock and generates the control siggl signals necessary for data transfer.

Instruction Register and Decoder (4) :

These are the parts of ALU. The instruction fetched from the memory goes to IR. The decoder decodes the instruction and establishes the sequence of events to follow. This register is not available to the user.

The detailed Functional block diagram is given in Fig.3.

3.6 Why 8085 :

We have given comparison of various 8-bit microprocessors in Table 3. Our choice has fallen on Intel 8085 MP because of the following points.

1) The peripherals such as 8255, 8253, 8259, 8257 etc are easily available. These are compatible with 8085 MP and useful for system expansion.

2) Intel has published volumes of literature on 8085, intel compatible peripherals and accplication manual.

3) The microprocessor 8085 has met the industrial standard and widely used for amny applications.

3.7 (a) Some Techniques of Temperature measurement and control (12) :

In Fig. 3.2, 555 timer is shown in astable mode. Instead of resistors, transistor Q_1 and thermister R_T are used. This transistor turns on during the time the capacitor is charging. Assuming the on seate resistance of the transistor to be very small the frequency of multivibrator is given by.

Table No. 3 : Comparison of various microprocessors: (5, 6, 7, 8, 9 10, 11)

Microprocessor	8085	3 - 80	6800	6502
Manufacture	Intel	Zilog Inc	Motorola	Mos Technology
Clock	500 K to 3 MHZ	1 to 4 MHZ	1 MHZ	1 MHZ
Instructions	74	158	72	70
Register, 8-bit	8	18	3	3
16-bit	PC, SP	PC, SP, I_x, I_y	PC, SP, I_x	PC
Flags	5	8	6	7
Interrupts	5, RST 7.5, RST 6.5, RST 5.5, TRAP, INTR	2, NMI, INT	3, IRQ, NMI, Reset	3, IRQ, NMI, Reset
Addressing modes	Direct, register, register-indirect, immediate.	Immediate, immediate extended modified page "0" Relative extended, Indexed, Register, Implied, Register indirect.	Extended Indexed relative and implied.	Immediate, direct indexed relative implied.
Classification of Instruction.	i) Data transfer group ii) Arithmetic group iii) Logical group iv) Branch group v) Stack I/O		Data handling Arithmetic & logical control and transfer instruction. Condition codes handeling. Index register and stack manipulation instructions Interrupt handeling.	Immediate, Absolute, zero page, ACC. implied Relative absolute X & Y Zeropage X and zero page Y Indirect Indexed indirect.

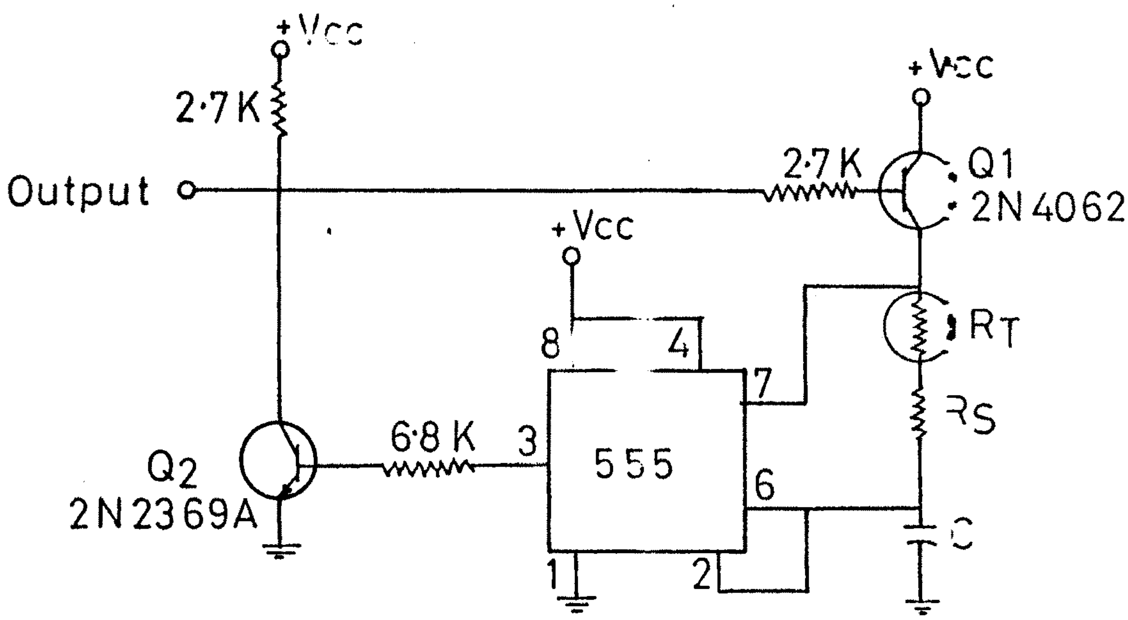

+Vcc
2·7K
Output
+Vcc
2·7K
Q1
2N4062
+Vcc
8
4
RT
7
RS
Q2
2N2369A
6·8K
3
555
6
C
1
2

Fig.3·2

$$f = \frac{0.732}{(R_T + Rs)C}$$

A temperature controll system can also be formed by using a thermistor in the resistor divider Network. The internal comparator derives its input from this divider Network. When the voltage at the pin-2 goes below Vcc/3 because of the thermistor cooling. The triac controlled heating element is turned on and the timing cycle starts. When the thermister temperature goes above the set point before the end of the timing cycle the heating element goes off at the end of the timing period otherwise it remains on. The thermistor can be selected from the relationship.

One more circuit for temperature controll is shown Fig. 3.3

When the temperature is rising the output of the timer is high and the threshould input voltage is determined by the voltage divider formed by R_T, R_1 and R_2. When the thermistor resistance R_T equals it resistance at set point temperature R_{TH} The divider relationship to keep 2/3 Vcc at Pin-7 is

$$\frac{R_{TH} + R_1}{R_{TH} + R_1 + R_2} = 0.5$$

After an input to the internal comparator reaches this level, the discharge transistor is switched ON, effectively

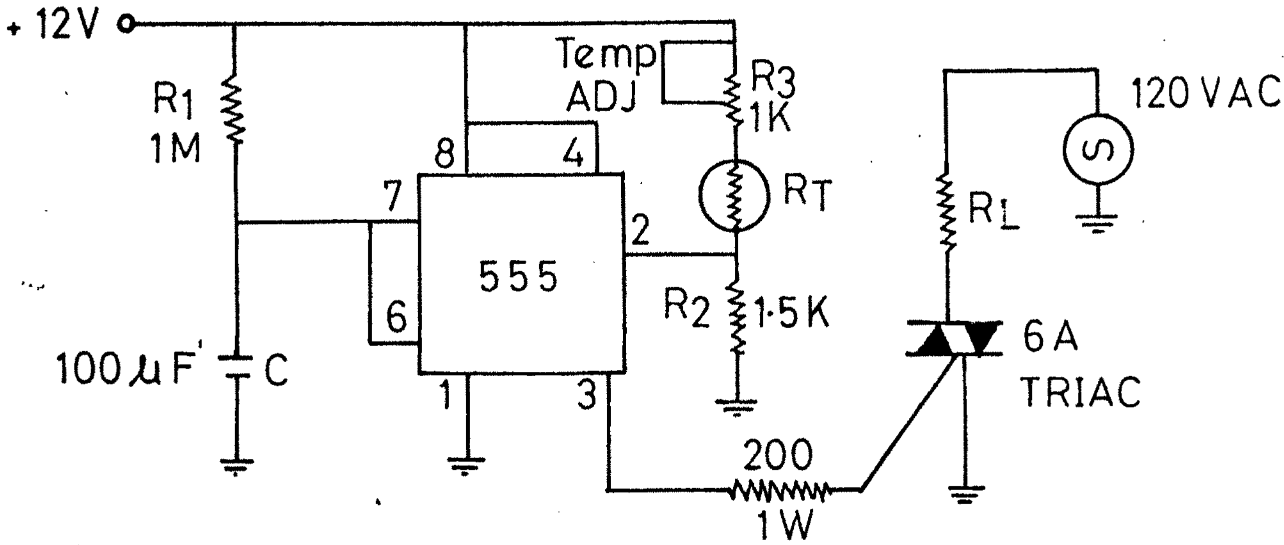


Fig. 3·3 a

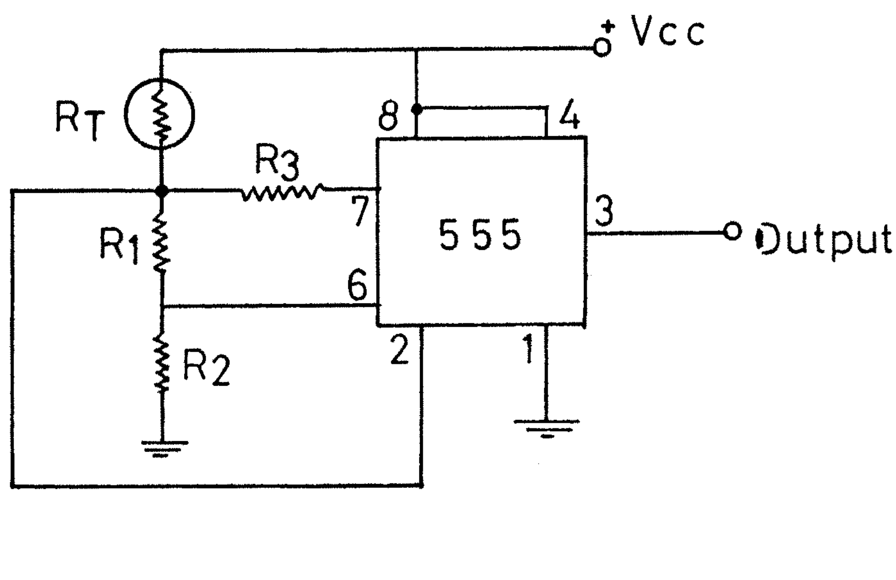


Fig. 3·3 b

placing R_3 in parallel with $(R_1 + R_2)$. As the temperature drops, R_T increases so that the voltage is divided between R_T and R_3 in parallel with $(R_1 + R_2)$. When R_T equals the resistance at the "Cold" set point temperature, R_{TC}, the divider produces a voltage of Vcc/3 at Pin2. Then, the divider relationships becomes.

$$0.5 = \frac{R_3 \,||\, (R_1 + R_2)}{R_{TC} + R_3 \,||\, (R_1 + R_2)}$$

where $R_3 \,||\, (R_1 + R_2) = \dfrac{R_3\,(R_1 + R_2)}{R_1 + R_2 + R_3}$

When a standard thermistor is used, and its resistance as a function of temperature is known, we can determine the required values of R_1, R_2 and R_3 based upon the ratio.

$R_{TC}/R_{TH} = \alpha$ if $\alpha \geqslant 2$, then

$$R_1 = (0.5\alpha - 1)\,R_{TH}$$

$$R_2 = R_{TH}$$

$$R_3 = (3\alpha^2 - 1)\,R_{TH}/\,(4\alpha - 2)$$

However, if $\alpha < 2$

$$R_1 = 0$$

$$R_2 = 2R_{TH}$$

$$R_3 = 2R_{TH} R_{TC} / (2R_{TH} - R_{TC})$$

To prevent noise signals from triggering the timer prematurely, pins 2 and 6 should be bypassed with 0.01 mfd disc capacitors.

3.7 (b) Microprocessor based control systems :

The microprocessor based control system perform the following functions (13).

1. Reading and checking of inputs.

2. display of process variables, set-points, actuator, etc and

3. Control of the plant.

The advantages of using a microprocessor as a dedicated controller is :

1. Commissioning, modification and replacement are made easier.

2. Its memory and arithmetic capability offer greater sophistication than discrete logic.

3. It can be reprogrammed for the variety of task.

4. It is less expensive than dedicated analog devices and

5. It can be used where size, weight and power consumption are severe constraints.

Fig. 3.4 gives the experimental system for PID control of a given process that can be built around any microprocessor.

Some of the examples of the analog quantities which can be controlled by microprocessor are temperature, pressure, liquid level, flow rate etc.

A typical temperature measurement and control system is shown in Fig. 3.5 14

1) The basic objective is to control the oven temperature, which is increased or decreased by switching the heating element oON or OFF.

Since the heating element carries a fairly large electric current an electromagnetic relay is used to switch the heater current. Relay is directly connected to the microprocessor output port. The oven temperature is sensed by a thermocouple and transmitted to microprocessor Either for measurement or control. If the temperature is too high the microprocessor software causes the relay to cut-off

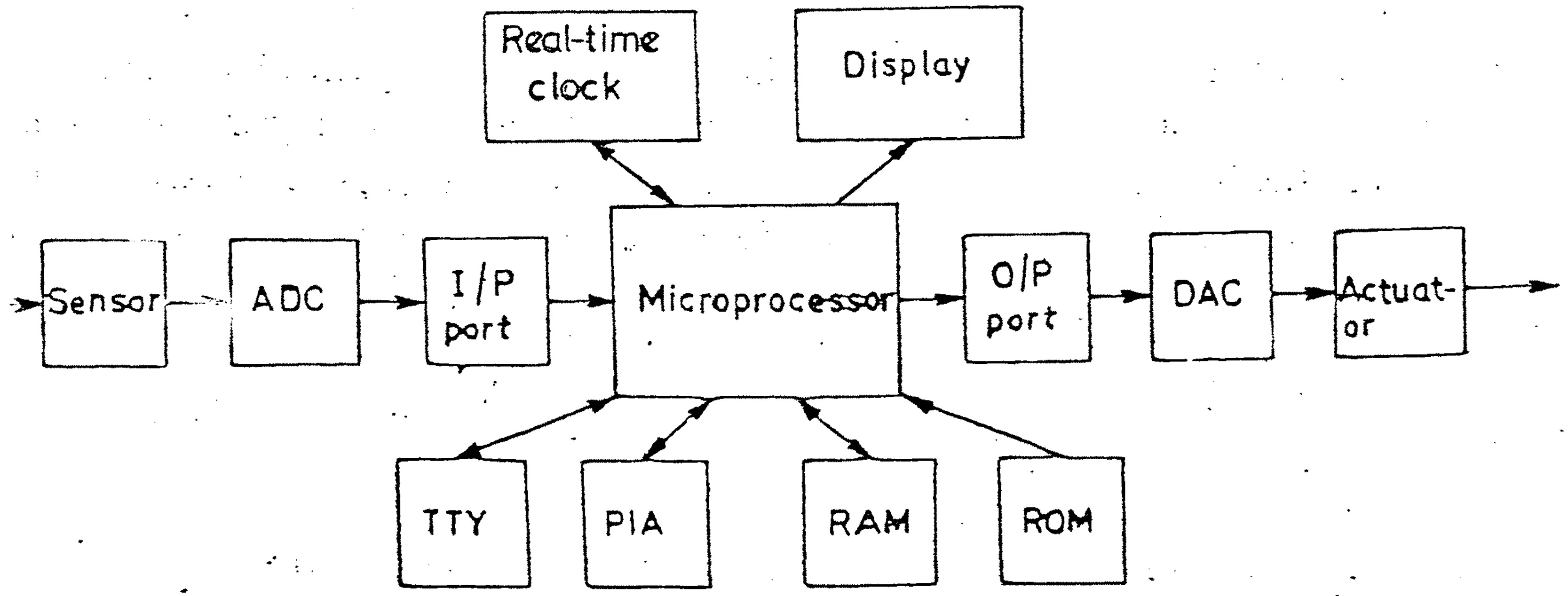
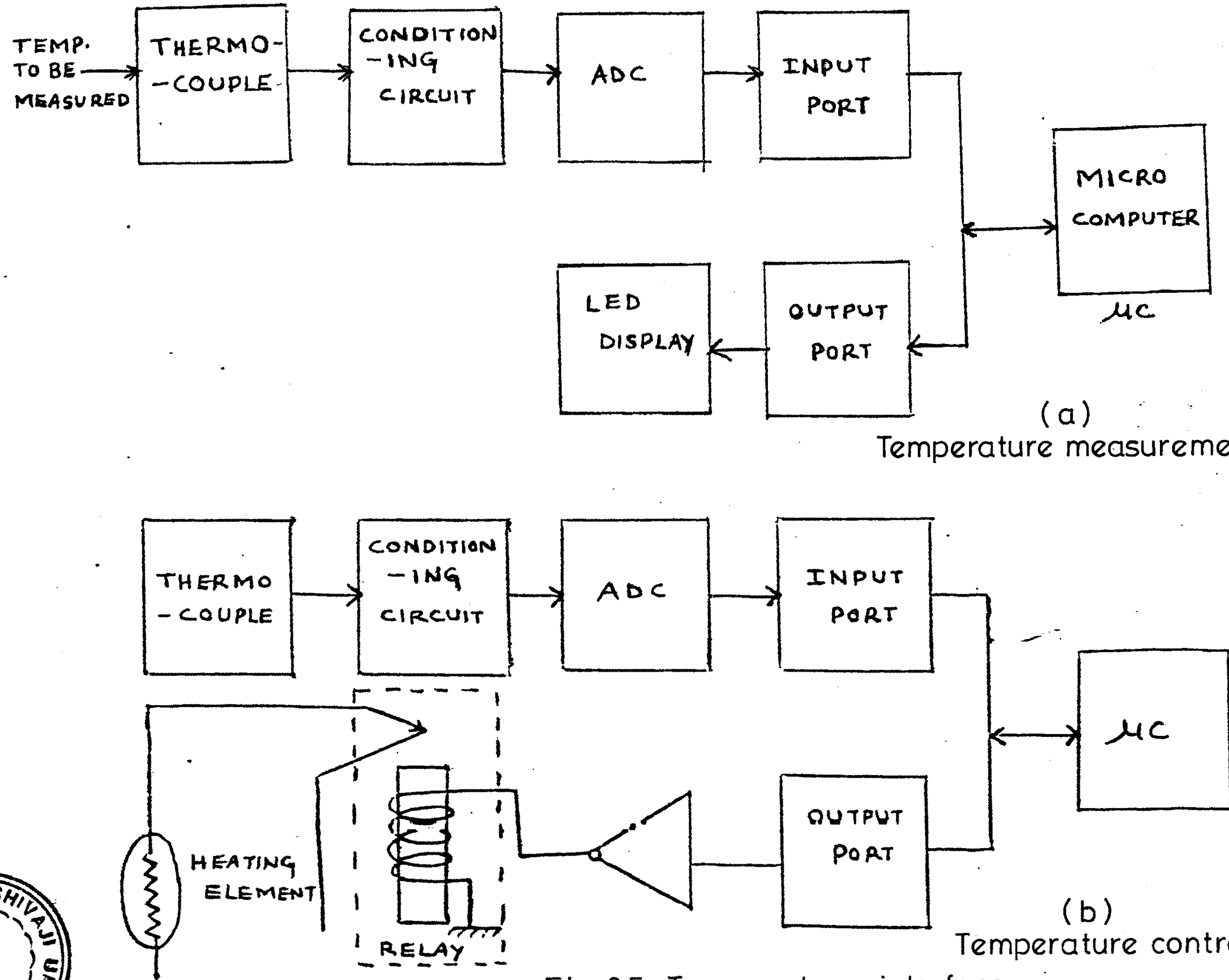


Fig.3·4 Microprocessor based control system



(a)
Temperature measurement

(b)
Temperature control

Fig.3·5 Temperature interface

the current to the heating element, thereby lowering temperature conversely, If temperature is lowered the microprocessor switches on heating element.

2) A simple ON-OFF control is discussed (13). The generalised flow chart is given in the Fig. 3.6

Here the reference temperature Tref is Kept Constant. The control is such that when the sampled temperature Tin exceeds Tref the heater is turned off and when the samples temperature Tin drops below Tref the heater is turned ON. The close loop temperature control system is shown in the fig. 3.6

The microprocessor 8080 is used as a dedicated controller. The input temperature is sampled and monitored contineously using programmed data transfer technique.

The CPU reads the data from ADC which is compared with the desired reference temperature. If this T_{in} differs from T_{ref} by the amount exceeding the limits $\pm$ T. Then appropriate control signal (00/01) is used to turn heater ON or OFF. The program for 8080 microprocessor is given.

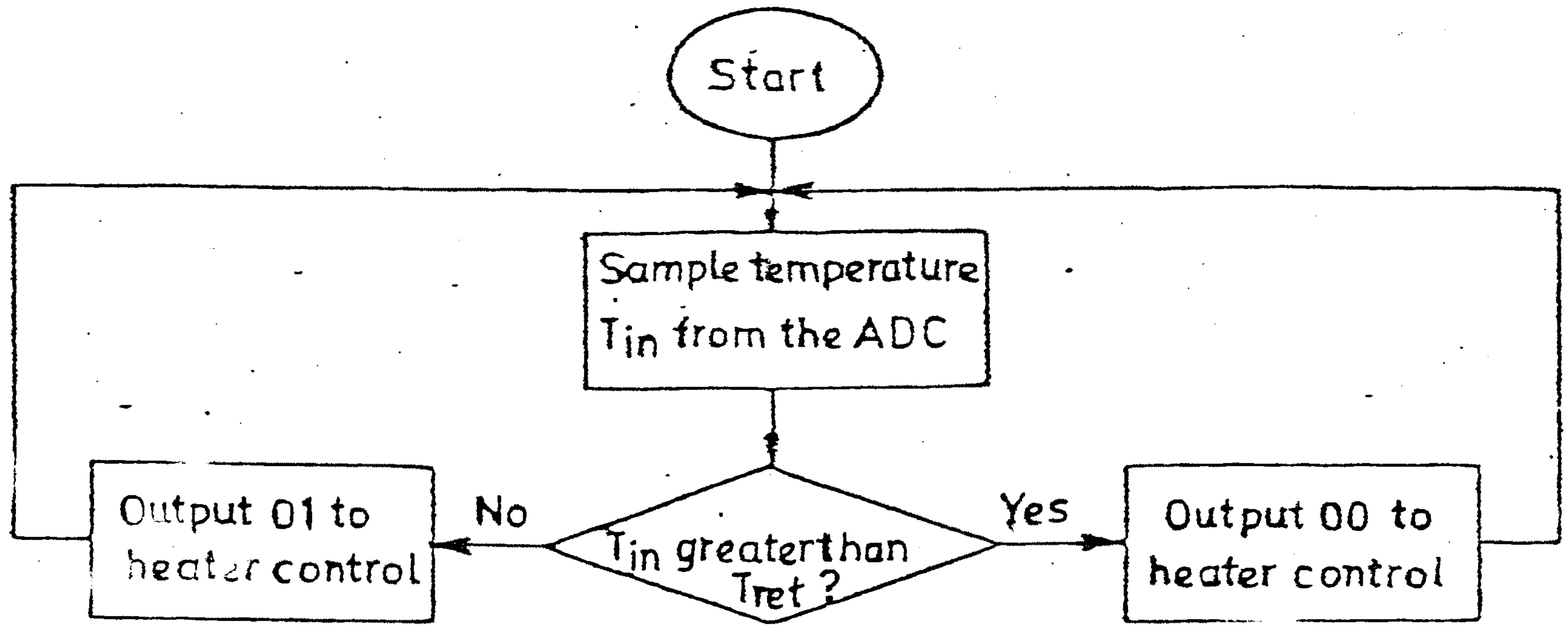


Fig. 3·6 Generalized flochart for on/off control.

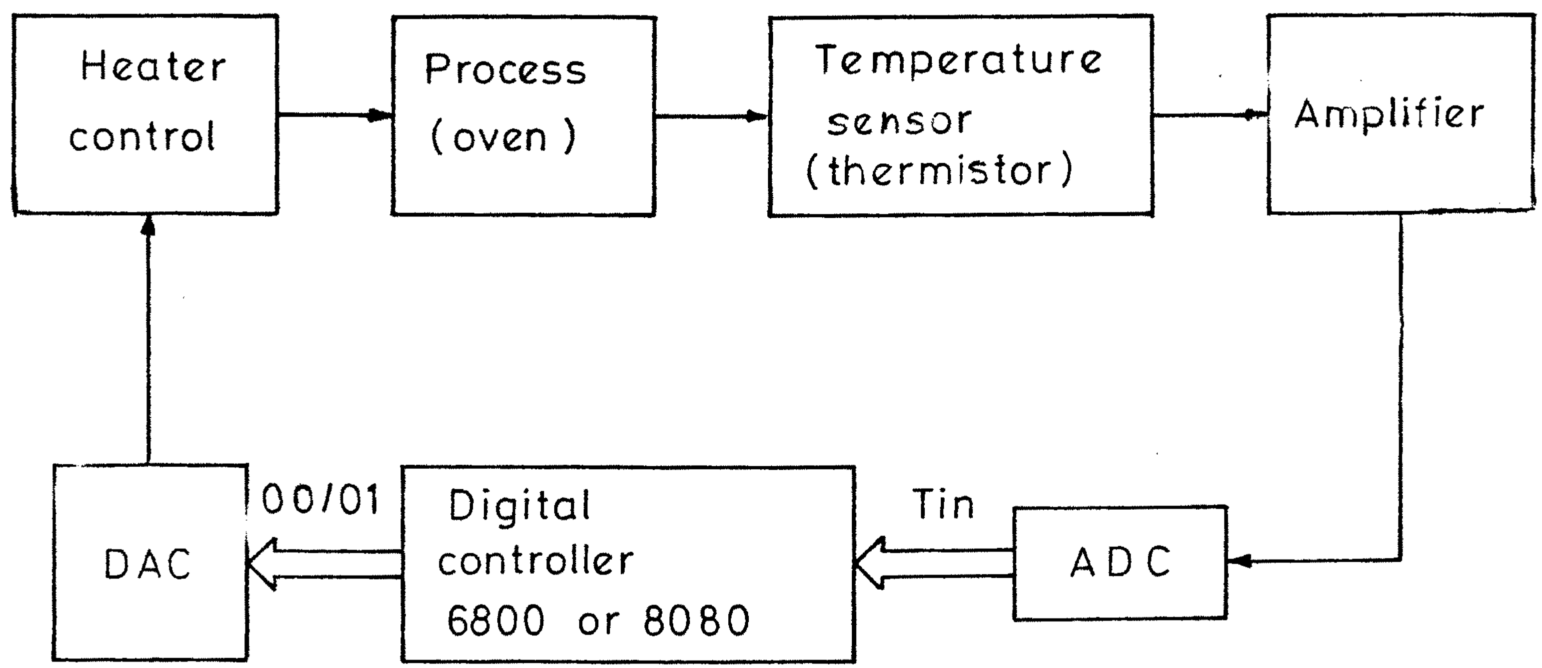


Fig. 3·6 b The close loop temperature control system

8080 Program for ON-OFF control (13)

Address	Mnemonic	Comment
2000	IN	Sample ADC data (T_{in}) by loading the accumulator from port 00.
2000	00	
2002	CMPD	Compare contents of Accumulator with T_{ref}.
2003	JP	Jump to 2009 if T_{in} T_{ref}.
2004	09	
2005	20	
2006	JM	Jump to 200F if T_{in} T_{ref}.
2007	OF	
2008	20	
2009	XRA A	Clear accumulator.
200A	OUT	Output ON-OFF control to the heater.
200B	03	
200C	JMP	Goback to 2000 for the next sample.
200D	00	
200E	20	
200F	MVIA	Load accumulator with 01.
2010	01	
2011	JMP	Jump to 200A to switch the heater ON.
2012	0A	
2013	20	

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