# UNIT 3:

(DAC R-2R ladder,ADC Sucessive approximation method, Interfacing of A / D converter , Interfacing LED, Seven segament display, Relay & optocoupler with 8085.)

**Digital to Analog converter(DAC):**R-2R Ladder method

In many industrial applications analog data ( e.g. voltage or current produsd by sensor) is given to microprocessor in this case this data must be converted in to digital form an electronic circuit that will cinvert analog data in to digital data is known as Analog to digital converter.(DAC) it is also necessary to convert digital data from microprocessor to analog form (voltage or current) An electronic circuit that will convert digital data into analog is known Digital to Analog converter.(DAC).Two methods are used for this purpose.one is resistar divider network or binry weighted method and another R-2R or binary ladder method .

Diagram for 4 bit binary ladder method is as shown in fig. below.in which only two values of resistor R and 2R are used. 4 bit digital data is applied at D0,D1,D2,D3 and analog data is obtained at V0

Initially assume that all inputs are grounded now consider point A from point A resistance toward ground is 2R and towards D0 bit is also 2R which is also grounded hence equvalent resistance of 2R and 2R is only R hence its equvalent diagram will becomes as shown in fig ii

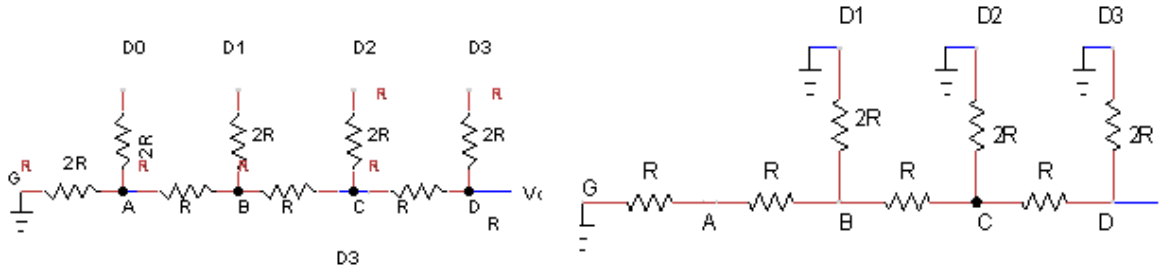
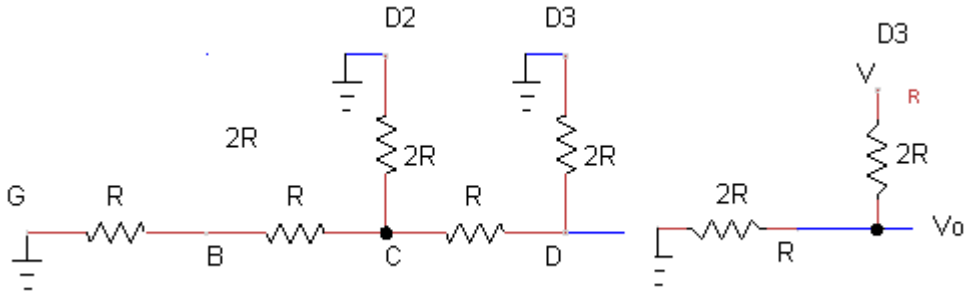



**fig ii**

**C**onsider point B from fig ii again resistace towards point G is R + R=2R and towards point D1 is also 2R . again equivalent resistance of 2R and 2R is R hence equivalent diagram is as shown in fig iii

**Fig iii**




**A**gain from point C resistance towards G is 2R and towards D2 is 2R hence equivalent resistance of 2R and 2R is R hence equivalent diagram becomes as shown in fig iv

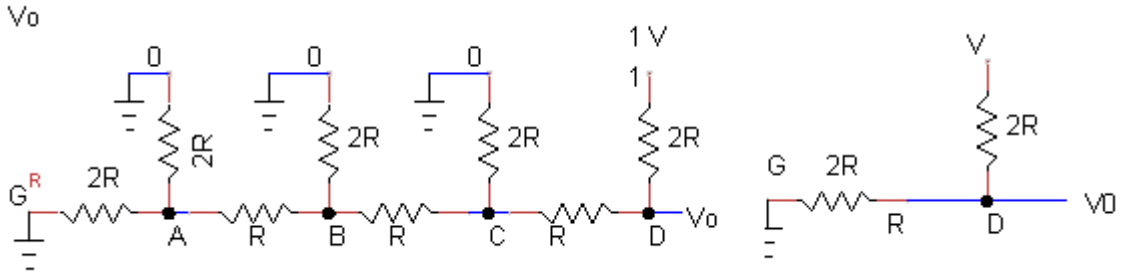
Fig.iv

From this we conclude that in R -2R ladder resistace toward ground is 2R and towards terminating end is also 2R though it is grounded or conectted +V.

By applying digital signal to binary ladder we claculate out put voltage as follows

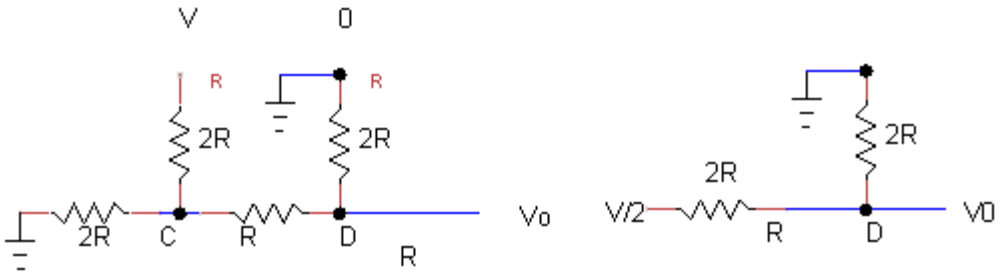
I ) If signal 0001 is applied to circuit ( 0 means 0V and 1 is some +voltage known as refrance voltage) as shown in fig.

According to theory of R-2R from point D resistance toward ground is 2R and resistance towarrds V is also 2R ence equivalent diagram will becomes.as shown in fig.




This forms voltage divider system hence out put voltage
V0= V x 2R = V/2 **Hence if 1 is applied at MSB output voltage is V/2**
2R+2R
ii) Now we apply 1 at second MSB i.e. signal 0010 is applied as shown in fig.below

From point C resistance towards ground is 2R hence equivalent diagram will becomes




2R and 2R at point C forms voltage divider hence voltage at point C is V/2 again diagram becomes as shown in fig.

This is again forms voltage divider system with applied voltage V/2 hence output voltage V0= V/4
Similarly if signal 0100 is applied o/p voltage is V/8
In genral O/P voltage is given by
V0= V/16 + V/8+V/4+V/2 or $V0 = \frac{V0\ 2^0 + V1\ 2^1 + V2\ 2^2 + V3\ 2^3 \text{----------}}{2^n}$

Resolution of DAC : Is the minimum voltage that will be prouduced by DAC .this minimum voltage is produced when signal 0001 is applied for 4 bit binary system which is $½^4$= 1/256
This means minimum voltage produced is 1/256 times applied refrance voltage.if 0=0V and 1=5V then with 0001 signal O/P is 5/256 = 0.0195 V or O/P voltage changes in the step of 0.0195 step.and O/P voltge for signal 1111=5 V .resolution of DAC will depends on number of bits used in DAC.

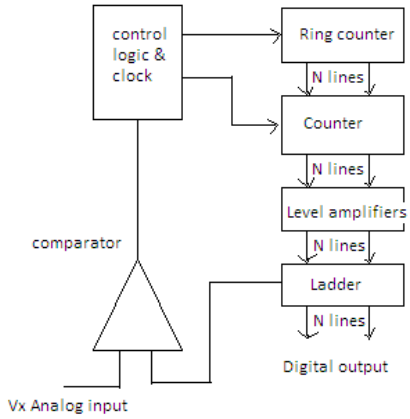
**ANALOG TO DIGITAL CONVERTER (ADC)**

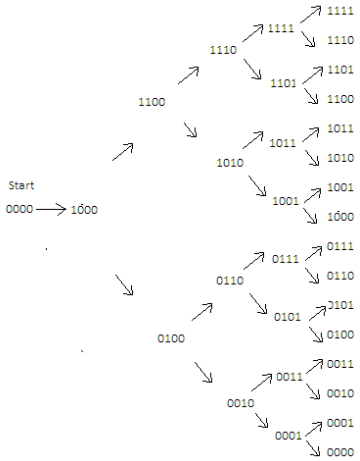
An analog to digital converter coverts analog voltage or current in to digital form different methods are usedfor this some of these are Flash converter,Single slope method,Dual slope method,Successive Approximation method.We study most commanly used method i.e.

**Succesive Approximation method:**

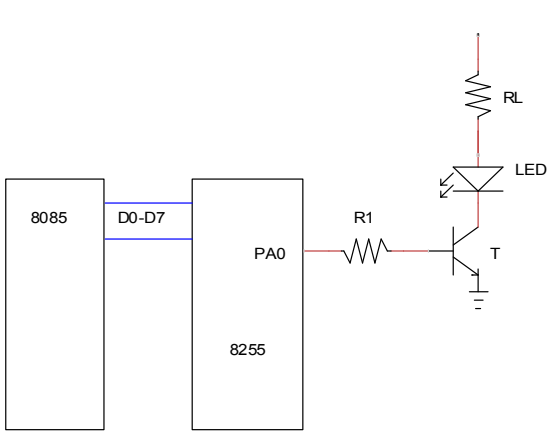
**Principle:** Operates by successively dividing the voltages in half.

The counter is first reset to all zeros & the MSB is then set. The MSB is then left or taken out by resetting the MSB FF, depending on the output ofte comparator. Then the second MSB is et in, & a comparison is made to determine whether to reset the second MSB FF. This process is repeated down to the LSB. Now the desired number is in the counter. Beginning with the MSB one FF is operated at a time. Therefore, a ring counter is used for FF selection.




**Interfacing of LED with microprocessor:** To interface LED circuit diagram is as shown in fig. We cannot connect directly LED to microprocessor to interface it with microprocessor PPI ic 8255 and transistor as buffer is used as shown in fig. Resistance RL limits the current through LED and resistance R1 limits current through transistor T So when pin PA0 of Port A is high small current flows through R1 and base of Transistor hence current flows through RL ,LED,Collector and emmiter and LED will become ON and when PA0 is low LED will Off.




Port A is used as output Port other ports are not used assume all ports are confugrate as out put ports hence control word for 8255 will become

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| For I/O mode | Mode 0 | Mode 0 | Port A as out put | Port c u as O/P port | Mode O for Port B and Cl | Port B as O/P | Port CLower as O/P |

| = 8 Hex of 1 0 0 0 of D7,D6,D5,D4 | =0 Hex Of 0 0 0 0 Of D3,D2,D1,D0 |
|---|---|

Control word is 80 H Again asumme that address for PORT A= 00 port B=01 port C= 02 and control register=03

STEPS: 1) Confugrate all ports as output ports in mode 0 and send control word to control register

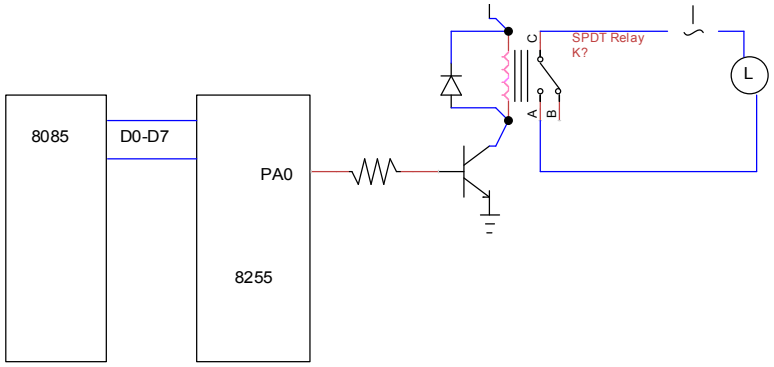
2) Make PA0=1 so transistor is on And LED will on
3) Call delay subroutine
4) Make PA=0 So LED will off
5) Call delay again
6) Repeat process forever.

PROGRAM TO INTERFACE LED:

MVI A 80

```
        OUT 03                      Send control word to control register
Start: MVI A 01
        OUT  00                 Send no 01 to port A so that PA0=1
        CALL Delay                Wait for some time
         MVI  A  00
         OUT  00                Send no 00 to Port A so LED will off
          CALL Delay
          SJMP   Start          Repeat  forever
```

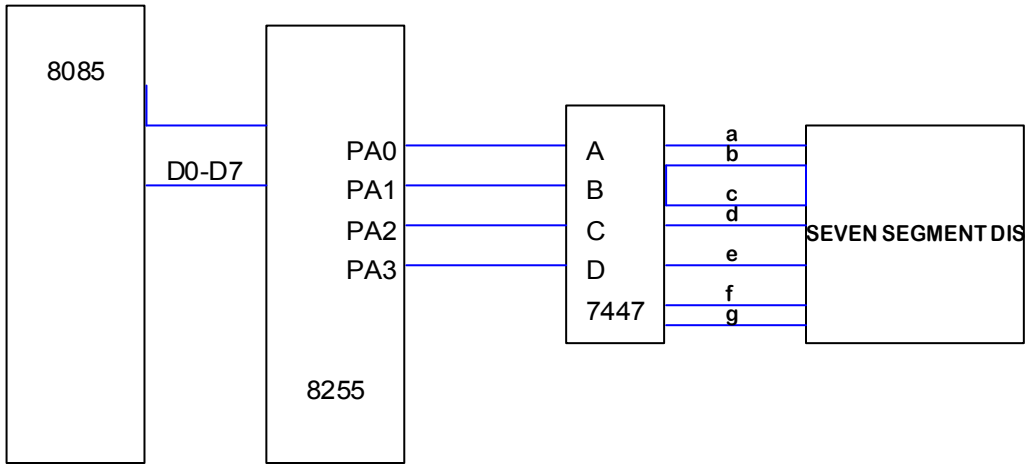
**To interface RELAY with 8085:**




**To** interface high voltage devices with microprocessor An elecromechanical devices known as RELAY is used Science coil of relay requires more current to make relay ON and OFF hence to drive relay a transistor is used as buffer. A reverse biased diode is connected across coil of relay to protect transistor from back emf produced by coil of relay when it becomes off.

- All other explanation and program is similar to LED ON/ OFF

**INTER FACING OF SEVEN SEGMENT DISPLAY : To** interface seven segment display with 8085 microprocessor we use PPI ic 8255 Port A is used as out put port its four pins PA0,PA1,PA2,PA3 are connected to four inputs A,B,C,D of decoder IC 7447. Outputs a,b,c,d,e,f,g.of decoder are connected to corresponding pins of common anode display as shown in fig.




Assume all ports are output ports in mode 0 hence control word for this is

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| For I/O mode | Mode 0 | Mode 0 | Port A as out put | Port c u as O/P port | Mode O for Port B and Cl | Port B as O/P | Port CLower as O/P |

| = 8 Hex of 1 0 0 0 of D7,D6,D5,D4 | =0 Hex Of 0 0 0 0 Of D3,D2,D1,D0 |
|---|---|

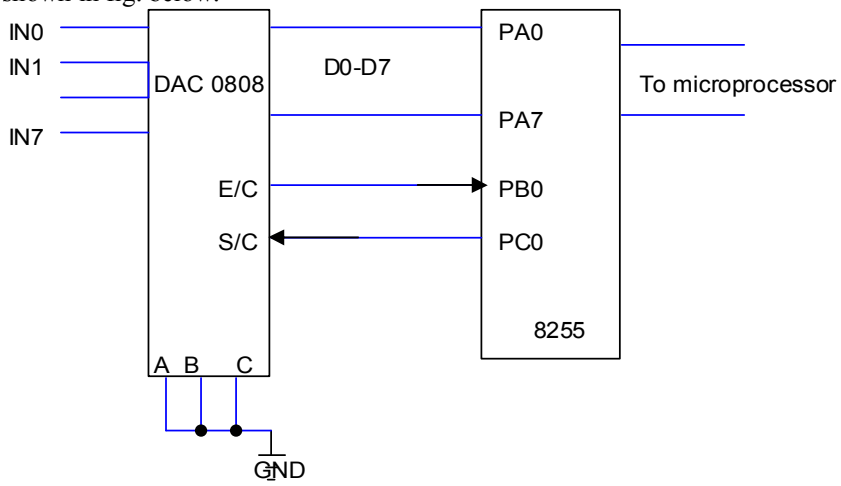
=80 H
Assume Address of PORT A= 00,PORT B=01,PORT C=02, control register=03
Software to display nos. 0 to 9 on seven segment display.
Algorithm: 1) Send control word to control register
2) Load register B as counter with no.9 ( to show nos. 0 to 9)
3) Send first no 00 on accumulator to 7447 through port A
4) wait for some time
5) Increment accumulator ,
6) Decrement reg.B by one if it is not zero go to step 3

Program:

```
        MOV A 80
        OUT   03            send control word to control register
        MVI A  00
Loop:   OUT  00             Send  00 to PORT A (ITS Address is 00)
        CALL DELAY          Wait for some time
        INR  A              increment  A by ONE
        DCR  B              Decrement counter by one
        JNZ   Loop          If B is not equal to zero goto loop and repeat  same until 9 is displayed
        Stop
```

**Interfacing of ADC 0808 with 8085**

To interface analog voltage (e.g.O/P of temp.sensor)with microprocessor ,this analog voltage must be converted into digital form using Analog to Digital converter IC ADC 0808 circuit diagram to interface ADC with 8085 is as shown in fig. below.




ACD 0808 have 8 input channels IN 0 to IN 7 .analog input can be applied to any one of the input .These input channels are selected by giving address to A B C input In above circuit diagram A B C are grounded hence channel IN 0 is selected .
After applying analog signal to IN 0 A high to low pulse is applied to S/C pin of ADC which will start conversion of analog signal to digital.After complision of conversion ADC will make E/C (End of conversion) pin high which will be detected by PB0 pin of port B. And then after Digital DATA is transferred to microprocessor through PORT A
Ports are confugrated as
PORT A = INPUT PORT Let add.of PORT A=00
PORT B= INPUT PORT Let add.of PORT b =01
PORT C= output PORT Let add.of PORT C=02
Control word is

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| For I/O mode | Mode 0 | Mode 0 | Port A as Input | Port c u as O/P port | Mode O for Port B and Cl | Port B as I/N | Port CLower as O/P |
|---|---|---|---|---|---|---|---|

| = 9 Hex of 1 0 0 1 of D7,D6,D5,D4 | =2 Hex Of 0 0 1 0 Of D3,D2,D1,D0 |
|---|---|

=92 H
Address of control reg=03
Program:

```
START: MVI A  92
OUT 03        control  word to control reg.
MVI  A 01
OUT 02              Make  Pc0 pin High
Call Delay        wait for some time
MVI A 00
OUT  02     Make Pc0 =0  A S/C pulse is given
LOOP: IN  01
        ANI 01
       JNZ   LOOP     Check Pin Pb0 is high or not If PB 0 is 1 ANI 01 makes A=0
IN 00 Take data in from port A
STA  8000 Store data at 8000
JMP START
```