UNIT III

PROGRAMMABLE PERIPHERAL INTERFACE

- Keyboard interfacing
- LED display
- ADC interface
- DAC interface

Keyboard interfacing

3.5 Keyboard Interfacing

- Keyboards are organized in a matrix of rows and columns.
- The CPU accesses both rows and columns through ports.
- Therefore, with two 8-bit ports, an 8 x 8 matrix of keys can be connected to a microprocessor.
- When a key is pressed, a row and a column make a contact.
- Otherwise, there is no connection between rows and columns.
- A 4 x 4 matrix connected to two ports.
- The rows are connected to an output port and the columns are connected to an input port.
- Getting meaningful data from a keyboard requires three major tasks :
  1. Detect a keypress
  2. Debounce the keypress.
  3. Encode the keypress (produce a standard code for the pressed key).
- Logic 0 is read by the microprocessor when the key is pressed.

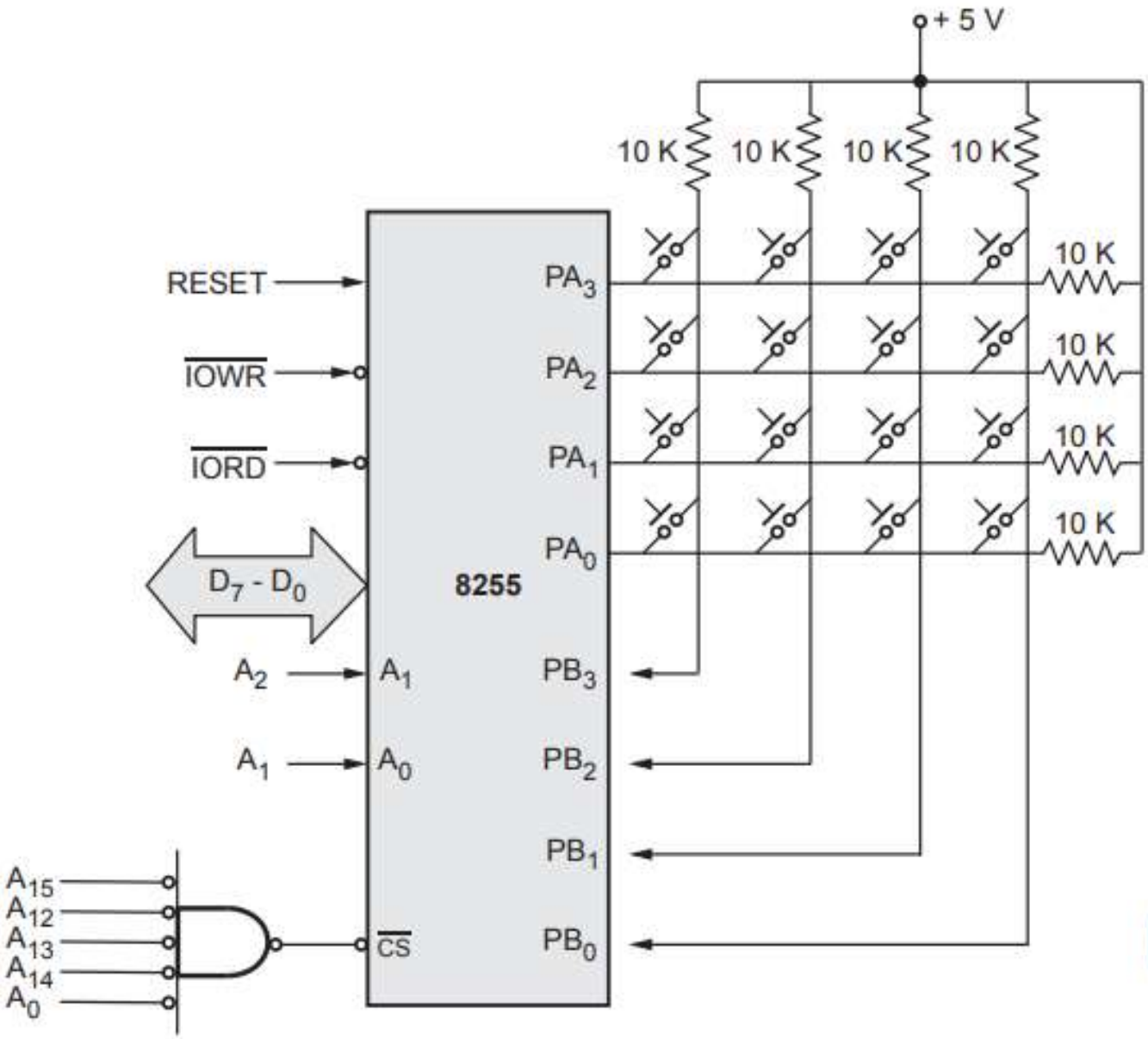


Fig. 3.5.3 Interfacing 4x4 keyboard

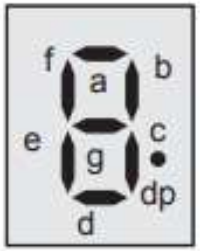
LED display

3.6 Display Interfacing

- The most popular display is the Light Emitting Diode (LED) which is available in a variety of forms : single LED, bi-colour LED, and seven segments LED.
- Another popular display device is the Liquid Crystal Display (LCD) , which is also gaining popularity because of its low power consumption.

3.6.1 Seven Segment LEDs

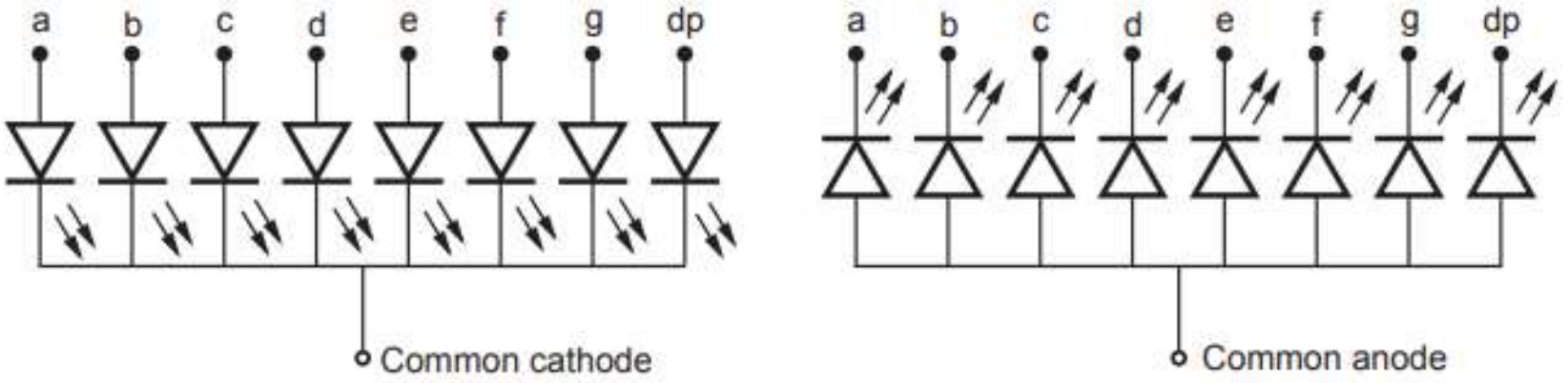
- There are many applications where you have to display numbers.
- The most popular display device used for displaying numbers is seven - segment LED displays.
- Seven Segment displays are used in a number of systems to display the numeric information.
- The seven segments can display one digit at a time.
- Thus the number of segments used depends on the number of digits in the number to be displayed.



(a) Seven-segment LED display module

Fig. 3.6.1

- In each module, seven (eight including the display point) LED segments are fabricated in a pattern as shown in Fig. 3.6.1 (a).
- The seven segments are numbered as a, b, c, d, e, f, g and the decimal point as dp.
- To reduce the number of pin counts, either all the cathodes are connected together inside the module providing common cathode type display as shown in Fig. 3.6.1 (b) or all the anodes are connected together providing common anode type display as shown in Fig. 3.6.1 (c).



(b) Common cathode type seven-segment LED **(c) Common anode type seven-segment LED**

Fig. 3.6.1

- Both the types are commercially available.
- Depending on the type used, interface circuitry has to be made accordingly.
- All hex character from 0 to F can be conveniently displayed using seven segment LED displays as shown in Fig. 3.6.2.
- One disadvantage of LED is that the readability of display becomes poor in bright light.
- To improve readability, the display is covered with an amber coloured plastic sheet.

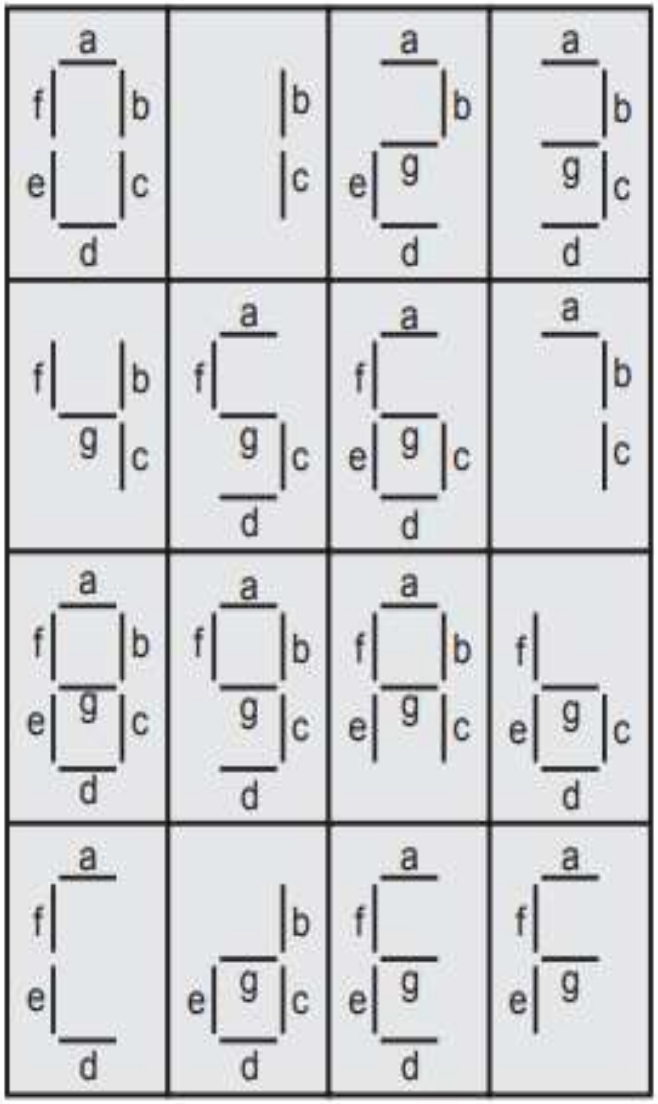


Fig. 3.6.2 Display of hex characters using seven-segment LEDs

3.6.2 Interfacing LED Display

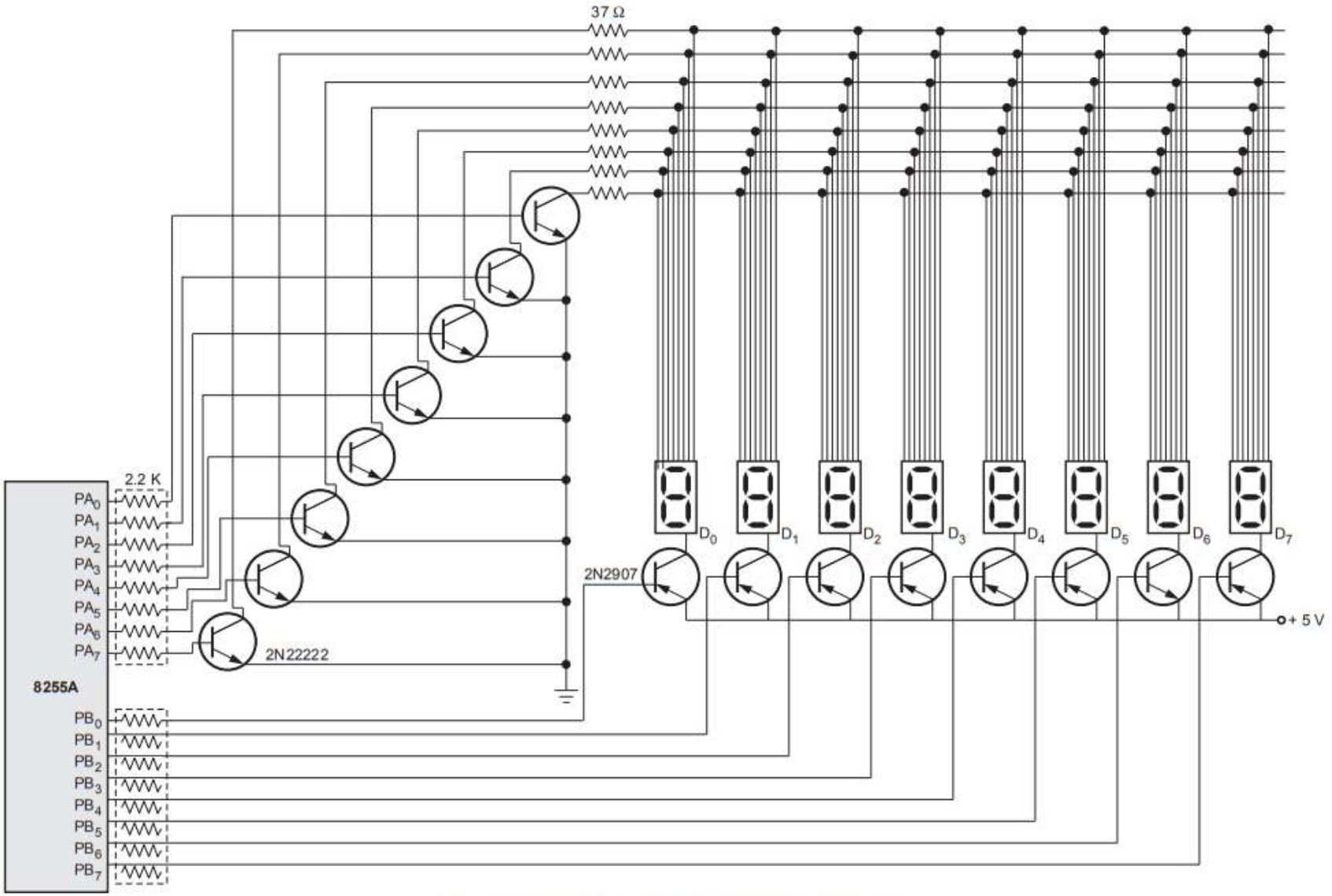


Fig. 3.6.3 Interface of 7 segment display through 8255 A

- Fig. 3.6.3 shows the 8255A connected to set of 8, seven segment LED displays.

- In this circuit ports A and B are programmed as (mode-0) simple latched output ports.
- Port-A provides the segment data inputs to the display and port-B provides a means of selecting a display.
- The resistor in series with the base of the segment switch assumes that the minimum gain of the transistors is 100.
- The base current is, therefore, 80 Ma/100 = 0.8 mA.

3.7.1 Analog to Digital Converter (ADC)

- An Analog to Digital Converter (ADC or A/D or A to D) is a device that converts a continuous physical quantity to a digital number that represents the quantity's amplitude.

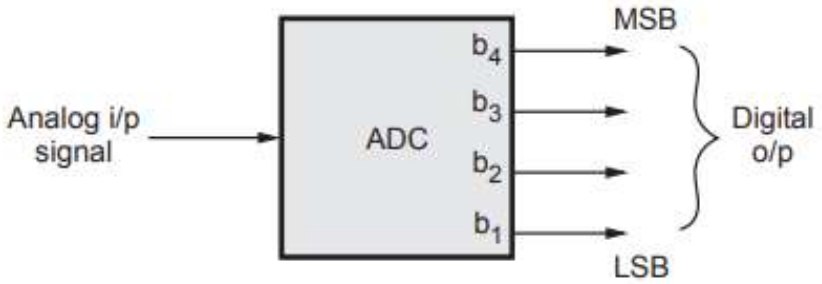


Fig. 3.7.1 Block schematic of ADC

- To convert an analog signal to digital, the time axis has to be divided into a number of equally spaced intervals.
- This process is knows as "Quantisation".
- The input to ADC is the analog signal and output is in digital form.

Types of ADC

Various types of ADCs are

1. Flash type ADC
2. Counter / ramp type ADC
3. Successive approximation type ADC

ADC interface

3.7.5 Interfacing

- Fig. 3.7.5 shows typical interfacing circuit for ADC 0808 with microprocessor system.

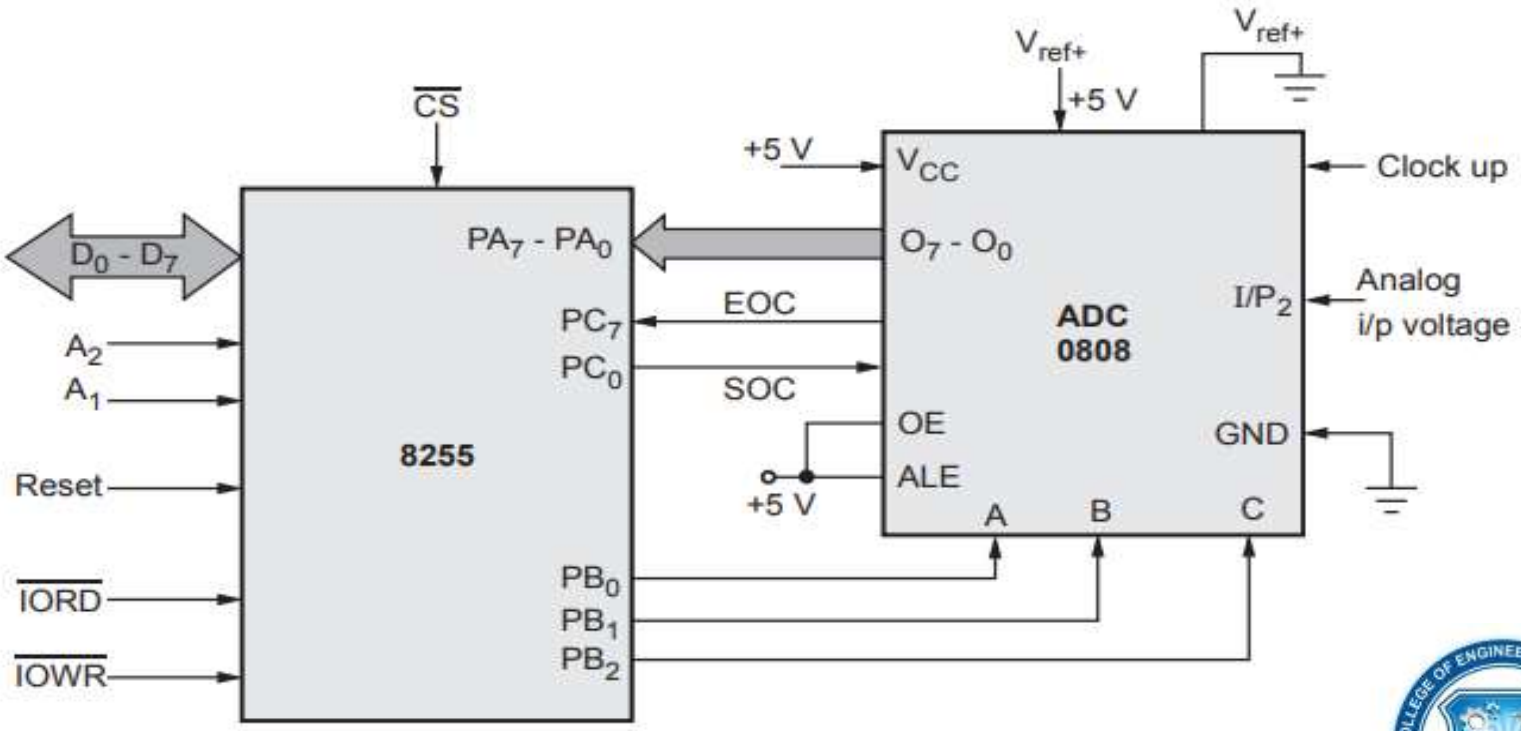


Fig. 3.7.5 Interfacing 0808 with 8086

DAC interface

3.8 DAC

- Digital to analog converter is used to convert digital quantity into analog quantity.
- DAC converter produces an output current of voltage proportional to digital quantity (binary word) applied to its input.
- Today microcomputers are widely used for industrial control.
- The output of the microcomputer is a digital quantity.
- In many applications the digital output of the microcomputer has to be converted into analog quantity which is used for the control of relay, small motor, actuator etc.
- In communication system digital transmission is faster and convenient but the digital signals have to be converted back to analog signals at the receiving terminal.
- DAC converters are also used as a part of the circuitry of several ADC converters.
- The input to a ADC is an n-bit binary signal available in parallel form $(b_1, b_2, b_3 \ldots . b_n)$.
- The output can be either voltage or current.
- Fig. 3.8.1 shows inputs and outputs of DAC.

- The output voltage of DAC is given as

$$V_o = K_V V_{ref} \left(b_1 2^{-1} + b_2 2^{-2} + \ldots\ldots + b_n 2^{-n}\right)$$

where V_{ref} - Reference voltage

K_V - Scaling constant

b_n - '0' or '1' depending on logic level of corresponding input.

V_o - The result of multiplying the analog reference signal by the digital input.

- Full scale range, V_{FS} is given by -

$$V_{FS} = K_V V_{ref}$$

MSB contribution to $V_o = \frac{V_{fs}}{2}$

LSB contribution to $V_o = \frac{V_{fs}}{2^n}$

The LSB contribution is called as **resolution of DAC.**

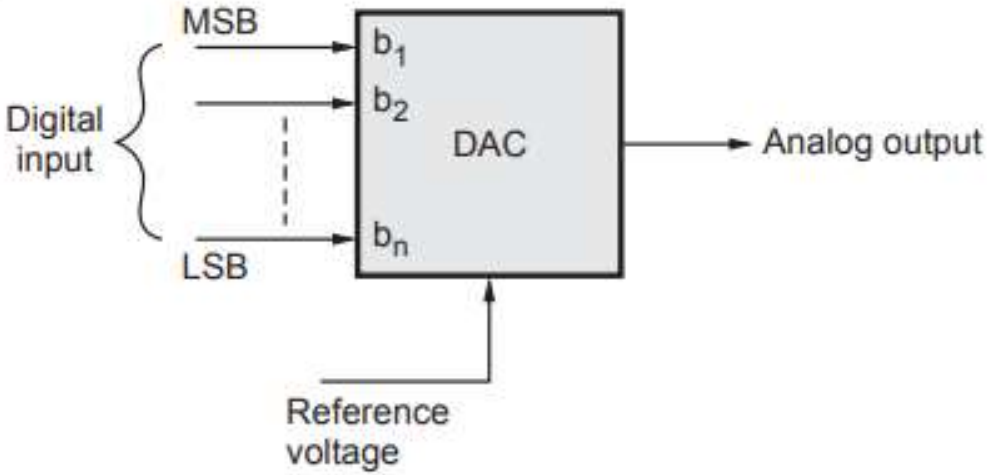


Fig. 3.8.1 Block schematic of DAC

3.8.1 Types of DACs

- There are two main types of DACs
  1. Weighted resistor type DAC
  2. R-2R ladder type DAC.

3.8.2 Weighted Resistor Type DAC

- Fig. 3.8.2 shows a 4-bit weighted-resistor D/A converter which includes a reference voltage source, a set of four electronically controlled switches, a set of four binary-weighted precision resistors, and an op amp.

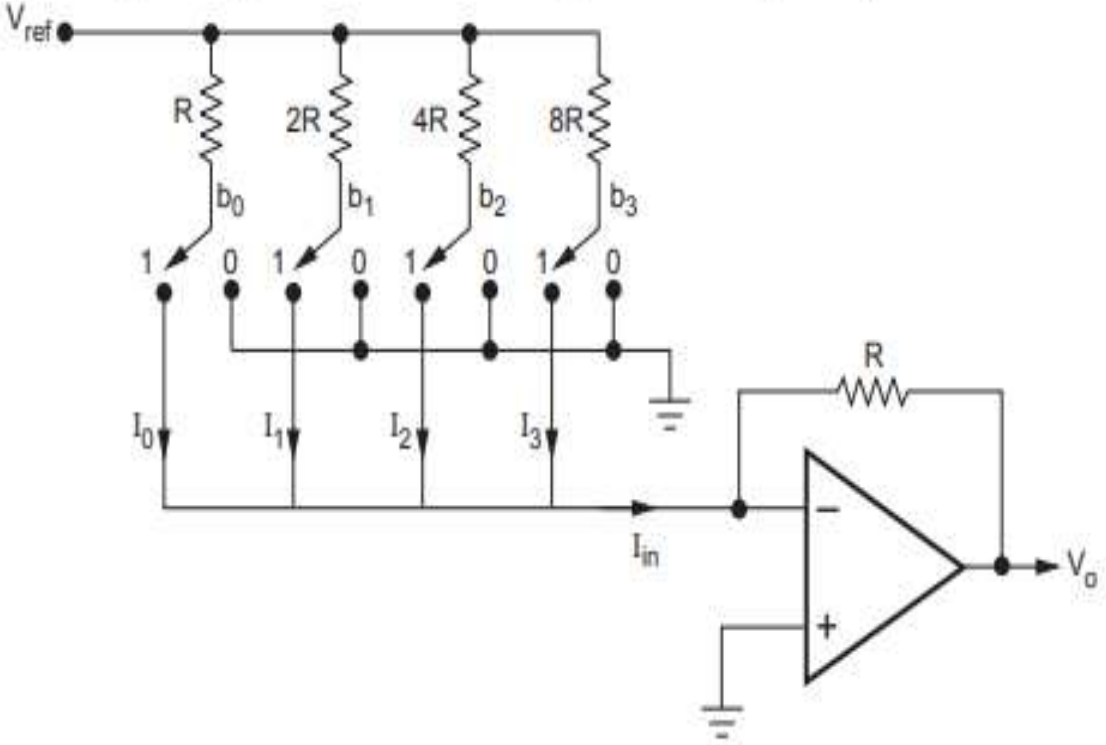


Fig. 3.8.2 4 Bit weighted resistor D/A converter

- Each binary bit of digital input code controls its own switch.
- The switch closes with a bit value of 1, and the switch stays open with binary 0.
- The resistor connected to the most significant bit (MSB), b0, has a value of R; b1 is connected to 2R, b2 to 4R, and b3 to 8R.
- Thus, each low-order bit is connected to a resistor that is higher by a factor of 2. For a 4-bit D/A converter, the binary input range is from 0000 to 1111.
- An important design parameter of a D/A converter is the resolution, which is the smallest output voltage change, V , which for an n-bit D/A converter is given by

$$\Delta V = \frac{V_{ref}}{2^n - 1}$$

- The range of resistor values becomes impractical for binary words longer than 4 bits.
- Also, the dynamic range of the op amp limits the selection of resistance values.
- To overcome these limitations, the R-2R ladder D/A converter is developed.

Advantages :

1. It is Simple in Construction.
2. It provides fast conversion.

Disadvantages :

1. This type requires large range of resistors with necessary high precision for low resistors.
2. Requires low switch resistances in transistors.
3. Can be expensive. Hence resolution is limited to 8-bit size.

3.8.3 R-2R Ladder Type DAC

- The 4-bit R-2R ladder type DAC is the most popular DAC.
- It uses a ladder network containing series-parallel combinations of values R and 2R.
- It is easily scalable to any desired number of bits.
- Its uses only two values of resistors which make for easy and accurate fabrication and integration.
- Output impedance is equal to R, regardless of the number of bits, simplifying filtering and further analog signal processing circuit design.

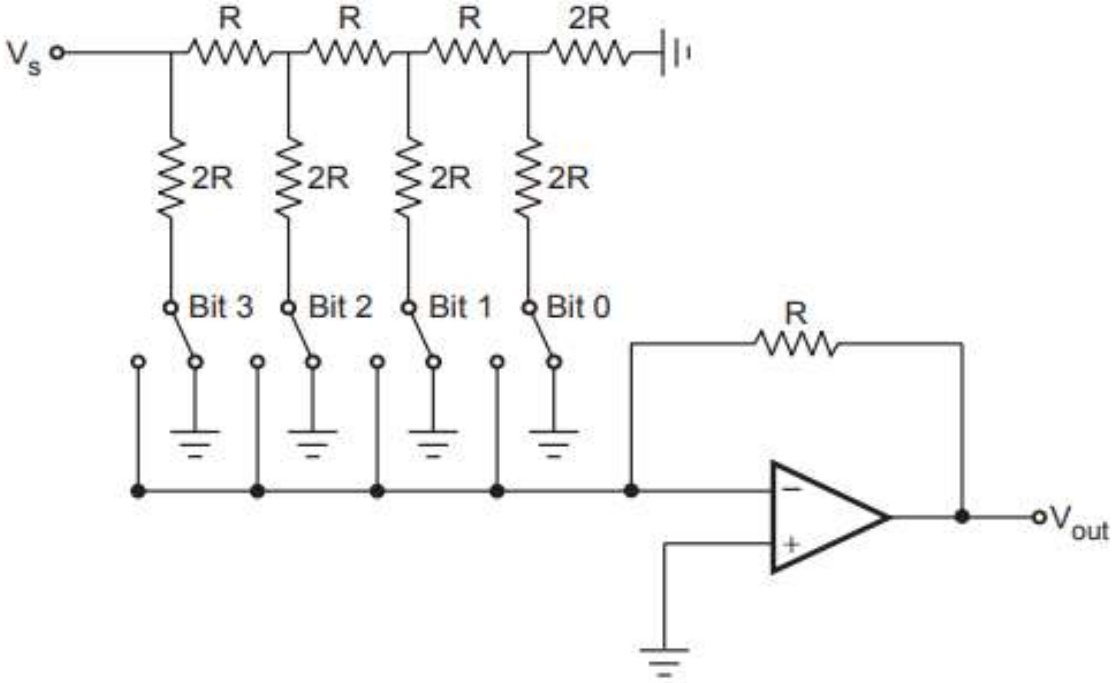


Fig. 3.8.3 (a) 4 bit R-2R Ladder Type DAC

- Each bit corresponds to a switch:

i. If the bit is high, the corresponding switch is connected to the inverting input of the op-amp.

ii. If the bit is low, the corresponding switch is connected to ground.

- Requires only two precision resistance value (R and 2R).

Advantages of R-2R Ladder Type DAC

1. Only two resistor values.
2. Does not need as precision resistors as Binary weighted DACs
3. Cheap & Easy to manufacture
4. Faster response time

Disadvantages of R-2R Ladder Type DAC

1. Slower conversion rate
2. More confusing analysis

3.8.6 Interfacing of DAC0800 with 8086

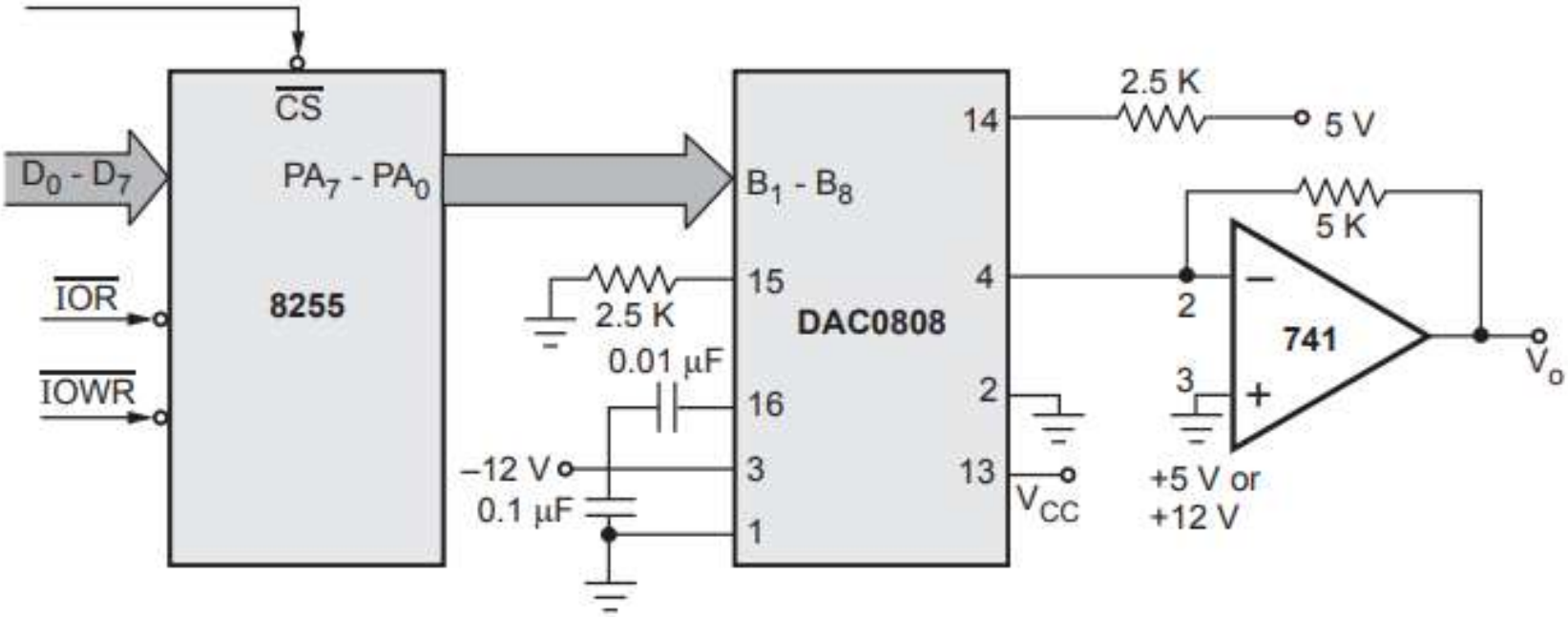


Fig. 3.8.5 Interfacing of DAC0800 with 8086

3.8.6 Interfacing of DAC0800 with 8086

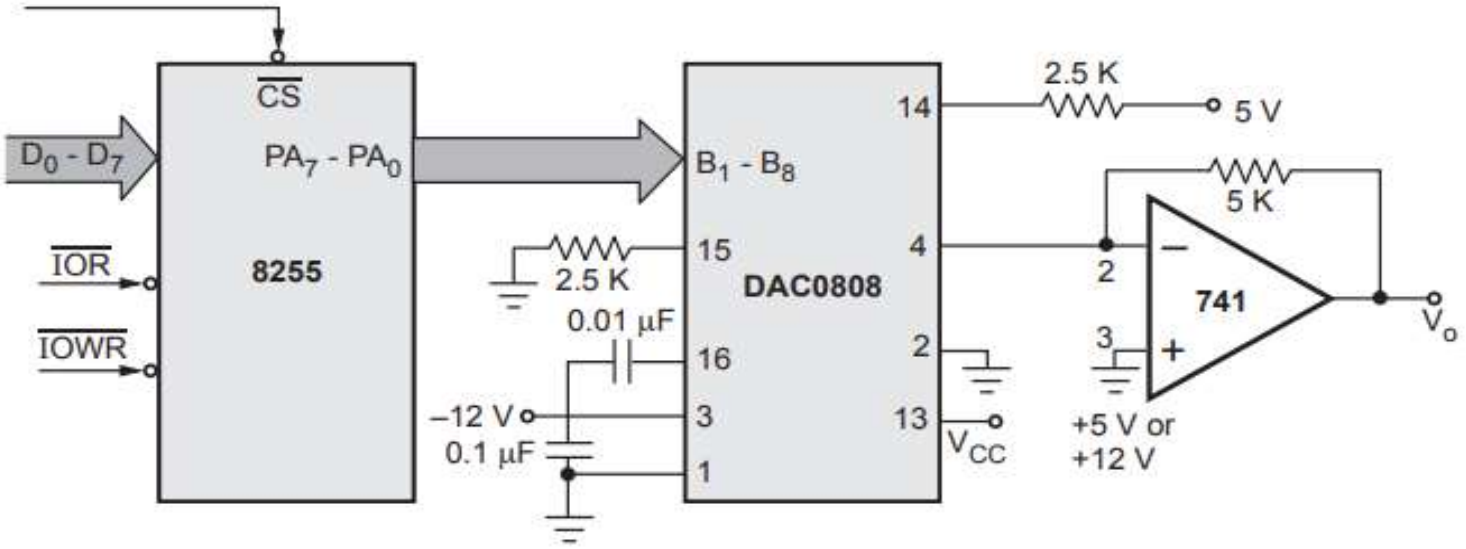


Fig. 3.8.5 Interfacing of DAC0800 with 8086

3.8.4 Features of DAC0800

i. DAC0800 is a monolithic 8-bit DAC manufactured by National semiconductor.

ii. It has settling time around 100 ms

iii. It can operate on a range of power supply voltage i.e. from 4.5 V to +18 V. Usually the supply V+ is 5 V or +12 V. The V- pin can be kept at a minimum of –12 V.

iv. Resolution of the DAC is 39.06 mV

Thank You


ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY
PALKULAM, KANYAKUMARI
OBSERVE OPTIMIZE OUTSPREAD