D/A AND A/D INTERFACE

Digital-to-Analog Converter DAC0800

Digital-to-analog converters (DACs) translate digital information into equivalent analog voltage or current.

D_1

D_2 Analog Output

D_3

Fig :3-bit DAC There are two types of DAC:

1. R-2-R ladder network and
2. weighted resistor network.

1. R-2-R ladder network DAC:

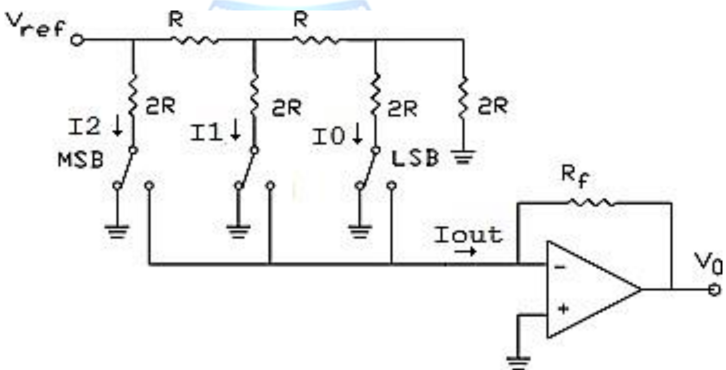


Fig: R-2-R ladder network DAC

It uses only two values of resistor R and 2R. One of the switch positions is connected to the reference voltage and other switch position is connected to the ground. The switches in the circuit can be transistors which connect the resistance either to the ground or V_{ref}. The resistors are connected in such a way that for any possible binary input , the total current I_T is proportional to the binary input. The op amp converts the current I_T to a voltage signal V_0.

2. Weighted resistor DAC:

The weighted resistor DAC uses an op-amp to sum n - binary weighted currents derived from a reference voltage V_R via current scaling resistors 2R , 4R, 8R…..2^nR.

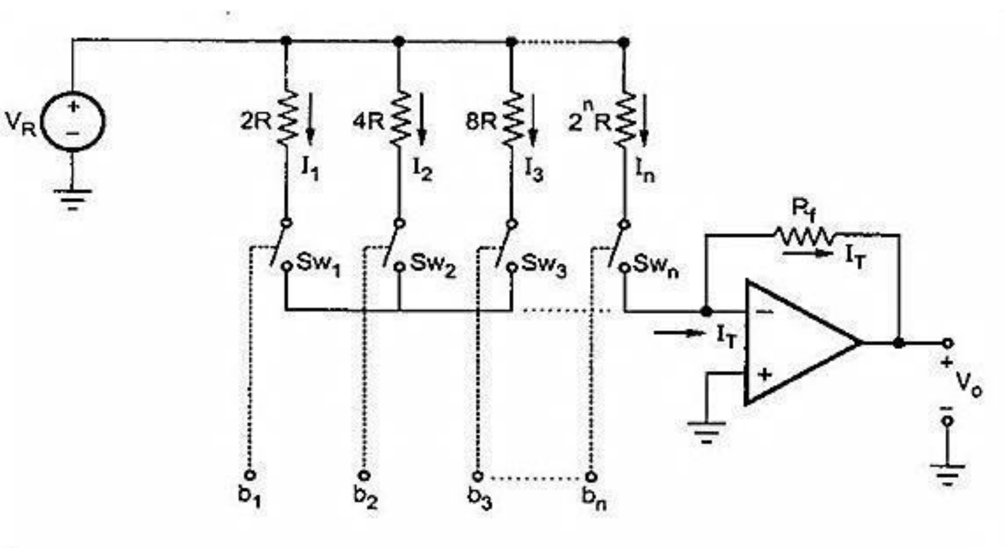


Fig:Weighted resistor DAC

The switch positions are controlled by the digital input. When the digit input is 1, it connects the corresponding resistance to the reference voltage $V_{R,-}$ otherwise it leaves the resistor open. Hence for the ON switch $I=V_R/R$ and for the OFF switch I=0.

The op amp acts as a summing amplifier. The summing current flows through R_f. Hence , the total current through R_f is given as $I_f = I_1+ I_2+ I_3+\ldots\ldots.+ I_n$. The output voltage across R_f is given as : $V_0 = - IR_f$

Interfacing DAC with microprocessor:

Features:

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

ii. It has settling time around 100ms iii. It can operate on a range of power supply voltage i.e. from 4.5V to +18V. Usually the supply V+ is 5V or +12V. The V-pin can be kept at a minimum of -12V.

iv. Resolution of the DAC is 39.06Mv

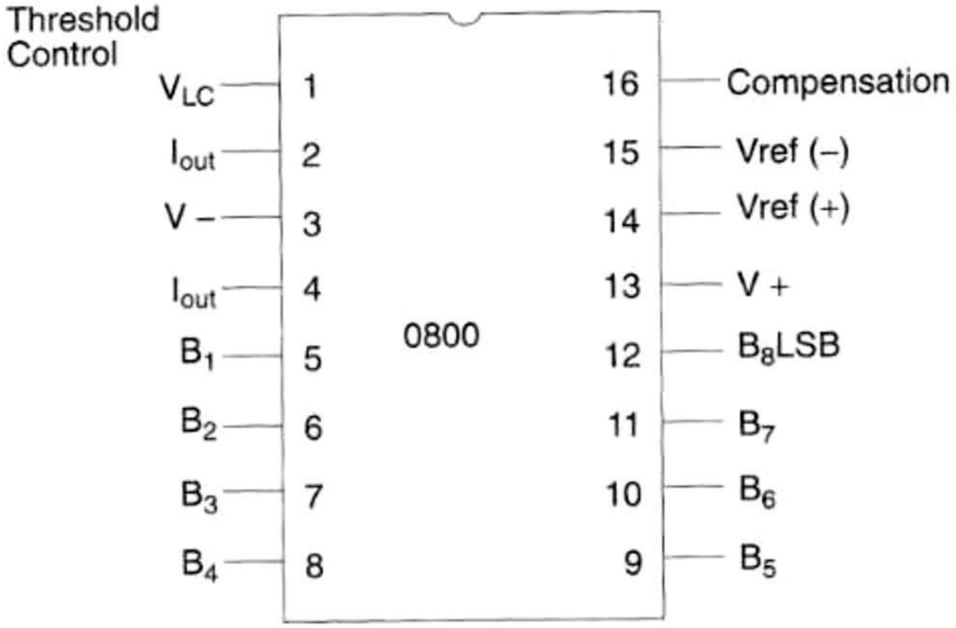
The diagram illustrates a Digital-to-Analog Conversion (DAC) systemusing:

1. 8255 Programmable Peripheral Interface (PPI) ○ Used here to send digital data (D0–D7) from a microprocessor to the DAC.
   - Port A pins (PA7–PA0) provide the 8-bit parallel digital output.
2. DAC0808 (8-bit DAC) ○ Converts the 8-bit digital word into a proportional analog current.
   - Inputs: B1–B8 (digital bits from the 8255). ○ Requires both +Vcc (5 or 12 V) and −12 V supply for operation.
   - Needs external resistors and capacitors for biasing and stability.
3. Operational Amplifier (741 op-amp) ○ Used as a current-to-voltage (I/V) converter. ○ DAC0808 outputs a current, which cannot be directly used as voltage. ○ The op-amp with feedback resistor (5 kΩ) converts the DAC output current into voltage

(V_0). ○ The 2.5 kΩ resistor connected to +5 V acts as reference current input for the DAC.

Working Principle

1. The microprocessor writes an 8-bit digital value into Port A of 8255.
2. The digital word is fed into DAC0808 as inputs B1–B8.
3. DAC0808 produces an analog current proportional to the digital input and the reference current.
4. The op-amp (741) converts this current into an analog voltage: $V_o = -I_o \times R_f$ where $R_f = 5$ kΩ is the feedback resistor.
5. Hence, the circuit produces a corresponding analog voltage (V_0) for every digital word given by the microprocessor.



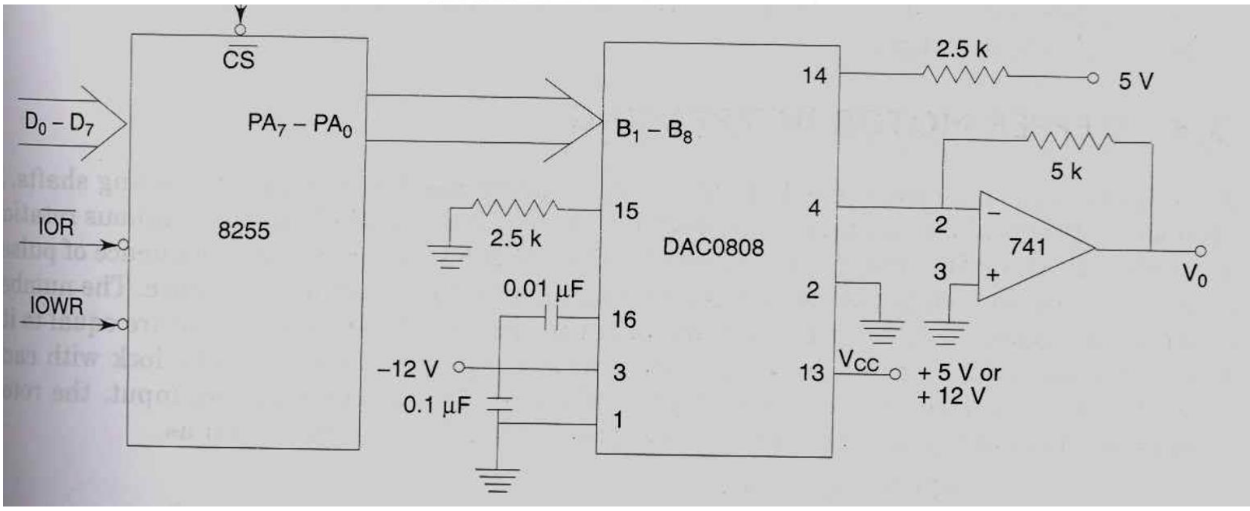


Fig:Interfacing DAC with microprocessor:

Analog-to-Digital Converter ADC0808/0809

The analog-to-digital converter (ADC) converts analog signal to its digital equivalent.

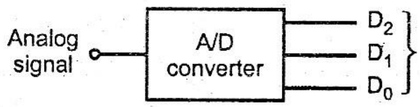


Fig :3 – bit ADC

The analog-to-digital converter (ADC) deals with the following signals.
Input voltage Input analog voltage. Input to ADC Start Convert Command to start conversion.

End of Conversion Information that conversion is complete and the output can be read.

Digital output Digital value of analog input derived from conversion.

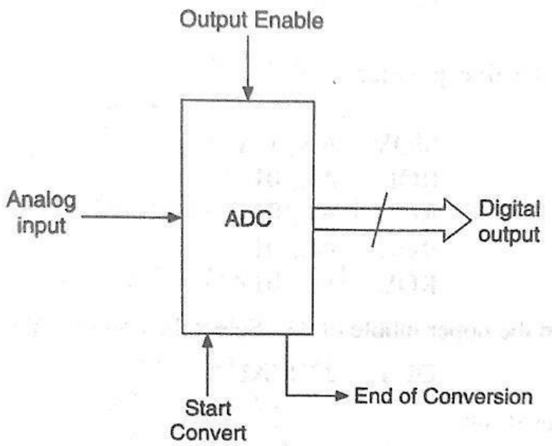


Fig: ADC chip configuration

Successive approximation ADC:

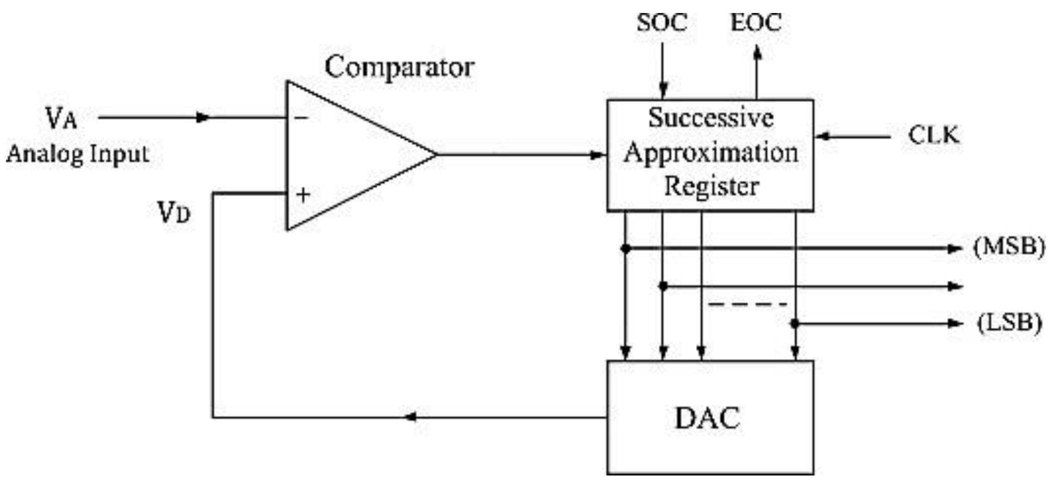


Fig: Successive approximation ADC

It includes 3 major elements namely the D/A converter, the successive approximation register (SAR) and the comparator. The conversion technique compares the output of D/A converter V_0 with the analog input V_{in}. The digital output to the DAC is generated using the successive approximation method. When the DAC output matches the analog signal the input to the DAC is equivalent digital signal.

If the DAC output and the analog input V_{in} are not same the comparator generates a difference voltage. The output register will change the value and the next digital output will be generated. The process will be continued until the analog input V_{in} matches the digital output V_0.

Interfacing ADC to microprocessor

The analog to digital converter chips 0808and 0809are 8-bit CMOS,*successive approximation converters.*

Successive approximation techniqueis one of the fast techniques for analog to digital conversion. The conversion delay is 100 µsat a clock frequency of 640kHz.

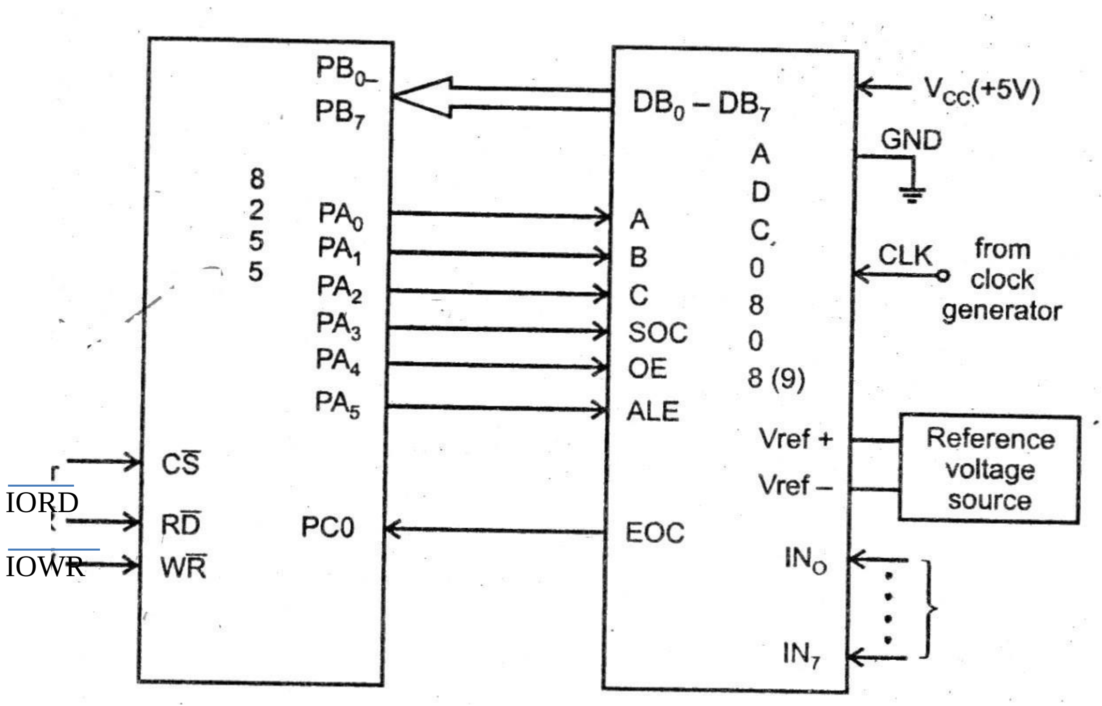


Fig: Interfacing ADC to microprocessor

8255 PPI ○ Interfaces between microprocessor and ADC.

- Provides control signals (ALE, SOC, OE, channel selection) through its Port A lines.
- Port B receives the converted **digital output data (DB0–DB7)** from the ADC.
- Port C is partly used for status signals (e.g., End of Conversion).

ADC0808/0809
- An **8-bit ADC** with 8 analog input channels (IN0–IN7).
- Converts selected analog input voltage into an 8-bit digital output.
- Requires a **clock input** for conversion timing.
- Reference voltages (Vref+ and Vref–) set the conversion range.

Reference Voltage Source
- Provides upper and lower reference voltages (Vref+ and Vref–).
- Determines the input voltage range for conversion.
- Example: if Vref+ = 5 V and Vref– = 0 V → ADC converts 0–5 V into 8-bit digital data (0–255).

Signal Explanation

- **Address Lines (A, B, C)**: Select which analog input channel (IN0–IN7) will be converted.
- **ALE (Address Latch Enable)**: Latches the input channel address.
- **SOC (Start of Conversion)**: Signal to begin conversion.
- **EOC (End of Conversion)**: Status output; goes high when conversion is finished.
- **OE (Output Enable)**: Enables the digital output DB0–DB7 to be read by 8255.
- **DB0–DB7**: 8-bit digital output of ADC (goes to Port B of 8255).

Working Principle

1. **Channel Selection**
   - Microprocessor writes the channel address (via PA0–PA2) into the ADC.
   - ALE signal from 8255 latches this address.
2. **Start Conversion**
   - SOC pulse is sent from 8255 to ADC → ADC starts converting selected analog input.
3. **Conversion Process**
   - ADC uses the clock signal to perform successive approximation conversion.
   - After completion, ADC raises **EOC** (End of Conversion).
4. **Read Data**
   - 8255 detects EOC via Port C.
   - Then it activates OE → 8-bit digital output becomes available on DB0–DB7.
   - This data is read into 8255 Port B → and then to microprocessor.