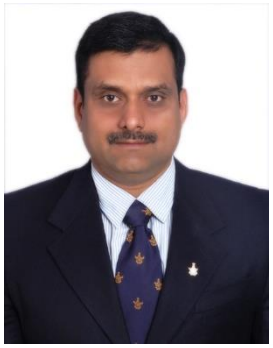
Microprocessors and Interfaces: 2021-22
Lecture 32

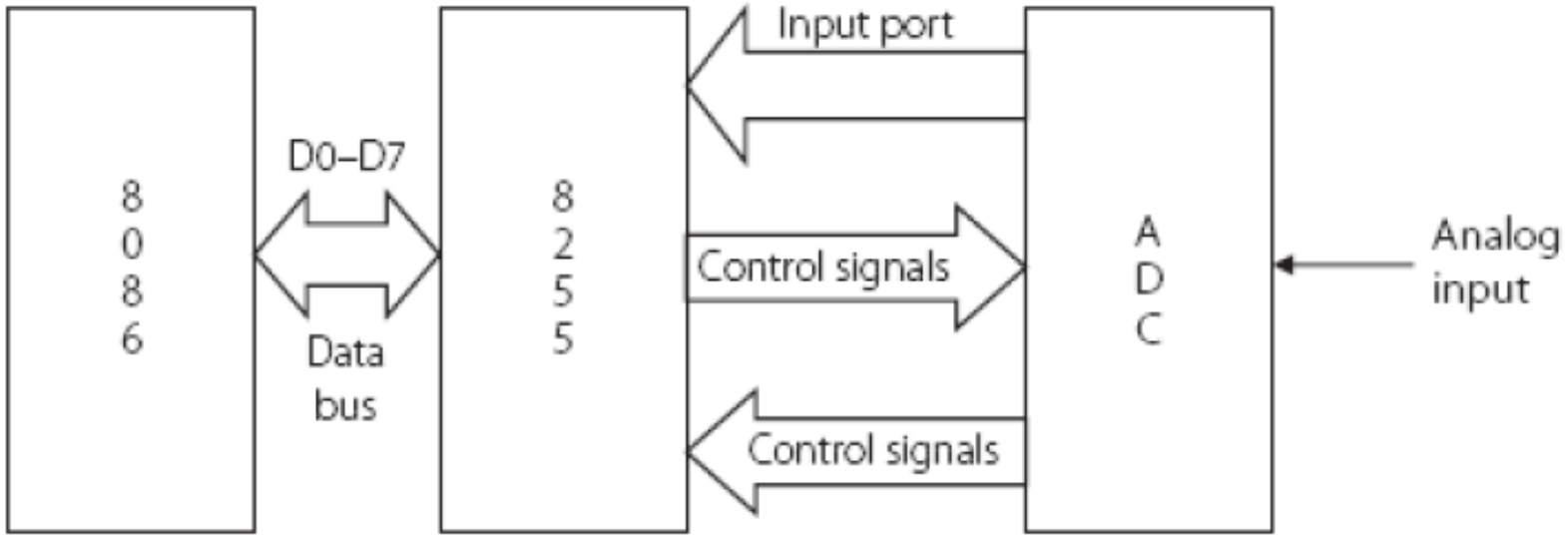
ANALOG-TO-DIGITAL (ADC)
&
DIGITAL-TO-ANALOG (DAC) CONVERTERS

By Dr. Sanjay Vidhyadharan



ADC (Analog-to Digital Converter)

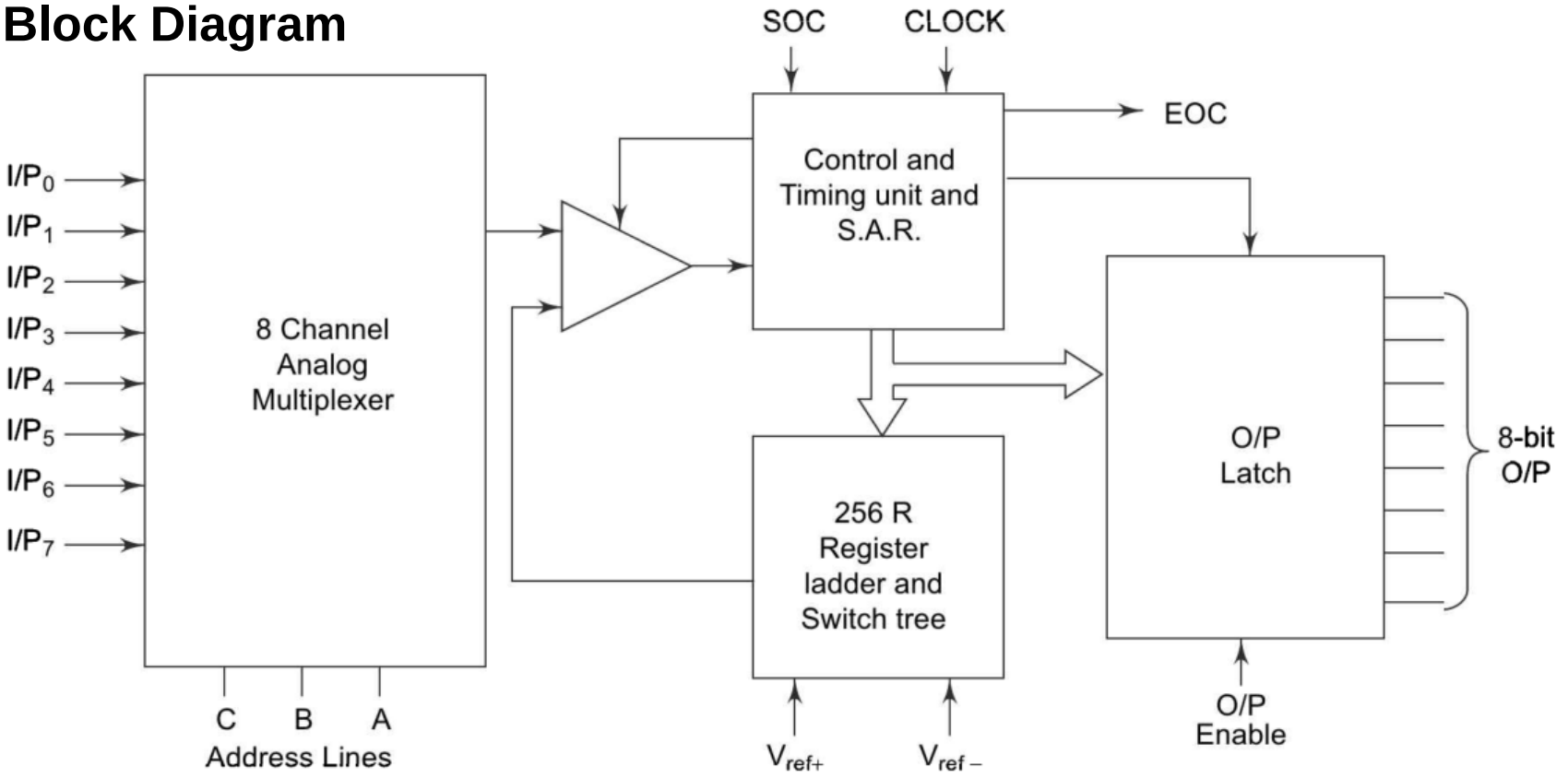
Interface with 8086



SOC: Start of Conversion
EOC : End of Conversion

ADC 0808 / 0809

Block Diagram



Low-cost ADC, Power 15 mW,

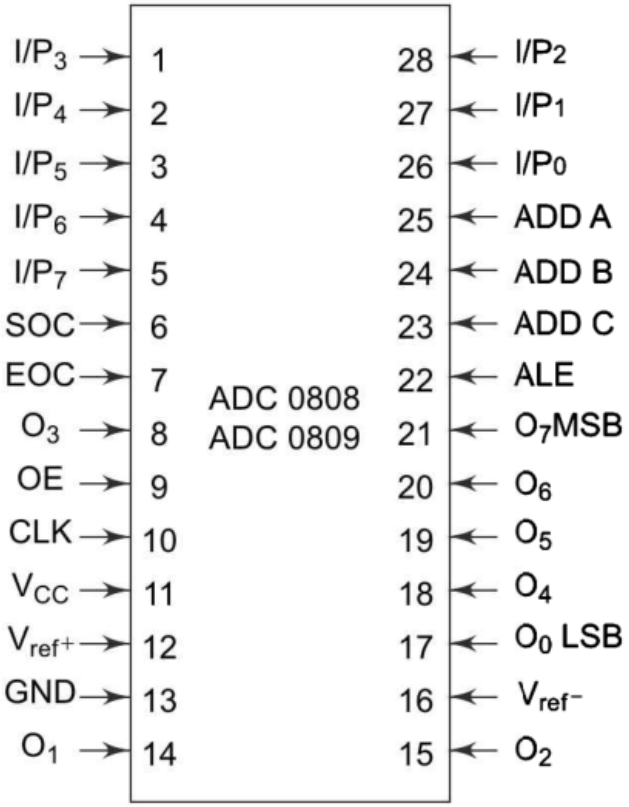
Compatible with a wide range of microprocessors. Power Supply 5 V

Moderate speed 100 μs

Moderate accuracy Error $\pm$ LSB

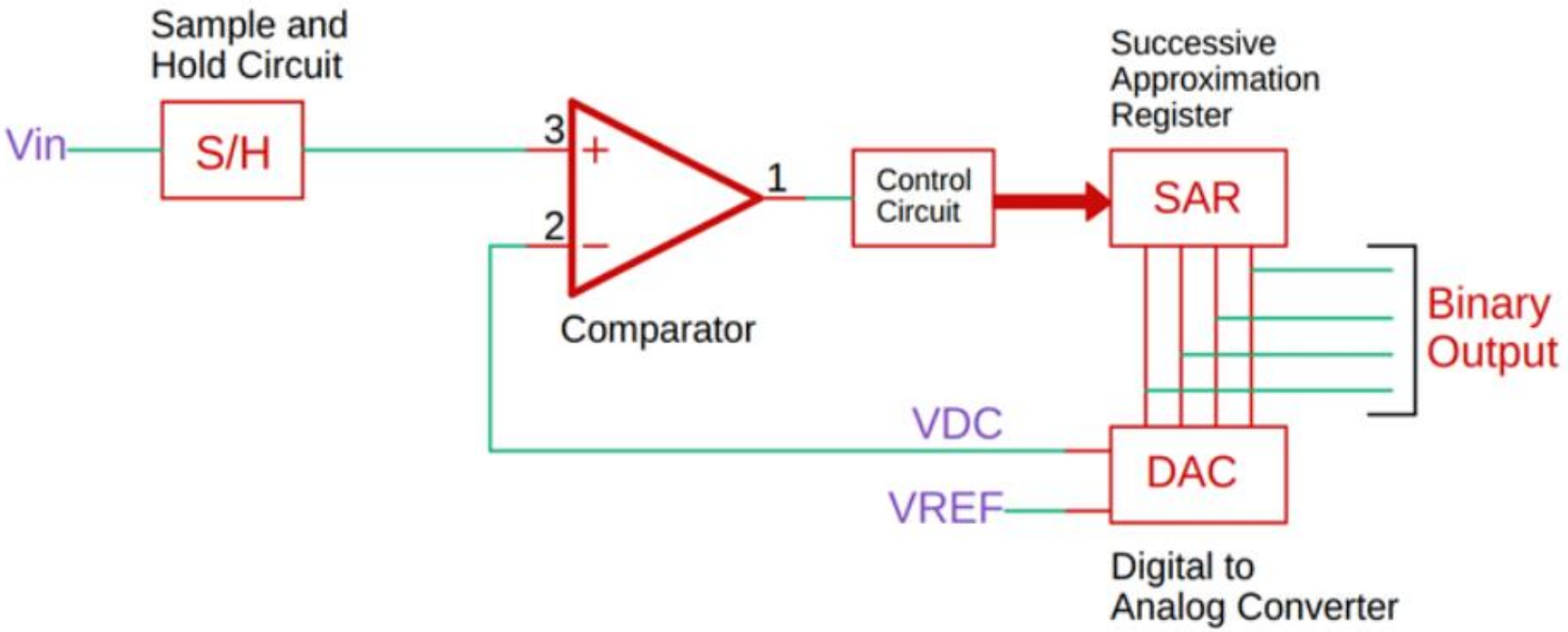
ADC 0808 / 0809

Pin Diagram

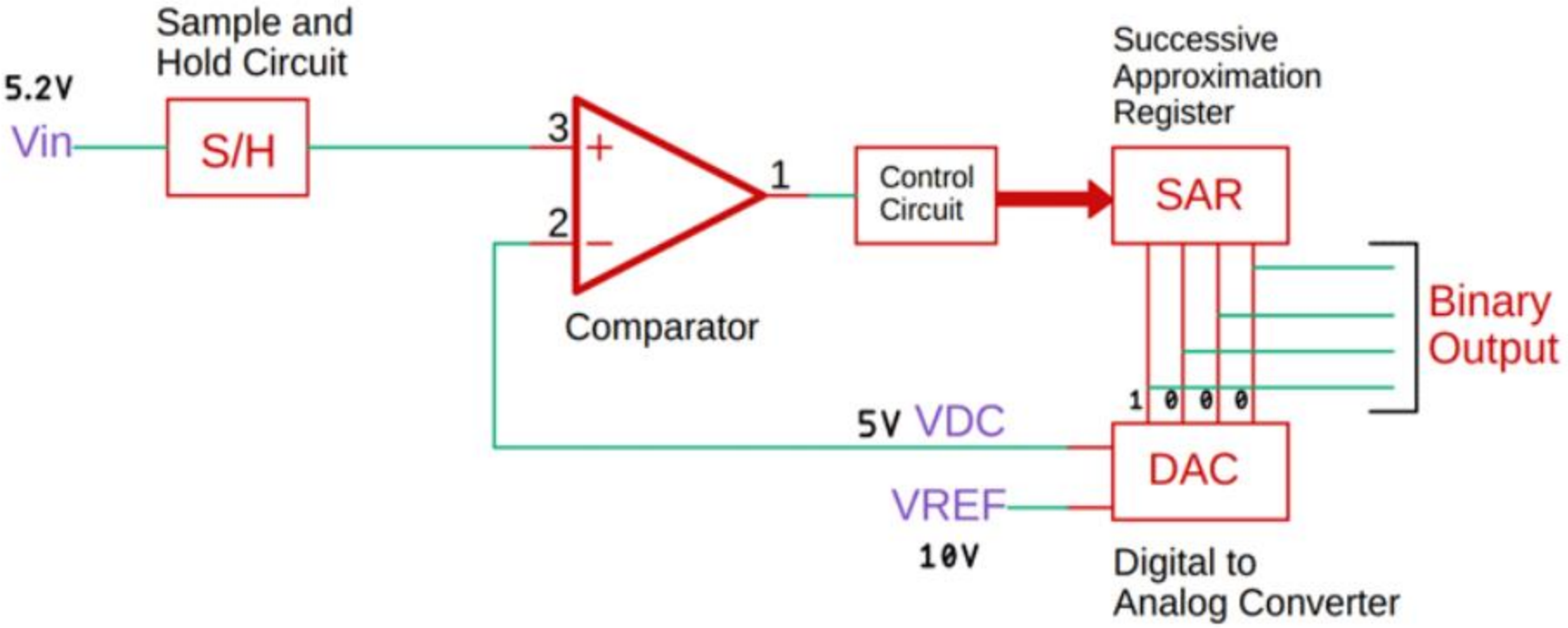


I/P_0–I/P_7	Analog inputs
ADD A, B, C	Address lines for selecting analog inputs
O_7–O_0	Digital 8-bit output with O_7 MSB and O_0 LSB
SOC	Start of conversion signal pin
EOC	End of conversion signal pin
OE	Output latch enable pin, if high enable output
CLK	Clock input for ADC
V_{CC}, GND	Supply pins +5V and GND
V_{ref+} and V_{ref-}	Reference voltage positive (+5 Volts maximum) and Reference voltage negative (0V minimum)

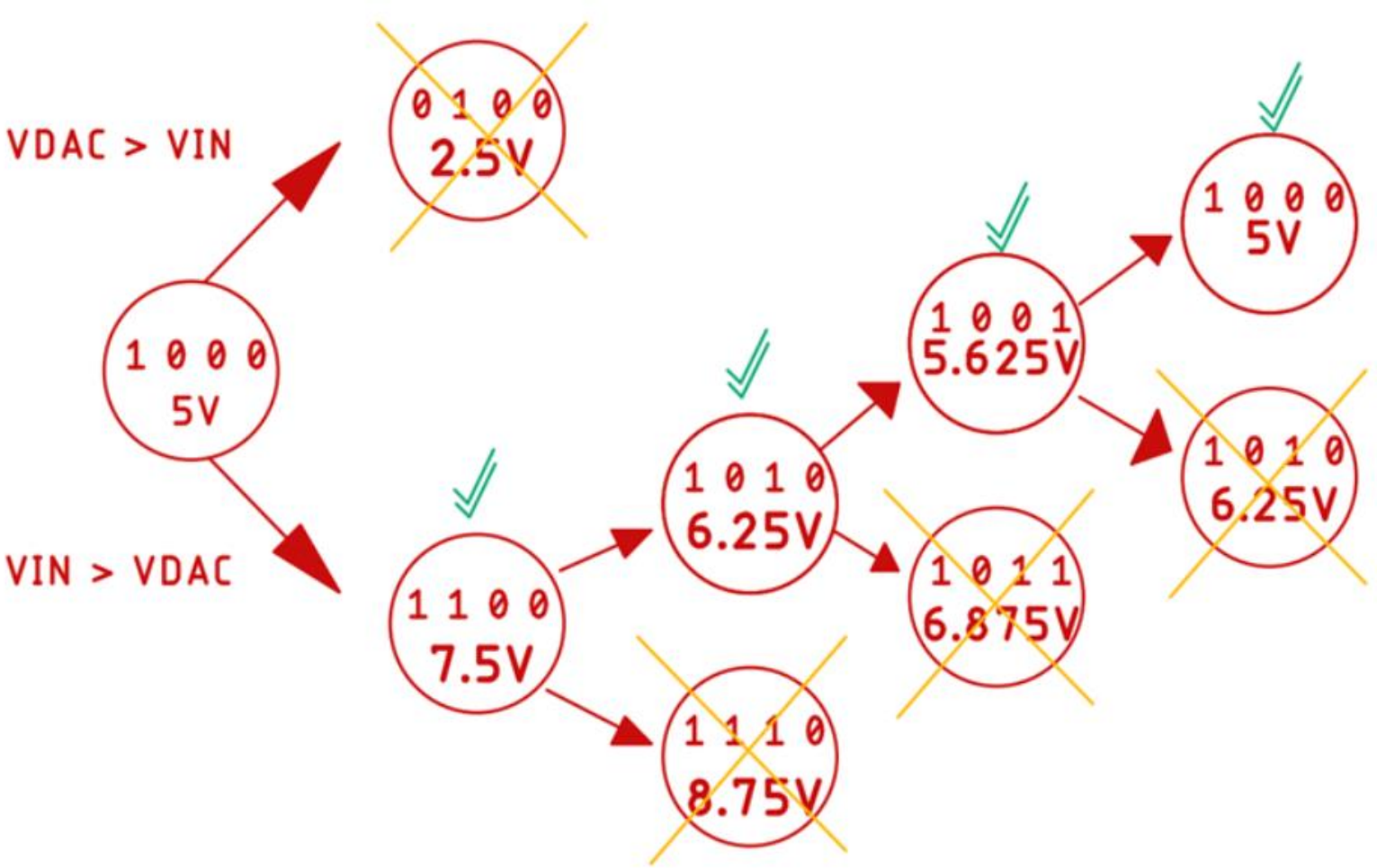
Successive Approximation ADC



Successive Approximation ADC

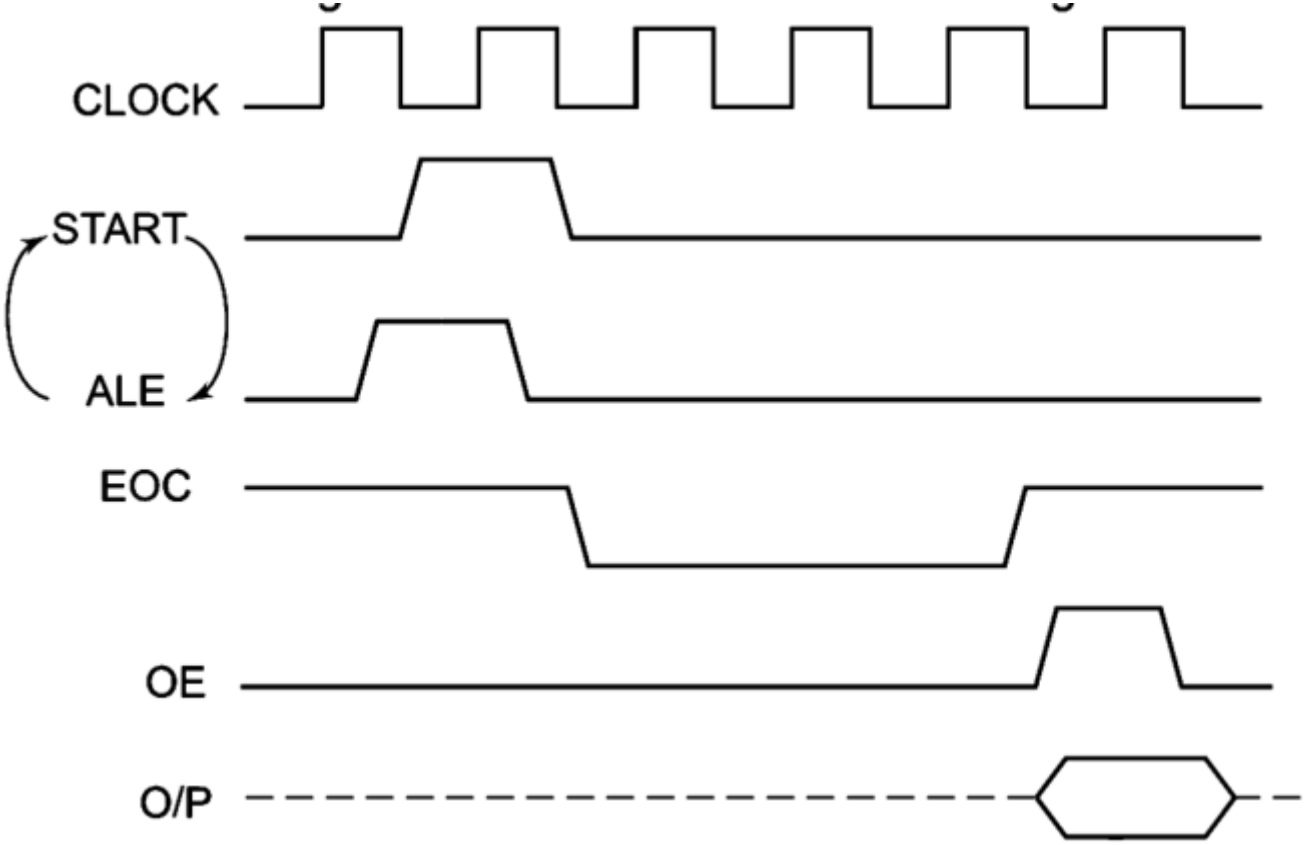


Successive Approximation ADC



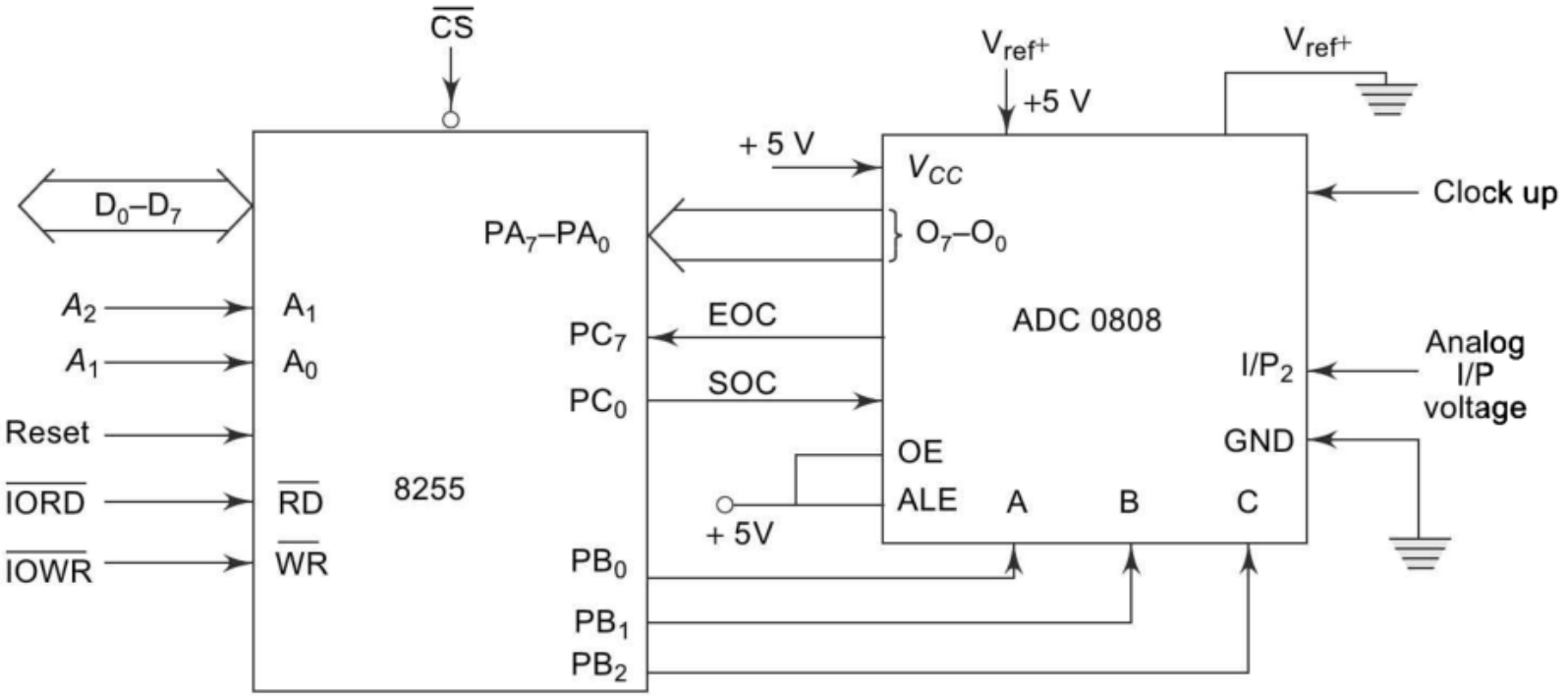
ADC 0808 / 0809

Timing Diagram



ADC 0808 / 0809

Interface ADC 0808 with 8086 using 8255 ports. Use Port A of 8255 for transferring digital data output of ADC to the CPU and Port C for control signals. Assume that an analog input is present at I/P_2 of the ADC and a clock input of suitable frequency is available for ADC. Draw the schematic and write required ALP.



ADC 0808 / 0809

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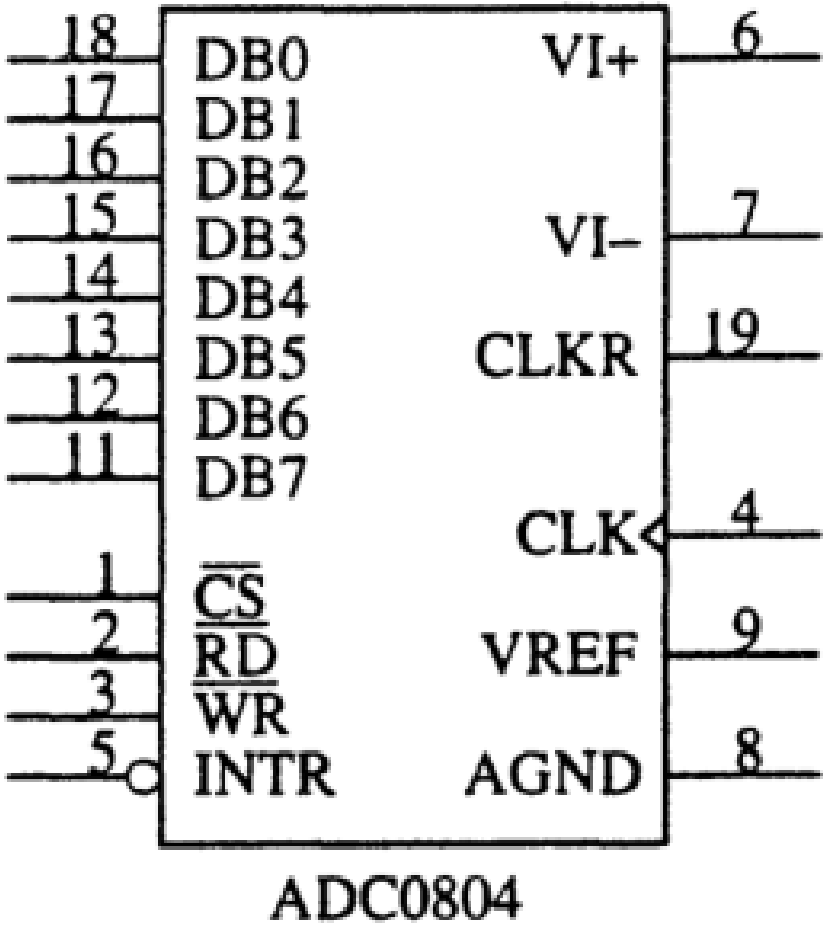
D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Control word
1	0	0	1	1	0	0	0	= 98 H

D7=1; I/O Mode.
D6=0 and D5=0; Port A Mode
.
D4=1; Port A is input port
D3=1; Port C (Upper) is input
D2=0; Port B Mode 0.
D1=0; Port B is output
D0=0; Port C (Lower) is output

The required ALP is given as follows:

```
        MOV AL,98 H          ; Initialise 8255 as
        OUT CWR,AL           ; discussed above
        MOV AL,02H           ; Select I/P2 as analog
        OUT PORT B,AL        ; input
        MOV AL,00H           ; Give start of conversion
        OUT PORT C,AL        ; pulse to the ADC.
        MOV AL,01 H          ;
        OUT PORT C,AL        ;
        MOV AL,00H           ;
        OUT PORT C,AL        ;
WAIT :  IN AL,PORTC          ; Check for EOC by
        RCL                  ; reading port C upper and
        JNC WAIT             ; rotating through carry.
        IN AL,PORTA          ; If EOC, read digital equivalent in
                                  AL
        HLT                  ; Stop
```

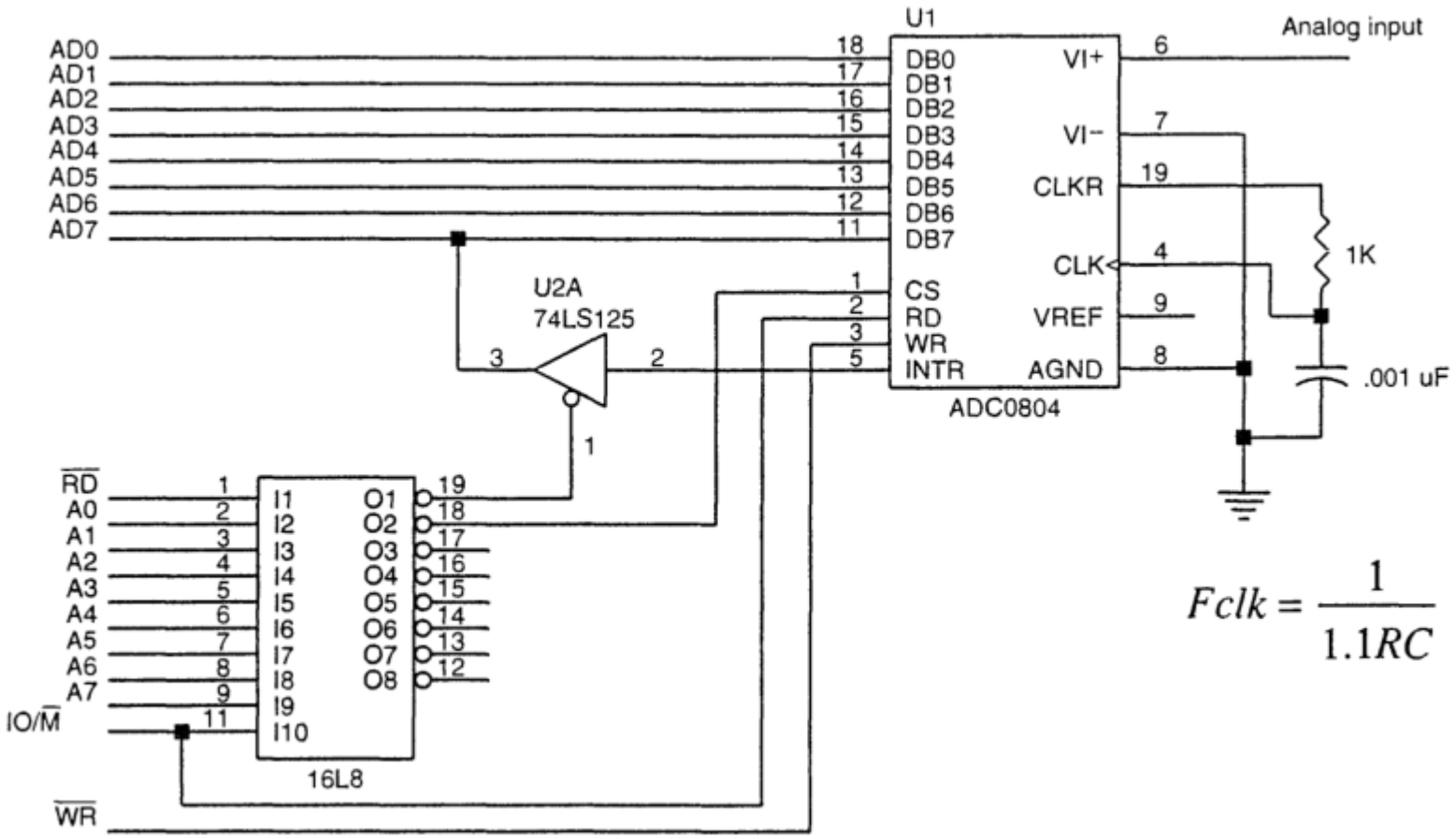
ADC 0804



SOC: Start of Conversion WR' and CS'

EOC : End of Conversion INTR

ADC 0804

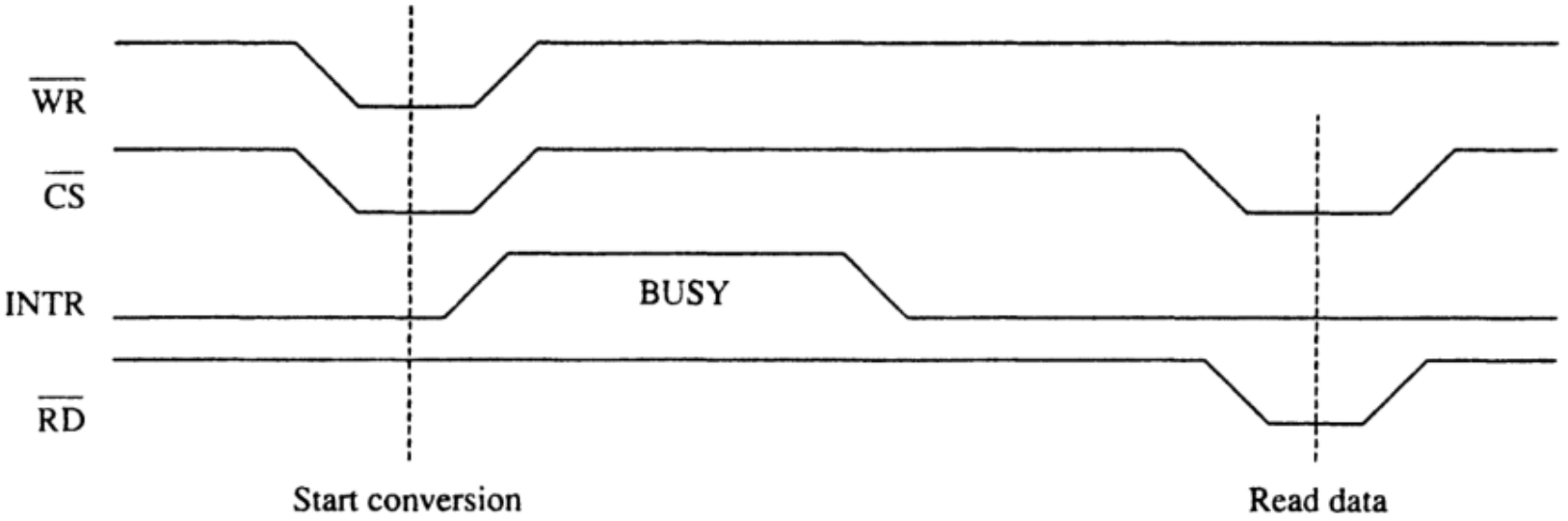


$$Fclk = \frac{1}{1.1RC}$$

Permissible range of clock frequencies is 100 KHz - 1460 KHz. desirable to use a frequency as close as possible to 1460 KHz so conversion time is minimized

ADC 0804

Timing Diagram



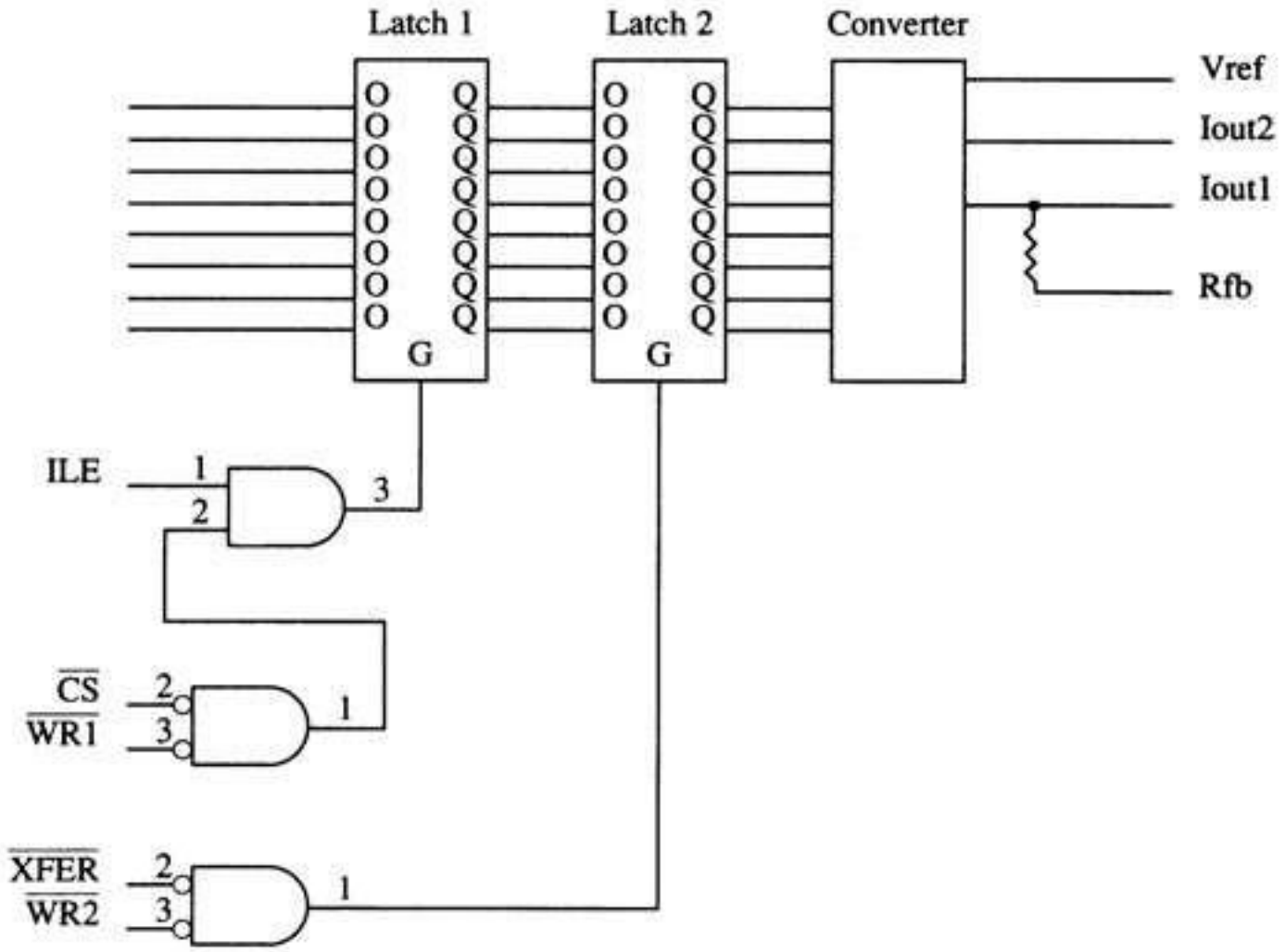
DAC0830

- A fairly common and low-cost digital-to-analog converter is the DAC0830.
- An 8-bit converter that transforms an 8-bit binary number into an analog voltage.
- Other converters are available that convert from 10-, 12-, or 16-bit binary numbers into analog voltages.

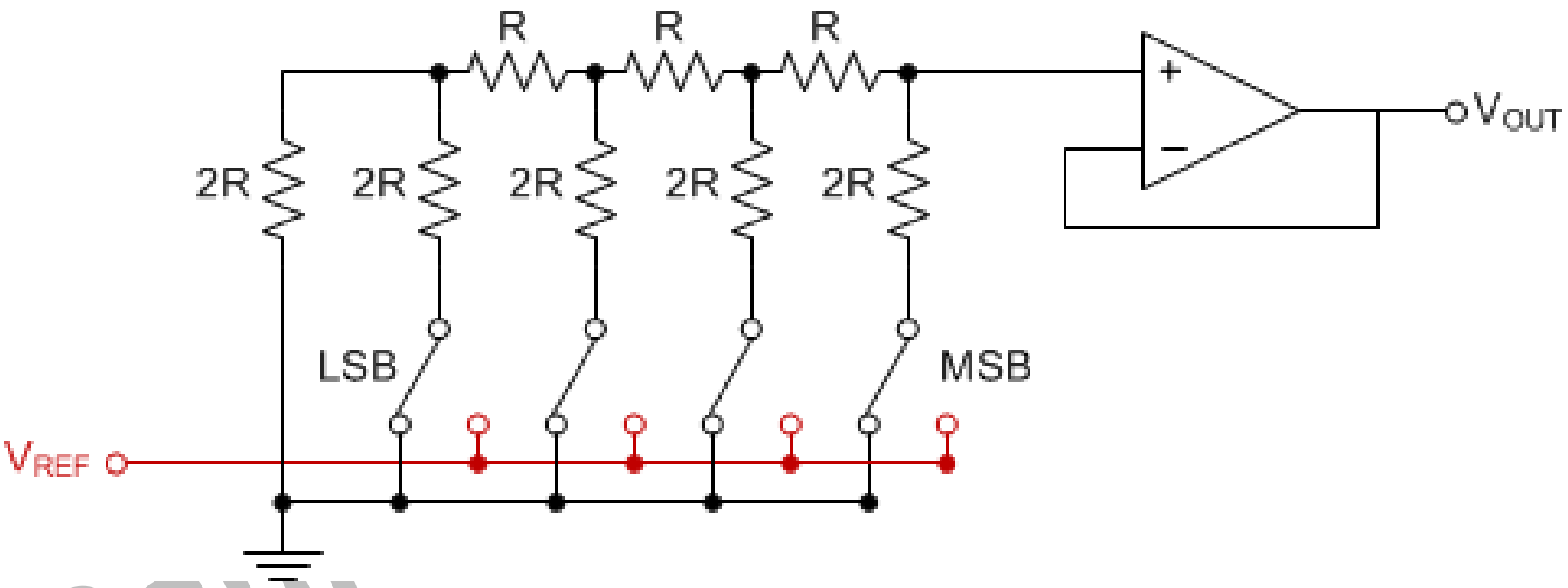
DAC0830

- The number of voltage steps generated by the converter is equal to the number of binary input combinations.
  - an 8-bit converter generates 256 voltage levels
  - a 10-bit converter generates 1024 levels
- The DAC0830 is a medium-speed converter that transforms a digital input to an analog output in approximately 1.0 μs.

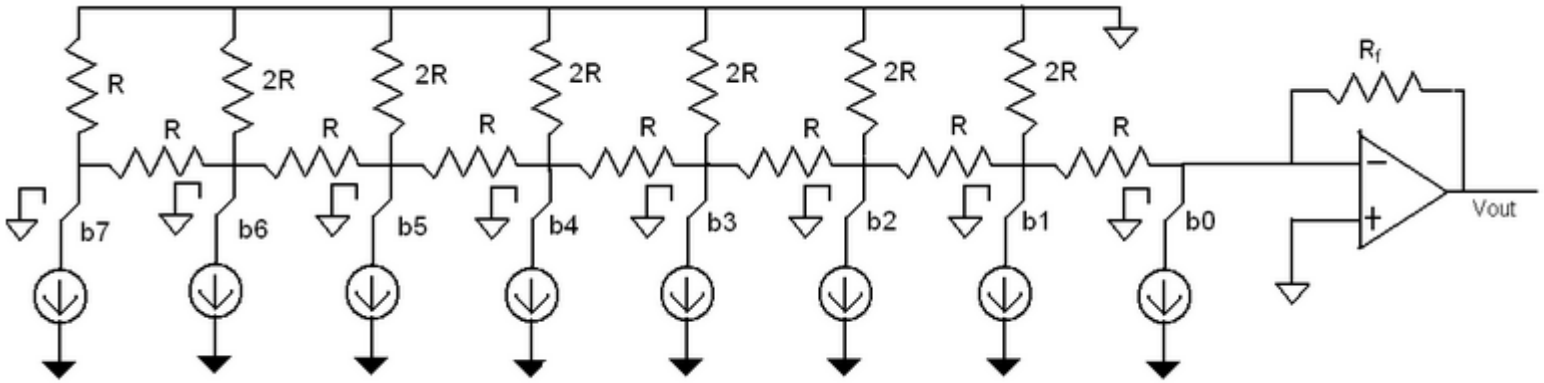
DAC0830


Latch 1
Latch 2
Converter
Vref
Iout2
Iout1
Rfb
D
Q
G
ILE
1
2
3
CS
WR1
XFER
WR2

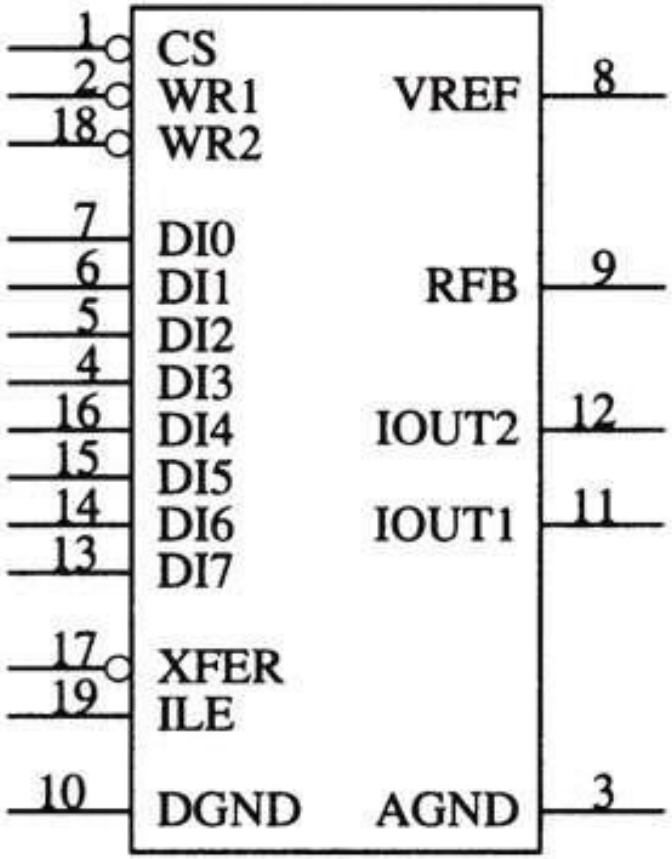
R-2R Ladder DAC



R-2R Ladder DAC



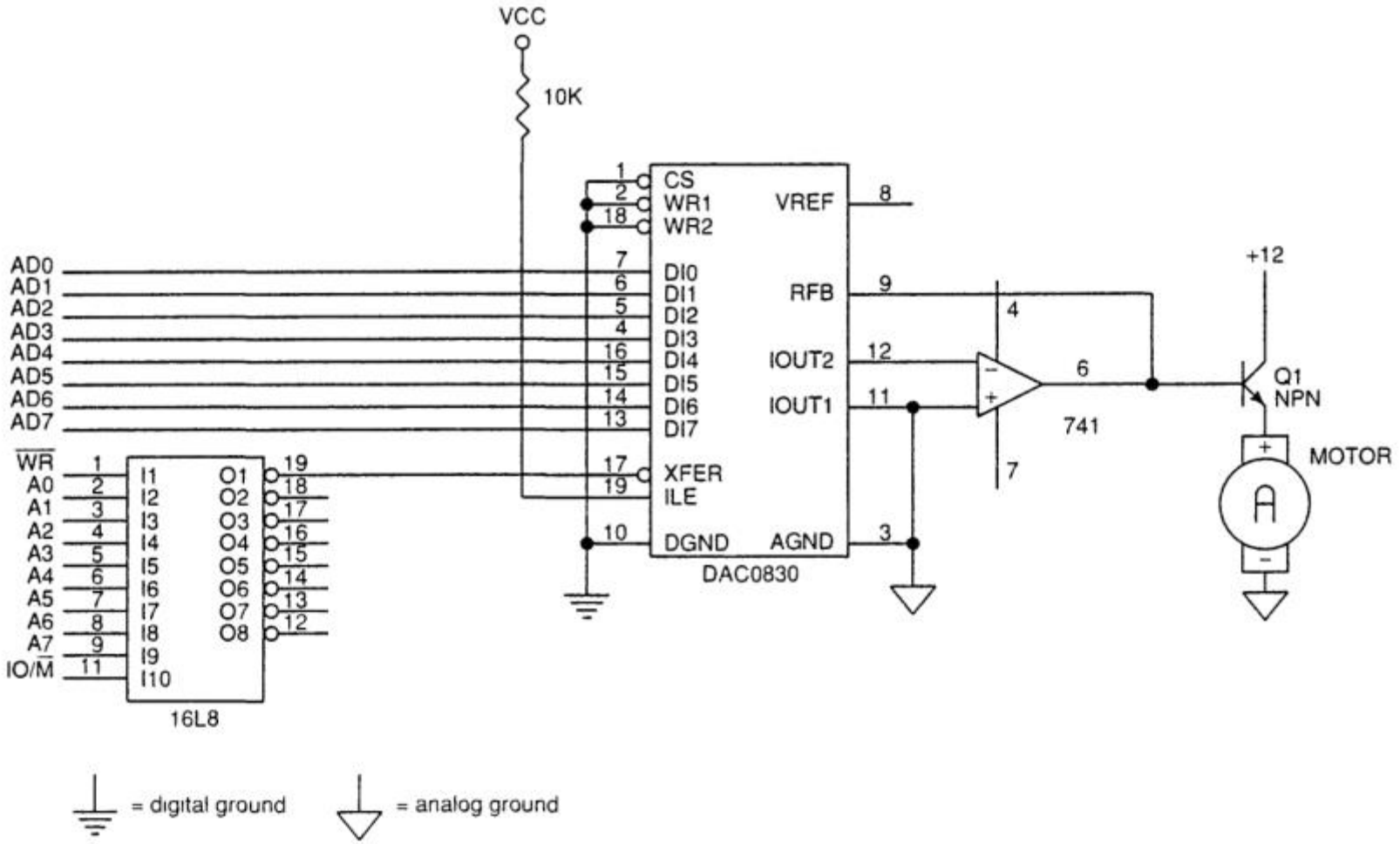
DAC0830



DAC0830

Because this is an 8-bit converter, its output step voltage is defined as $-V_{REF}$ (reference voltage), divided by 255. The step voltage is often called the resolution of the converter

DAC0830



Analog outputs labeled IOUT1 & IOUT2 are inputs to an external operational amplifier.

Thankyou