

DAC

(chapter 13)

MBSD, 6th Semester

DCSE, UET Peshawar

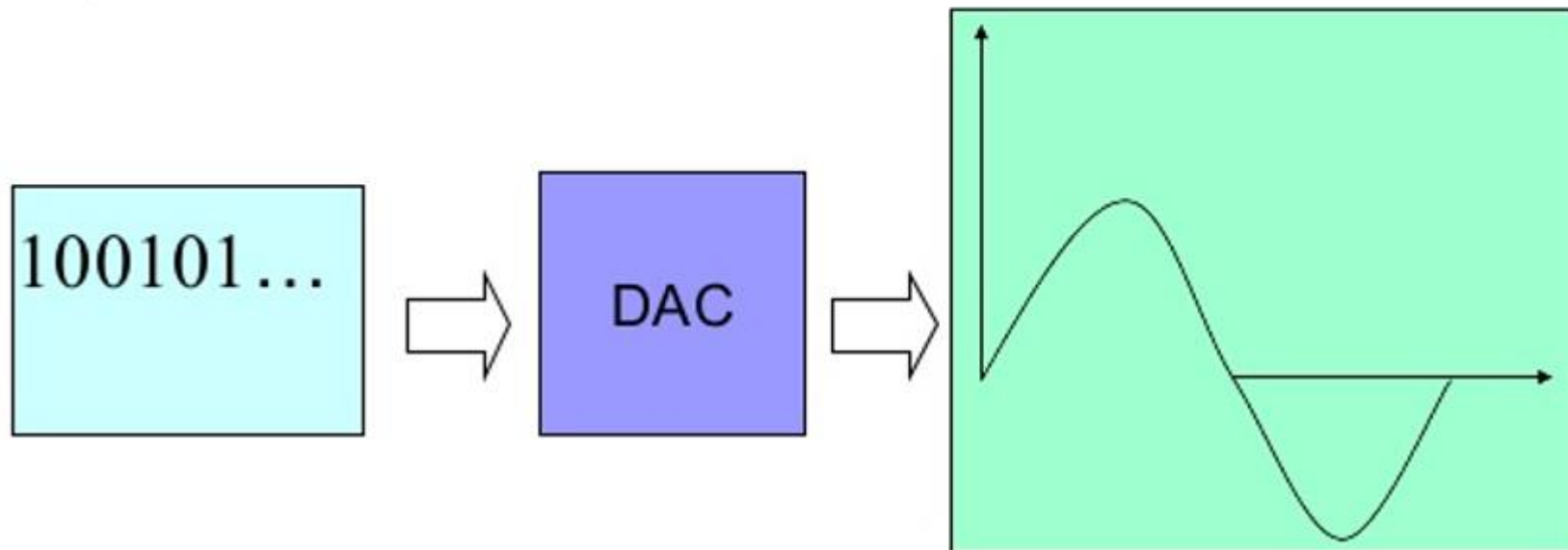
Bilal Habib

Some photos taken from Khulna University

DAC: Digital to Analog Convertor

What is a DAC?

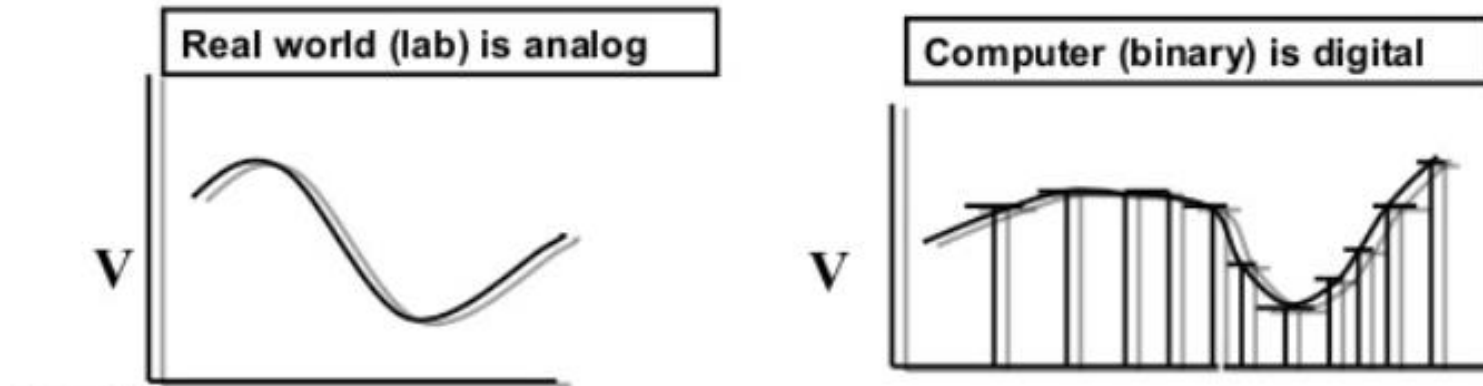
A digital-to-analog converter (DAC) takes a digital code as its input and produces an analog voltage or current as its output. This analog output is proportional to the digital input.



Terminology

- **Analog:** continuously valued signal, such as temperature or speed, with infinite possible values in between.
- **Digital:** discretely valued signal, such as integers, encoded in binary.

digital-to-analog converter: DAC, D/A, D2A



DAC

❑ General Concept:

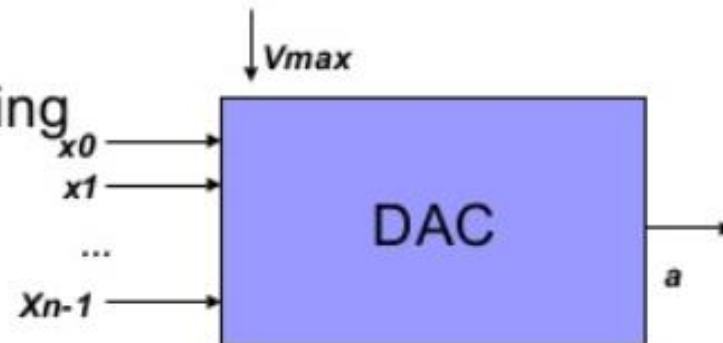
➤ Digital to Analog conversion involves transforming the computer's binary output in 0's and 1's (1's typically = 5.0 volts) into an analog representation of the binary data

❑ DAC:

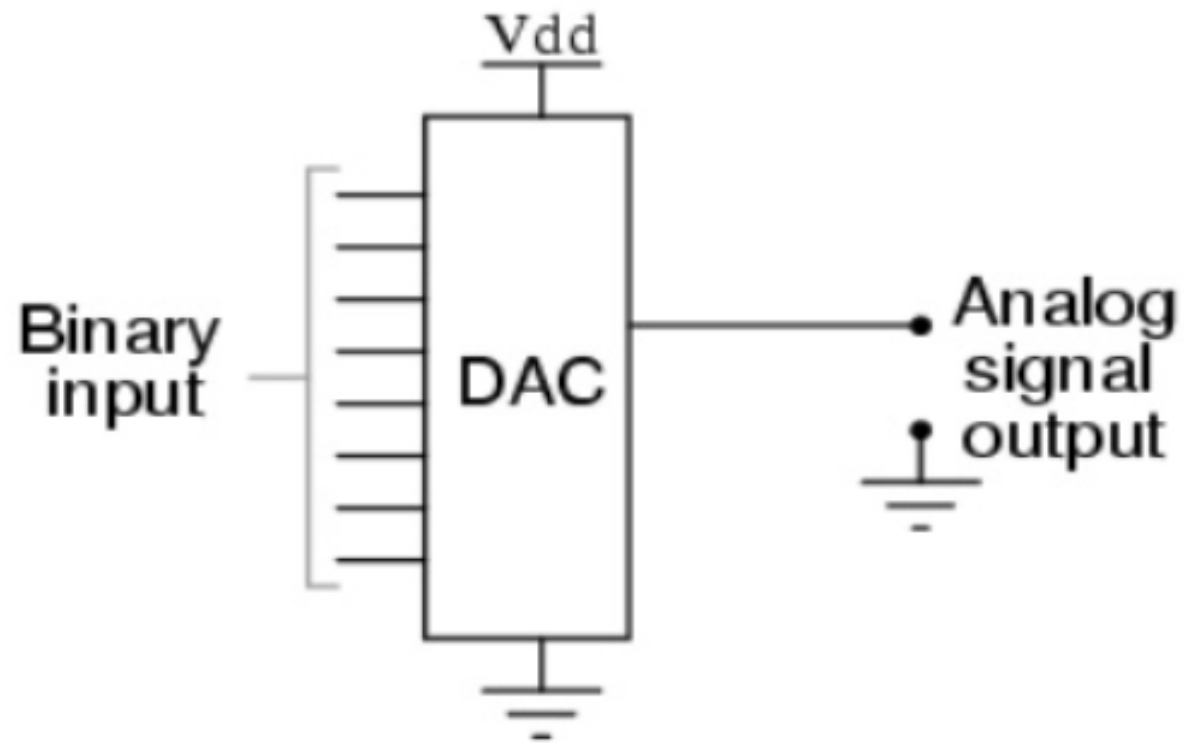
➤ n digital inputs for digital encoding

➤ analog input for V_{max}

➤ analog output a



Block Diagram



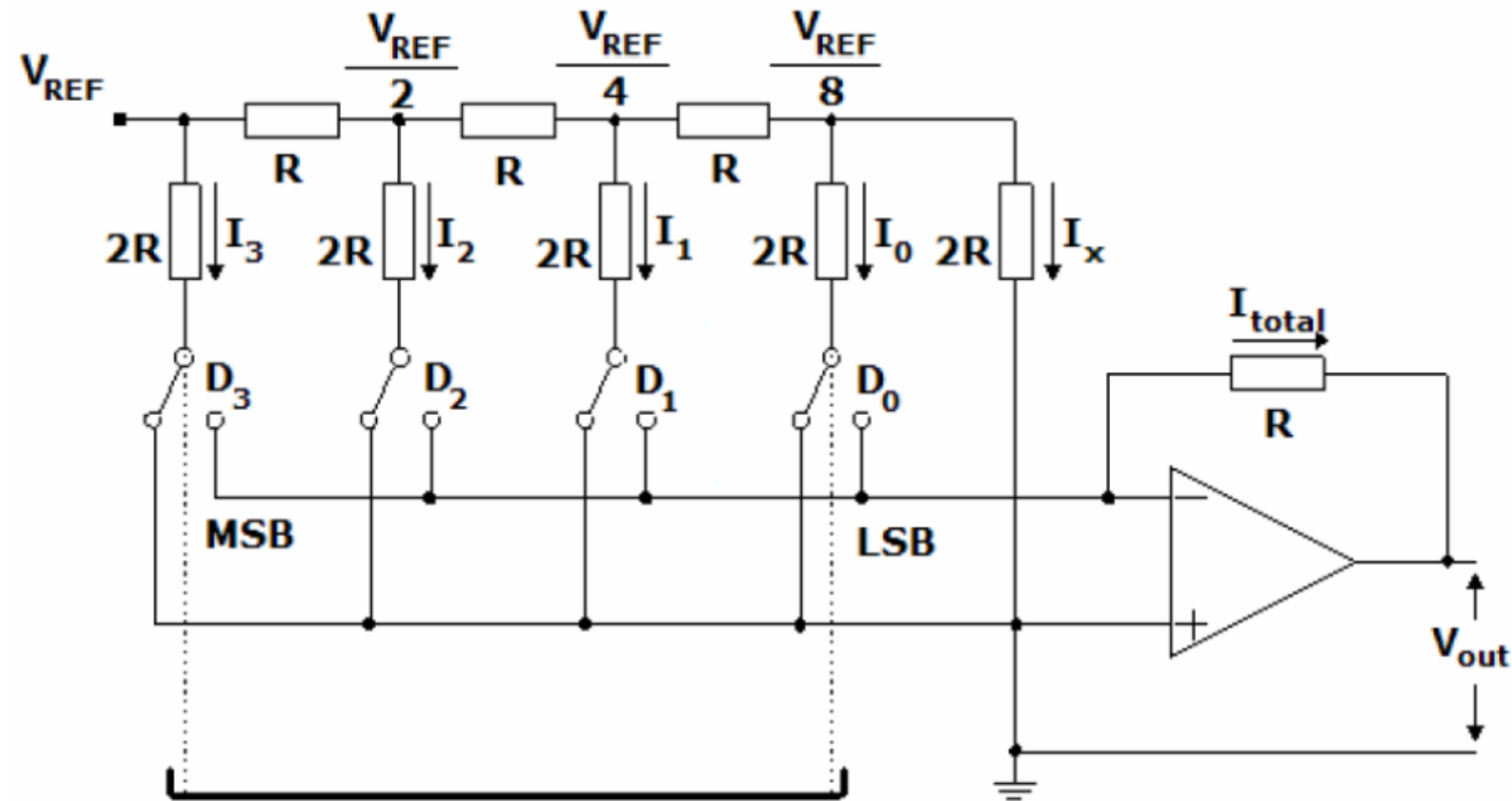
DAC Resolution

Resolution is the amount of variance in output voltage for every change of the LSB in the digital input.

- Just as with ADCs, there are several common ways of specifying a DAC's resolution:
- Number of bits, n
- Number of output codes = 2^n , or number of steps in the output = $2^n - 1$

R/2R 4-bit DAC Architecture (1/2)

- Uses a repeating cascaded structure of resistor values R and $2R$ to create a binary weighted DAC.
- The R/2R ladder divides down a positive reference voltage by switching individual resistors between a positive reference voltage, V_{REF} , and the analogue ground, generating a current.
- The equivalent resistance between V_{REF} and ground is R .
- An operational amplifier converts this current to Voltage (V_{out})

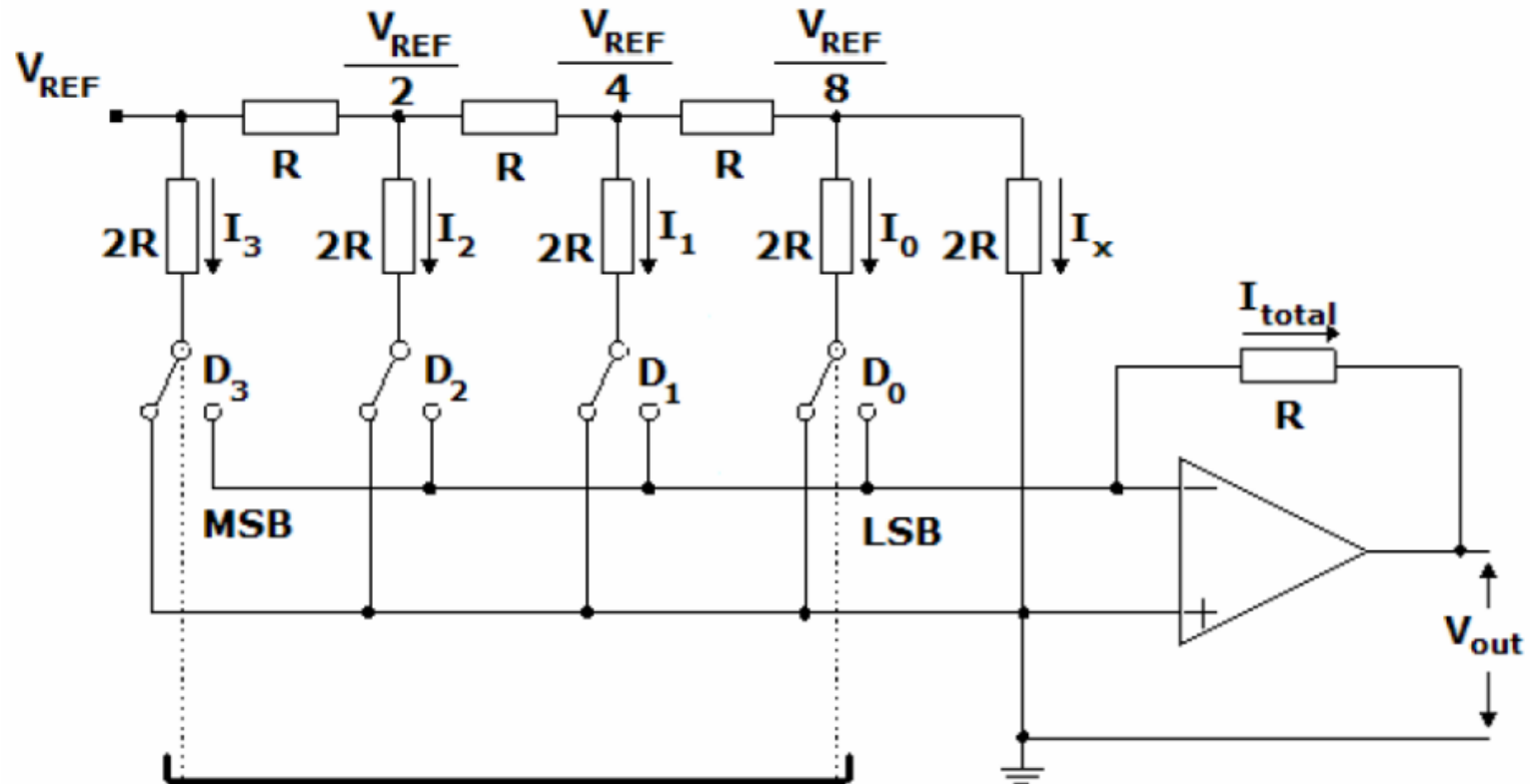


Data bit "Low" -> Switch current to ground

Data bit "high" -> Switch current to negative input of OpAmp

R/2R 4-bit DAC Architecture (2/2)

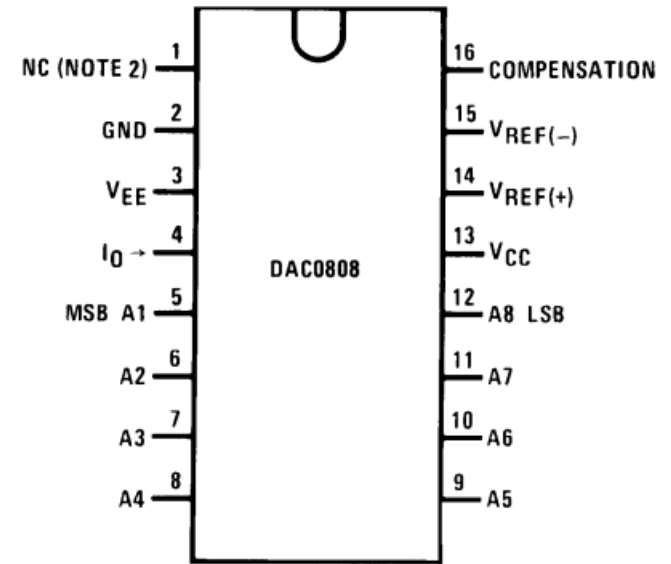
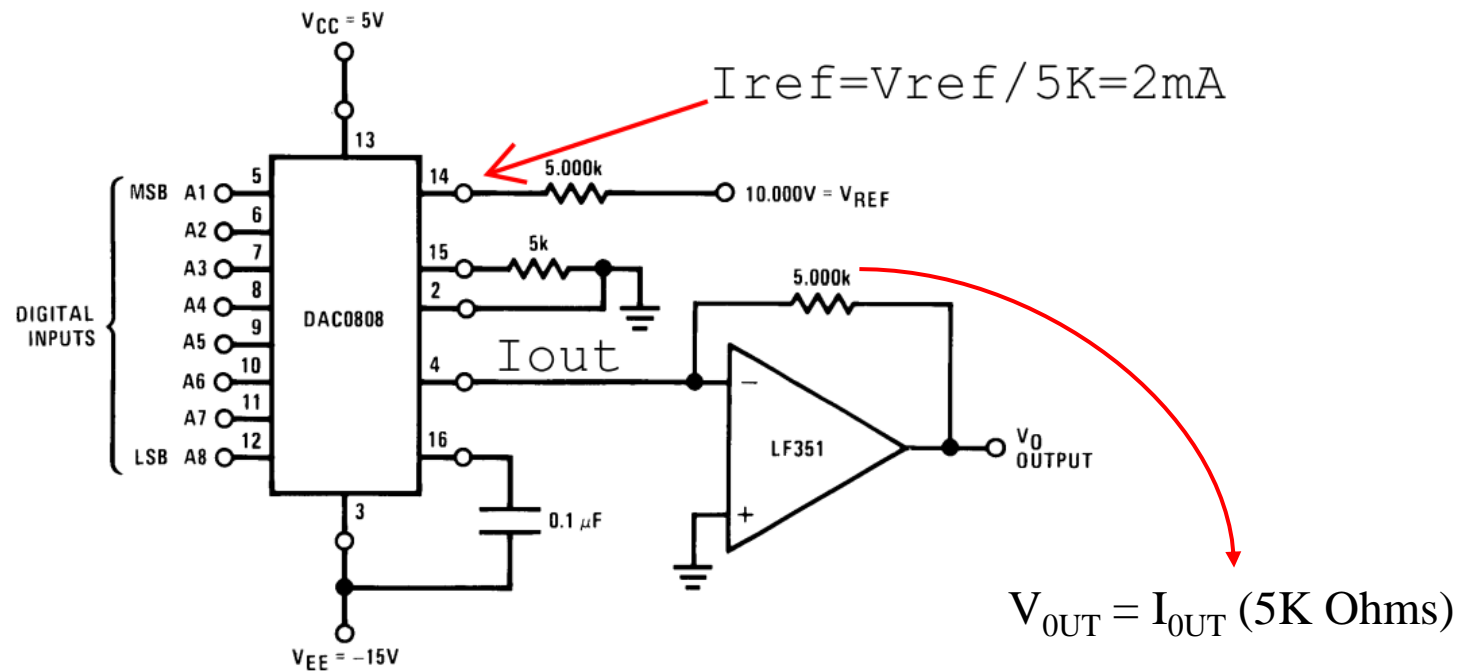
- $V_{out} = \frac{V_{ref}}{2^4} * \text{Value}$
- Example:
 - if Value = 15 & $V_{ref} = 2.5$ Volts.
 - $V_{out} = ?$
- Step size = ?



Data bit "Low" -> Switch current to ground

Data bit "high" -> Switch current to negative input of OpAmp

Typical Application (DAC0808)



$$I_{OUT} = I_{ref} (D_7/2 + D_6/4 + D_5/8 + D_4/16 + D_3/32 + D_2/64 + D_1/128 + D_0/256)$$

$$V_{OUT} = I_{OUT} (5K \text{ Ohms})$$

DAC interfacing

