



FACULTY OF ENGINEERING & TECHNOLOGY

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A/D & D/A CONVERTERS

Examining Digital-to-Analog Conversion

The diagram illustrates a digital-to-analog converter circuit. On the left, a 16-bit digital signal generator (XWG1) provides digital signals to a 4-bit digital-to-analog converter (XLA1). The XLA1 has four outputs (C, Q, T) connected to resistors R1, R2, R3, and R4 (all 2.0kΩ). These resistors are connected to a summing junction. A feedback path consists of resistors R5, R6, R7, and R8 (all 1.0kΩ) connected to a summing junction and a ground reference. The output of the summing junction is connected to an oscilloscope (XSC1). The oscilloscope screen shows a square wave input and a staircase-like analog output. The oscilloscope settings are: Agilent 54622D MIXED SIGNAL OSCILLOSCOPE, 100 MHz, 200 MS/s, 1.79V, 500mV, 0s, 2ms, Auto, 1.820mV.

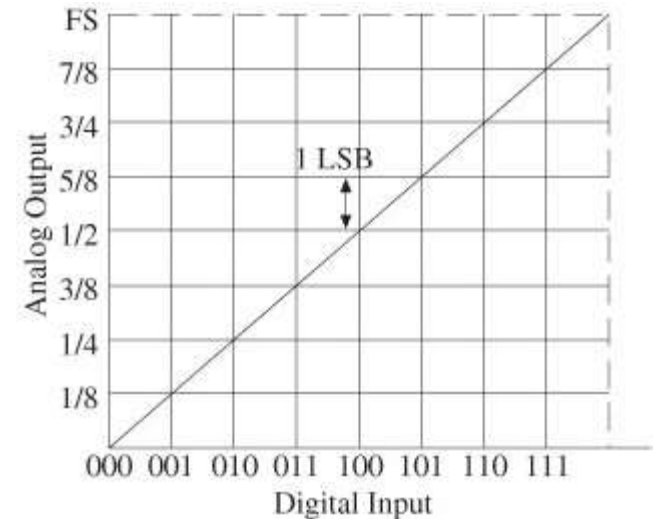
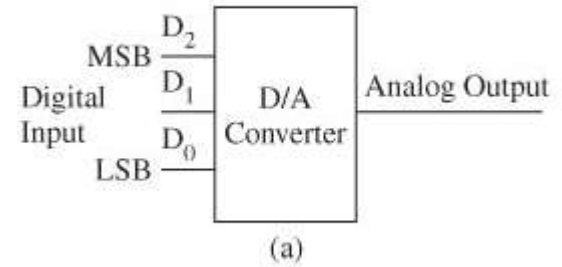
**For Extra credit:
Change the circuit to generate this output:**

The target waveform is a staircase-like signal with 16 steps, representing a 16-bit digital-to-analog conversion. The signal starts at a low level and increases in discrete steps, forming a sawtooth-like pattern.

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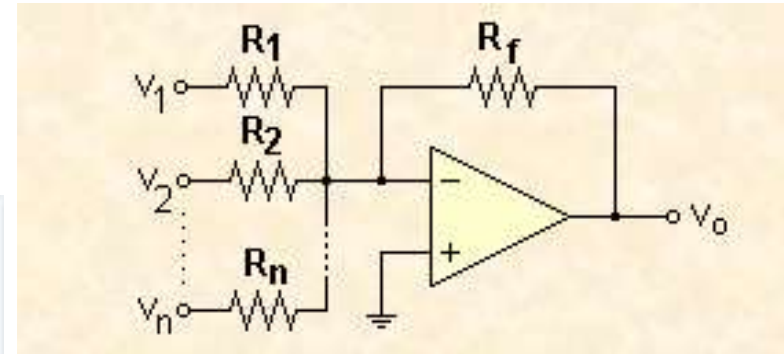
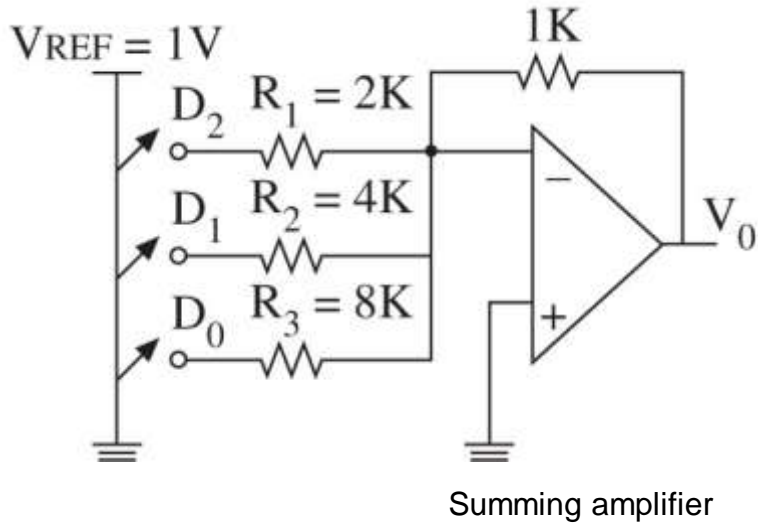
Digital to Analog Conversion

- The resolution of a DAC is defined in terms of bits—the same way as in ADC.
- The values of LSB, MSB, and full-scale voltages calculated the same way as in the ADC.
- The largest input signal 111 is equivalent of 7/8 of the full-scale analog value.
- Can be designed using an operational amplifier and appropriate combination of resistors
- Resistors connected to data bits are in binary weighted proportion, and each is twice the value of the previous one.
- Each input signal can be connected to the op amp by turning on its switch to the reference voltage that represents logic 1.
 - If the switch is off, the input signal is logic 0.



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3-bit D/A Converter Circuit



- The transfer function of the summing amplifier :

$$v_o = -(v_1/R_1 + v_2/R_2 + \dots + v_n/R_n)R_f$$

R/2R Ladder Network for D/A Converter

- Thus if all input resistors are equal, the output is a scaled sum of all inputs.
- If they are different, the output is a weighted linear sum of all inputs.