R-2R ladder DAC

Digital systems are used in ever more applications because of their increasingly efficient, reliable, and economical operation. With the development of micro processor, data processing has become an integral part of various systems.

Types of Digital to analog Converters:

1. Digital to analog converter with binary weighted resistors
2. Digital to analog converter with R and 2R resistors
3. Monolithic/hybrid digital to analog converter

R-2R ladder DAC:

In this type of converter, a precision voltage reference is divided into 2^N–1 parts in an internal voltage divider, where N is the number of bits specified for the converter. One switch at a time turns on, corresponding to the correct dc level

For a given reference voltage V_{REF}, a current I flows through resistor R. If two resistors, each the same value (2R) are connected from V to ground, a current I/2 flows through each leg of the circuit. But the same current will flow if one leg is made up of two resistors, each with the value of R. If two resistors in parallel whose value is 2R replace the bottom resistor, the parallel combination is still R. I/4 flows through both legs, adding to I/2. Extending the network for 4 bits as shown on the right, the total current on the bottom leg is I/4 plus I/8 plus I/16 plus I/16 in the resistor to ground. Kirchoff's current law is satisfied, and convenient tap points have been established to construct a D/A converter

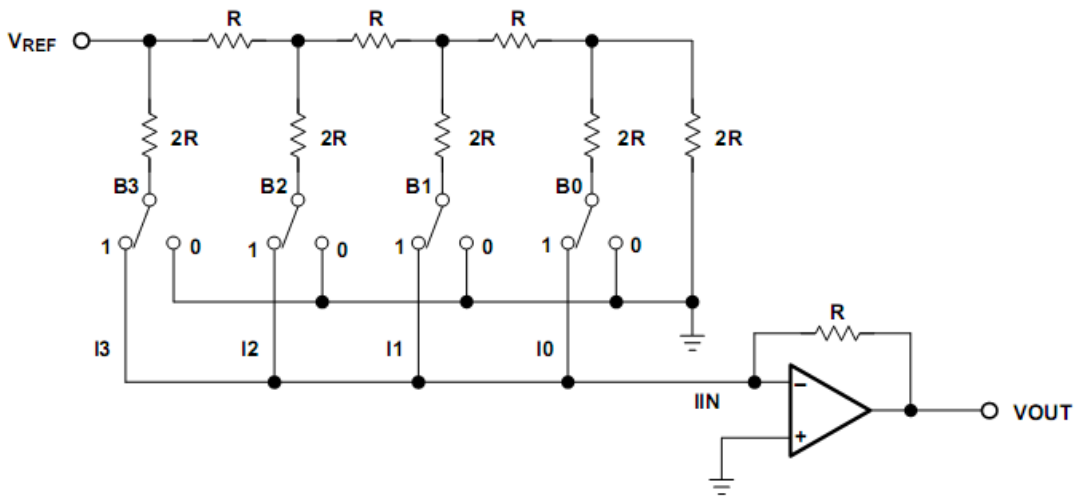

Figure 5.3

This converter architecture has advantages over the types previously mentioned. The number of resistors has doubled from the number required for the current-summing type, but there are only two values. Usually, the 2R resistors are composed of two resistors in series, each with a value of R. The feedback resistor for the buffer amplifier is again fabricated on the converter itself for maximum accuracy.

Although the op amp is still not operated in unity gain mode for all combinations of bits, it is much closer to unity gain with this architecture. The important op amp parameters for all resistor ladder D/As are: Input offset voltage —the lower the better. It adds to the converter offset error. Input bias current the lower the better. The product of the bias current and the feedback resistance creates an output offset error. Output voltage swing — it must meet or preferably exceed the zero to full-scale swing from the D/A.

Settling time and slew rate must be fast enough to allow the op amp to settle before the next digital bit combination is presented to the D/A input register

$$Vo= \quad -R_f \left(\frac{}{} + \frac{}{} + \frac{}{} + \frac{}{}\right)$$