Analog multiplexer and op amp unite for precise d-a converter

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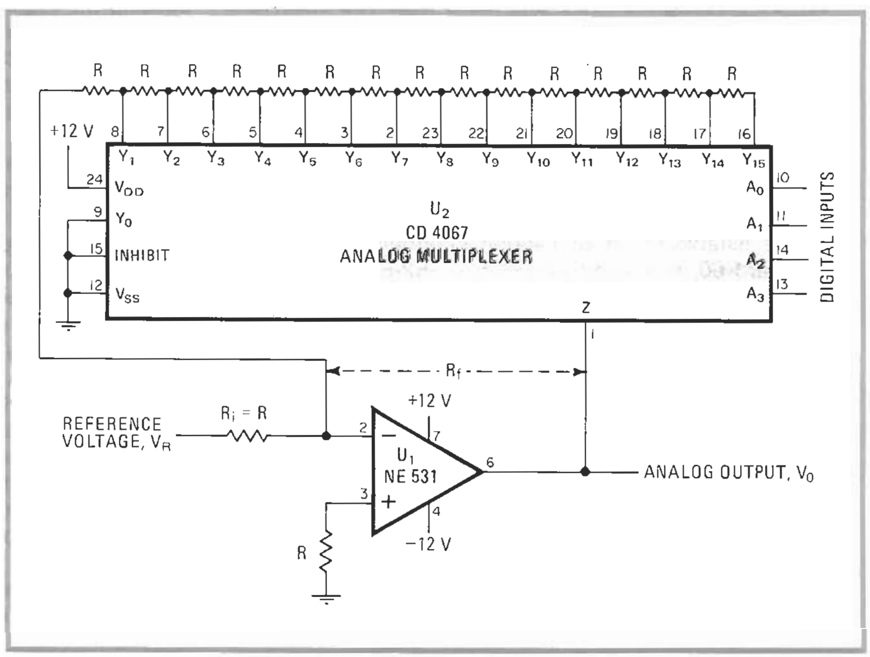
This simple low-cost digital-to-analog converter uses just an operational amplifier and an analog multiplexer to convert a 4-bit digital input into an analog output. Cascading an additional 16-channel analog multiplexer will extend the input digital word length of the d-a converter to 8 bits. The accuracy and the stability of the converter depend mainly on the accuracy of the resistors and stability of the reference voltage.

Operational amplifier U_1 operates as an inverting amplifier with a weighted-resistor switching network connected in its feedback path. The 16-channel analog multiplexer, U_2, functions as the resistor switching network that is controlled by the four binary inputs A_0–A_3. A 4-bit input, whose decimal equivalent is N, switches multiplexer channel $Y_n - Z$ on and provides a feedback resistance of $R_f = NR$. Thus U_2 sets as the gain of the amplifier a value that corresponds to the equivalent digital input.

The analog output of the d-a converter is $V_O = -(R_f/R_i)V_R = -(NR/R)V_R = -NV_R$, where V_R is a stable reference voltage used in the circuit. The above relationship shows that the analog output V_O is proportional by a factor of V_R to the digital input:

As an example, consider a 4-bit input 0101, whose decimal equivalent is $N = 5$. Using, for simplicity, a reference voltage of $V_R = -1$ volt, the circuit produces an analog output of $V_O = -5(-1)v = +5$ v.

Op amp NE531 offers a high slew rate for high-speed operation. The circuit may be used as a programmable–gain-control amplifier whose desired gain can be set by thumbwheel switches. In addition, by interchanging input resistor R and multiplexer U_2, the circuit can serve as a programmable attenuator. □



D-a converter. Analog multiplexer U_2 places resistors in the feedback path of amplifier U_1 to control the latter's gain and thereby produce an output proportional to the digital input. The analog output $V_O = -NV_R$, where N is the decimal equivalent of the digital input and V_R is the reference voltage.