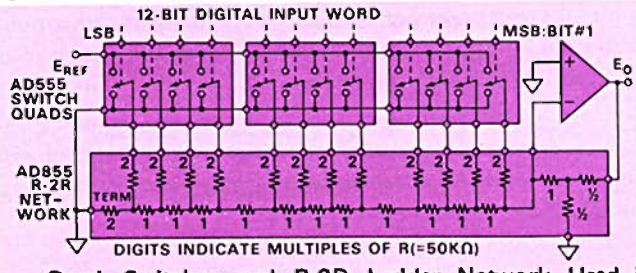
Application Brief

The Many Scale Factors of the AD855 R-2R Ladder Network

In Vol. 5, No. 2 of *Dialogue*, the matter of voltage switches and R-2R resistive ladder networks for D-A conversion and 2- or 4-quadrant hybrid multiplication was discussed in some depth*, with particular reference to the AD555 12-bit quad voltage switches and the AD855† 12-bit R-2R resistive ladder network. As a reminder of that article, we reproduce here its "Figure 3" showing the connection of these devices as a 2-quadrant 12-bit multiplier (Unipolar digital number X bipolar analog signal).

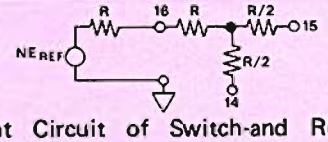


Quad Switches and R-2R Ladder Network Used in Simple 12-bit D/A Converter or 2-Quadrant Hybrid Multiplier. Amplifier may be used Either Inverting, with Tracking Gain Resistors, as Shown, or Non-Inverting, with External Feedback Network.

A feature of that circuit that bears some further discussion is the set of three feedback resistors shown in a "T-network" feedback connection around the operational amplifier. These resistors track one another, as well as the rest of the network, rather closely because of their monolithic construction and their close physical proximity.

If the output of the ladder is connected to the summing point of an inverting operational amplifier, and these resistors are used in the feedback path, a number of highly-precise scale factors are available, depending on the connection used. If, on the other hand, the amplifier is used non-inverting, these resistors may be used to obtain a number of values of fixed input attenuation. (Unfortunately, the 16-lead package used for the AD855 limits the number of available external leads, and thereby constrains the number of possible applications to something less than the ultimate number of permutations of three resistors and an op amp.)‡

The illustrations on this page show how to connect the resistors for each value of gain or attenuation. The network can be represented by the following equivalent circuit:



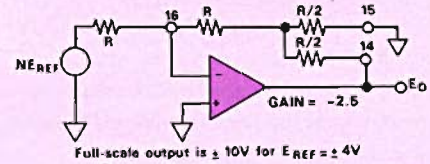
Equivalent Circuit of Switch-and Resistor Network, One Side Grounded. N is the Value of the Digital Number, as a Fraction of Full Scale (2^n), E_{REF} is the Input Voltage, in the Range ±4V (for AD555).

*"AD555 Monolithic 'μDAC' Quad Switches Make 4-Quandrant Multiplying DAC's with 12-Bit Linearity," Vol. 5, No. 2, pp 3-5

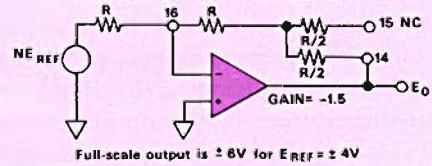
†For complete information on monolithic quad switches and resistor networks for D-A conversion, use reply card. Circle D13

‡We appreciate the assistance of Dr. Richard J. Gurski, of HyComp, Inc., in achieving this degree of circuit flexibility.

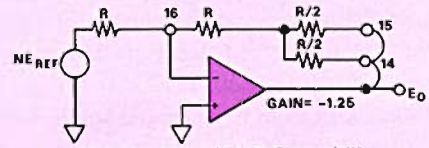
INVERTING CONNECTIONS



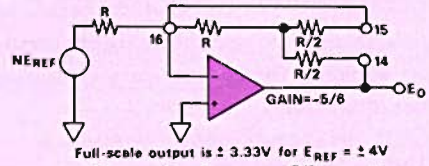
Full-scale output is ± 10V for E_{REF} = ± 4V



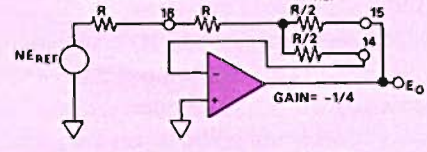
Full-scale output is ± 6V for E_{REF} = ± 4V



Full-scale output is ± 5V for E_{REF} = ± 4V

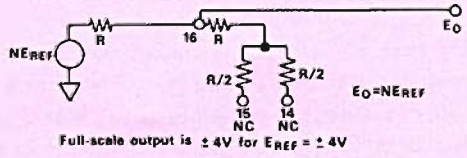


Full-scale output is ± 3.33V for E_{REF} = ± 4V

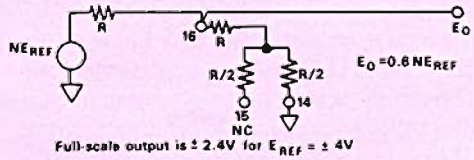


Full-scale output is ± 1V for E_{REF} = ± 4V

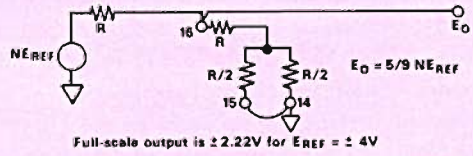
NON-INVERTING CONNECTIONS (output to follower-connected op amp)



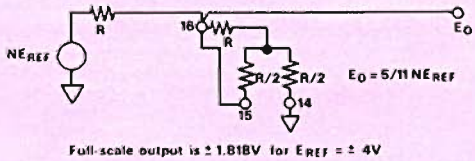
Full-scale output is ± 4V for E_{REF} = ± 4V



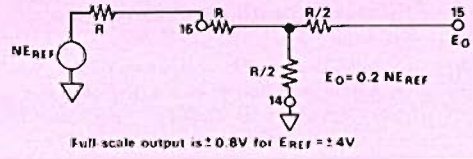
Full-scale output is ± 2.4V for E_{REF} = ± 4V



Full-scale output is ± 2.22V for E_{REF} = ± 4V



Full-scale output is ± 1.818V for E_{REF} = ± 4V



Full-scale output is ± 0.8V for E_{REF} = ± 4V