Gain-programmable circuit offers performance and flexibility

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You can use a standard precision instrumentation amplifier, such as the INA118 or AD623, as a gain-programmable amplifier with high accuracy and wide gain range. However, the gain range of such parts is fixed at certain values, limiting their flexibility. To solve the problem, a usual way is to use a gain-adjustable circuit controlled by a microcomputer (**Figure 1**).

IC_2 is a programmable 1-of-8 analogy multiplexer that connects to eight weighting resistors, R_1 to R_8, to improve the gain range of the circuit based on IC_2, a general-purpose precision amplifier. The overall gain of the circuit depends on the value of the selected weighting resistor, as follows:

$$V_{OUT} = -V_{IN}\left(\frac{R_X + R_{ON}}{R_0}\right),$$

where R_{ON} is the on-resistance of IC_2, and R_X is one of the selected weighting resistors, R_1 to R_8. You control the port-select pins Z_0 to Z_2 of IC_2 with a microcontroller to provide self-adjustable gain according to the selected weighting resistor. Unfortunately, the performance and quality of the circuit cannot provide good performance and high quality due to the on-resistance of IC_2, which you also cannot control, especially as the temperature changes.

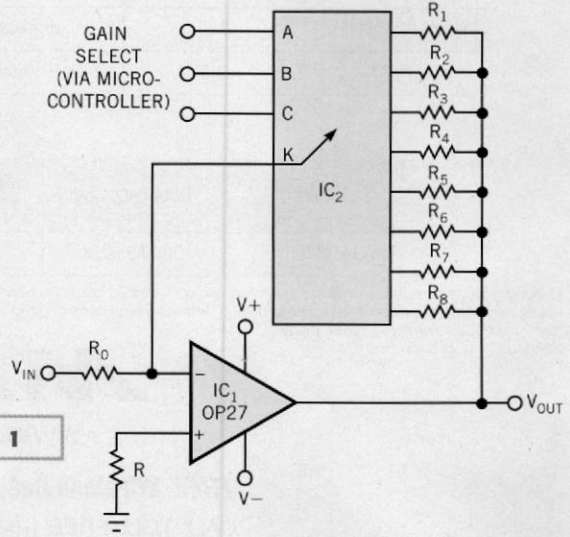

Figure 1

A basic gain-programmable amplifier circuit uses digital outputs from a microcontroller to set gain.

The modified gain-adjustable amplifier circuit in **Figure 2** uses the same IC_1 but changes IC_2 to a programmable 2-of-8 difference-input analog multiplexer, which connects to four balancing resistors, R_{01} to R_{04}, and eight weighting resistors, R_{G1} to R_{G8}, to improve the gain range of the circuit. By controlling the port-select pins Z_0 to Z_1 of IC_2 with a microcontroller, the

circuit provides self-adjustable gain with high quality. The overall gain of the circuit is:

$$V_{OUT} = V_{IN}\left(1+\frac{R_{GB}}{R_{GA}}\right),$$

where R_{GA} is one of the selected weighting resistors, R_{G1} to R_{G4}, and R_{GB} is one of the selected weighting resistors, R_{G6} to R_{G8}.

Analog multiplexer IC_2 is on the input side of amplifier IC_1. Resistors R_{01} to R_{04} balance the signal-input channel to decrease the level-shifting because of the on-resistance of multiplexer IC_2 and minimize the effect of that resistance. Additionally, two operational amplifiers, IC_{01} and IC_{02}, act as followers to improve the overall driver performance and common-mode-rejection capacity of the circuit.□

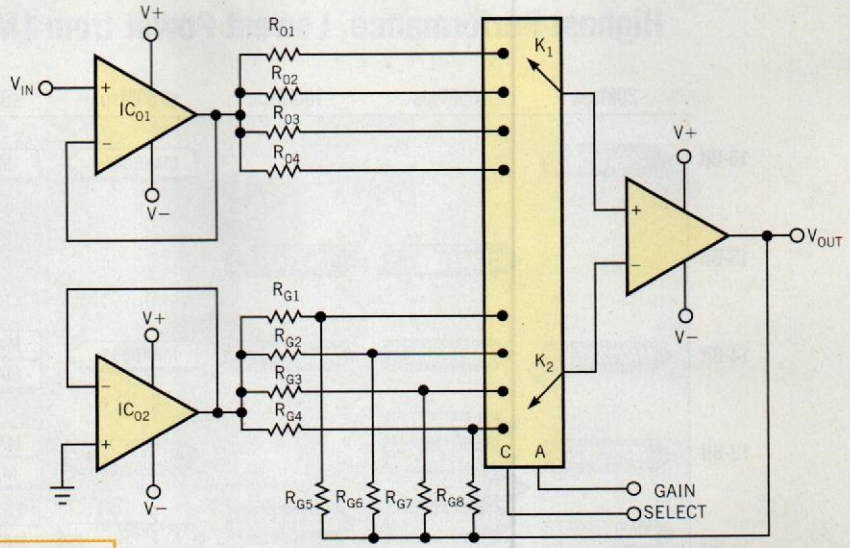

Figure 2

The modified circuit provides more flexibility, along with high performance.