EDITED BY BRAD THOMPSON
AND FRAN GRANVILLE

designideas

READERS SOLVE DESIGN PROBLEMS

Gain-of-two instrumentation amplifier uses no external resistors

Marián Štofka, Slovak University of Technology, Bratislava, Slovakia

An instrumentation amplifier offers precise gain without feedback resistors, and, at any value of gain, it provides high input impedances at its noninverting and inverting inputs. In a typical IC instrumentation amplifier, a single resistor that connects across two gain-adjustment pins determines the circuit's overall gain. Integrated versions of most instrumentation amplifiers allow the pins to remain open for unity gain but require finite-value gain-setting resistors for gains exceeding one. Although the gain-adjustment resistor might comprise a tiny surface-mounted device, its electrodes and internal resistive layer extend the conductive surface connected to the IC's gain-adjustment pins. The extended surface acts as an antenna and thus makes the amplifier more susceptible to stray external electromagnetic fields.

Figure 1 shows an instrumentation amplifier that offers a gain of two without using any external resistors. The circuit comprises a cascade of a symmetrical, differential-output amplifier, formed by two channels of IC_1; an Analog Devices (www.analog.com) AD8222 instrumentation amplifier; and a difference amplifier comprising one half of IC_2, a second AD8222. All three instrumentation-amplifier sections in the circuit provide a standalone gain of one. Because the differential outputs of the first stage have opposite signs, their difference is twice

DIs Inside

82 Analog switch converts 555 timer into pulse-width modulator

86 Drive a blue LED from a 3V battery

88 Add simple disable function to a panoramic-potentiometer circuit

90 Simple single-cell white-LED driver uses improvised transformer

90 Implement a stepper-motor driver in a CPLD

What are your design problems and solutions? Publish them here and receive $150! Send your Design Ideas to edndesignideas@reedbusiness.com.

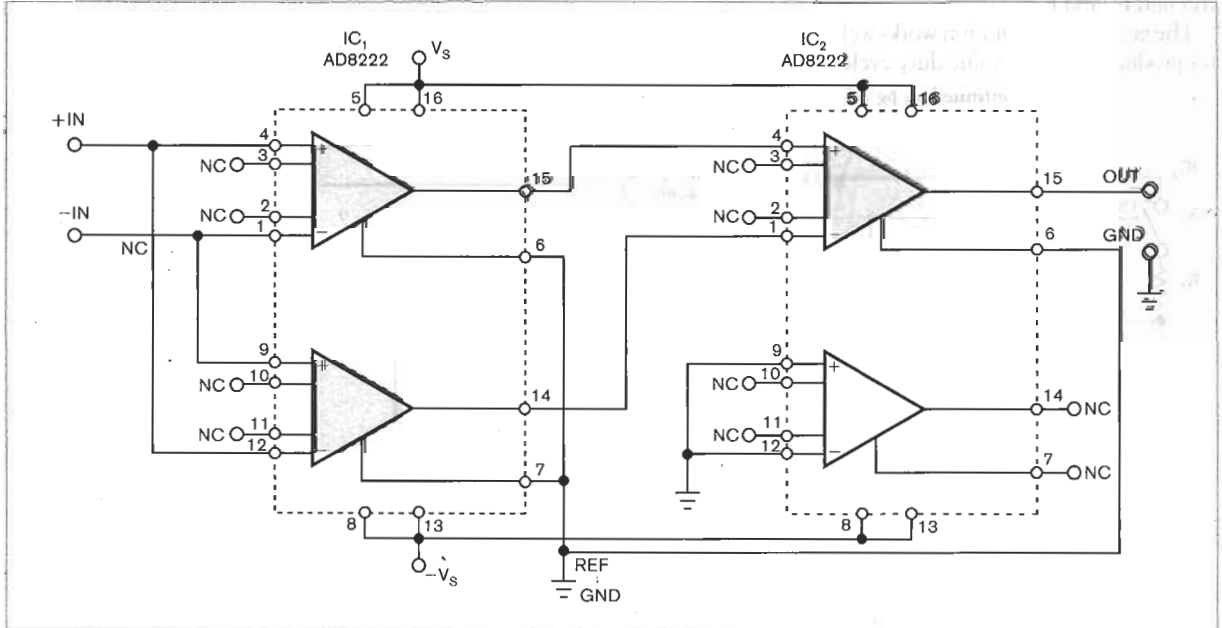

Figure 1 Based on two dual-section instrumentation amplifiers, this composite instrumentation amplifier offers a gain of two with an error margin of less than 0.06% and requires no gain-setting resistors.

that of the difference of the input signals.

The circuit's worst-case gain error does not exceed the value of $\delta_2=3\delta_1$, where, at a gain of one, δ_1 represents the maximum gain error of one section of the AD8222. For B-grade ICs, you calculate the value of δ_2 as $\delta_2 \leq$ 0.06% (**Reference 1**). Typically, the value of δ_2 rarely reaches its maximum value. Given the reasonable assumptions that all three amplifiers' gain errors are independent and obey a gaussian distribution, the probability of occurrence of $\delta_2=3\delta_1$ is about 1/20 the probability of encountering a single amplifier that has a maximum gain error of δ_1.**EDN**

REFERENCE

"AD8222 Precision, Dual-Channel Instrumentation Amplifier," Analog Devices Inc, www.analog.com/en/prod/0,2877,AD8222,00.html.