DIs Inside

Build a precise dc floating-current source

D Ramírez, S Casans, C Reig, AE Navarro, and J Sánchez,
University of Valencia, Burjassot, Spain

Although well-known to active-filter theorists and designers, GICs (generalized impedance converters) may be less familiar to analog generalists. Comprising a one-port active circuit typically comprising low-cost operational amplifiers, resistors, and capacitors, a GIC transforms capacitive reactance into inductive reactance and thus can substitute for an inductor in a filter that an RLC-transfer function describes. In addition, the flexibility of a GIC's input-impedance equation permits the design of virtual impedances that don't exist as physical components—for example, frequency-dependent resistance (**Reference 1**). The GIC, which its developers introduced 30 years ago, has seen its greatest application in ac-circuit and active-filter applications.

Figure 1 shows a classic GIC circuit in which the input impedance, Z_{IN}, depends on the nature of impedances Z_1 through Z_5. The following equation describes the circuit's input impedance:

$$Z_{IN}=\frac{V_{IN}}{I_{IN}}=\frac{Z_1\times Z_3\times Z_5}{Z_2\times Z_4}.$$

For example, if Z_1, Z_2, Z_3, and Z_5 comprise resistors R_1, R_2, R_3, and R_5, and Z_4 comprises capacitor C_4, then the input impedance, Z_{IN}, appears as a virtual inductor of value L_{IN}:

$$L_{IN}=\frac{R_1\times R_3\times R_5\times C_4}{R_2}.$$

Figure 2 shows the GIC circuit in its dc configuration. When you consider the GIC circuit in a purely dc environment, you can envision new applications. For example, you could replace impedances Z_1 through Z_5 with pure resistances R_1 through R_5. Instead of an ac input-voltage source, connect a precision temperature- and time-stable dc reference voltage to the input port. A simple circuit analysis using ideal op amps for IC_1 and IC_2 shows that the reference input voltage, V_{REF}, appears across resistor R_5, and, as the following equation shows, a constant current, I_O, flows through R_5.

$$I_O=\frac{V_{REF}}{R_5}.$$

However, op amp IC_2's noninverting input diverts a small amount of current from the junction of R_4 and R_5, and I_O thus also flows through R_4. Selecting

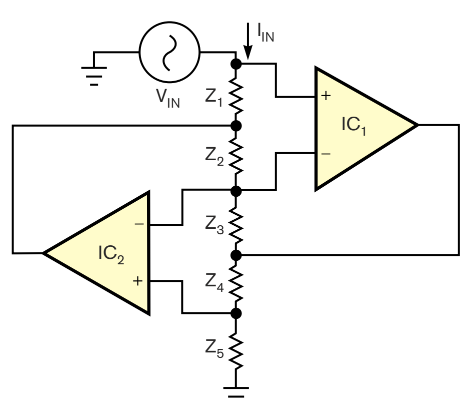

Figure 1 A classic generalized impedance converter provides a single-port impedance that appears at V_{IN}. The schematic omits power connections for clarity.

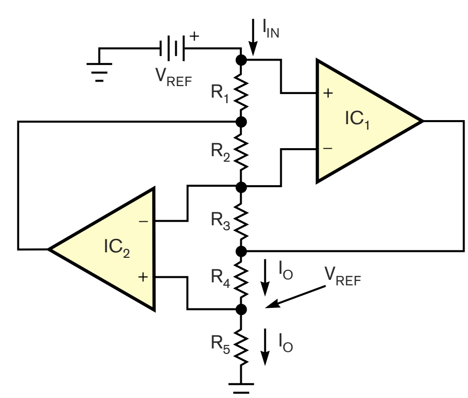

Figure 2 Replacing all of a GIC's impedances with resistors creates a constant-current source.

large values for R_1, R_2, and R_3 helps minimize current drawn from the reference voltage. For example, the circuit can supply 2 to 10 mA to R_4 and draw only a few tenths of a microampere from the reference source. Using tight-tolerance and low-drift components for V_{REF} and R_5 ensures the stability of I_O. Applications include providing constant-current drive for Wheatstone-bridge and platinum-element sensors (**Reference 2**). In addition, you can replace R_4 with a series of resistive sensors as in an Anderson loop (**Reference 3**).EDN

REFERENCES

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