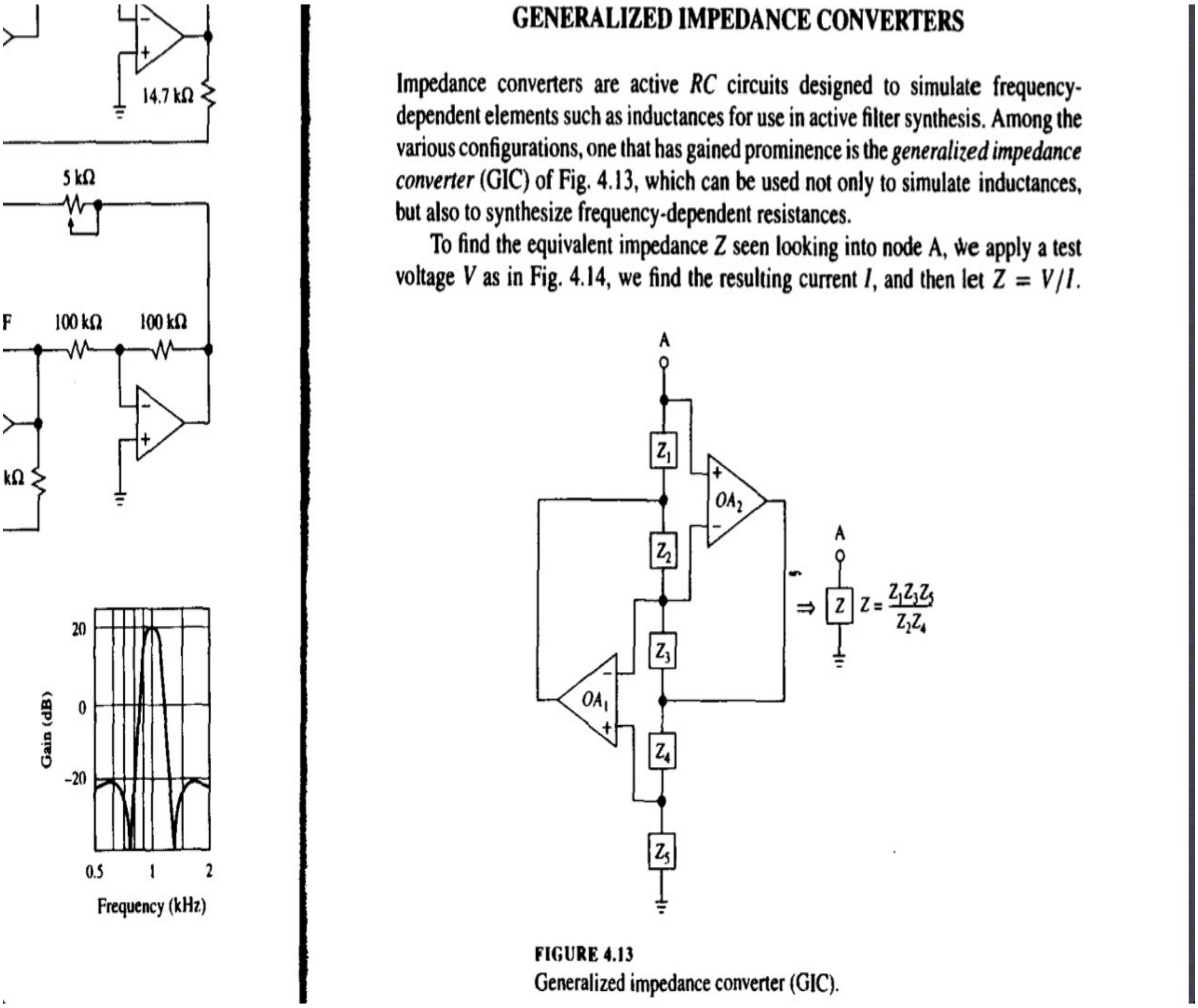
Generalized Impedance Converter



GENERALIZED IMPEDANCE CONVERTERS

Impedance converters are active *RC* circuits designed to simulate frequency-dependent elements such as inductances for use in active filter synthesis. Among the various configurations, one that has gained prominence is the ***generalized impedance converter*** (GIC) of Fig. 4.13, which can be used not only to simulate inductances, but also to synthesize frequency-dependent resistances.

To find the equivalent impedance Z seen looking into node A, we apply a test voltage V as in Fig. 4.14, we find the resulting current I, and then let $Z = V/I$.

FIGURE 4.13
Generalized impedance converter (GIC).

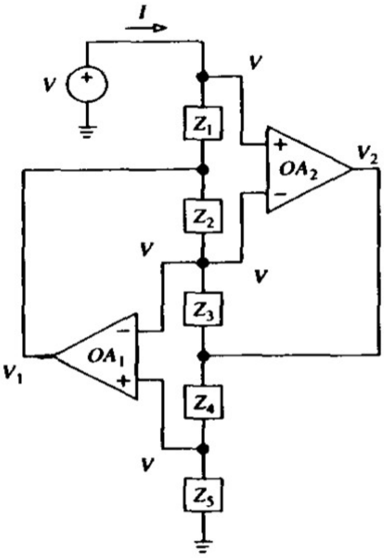


FIGURE 4.14
Finding the equivalent impedance of a GIC toward ground.

Exploiting the fact that each op amp keeps $V_n = V_p$, we have labeled the voltages at the input nodes of both op amps as V. By Ohm's law, we have

$$I = \frac{V - V_1}{Z_1}$$

Summing currents at the node common to Z_2 and Z_3 and at the node common to Z_4 and Z_5 we obtain, respectively,

$$\frac{V_1 - V}{Z_2} + \frac{V_2 - V}{Z_3} = 0 \qquad \frac{V_2 - V}{Z_4} + \frac{0 - V}{Z_5} = 0$$

Eliminating V_1 and V_2, and solving for the ratio $Z = V/I$, we get

$$Z = \frac{Z_1 Z_3 Z_5}{Z_2 Z_4} \tag{4.10}$$

Depending on the type of components we use for Z_1 through Z_5, we can configure the circuit for various impedance types. The most interesting and useful ones are as follows:

1. All Zs are resistances, except Z_2 (or Z_4), which is a capacitance. Letting $Z_2 = 1/j\omega C_2$ in Eq. (4.10) gives

$$Z = \frac{R_1 R_3 R_5}{(1/j\omega C_2) R_4} = j\omega L \tag{4.11a}$$

$$L = \frac{R_1 R_3 R_5 C_2}{R_4} \tag{4.11b}$$

2.

4.1
tan
use
suf