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NASA TECH BRIEF

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Improved Capacitance Multiplier Circuit

The problem:

Capacitance-multiplier circuits create a much larger capacitance than is possible with capacitors of an equivalent physical size. They have many applications in miniature circuits, such as in integrators, sample-and-hold circuits, and phase-locked loops. However, their use has been restricted because of their limited dynamic range. Conventional capacitance-multipliers amplify signal voltage by approximately the same factor as they increase capacitance. The output-voltage rating of amplifiers in the capacitance-multiplier circuit therefore limits the maximum input voltages.

The solution:

An improved circuit multiplies capacitance without increasing the overall circuit gain. In addition, the circuit may be designed to include a lag or a lead/lag transfer function and an independent gain adjustment.

How it's done:

The basic circuit for the improved capacitance-multiplier is shown in Figure 1. An operational amplifier is connected in a differential configuration. One terminal, with an integrating capacitor C, receives the input signal through a resistor. The other terminal is connected to the input signal across two resistors, R_1 and R_2; the junction between these is connected to the amplifier output. The effective capacitance C_o of the circuit is

$$C_o = C\frac{(R_1+R_2)}{R_2}$$

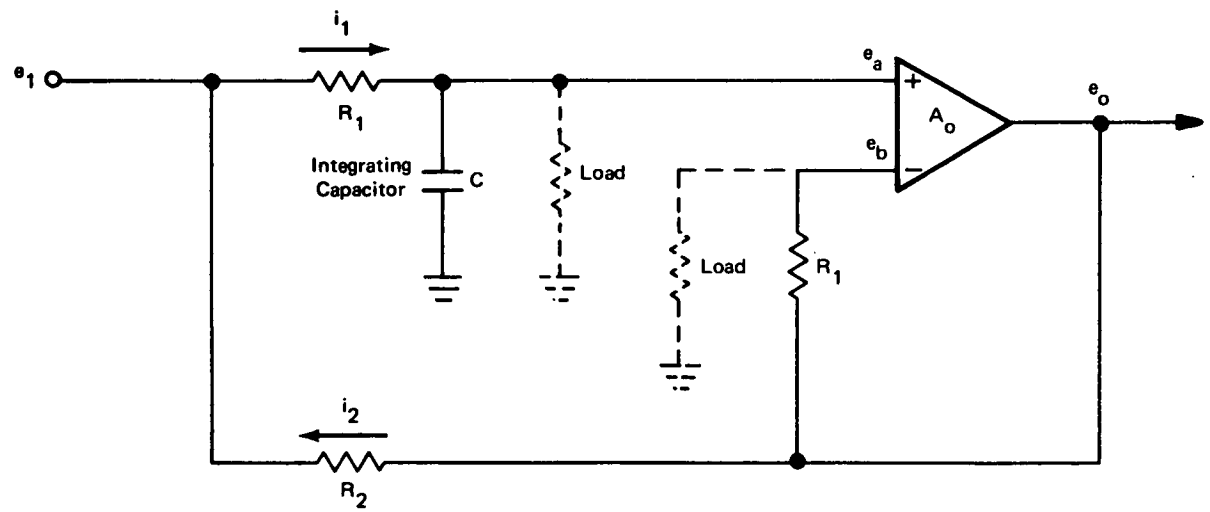

Figure 1. Basic Capacitance-Multiplier Circuit

(continued overleaf)

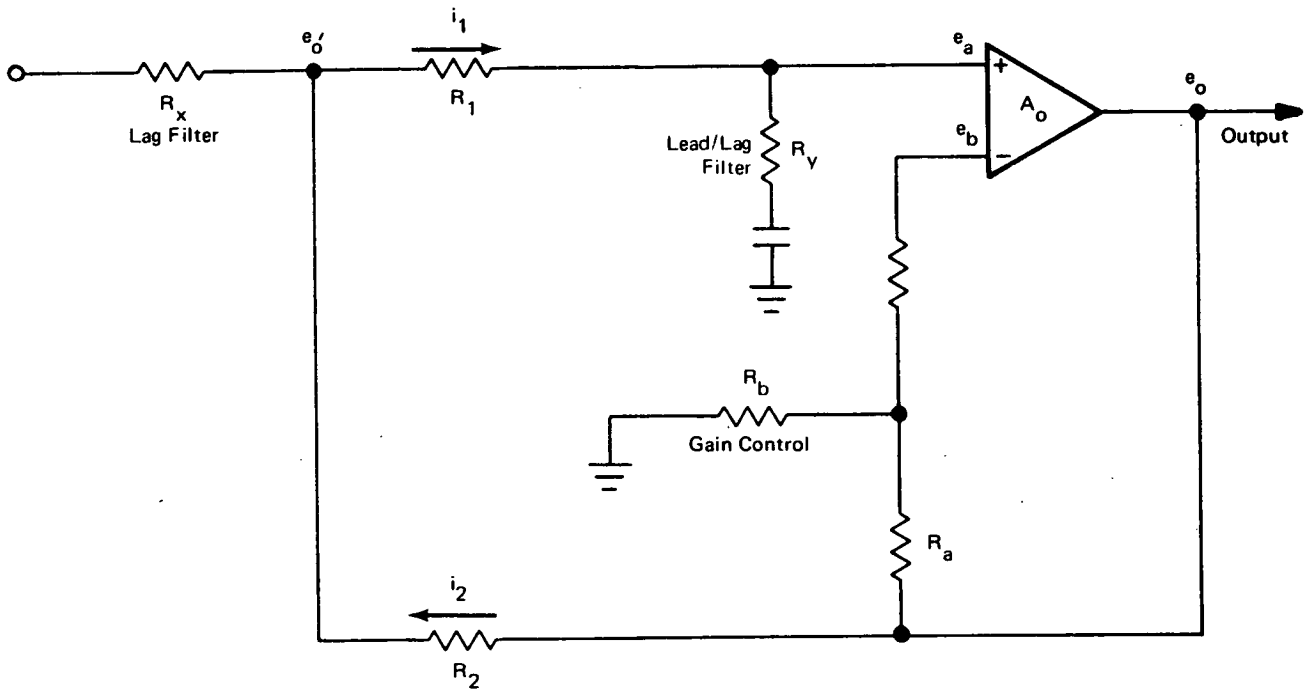

Figure 2. Capacitance-Multiplier Circuit With Additional Features

In Figure 2 the circuit has been modified to include a lag filter (R_x) and a lead/lag filter (R_y). Resistors R_a and R_b have been added to allow independent control of the circuit gain. This circuit has been used in a phase-locked loop filter that required a long time constant. It has allowed the capacitance to be increased by a considerable factor of 5 without amplifying the signal voltage.

Note:

Requests for further information may be directed to:

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Reference: TSP74-10162

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

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