Two-amplifier integrator extends timing performance

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A simple integrator normally consists of a single operational amplifier and an RC network for setting up the desired time constant. Although uncomplicated, this approach can be troublesome if either a very small or a very large time constant is needed.

The integrator in the figure, however, makes it easy to obtain either short or long timing periods because the values of the timing components are scaled by a straight resistance ratio. The integrator's output voltage is given by:

$$V_{out} = -\frac{R_1}{RCR_2}\int V_{in}\,dt$$

and its time constant becomes $(R_2/R_1)RC$. The circuit provides very good linearity when precision resistors having a tolerance of ±0.1% are used for resistors R_1 and R_2.

Although a second op amp is needed to build the integrator, the circuit offers some additional advantages. For example, it permits initial conditions to be established easily. One of the capacitor's leads goes to ground, and if one end of the switch is connected either to ground or to some dc voltage, the capacitor's initial condition can be set up as either zero or otherwise by simply closing the switch.

Furthermore, when the switch is activated, the integrator's output is not shorted, and the circuit's output op amp operates as a voltage-follower. In a conventional integrator, the initial-condition switch is generally placed across the capacitor, which is in the op amp's feedback loop. With the switch closed, then, the output of a conventional integrator is shorted to the op amp's inverting input.

The integration period of the two-amplifier circuit described here can be as short as 1 nanosecond or as long as 1,000 seconds. The bandwidth of the integrator depends on which op amps are used. For high-frequency operation, National's type LM318 op amp and RCA's type CA3100 op amp are recommended. □

Broad timing range. An extra op amp permits this integrator's time constant to be scaled by resistors R_1 and R_2 so that an exceptionally short or long timing period can be obtained easily. The time constant is $(R_2/R_1)RC$, rather than the usual RC alone. The desired initial condition for the capacitor is established by simply closing the switch, which can go to ground (for zero initial charge) or to some dc voltage.