Originally published in the Feb 4, 1991, issue of *EDN*

Buffers stabilize oscillator

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Adding a CMOS buffer to a classic op-amp oscillator dramatically improves its performance while preserving its low cost and low power consumption.

The overriding source of frequency drift in **Figure 1a** is the nonsymmetry and variability of the op amp's output-saturation voltages. These effects produce output-amplitude variations, which, when fed to the inputs via R_1 and R_2, produce switching-threshold changes. Supply voltage, temperature, loading, and op-amp selection also affect these saturation voltages. You can clamp the op amp's output with reference diodes, but such diodes are expensive and power hungry.

The circuit of **Figure 1b** overcomes these problems and has other advantages as well. Gates A and B produce a rail-to-rail voltage swing to feed back to the circuit's input, eliminating the saturation-voltage drops of the op amp. If you select the proper op amp, only the circuit's passive components will affect its frequency stability. The circuit's output symmetry is nearly perfect over a wide range of supply voltages. Further, the buffers' output transitions are much faster than the op amp's slew-rate-limited transitions, allowing you to use a micropower op amp.

The circuit's output frequency is:

$$f_o = \frac{\log e}{2\log\left(1-\frac{2R_1}{2R_1=R_2}\right)RC},$$

$$R_1 = \frac{R_1'R_2'}{R_1'+R_2'},$$

$$\text{if } R_2=3R_1,\ f_o \approx \frac{0.979}{RC}.$$

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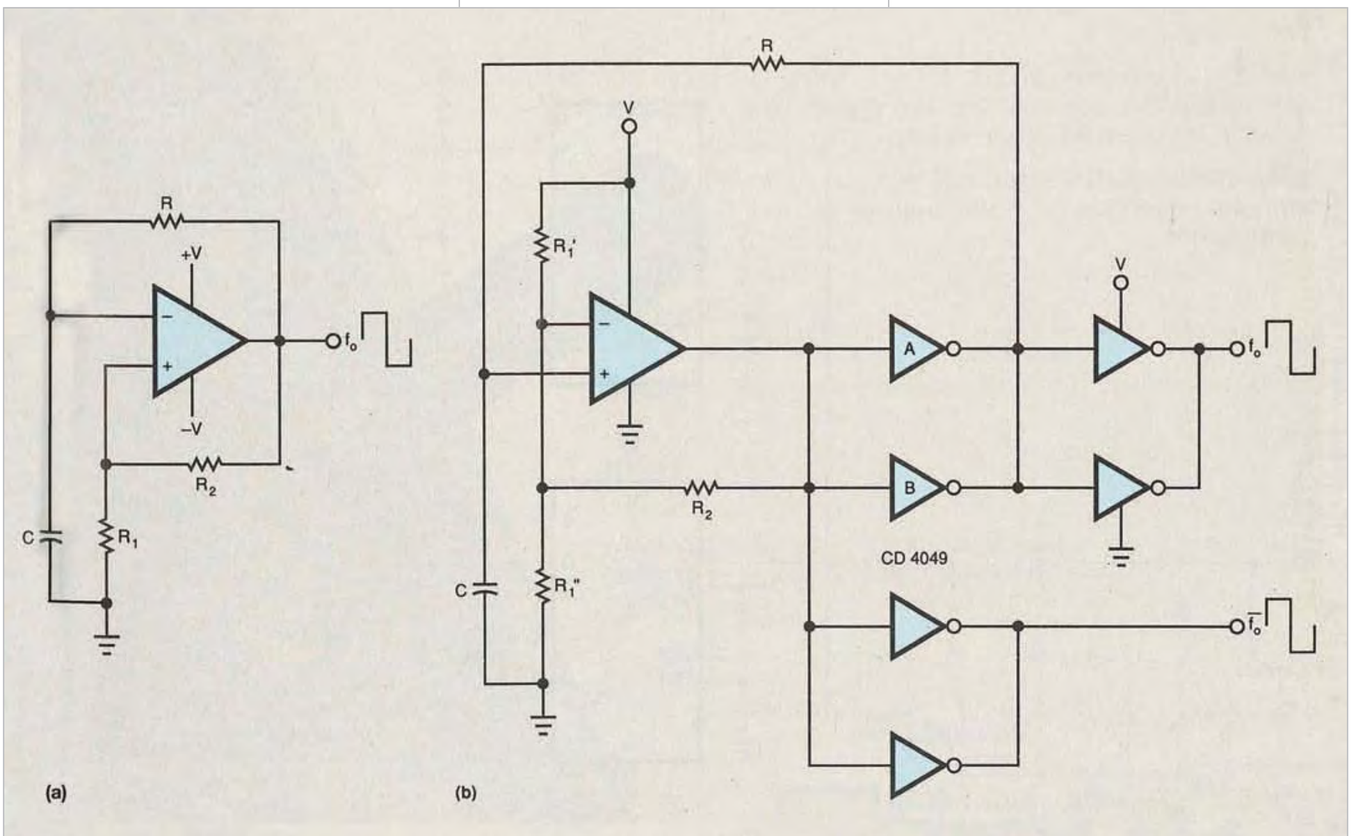

Figure 1 Adding CMOS buffers to a classic op-amp oscillator (a) improves the oscillator's performance without significant increases in power consumption or cost (b).