

## Single-Supply Wien Bridge Oscillator

by James Wong

Wien bridge oscillators have the advantage of requiring only one op amp, and this advantage is particularly important for battery-operated applications. This oscillator circuit operates from a single 9V battery.

The conditions for Wien bridge oscillation are

$$1 - R_1 R_2 C_1 C_2 \omega_0^2 = 0 \text{ and}$$

$$\frac{R_2 C_1}{R_1 C_1 + R_2 C_2 + R_2 C_1} = \beta$$

where  $\beta$  is the ratio of output voltage feedback to the inverting input. If  $R_1 = R_2$  and  $C_1 = C_2$ , then  $\omega_0$  is  $1/RC$  and  $\beta$  is  $1/3$ .

This oscillator should be set to just diverge in amplitude. Diodes are used to obtain a nonlinear feedback characteristic which will limit the divergence without causing too much distortion. The condition for oscillation is

$$\frac{R_3}{R_3 + 2(R_5 + R_4')} = \frac{1}{3}, \quad R_4' = \text{Parallel combination of } R_4 \text{ and diodes}$$

As a design example, consider

$C_1 = C_2 = 0.01 \mu\text{F}$	$R_4 = 10\text{k}\Omega$
$R_1 = 15.8\text{k}\Omega$	$R_5 = 40\text{k}\Omega$ nominally
$2R_2 = 31.8$	Diodes = 1N914 or 1N4148
$R_3 = 50\text{k}\Omega$	$R_S = 1\text{M}\Omega$

Using these component values,  $f_0$  will be 1004Hz. Resistor  $R_5$  must be adjusted for best amplitude stability. If  $R_5$  is too low, the oscillation might converge; if too large, then the oscillation will diverge until the output clips. An oscillation output of 6V peak-to-peak when operating from a 9V battery is recommended. Resistor  $R_5$  needs to be a nominal 40k $\Omega$  with a  $\pm 2.5\text{k}\Omega$  adjustment range.

The OP-22 is operated with a 1M $\Omega$  set resistor for a set current of 7.8 $\mu\text{A}$  which corresponds to a supply current of approximately 100 $\mu\text{A}$ . Gain-bandwidth product and slew-rate vary directly with the set current, so  $R_S$  should be optimized for the specific oscillation frequency. Supply drain can be reduced for lower frequencies. The OP-22 works well for frequencies in the range of 100Hz to 1kHz; the OP-27 is recommended for higher frequencies.

