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

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

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 \( \pm 2.5 k\Omega \) adjustment range.

The OP-22 is operated with a 1M\Omega set resistor for a set current of 7.8\mu A which corresponds to a supply current of approximately 100\mu A. Gain-bandwidth product and slew-rate vary directly with the set current, so \( R_5 \) 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.