Easily Tuned Sine Wave Oscillators

One approach to generating sine waves is to filter a square wave. This leaves only the sine wave fundamental as the output. Since a square wave is easily amplitude stabilized by clipping, the sine wave output is also amplitude stabilized. A clipping oscillator eliminates the problems encountered with AGC stabilized oscillators such as those using Wein bridges. Additionally, since there is no slow AGC loop, the oscillator starts quickly and reaches final amplitude within a few cycles.

If a lower distortion oscillator is needed, the circuit in Figure 2 can be used. Instead of driving the tuned circuit with a square wave, a symmetrically clipped sine wave is used. The clipped sine wave, of course, has less distortion than a square wave and yields a low distortion output when filtered. This circuit is not as tolerant of component values as the one shown in Figure 1. To insure oscillation, it is necessary that sufficient signal is applied to the zeners for clipping to occur. Clipping about 20% of the sine wave is usually a good value. The level of clipping must be high enough to

The circuit in Figure 1 will provide both a sine and square wave output for frequencies from below 20 Hz to above 20 kHz. The frequency of oscillation is easily tuned by varying a single resistor. This is a considerable advantage over Wein bridge circuits where two elements must be tuned simultaneously to change frequency. Also, the output amplitude is relatively stable when the frequency is changed.

An operational amplifier is used as a tuned circuit, driven by square wave from a voltage comparator. Frequency is controlled by \( R_1, R_2, C_1, C_2, \) and \( R_3 \), with \( R_3 \) used for tuning. Tuning the filter does not affect its gain or bandwidth so the output amplitude does not change with frequency. A comparator is fed with the sine wave output to obtain a square wave. The square wave is then fed back to the input of the tuned circuit to cause oscillation. Zener diode, \( D_1 \), stabilizes the amplitude of the square wave fed back to the filter input. Starting is insured by \( R_6 \) and \( C_5 \) which provide dc negative feedback around the comparator. This keeps the comparator in the active region.

If a lower distortion oscillator is needed, the circuit in Figure 2 can be used. Instead of driving the tuned circuit with a square wave, a symmetrically clipped sine wave is used. The clipped sine wave, of course, has less distortion than a square wave and yields a low distortion output when filtered. This circuit is not as tolerant of component values as the one shown in Figure 1. To insure oscillation, it is necessary that sufficient signal is applied to the zeners for clipping to occur. Clipping about 20% of the sine wave is usually a good value. The level of clipping must be high enough to

![FIGURE 1. Easily Tuned Sine Wave Oscillator](image-url)
In both oscillators, feedforward compensation\(^2\) is used on the LM101A amplifiers to increase their bandwidth. Feedforward increases the bandwidth to over 10 MHz and the slew rate to better than 10 V/µs. With standard compensation the maximum output frequency would be limited to about 6 kHz.

Although these oscillators are not particularly tricky, good construction techniques are important. Since the amplifiers and the comparators are both wide band devices, proper power supply bypassing is in order. Both the positive and negative supplies should be bypassed with a 0.1 µF disc ceramic capacitor. The fast transition at the output of the comparator can be coupled to the sine wave output by stray capacitance, causing spikes on the output. Therefore the output of the comparator with the associated circuitry should be shielded from the inputs of the op amp.

Component choice is also important. Good quality resistors and capacitors must be used to insure temperature stability. Capacitor should be mylar, polycarbonate, or polystyrene — electrolytics will not work. One percent resistors are usually adequate.

The circuits shown provide an easy method of generating a sine wave. The frequency of oscillation can be varied over greater than a 4 to 1 range by changing a single resistor. The ease of tuning as well as the elimination of critical agc loops make these oscillators well suited for high volume production since no component selection is necessary.

REFERENCES
Easily Tuned Sine Wave Oscillators

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.