Friday, 2/24/17

Nonlinear Oscillators

Our definition: an oscillator with a periodic non-sinusoidal output, such as a square wave.

1) Sinusoidal oscillator circuit with really high amplifier gain, much higher than necessary to satisfy the BSC

Let's revisit the Wein bridge oscillator (shown on next page)

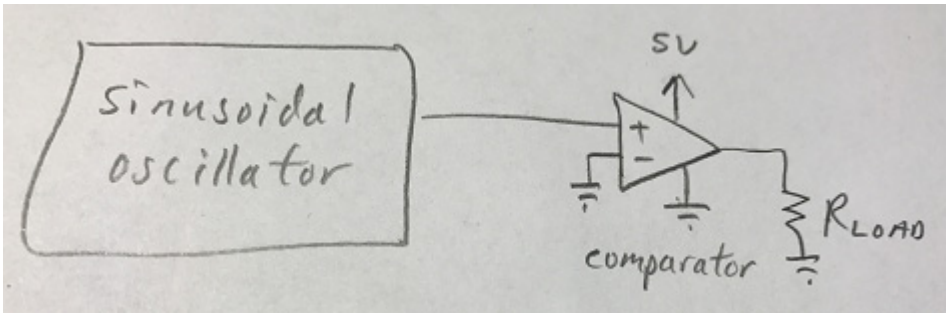
R_3 of 15 kΩ achieved oscillation. Let's make R_3 by 25 kΩ and evaluate the difference. As R3 gets large, the tops of the output signal flatten out, more closely approximating a square wave. This forces more of the time varying signal to reside in the nonlinear range of the op amp, effectively clipping it.

However, the bottom part of the output square wave is close to -4V, not 0V, as would be expected of a digital signal. A clipping diode can be added off the op amp output signal and applied to a 100 kΩ load resistor. This removes most of the negative going part of the periodic signal.

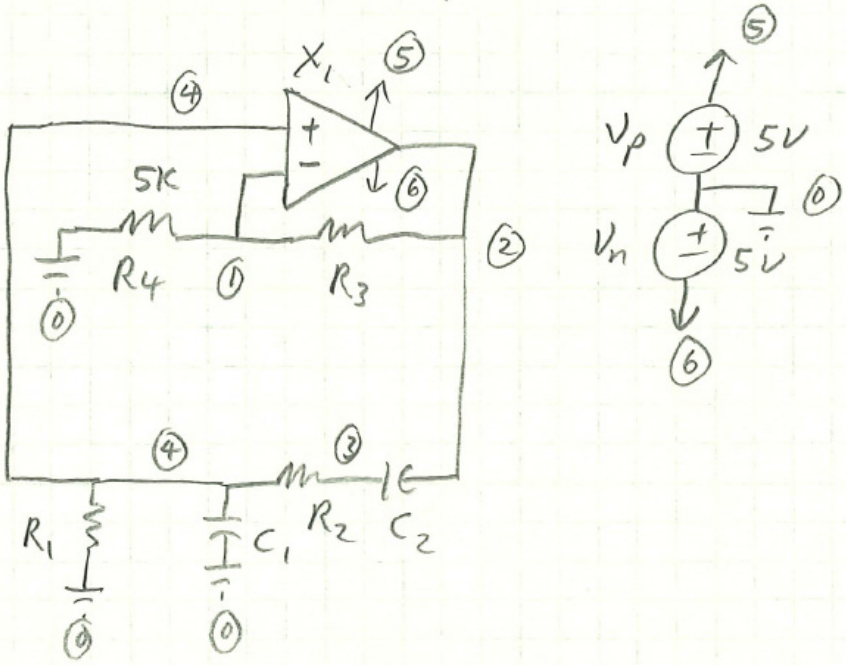
Two CMOS inverters were added after the 100 kΩ load resistor, and fed to another 100 kΩ load resistor to square up the signal <see below>.

2) A rail-to-rail comparator added to the sinusoidal oscillator's output

This circuit can convert the sinusoidal output voltage to a square wave.



PSpice Simulated Wein Bridge Oscillator



$f = \frac{1}{2\pi RC} = \frac{1}{2\pi(159.155)(1\times10^{-6})} = 1000\ kHz$

$C_1 = C_2 = 1\mu F$

$R_1 = R_2 = 159.155\Omega$

$1 + \frac{R_3}{R_4} = 3 \rightarrow R_4 = 5K\Omega,\ R_3 = 10K\Omega$

X_1: AD8610 op amp → 25MHz GBW product

Result → no oscillation

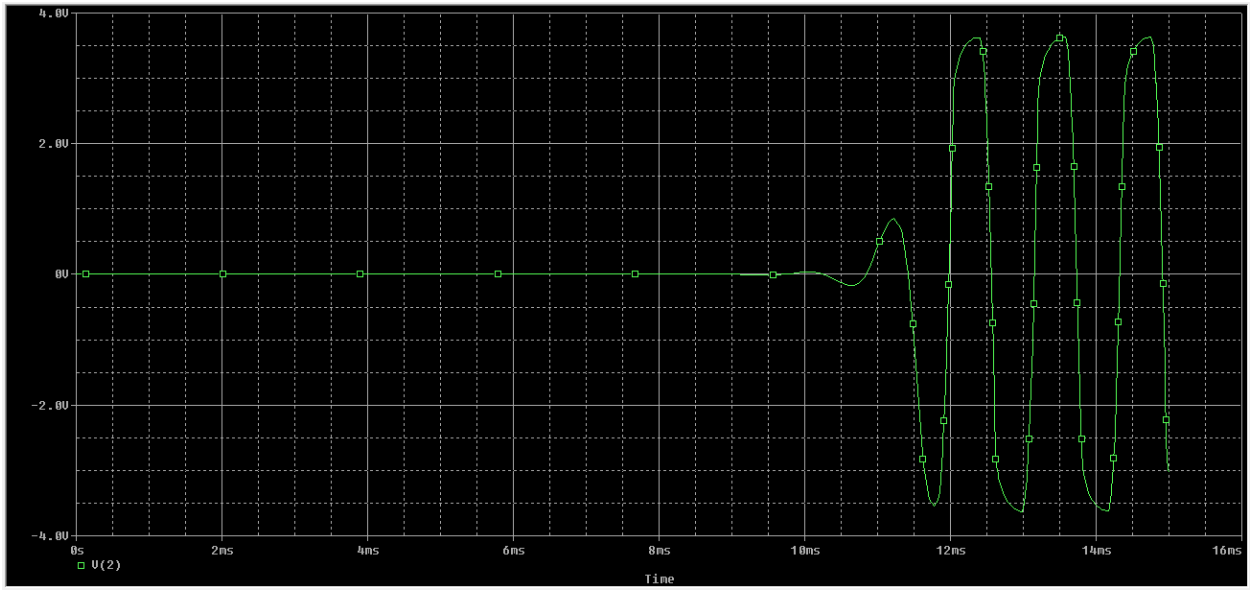
∴ R_3 increased to 15 KΩ to achieve oscillation

Output: Distorted sinusoid: f = 857.93 Hz

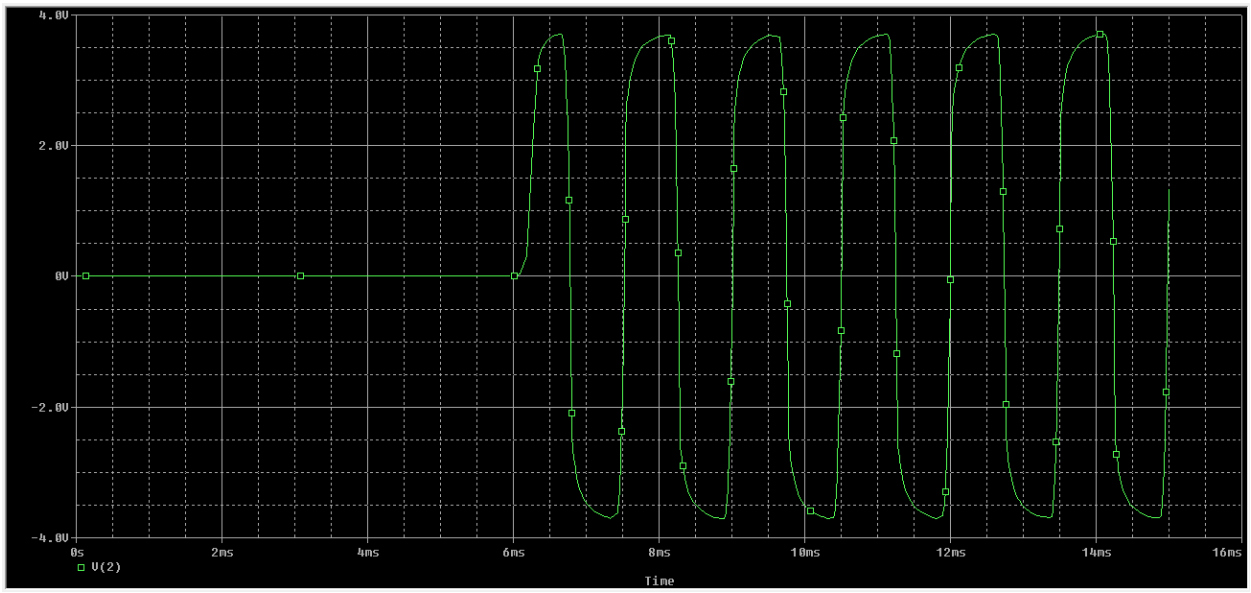
Possible causes for lower freq:

① phase shift in op amp

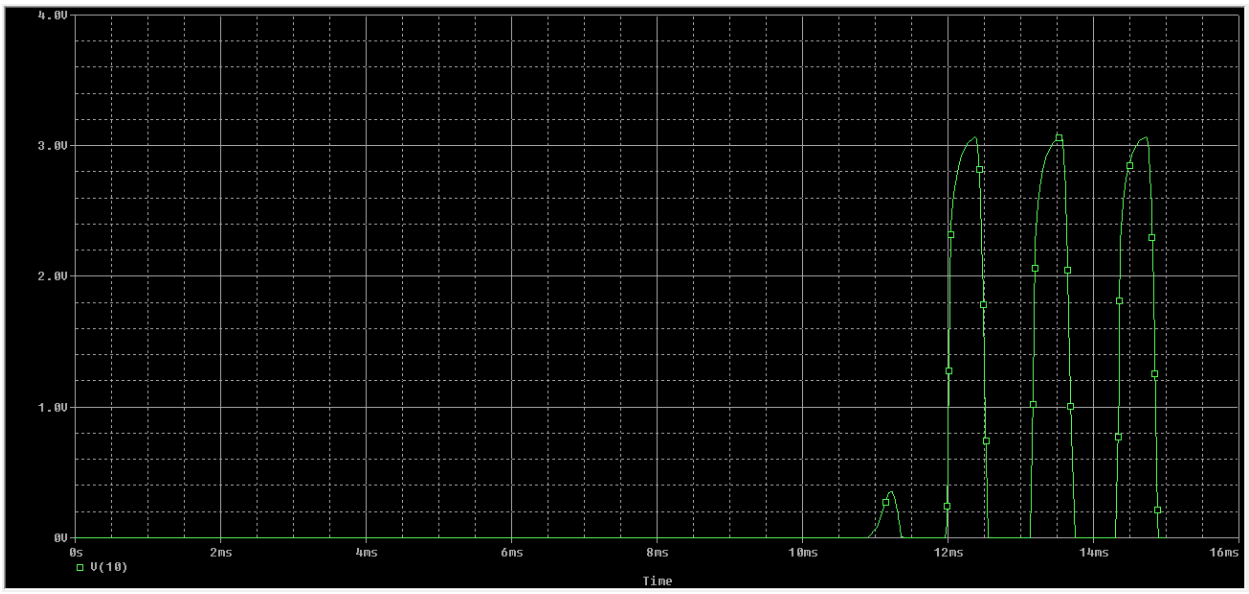
② nonlinear distortion near power supply rails



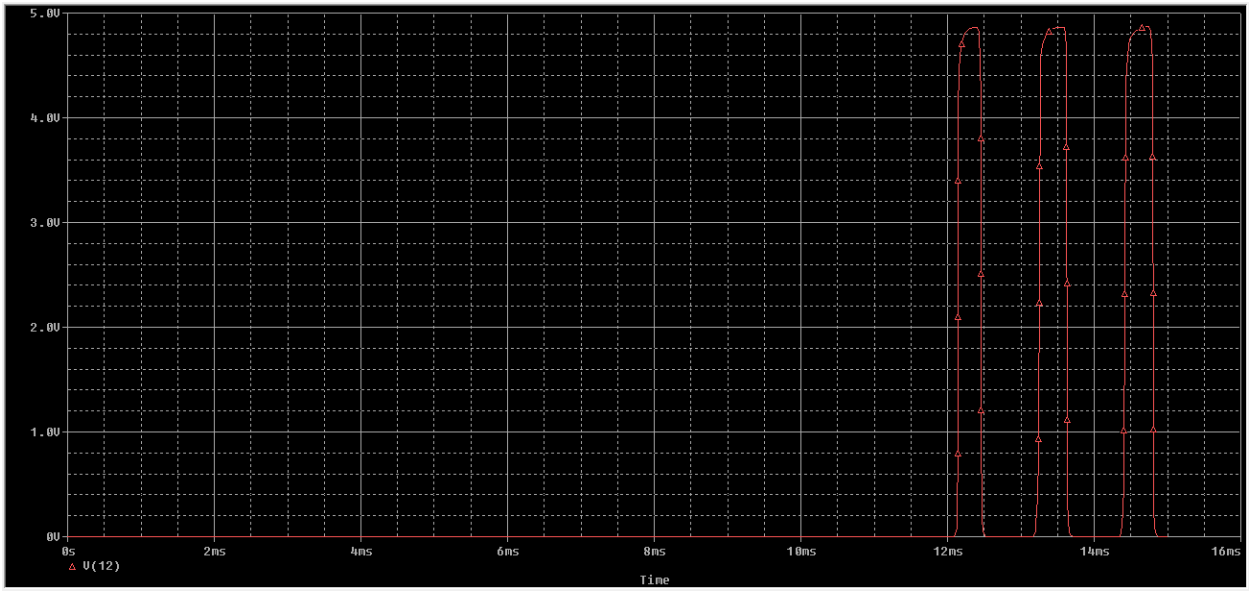
V(2) with R3 = 15 kΩ



V(2) with R3 = 25 kΩ



Voltage waveform after the diode. Observe that the peak voltage has dropped due to the voltage drop across the diode.



Voltage waveform after two CMOS inverters following the clipping diode circuit.