

Inexpensive voltage-controlled oscillator is rich in harmonics over entire audio range

For no more than \$5.50, a voltage-controlled oscillator (VCO) can be constructed to generate four harmonic-rich waveforms. Moreover, these four outputs can be processed through voltage-controlled filters and then mixed to produce a nearly infinite variety of sounds, making this VCO particularly suitable for music-synthesizer applications. The fundamental frequency is determined by V_{in} , which ranges from 5 mV to 5 V, typical, without losing any linearity.

The circuit in the figure is based on the classic scheme for VCOs: a voltage-controlled switched integrator (IC₁) followed by a Schmitt trigger (IC₂). The cycle of operation is straightforward.

Starting on the descending ramp of the triangle wave at output 1, note that the Schmitt trigger's output (pin 3 of IC₂) is low, which opens switches SW₁, SW₃ and SW₄, and closes (via the inversion provided by Q₁) SW₂. Thus, output 1 and output 3 are equal, output 2 is at its lowest level (-7.5 V), and output 4 is at zero.

When the trigger level of IC₂ (-2.5 V) is attained,

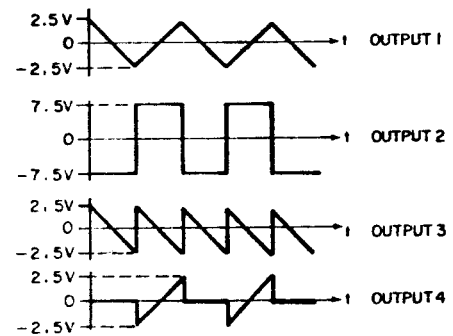
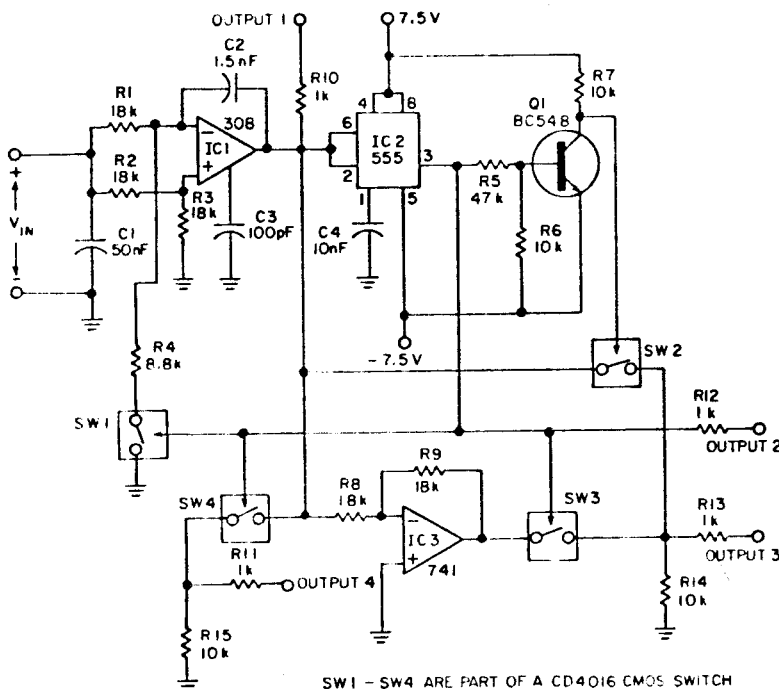
its pin 3 goes high (and so does output 2), which closes SW₁, SW₃ and SW₄, and opens SW₂. Then, as the output of integrator IC₁ begins to rise, output 4 becomes equal to output 1, while output 3 equals output 1 × -1 (multiplication done by IC₃). When IC₂'s upper threshold (2.5 V) is reached, its output (pin 3) goes low again, and the cycle repeats.

The result is the four output waveforms shown. Note that the frequency of the sawtooth (output 3) is twice the frequency of all the other outputs.

A 308 op amp is suitable for the integrator because of its low offset voltage and very high input impedance, which allow the oscillator to work over a wide range of values for V_{in} . With the components shown, the conversion factor (frequency/ V_{in}) is 2 kHz/V, which can be easily modified by changing C₂. It is quite possible to operate over the entire audio range without changing the conversion factor.

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The four outputs from this low-cost, widely adjustable VCO can be processed through filters and

mixed to form musical sounds. Output 4 is particularly useful for simulating reed instruments.