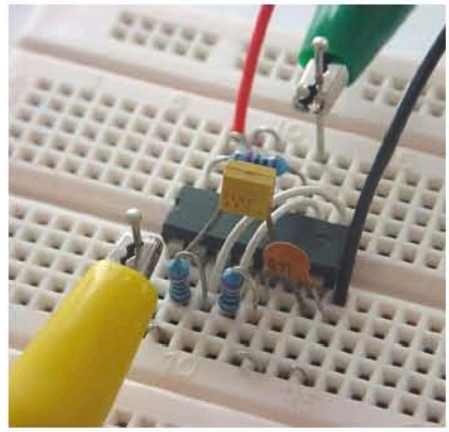
Theremin Is Alive and Well



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Léon Theremin (or as he was christened, Lev Sergeivitch Termen), a Russian inventor, left the ranks of the living in 1993, but the electronic musical instrument that he invented in 1919 and which bears his name has made him nearly immortal [1]. Here we describe a modern version of this instrument, which is played without touching it and has an almost mystical aura. After an hour's worth of work with the soldering iron, you can entrance your audience with unworldly sounds.

Of course, the construction of a real theremin is more complicated than the circuit described here. By using a small medium-wave AM radio as a supplementary external component, we managed to considerably reduce the number of components. This is because a theremin is essentially nothing more than a small radio transmitter whose frequency can be modified by moving your hand closer or further away, within a range of around 30 cm. This frequency change (modulation) results from the effect of capacitive coupling, and if you select the right carrier frequency it can be converted to the audible frequency range by using a suitable receiver.

With a bit of practice, you can easily learn how to wave your hands and arms in the air close to the theremin in order to impress your listeners with melodies produced entirely under your control – a process that often appears like magic to spectators who aren't aware of how it works. The circuit described here has one distinct shortcoming relative to a genuine theremin, which is that it not possible to vary the loudness of the generated tones.

The circuit is based on a type 4093 CMOS IC. The prototype was built using a Motorola type MC14093BPC. Only three of its four gates are used here. The inputs of the unused gate (IC1d) are tied to the supply voltage rail in order to prevent interference.

The first two gates act as oscillators. Gate IC1a oscillates at approximately 3 MHz, as determined by the frequency formula $f = 1 / (2.2 \times R \times C)$. In practice, the frequency of the oscillator is slightly lower than the calculated frequency. IC1b oscillates at around 100 kHz. The outputs of the two oscillators are mixed in gate IC1c. The signal from the mixing stage is responsible for the audible tone, which can be received by a radio placed next to the circuit – not only at 3 MHz, but also at several other spots on the dial. It can even be received in the short-wave band.

With the circuit switched on, rotate the tuning knob of the radio until you find the setting where the signal has the maximum volume and the least interference. You should hear a constant tone from the speaker. If you now move your hand close to the sense electrode (marked 'Sensor' in the circuit diagram), your body capacitance acts in parallel to C1 to increase its effective capacitance. This changes the frequency of oscillator IC1a, and thus the frequency of the audible tone. With only a small amount of practice, you can learn to play the instrument and produce exactly the melody you want to hear.

Use a short, well-soldered wire to connect the sensor to the circuit board. A piece of aluminium foil or copper-plated circuit board makes a suitable sensor. In the photo, the connection is made using the yellow alligator clip.

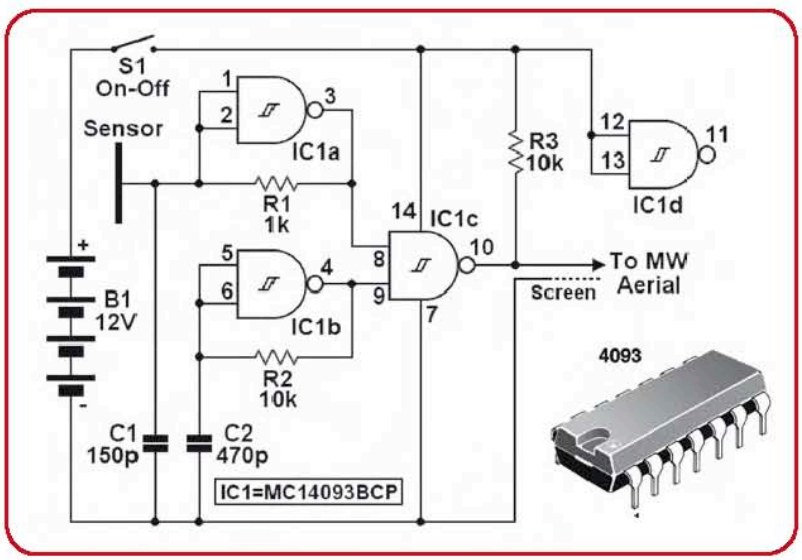
You can use a length of coaxial cable to feed the output signal of the circuit (from the pin with the green alligator clip in the photo) to the aerial input of the AM radio used as a receiver. The screen braid of the cable must be connected to circuit ground.

As radio receivers with an aerial connector for medium-wave signals have become rather scarce nowadays, you can also fit an alligator clip to the far end of the cable and secure it to the ferrite rod antenna of the receiver.

The Theremin circuit can also be used for non-musical purposes, such as a person detector or theft alarm. If you use a large piece of aluminium foil as a sensor and place it under the doormat, the arrival of a visitor will be signalled by a change in the pitch of the tone. Naturally, you could also use a metallic door knocker as the sensor.

If an object that you want to protect against theft is placed on top of the sensor foil, it effectively becomes part of the sensor. This means that the pitch of the tone will change if the object is removed. Here the actual sensor can be concealed by a non-conductive object, such as a tablecloth, a book, or the like.

The circuit can be powered by a battery or a (non-stabilised) 12-V AC mains adapter, and it draws only a few milliamperes.



Internet Link

[1] www.thereminvox.com