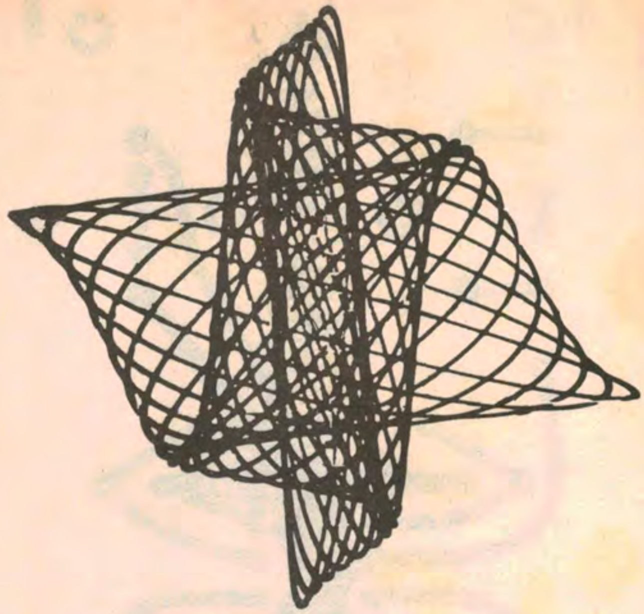
LISSAJOUS PATTERN GENERATOR



For Fun with an Oscilloscope

Based on a design published in "Elektor" magazine in September, 1978, this clever circuit using just three economy ICs will generate an endless variety of Lissajous figures on your oscilloscope. You can also use the circuit to produce some very interesting sound effects. Why not build it up just for fun?

by GERALD COHN

A great many of our readers have an oscilloscope and although it is an extremely useful instrument, it spends most of its time displaying a horizontal line, or even a blank screen. The circuit presented here can remedy this situation in that it produces a multitude of fascinating and attractive geometrical patterns on the screen of the scope.

The patterns are actually so-called "Lissajous" figures which are generated by two resonant circuits which are triggered at regular intervals, producing two damped sinusoidal outputs. By feeding these to the X and Y-inputs of the oscilloscope and disabling the internal timebase, we can modulate the position of the trace in a variety of patterns.

Perhaps the simplest possible example of a Lissajous figure is the case where we have two sine wave signals of exactly the same amplitude and frequency, but 180 degrees out of phase. The resulting pattern will be a perfect circle. If we were to now change the phase relationship between the two signals, say decrease the difference from 180 degrees to 90 degrees, the pattern will change from a circle to an elipse inclined at a 45 degree angle. Decreasing the phase difference even further, to zero degrees will result in a straight line at a 45 degree inclination.

One of the most familiar examples of a Lissajous figure is the pattern used by the ABC television network as its logo. This is generated using two sinewave signals, one of which is three times the frequency of the other, with the phase difference between them being 180 degrees.

Having said that, let us now take a look at how our circuit generates the patterns shown in the photographs. It should be noted at this stage that a complete analysis of the circuit is beyond the scope of this article.

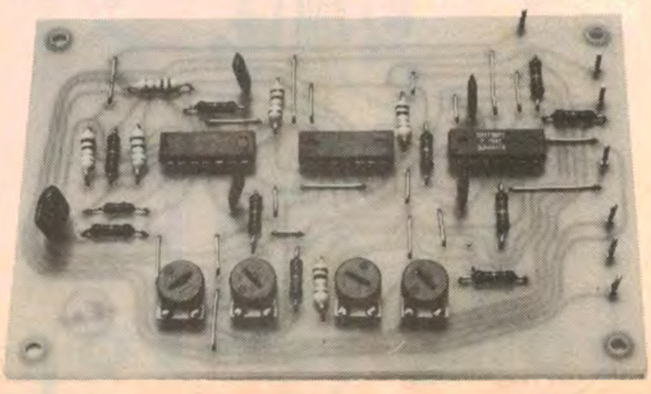
As mentioned before, the generation of these patterns requires two sinusoidal waveforms which have a fixed phase relationship between them.

The circuit has three major elements: an astable multivibrator with an uneven duty cycle, a quad bilateral switch and a pair of oscillators with variable damping. The two oscillators are switched on and off at regular intervals by the astable multivibrator. The two oscillators comprise IC1c and IC1d as the first and IC3b and IC3c, as the second.

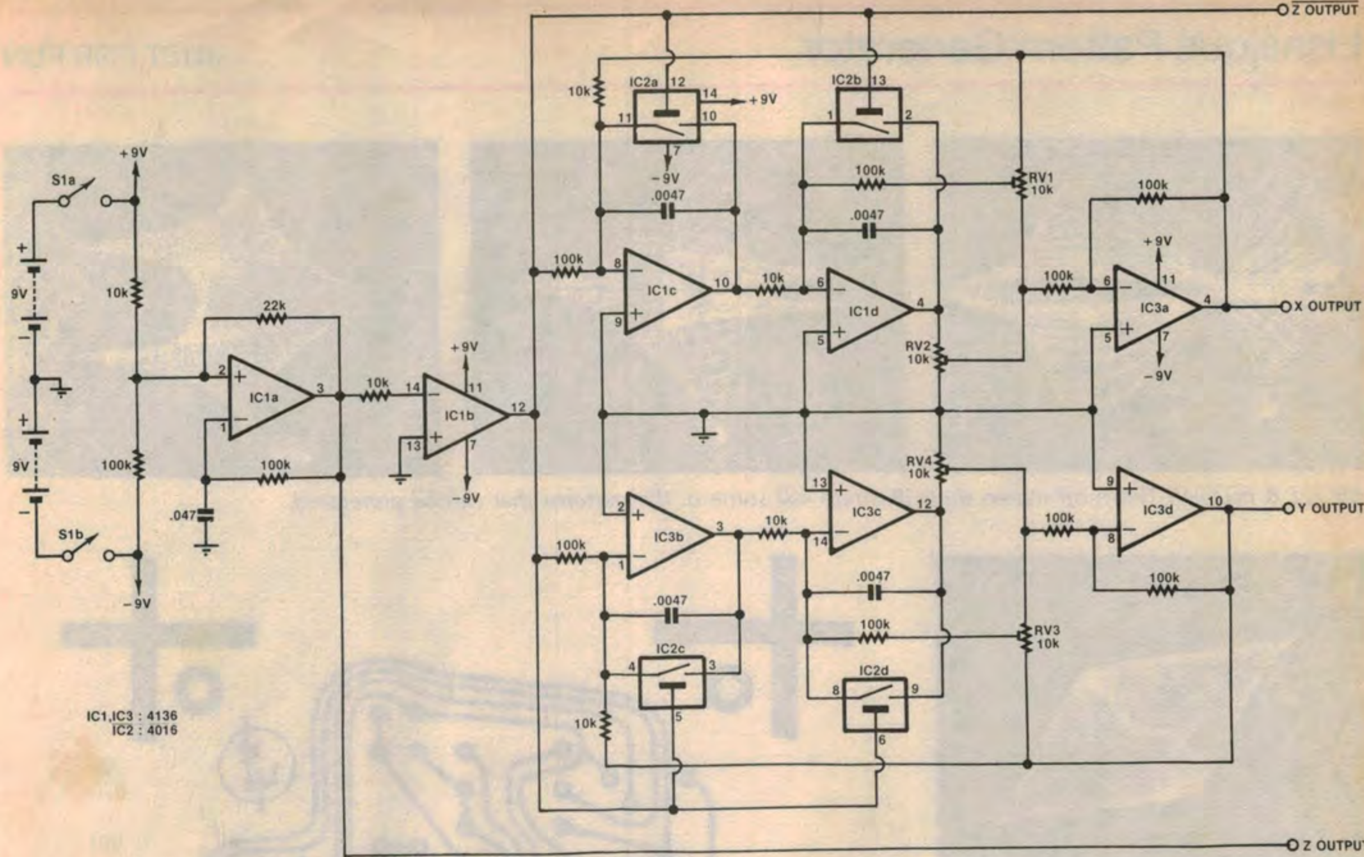
Synchronous switching of the two oscillators is accomplished by IC2, the quad bilateral switch, which is driven by the inverted and buffered output of multivibrator IC1a. Notice that the multivibrator buffer IC1b not only switches off the oscillators via IC2 (which shorts the .0047uF capacitors) but also triggers them back into oscillation via the 100k resistors connected to pins 1 and 8 of IC1c and IC3b respectively.

Because of the novel arrangement of multiple feedback paths around the two oscillators and their output buffers, IC3a and IC3d, the switching on of the two oscillators causes negligible DC shifts at the two outputs, although depending on the settings of the variable controls, there is usually a DC shift when the oscillators are switched off. This can be clearly seen on the dual trace waveforms which show how the oscillators work in synchronism.

The same dual trace patterns show how the frequency and "envelopes" of the two oscillators can be varied by means of the potentiometers RV1, 2, 3, and 4. By suitable juggling of these controls, the oscillators can be made to behave as if they were damped, which



A single PC board accommodates all of the circuitry. Note that a few detail changes were made to the board pattern after this photograph was taken.



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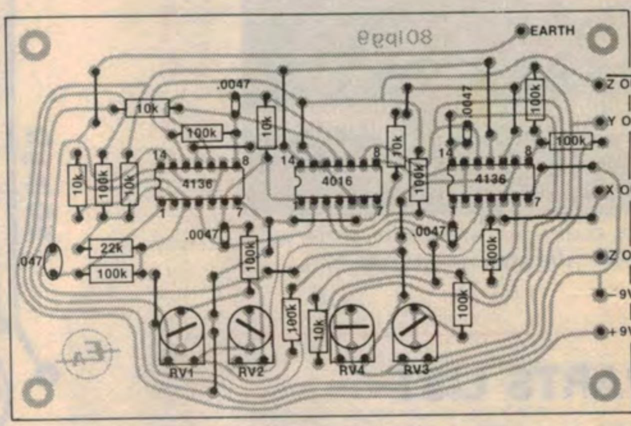
The circuit can be divided into three sections: an astable multivibrator (IC1a), a quad bilateral switch (IC2), and two oscillators (IC1c & IC1d; IC3b & IC3c).

gives rise to a large oscillation amplitude at first and then tapering off. Alternatively, the oscillators may appear undamped, in which case, the oscillation amplitude starts off relatively small and gradually builds up to a high level before being switched off.

Apart from the X and Y-outputs from the circuit, we have also provided trace modulation outputs, Z and Z-bar (the opposite polarity). If your oscilloscope has a Z-modulation input (generally found on the rear of the instrument), one or other of these outputs may be suitable for trace blanking during the periods in which the oscillators are switched. The circuit did not provide sufficient blanking voltage for the oscilloscope used for our photography, which is why there is a bright spot in each Lissajous figure.

The circuit may be powered from balanced supply rails of ±5V up to a maximum of ±9V. This upper limit is set by the maximum voltage rating of the 4016 quad bilateral switch. At ±9V, the current drain is typically 12 milliamps.

We have designed a printed circuit board for the unit, coded 80lpg9 and measuring 81 x 124mm. All the components are mounted on the board, including the four trimpots that are used to vary the patterns. Conventional potentiometers may be substituted for the trimpots if so desired.

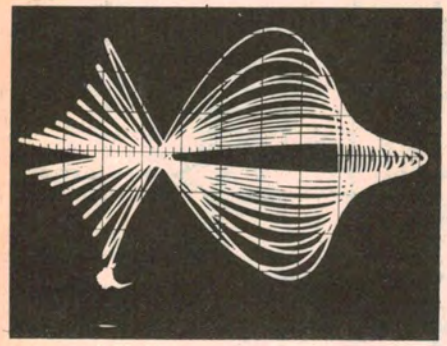


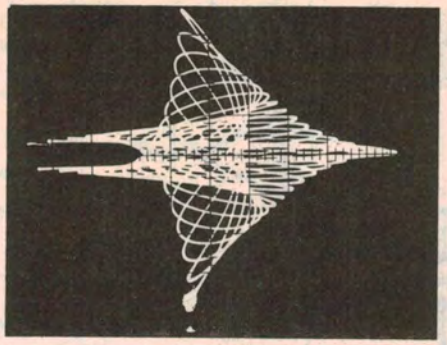
Follow this component overlay diagram when wiring up the unit. Use PC stakes to terminate external connections to the CRO and power supply rails.

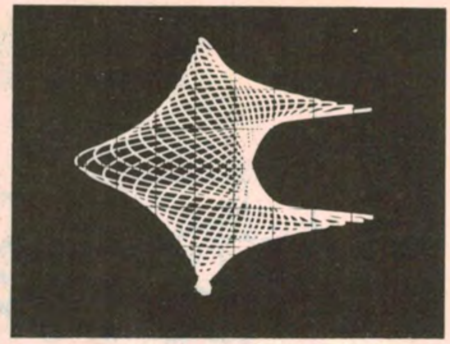
Construction is a simple matter, taking only about three quarters of an hour or so. The first thing to do is to place the links on the board and solder these in place. Follow these up with the resistors and the capacitors, and then finally the ICs. Note that the 4016 is a CMOS IC and that the usual precautions pertaining to the handling of CMOS should be taken: use a soldering iron with the barrel connected by a clip lead to either supply rail; solder the supply pins, 14 and 7, first and then solder the others.

The connections to the board are few but we suggest the use of PC stakes for this since they are so much more convenient when it comes to testing and terminating the board.

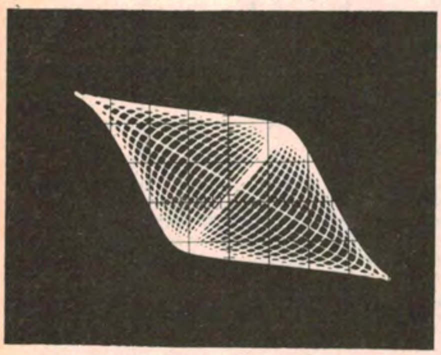
Assuming that you have checked the assembly of the board, apply power to it and then with a CRO, check the outputs of the two channels. If you have a dual trace CRO you can check both channels at the same time. The things to look for when checking the outputs are a decaying waveform whose frequency will vary in sympathy with one of the pots, and the rate of decay varying with adjustment of the other pot.

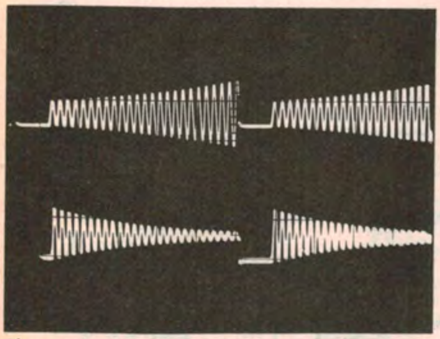






ABOVE & BELOW: These off-screen shots illustrate just some of the patterns that can be generated.

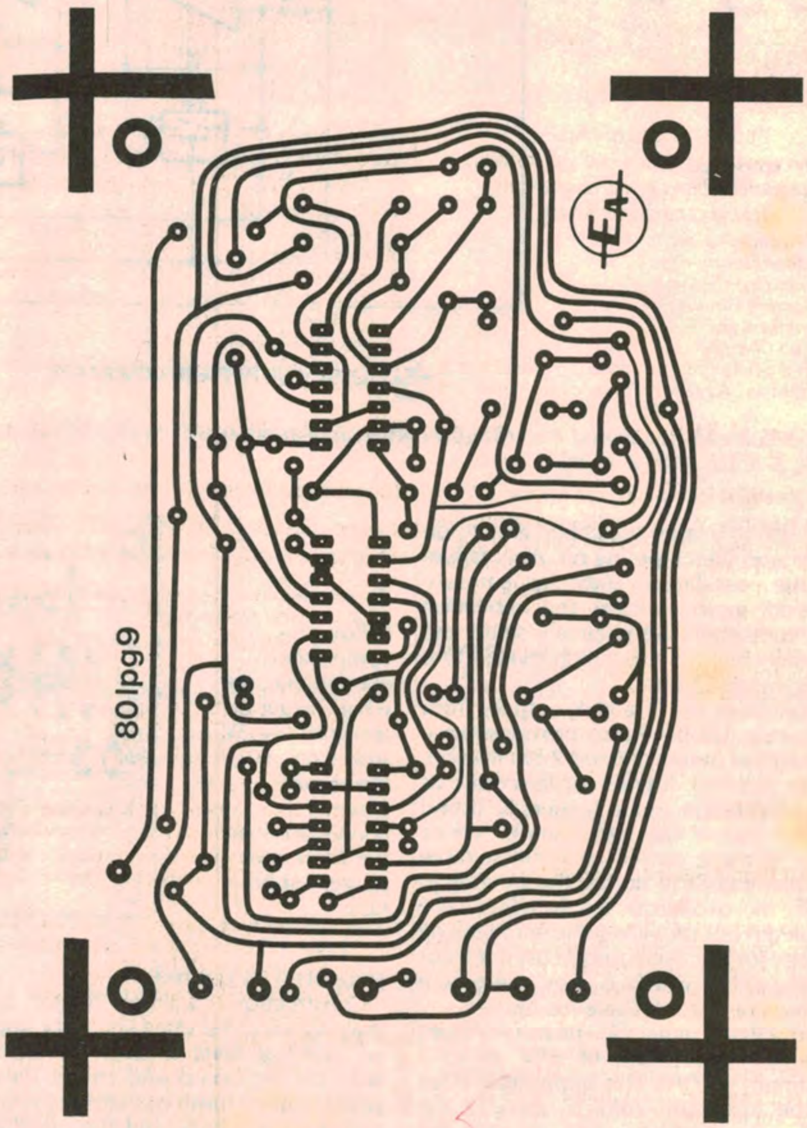




These dual trace waveforms were used to create the pattern on page 52.

PARTS LIST

1 PC board 81 x 124mm, code 801pg9
2 4136 ICs (quad op-amps)
1 4016 IC (quad bilateral switch)
4 10k miniature trimpots (see text)
1 double-pole, double-throw miniature toggle switch
2 9-volt batteries (type 216 or similar)
2 clips to suit batteries
7 PC stakes
RESISTORS (¼ or ½ wat, 5%)
10 x 100k, 1 x 22k, 6 x 10k
CAPACITORS
4 .0047uF metallized polyester
1 .047uF metallized polyester



When you are satisfied that the two oscillators are working properly, connect the CRO up for modulated XY operation and try setting up some patterns. You will find out with a little patience that the number of patterns that you can generate is almost infinite.

For those readers who may like to take this a little further, another thought might be to build a second trigger circuit, and trigger the two oscillators independently. This provides even more variety in the patterns since there is no fixed phase relationship between the two oscillators; ie the patterns will shift around continuously.