Experimenter's Corner

By Forrest M. Mims

APPLICATIONS FOR QUAD OP AMPS

NO IC is more useful or versatile than the operational amplifier unless it's four op amps in the same package. Quad op amps, as these relatively new chips are called, are now stocked by many parts dealers, and one of my favorites is National's LM324.

The LM324 (Fig. 1) comes in a 14-pin DIP for less than two bucks. The most impressive fact about this neat little package is that it can be operated from a single-polarity power supply. Some more experienced tinkerers might find it hard to believe that many new experimenters are reluctant to use op amps because conventional units require a double-ended power supply.

Another nice thing about the LM324 is that it will operate from a power supply ranging from as little as 3 volts to as much as 30 volts. This makes it compatible with TTL (5.5 volts) and ideal for operation from almost all common battery voltages.

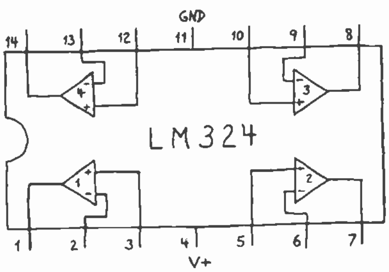

Fig. 1. Top view of the LM324.

I've been using LM324s for about a year now and haven't blown one yet, but the manufacturer warns that reverse polarity can quickly zap the device. The moral here is that if you use breadboard construction or conventional sockets be sure to plug the LM324 into the board or socket correctly.

Another precaution is to avoid output shorts to either ground or the positive power supply. Momentary shorts are no problem, but longer ones, especially on more than one amplifier, will cause excessive thermal build-up and eventual device destruction.

The LM324 will handle just about any op amp application, but it is particularly well suited for those utilizing several similar or identical circuits to perform parallel functions. I've particularly enjoyed tinkering with a versatile pulse generator and a nonlatching touch switch.

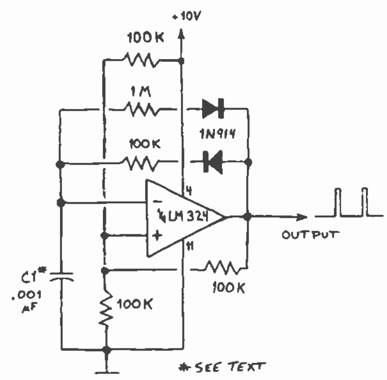

Fig. 3. Change C1 to vary pulses.

A basic pulse generator circuit which uses ¼ of an LM324 is shown in Fig. 2. Except for the common power supply, each of the four amplifiers in the LM324 is independent of the others, and one or more can be used simultaneously as noninteracting pulse generators.

With the values shown in Fig. 2, the pulse generator has a repetition rate of about 600 Hz and a pulse width of 600 microseconds. The pulse amplitude is 8.5 volts when the power supply voltage is 10 volts. All these parameters can be changed by varying *C1* and the power supply voltage.

A somewhat more versatile pulse generator is shown in Fig. 3. The repetition rate of this circuit can be changed from one pulse every few minutes to 200 kHz by simply changing *C1*. Here's a table of pulse parameters I measured with the prototype circuit:

C1 (µF)	Frequency (kHz)	Pulse Width (ms)
0.0001	200.0	0.025
0.001	20.0	0.25
0.01	2.0	2.5
0.1	0.2	25.0

You can use even larger values for *C1* to further reduce frequency.

The conventional pulse generator of Fig. 3 can also be used to experiment with applications like these:

1. A quadruple-output, nonsynchronized pulse source. Just connect each of the op amps in the LM324 as an independent pulse generator.

2. A dual-synchronized pulse generator with two independent repetition rates. Figure 4 shows how to connect two op amps in the LM324 to achieve this function. A circuit like this has obvious uses in electronic music, frequency synthesis, frequency division, etc.

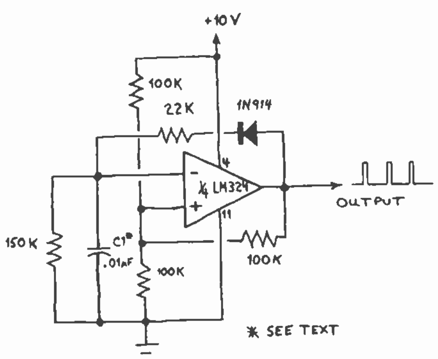

Fig. 2. Pulse generator circuit.

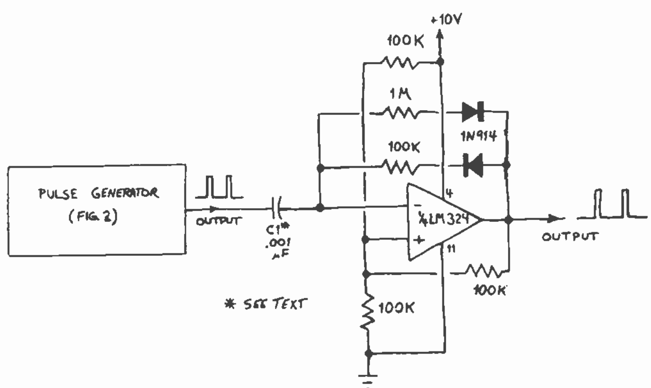

Fig. 4. Synchronized pulse generator uses half of an LM324.

3. A LED "random" flasher. See Fig. 5 for this variation of the circuit. For best results, use different values for the capacitors (*C1* in Fig. 3) to provide different flash rates. These values should range from about 0.2 to 1.0 µF so that the flashing will be discernable to the eye. Incidentally, you can house this circuit in a small plastic enclosure for permanent use as a novelty or attention-getting device.

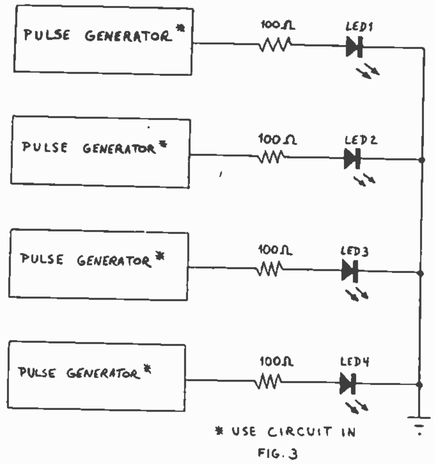

Fig. 5. Random LED flasher.

If the assorted pulse generator circuits described thus far don't appeal, try the super-simple nonlatching touch switch shown in Fig. 6. In this circuit, ¼ of an LM324 is operated as a comparator by simply omitting the feedback resistor. The noise signal injected into the op amp by a finger on the touch plate causes a positive voltage swing which activates the relay.

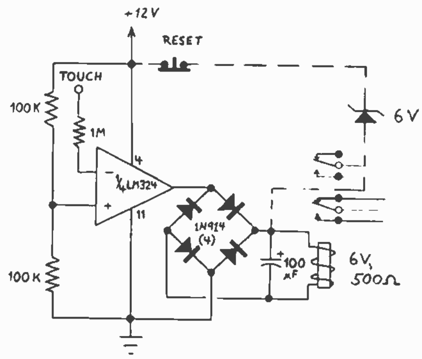

Fig. 6. Touch switch. For latching operation, add dashed circuitry.

Since the input noise signal is ac, the rectifier bridge is necessary to convert the output to dc. The pulsed dc output is smoothed by the capacitor to keep the relay from chattering. For best results, operate the circuit from a line-operated power supply instead of batteries. When used with a 6-volt, 500-ohm relay, the circuit will draw less than 10 mA. ◈