FLIP-FLOP WITH OP AMPS

NEW DIGITAL USE FOR THE VERSATILE LINEAR OP AMP

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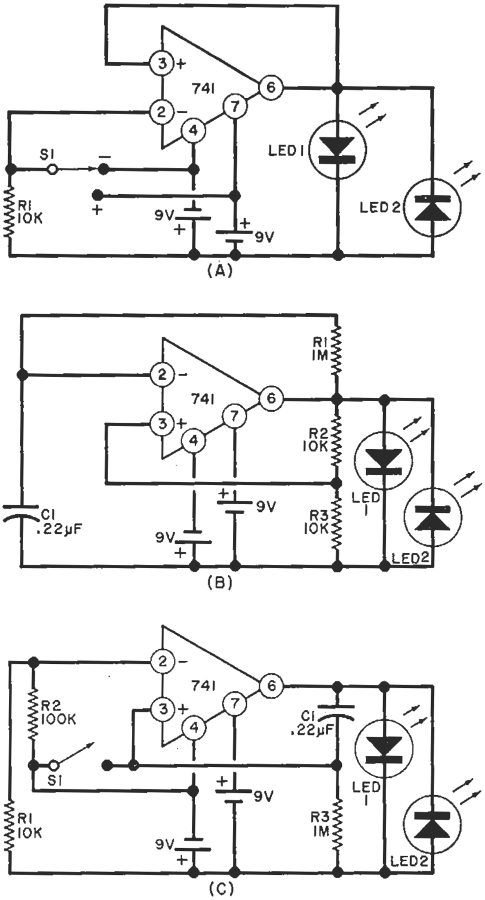
THE multivibrator is one of the most important circuits used in computers and other digital applications. Early multivibrator circuits used vacuum tubes with neon lights to indicate the "state" of the circuit. About ten years ago, transistorized multivibrators, using incandescent-lamp state indicators became popular. Now, a third generation of experimental multivibrators has evolved. They use linear integrated circuits with light-emitting diodes as the state indicators.

Three easy-to-build multivibrator circuits, using IC op amps, are shown in the diagram. The output of each of these circuits, as in all digital circuits, can only be at one of two voltages or states. Two light-emitting diodes (LED's) are used in each circuit to indicate whether the output is positive or negative.

Any of the popular gallium-arsenide-phosphide LED's will work well in these circuits. Each circuit uses two standard 9-volt transistor batteries and a type 741 operational amplifier.

Bistable Multivibrator (Flip-Flop). The easiest multivibrator to understand is the flip-flop, shown at (A) in the diagram. Assuming the output of the op amp (pin 6) is initially positive, *LED1* will be forward biased and on, with *LED2* reverse biased and off. The circuit is held in this condition by feedback to the positive (pin 3) input.

Now, if *S1* is momentarily switched to the positive supply voltage, the output will switch from positive to negative. Then



Unique digital uses for op amp: (A) a bistable flip-flop; (B) astable multivibrator; (C) monostable multivibrator.

LED1 goes off and *LED2* goes on. The feedback to pin 3 holds the circuit in this new state. If *S1* is now momentarily switched to the negative supply voltage, the output will flop back to its original state.

Because the flip-flop is stable for both postive and negative outputs (until *S1* is switched), the circuit is referred to as "bistable."

Astable Multivibrator. In contrast to the flip-flop, the circuit at (B) is not stable for either of the two possible outputs. To understand how this astable multivibrator works, assume that the op amp output is initially positive. In this case, *LED1* is on, *LED2* is off, and *C1* is charging up through *R1*.

As soon as the voltage across *C1* exceeds the fixed voltage at the positive input of the op amp, however, the output swings negative. Then *LED1* goes off and *LED2* goes on. Now *C1* charges negatively through *R1* until its voltage is less than the voltage at the positive input of the op amp. When this occurs, the output swings positive again and the cycle repeats.

For the component values shown, the LED's flash back and forth about twice a second.

Monostable Multivibrator (Single-Shot). While the flip-flop has two stable states and the astable multivibrator has no stable state, the monostable multivibrator, or single-shot, has one stable output state. The circuit of a single-shot is shown in the diagram at (C). Since the negative power supply is applied to the negative input of the op amp (through voltage divider *R1* and *R2*), the stable output state is positive. Now, *LED1* is on and *LED2* is off.

The single-shot can be triggered by momentarily closing *S1*. This applies a negative voltage to the positive input which causes the output to go negative. As soon as the switch is opened, however, *C1* will begin to charge through *R3*. When the voltage at the positive input exceeds the voltage at the negative input, the output will go back to its stable, positive state. The delay between the release of *S1* and the return of the circuit to its stable state is determined by the values of *C1* and *R3*. For the component values shown, the delay is about 0.5 second. ◈

LIQUID-CORE, LOW-LOSS OPTICAL FIBER

A SCIENTIST at Bell Laboratories has developed a new type of optical fiber which may be useful for optical communication systems of the future. The fiber is a liquid-filled fused quartz capillary which can transmit light signals with low transmission loss. The liquid used is tetrachloroethylene. The core diameter is about 65 microns, and the wall is about 15 microns thick. Loss characteristics for the fiber are 20 dB/km or less for 0.84-0.86 micron and 0.98-1.10 micron wavelengths.

Fiber research until now has focused on fibers with solid cores. The new liquid-core fiber, developed by Julian Stone, may someday be used in the Bell System for on-premises telephone connections, interoffice trunk lines, and large-capacity intercity phone links.

Optical fibers hold considerable promise as a high-capacity transmision medium in the future because of their small size, large bandwidth capacity, and potential low price. Bell Labs is conducting research in optical transmission techniques to anticipate the nation's needs for high-volume communication services in the future. It may not be long before fiber optics replace wires for the transmission medium. ◈