Experiment with a Binary Counting Demonstrator

It's easy to understand counting to the base two when you have a visual aid like this demonstrator to show you what's going on.

by DON LANCASTER

This binary counter demonstrator counts by two's instead of tens, showing the base two arithmetic and counting used by most computers. It counts up to sixteen and can be reset to zero at any time. You use it as a study or teaching aide, or as a science-fair or computer-technology entry, or for a school lab project. It uses three TTL integrated circuits and four transistors and may be built in an evening or two.

Why binary?

People are used to counting by tens, and before "modern math" came along, non-computer people gave very little thought to counting in any number base but ten. The problem with decimal or base ten counting is that you need ten
FIG. 2—COMPLETE WORKS of the binary counter. Note that the correct position of the IC's is indicated by the notch in one end.
ones) must deal with decimal, they re-encode it into a near-binary form, called Binary Coded Decimal (BCD). Even in this form, the numbers can only be handled in 16/10 the space that would be needed for binary, a storage penalty of 60% in the size of a machine. Arithmetic operations in BCD are also proportionately more complex than in straight binary.

How it works
The logic diagram of the demonstrator is shown in Fig. 1. The circuit consists of a four-stage binary ripple counter formed by cascading two dual JK flip-flop TTL integrated circuits. The input COUNT commands from a pushbutton are made noiseless and bounceless by a set-reset contact conditioning flip-flop made of half of a quad two-input gate TTL integrated circuit. Contact conditioning on the CLEAR line is not needed, for resetting a counter to 0000 a dozen times has the same effect as only doing it once. The states of the counters are indicated by connecting the Q terminal on each flip-flop to a lamp through an inverting pnp driver transistor.

Construction hints
The schematic is in Fig. 2. A printed circuit board is recommended for component mounting. Figs. 3 and 4 show how the board is set up. Three jumpers are needed. These may be made out of cutoff resistor leads and are positioned as shown.

Component locations are shown in Fig. 5. Note the polarity on C1 and the three IC's. The code notch and dot is between pins 1 and 14.

The photos show the internal assembly details. The circuit board is mounted on four standoffs along one end of the case, and leads are soldered directly to their respective pretinned terminal pads. The pilot lamps snap into place. Switch S1 is mounted with suitable hardware.

The binary counter may be powered by a high-quality 5-volt 250-mA lab bench supply, or the power supply shown in Fig. 2 may be built into the bottom of the case.

ROLLING PICTURE IN RCA KCS132A
The picture would roll constantly and would not lock-in vertically. When the vertical hold control was rotated the picture would roll up but never downward. The picture would roll slowly upward with the vertical hold control at top end of rotation. Undoubtedly, poor vertical sync. The vertical oscillator tube was changed. All voltages were quite close to what they were supposed to be, yet the picture continued to roll.

A check showed the feedback .0068-µF capacitor at the grid (pin 4) of the 6EM7 was leaky. A replacement restored normal performance. After a few years this capacitor becomes leaky and the picture has a tendency to roll.

Homer Davidson

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