How Multiplexed LED Displays Simplify Circuits

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A CONVENTIONAL digital readout system for LED's consists of a counter to generate a BCD (binary coded decimal) output and drive a seven-segment decoder for each of the seven segments. For several decades of readout, requiring a counter/decoder combination for each digit, the cost and circuit complexity can be very high.
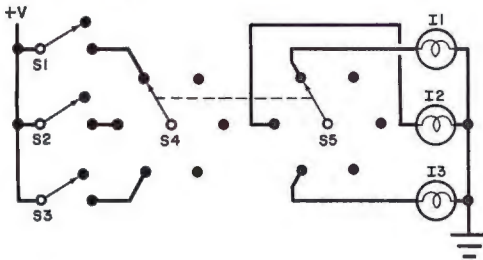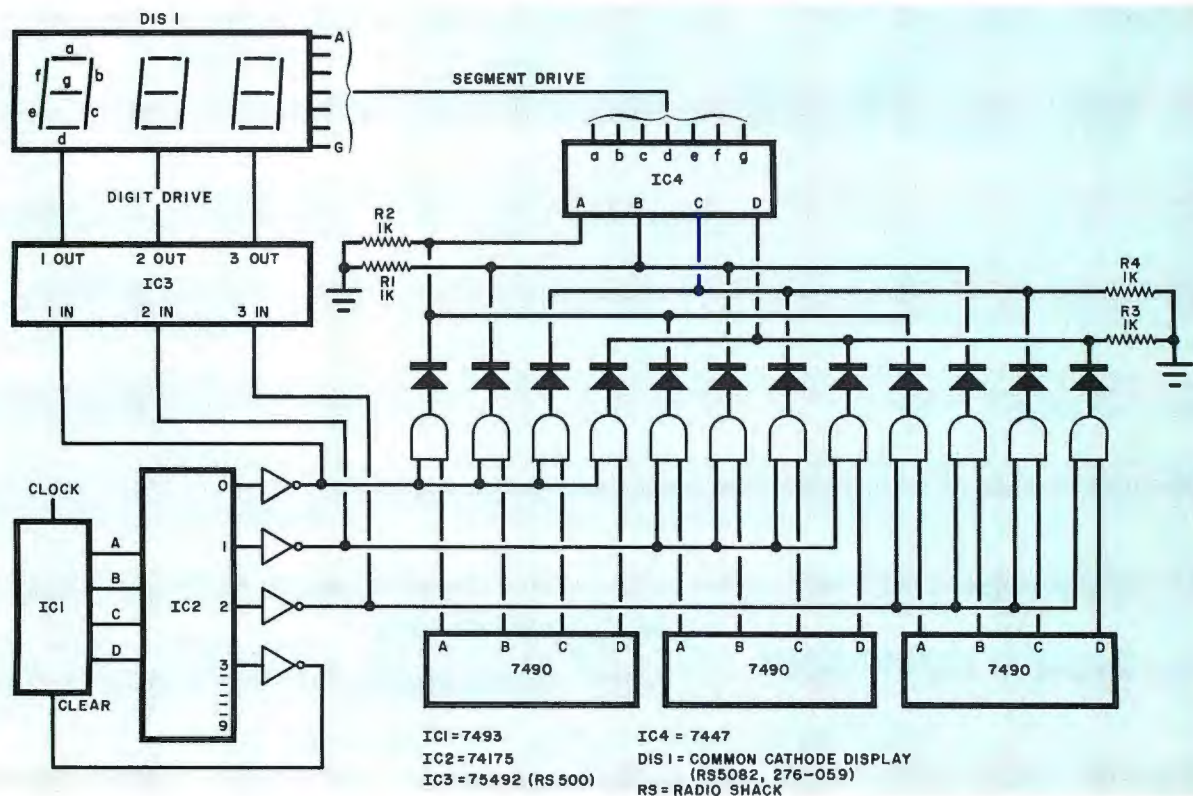
The use of digital multiplexing greatly reduces the number of parts and the size of a digital counter. It also means that inexpensive AND gates can be substituted for seven-segment decoder IC's; low-cost surplus multi-decade readout blocks can be used; and there is lower current drain on the power supply. The amount of wiring required can also be reduced.

How Multiplexing Works. Display multiplexing is based on a time-sharing technique which is shown in a simplified form in Fig. I. If switches S4 and S5 are driven from a common shaft, they carry "on" and "off" information from S1, S2 and S3 to lamps I1, I2, and I3 sequentially, so that the lamps respond to the position of each associated switch. That is, I1 responds only to S1, I2 responds only to S2, and I3 responds only to S3.

If S4 and S5 were made to switch very rapidly, it would appear to the eye that the lamps were either constantly on or constantly off depending on the position of the controlling switches. (When LED's are used, thermal lag in lamp filaments, which would have some import in incandescent lamps, can be disregarded.)

The actions of the mechanical switches can be duplicated with digi-

Fig. 1. Basic principle of mechanical multiplexing is a time-sharing scheme.

Fig. 2. Electronic multiplex can be used to experiment with multi-digit LED readouts—as many as nine digits.

ICI = 7493
IC2 = 74175
IC3 = 75492 (RS 500)

IC4 = 7447
DIS I = COMMON CATHODE DISPLAY
(RS5082, 276-059)
RS = RADIO SHACK

tal electronic circuits as shown in Fig. 2. The components in this circuit can be bought from almost any "blister package" rack. The three 7490 decade counters represent the output stages of a digital instrument. Although only three decades are shown, the circuit can be easily expanded to six decades simply by adding AND gates and diodes or to nine decades by duplicating IC3.

In Fig. 2, IC1 and IC2 act as the rotary switches of Fig.l. They are driven by IC1, which gets a clock pulse to determine the multiplex rate. Each output of IC2 turns on a single digit of the multi-digit readout by shunting a cathode to ground through IC3. Simultaneously, the output signal from IC2 turns on its set of AND gates to transfer the associated decade counter's BCD output to the common BCD-to-seven-segment decoder IC4.

In the digital readout block, all the similar segments are connected in parallel so that (for example) if segment A is driven, all A segments are driven. However, the digit driving circuit has activated only one digit so only the A segment of that digit will glow. The clock pulses then cause IC2 to switch to its next output so that the second digit is activated. If the clock rate to IC1 is high enough (above 200 Hz), each digit is strobed rapidly so that the display appears to be motionless. When the states of the 7490 IC's change, the readouts change accordingly.

As a rule, the output of a TTL gate is intended to drive the input of another gate. If the outputs are tied together, it is possible that, when one gate has a high output, one of the others may have a low output. The latter will then try to "sink"the output currents. This causes one gate to overheat and possibly malfunction.The diodes on the outputs of the AND gates in Fig. 2 prevent this problem by isolating the outputs. Resistors R1 through R4 provide a return path to ground to insure that the inputs of IC4 are low if no positive input is present.

The clock signal for IC1 can be obtained from any source of pulses whose frequency is greater than 200 Hz. If more than three decades are required, select an output from IC2 that is one digit higher than the number of digits to be displayed. Then invert this signal and apply it to the clear input of IC1. Expand the circuit by coupling the diodes to the BCD inputs of IC4. Each IC3 can handle six digits. ◈