PROJECT OF THE MONTH

By Forrest M. Mims

Simple BCD Keyboard Encoder

THE November 1978 "Project of the Month" was a hexadecimal keyboard encoder assembled from four TTL chips (a 7400, a 74173 and a 74193). Many circuits require only one decade of decimal entry (0 through 9). The circuit in Fig. 1 implements this function with only three readily available CMOS chips. Because this new circuit is a CMOS design, its power consumption is considerably less than the TTL circuit presented earlier.

In operation, an astable oscillator made from two cross-coupled inverters (*IC1A* and *IC1B*) supplies clock pulses to *IC2*, a 4017 decade counter/decoder, and to *IC3*, a 4518 dual BCD counter. Initially, both counters are disabled by the application of appropriate logic levels to their respective enable inputs (a logic 1 at pin 13 of *IC2* and a low at pin 10 of *IC3*). The LED readout, therefore, displays the status of the outputs of *IC3* immediately after power is applied.

The keyboard is activated by closing any of the ten input switches *S0* through *S9* and then toggling RESET switch *S10* from ground to $+V_{DD}$ and back to ground. If desired, the BCD output can be cleared to 0000 (all LEDs glowing) by toggling RESET switch *S10* prior to selecting a data input switch.

Assume *S3* is closed. All inactive outputs of the 4017 are *low*, so the keyboard (*S0* through *S9*) bus goes low and enables both *IC2* and, via *IC1C*, *IC3*. Both counters then begin a synchronized count of the pulses, applied to their CLOCK inputs.

When the fourth clock pulse has been counted, pin 7 of *IC2* goes to logic 1 and, via closed switch *S3*, disables *both* counters. The LEDs then display the BCD equivalent of the selected switch: 0100. Counter *IC3* stores and presents at its outputs the BCD equivalent of the selected switch, even if the selected switch is opened and another is closed. Only after *S10* has been momentarily toggled will a new switch closure be detected and indicated by the output LEDs.

What happens if two or more input switches are closed when *S10* is toggled? The first closed to be scanned by the 4017 is selected. This is a form of *priority encoding*. The October 1978 "Experimenter's Corner" described the operation and use of the 74147 priority encoder. This TTL chip accepts up to ten inputs and presents at its outputs the BCD equivalent of the highest priority or most significant input while ignoring all others.

Going Further. The output LEDs shown in Fig. 1 are optional. They permit the operation of the circuit to be verified but are unnecessary in many practical applications. Of course, they can be retained. Alternatively, the outputs can be decoded by a BCD-to-seven-segment decoder/driver such as the 4511 or 4543 for display on a LED or liquid-crystal readout.

The basic circuit shown in Fig. 1 can also be modified for different applications. For example, recall that the 4518 contains *two* BCD counters, only one of which is used. The second counter can be clocked in parallel with the first (and the 4017) to provide a storage register which can remember a previous keystroke.

Other modifications may require the addition of one or more chips. For example, a 4066 quad bilaterial switch can be connected to the outputs of the second counter to provide a 3-state output. ◇

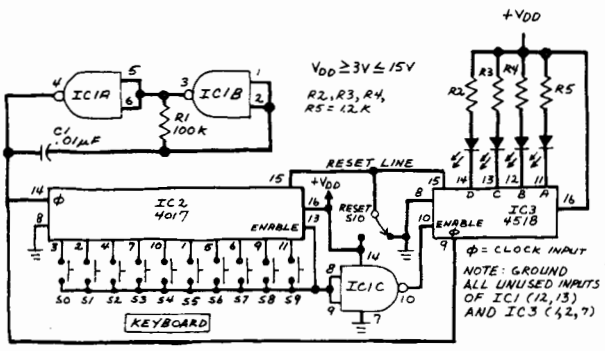

Fig. 1. A BCD keyboard encoder circuit using CMOS chips for low power consumption.