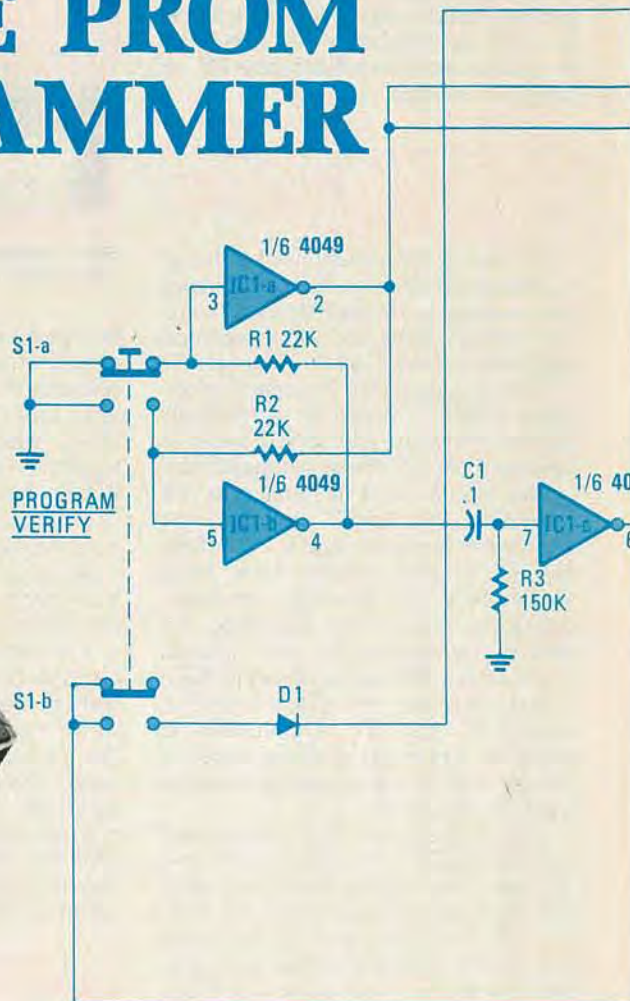


# BUILD THIS

# INEXPENSIVE PROM PROGRAMMER



T.E. LeVERE



Here's a simple circuit that will enable you to program the popular 74S-series of PROM's right on your own workbench.

MORE AND MORE ELECTRONIC DEVICES are being "programmed"—whether or not they contain a microprocessor. In many instances, as is the case with household appliances or games, those programs are not entered by hand or from a magnetic medium such as disk or tape, but are contained in integrated circuits called ROM's (for Read Only Memory).

The ROM is a type of memory device that is permanently programmed—while you can read the information it contains as many times as you like, you cannot change it. That's why it's called "read-only."

In general, there are two ways that ROM's are programmed. The first of these is called *mask programming* and is actually a part of the IC manufacturing process. That type of programming is useful only when large quantities of identical ROM's are to be produced.

The other type of ROM—and the one we'll discuss here—is actually known as a PROM (Programmable Read Only Memory). That type of memory IC is supplied with all its bits at either a high or low logic level. In programming it, you change those logic states to meet your requirements.

Typically, that programming is accomplished by "blowing" (burning out) internal titanium-tungsten (Ti-W) fuse links, each one representing a bit. That is done by applying a specific excess voltage to the power input of the PROM IC after selecting those bits that are to be a logic-high, and those that are to

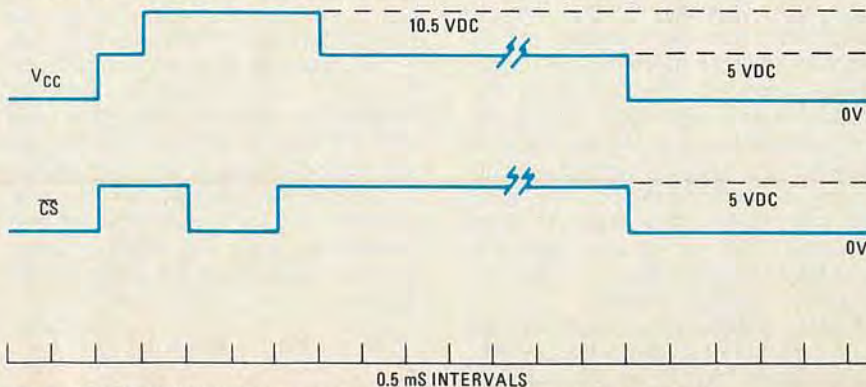


FIG. 1—TIMING SEQUENCE for programming a word of memory into the PROM.

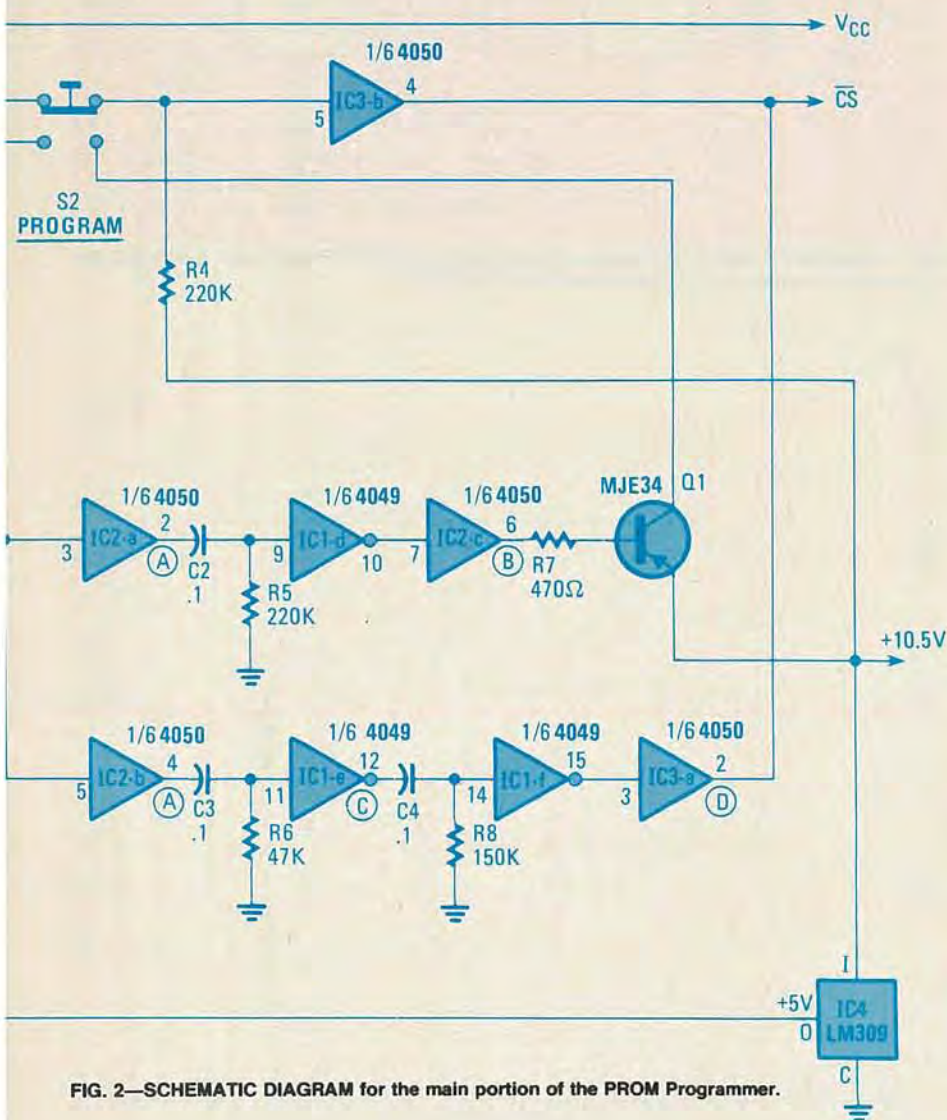


FIG. 2—SCHEMATIC DIAGRAM for the main portion of the PROM Programmer.

be a logic-low.

While in theory it sounds simple, a good deal of care must be taken when "burning" a PROM. If the voltage is too low, the fuse links will not be destroyed; if it's too high, or applied for too long a time, undesirable side effects may result. If just *one* bit is programmed incorrectly, the entire PROM is ruined.

The circuit presented here for programming fusible-link PROM's is a simple one, involving only three IC's, one transistor, and a voltage regulator, together with the switches necessary to set up the program. It is intended for use with Texas Instruments' 74S-series of programmable memories.

### The programming process

There were several reasons for selecting that family of PROM's to work with. First, they are readily available (check the advertisers in the back pages of *Radio-Electronics*). Second,

they are relatively inexpensive—a few dollars for a 32-word type. Third, they require only a single five-volt supply and are available with either open-collector or three-state output configurations, and are rather fast (under 30 nanoseconds, generally). Finally, while several different memory configurations are available in that series, each type of PROM is programmed in the same manner, which means that the circuit can be used for a number of applications.

The circuit design is intended to meet the rather tight timing sequence needed for programming that family of PROM's. Basically, programming involves selecting the word of memory to be programmed by setting the address lines, grounding the bits that are to be programmed, and holding the bits that *are not* to be programmed at the supply voltage (five volts). The actual programming takes place when

### PARTS LIST—PROGRAMMER

#### Resistors, 1/4 watt, 5%

- R1, R2—22,000 ohms
- R3, R8—150,000 ohms
- R4, R5—220,000 ohms
- R6—47,000 ohms
- R7—470 ohms
- R9-R13—220 ohms
- R14-R21—3900 ohms

#### Capacitors

- C1-C4—0.1  $\mu$ F, ceramic disc

#### Semiconductors

- D1—1N914 or 1N4148
  - IC1—4049 CMOS hex inverter (RCA)
  - IC2, IC3—4050 CMOS hex buffer/driver (RCA)
  - IC4—LM309 or LM340 five-volt regulator (National)
  - Q1—MTE34 PNP power transistor, (Motorola; or Radio Shack 276-2027 or equivalent)
  - LED1-LED13—jumbo red LED (Radio Shack 276-041 or equivalent)
  - S1—DPDT pushbutton switch
  - S2—SPDT pushbutton switch
  - S3-S7—SPDT toggle switch
  - S8—two-pole, nine-position rotary switch
- Miscellaneous:** perforated construction board, IC sockets (including one for PROM), 10.5-volt power supply, enclosure, wire, etc.

the supply voltage is briefly stepped-up to 10.5 volts and the IC is enabled by means of the chip-select ( $\overline{CS}$ ) line. Details of that sequence are shown in Fig. 1. The upper line indicates the voltage applied to the  $V_{CC}$  pin, while the lower one shows the voltage at the  $\overline{CS}$  pin of the IC.

Initially, the supply voltage (five volts) is applied to both the  $V_{CC}$  and  $\overline{CS}$  pins, which disables the IC. The programming sequence is started by raising the voltage at the  $V_{CC}$  pin to 10.5 volts and then, after 500 microseconds (0.5 mS)—TI suggests a range of from 10  $\mu$ S to 1 mS— $\overline{CS}$  is brought to ground and the memory enabled for 1 mS. After that,  $\overline{CS}$  is returned to five volts and the 10.5 volts at the  $V_{CC}$  pin is reduced to five volts. At this point it is possible to ground the  $\overline{CS}$  pin to verify that the programming took place as planned.

Texas Instruments makes several recommendations concerning the programming of the 74S-series. First, since the process involves burning out the Ti-W fuse links, it is recommended that  $V_{CC}$  be removed between programming sequences to avoid overheating the chip. Second, it is recommended that the 10.5-volt programming pulse have a duty cycle of no more than 30 percent of the entire programming cycle. With an automated programmer, that could be a problem but since our circuit is manually operated, it is nothing to be concerned about.

### Circuit description

The main portion of the PROM programmer circuit is shown in Fig. 2. It uses two 4050 CMOS hex buffer/drivers, a 4049 CMOS hex inverter, one PNP power transistor and a five-volt regulator, such as an LM309 or LM340.

A power supply that can provide 10.5 volts DC (Fig. 3) is required to open the fusible links of the PROM. The regulator reduces that to 5 volts, which is needed at several points in the circuit.

Two switches are used in this section. The first, S1, supplies power to the PROM and/or initiates the programming sequence while S2 supplies 10.5 volts to the  $V_{CC}$  pin when it is required.

Programming is accomplished by depressing switch S2 and holding it down while switch S1 is pressed momentarily. Verification is obtained through the use of S1 alone. Details of that will be presented later.

In brief: the 4049 hex inverter is used to debounce switch S1 and to form several half-monostable circuits



INTERNAL view of the PROM programmer shows how the perfboard is mounted inside the case. The front panel is connected via ribbon cable.

### PARTS LIST—POWER SUPPLY

#### Resistors, 1/2-watt, 10%

R22—1600 ohms

R23—220 ohms

#### Capacitors

C5—250  $\mu$ F, 25 volts, electrolytic

C6—.1  $\mu$ F, ceramic disc

C7—1  $\mu$ F, tantalum

#### Semiconductors

BR1—bridge rectifier, 50 PIV

IC5—LM317T, adjustable voltage regulator

T1—18 volts, one amp

Miscellaneous: construction board, wire, solder, etc.

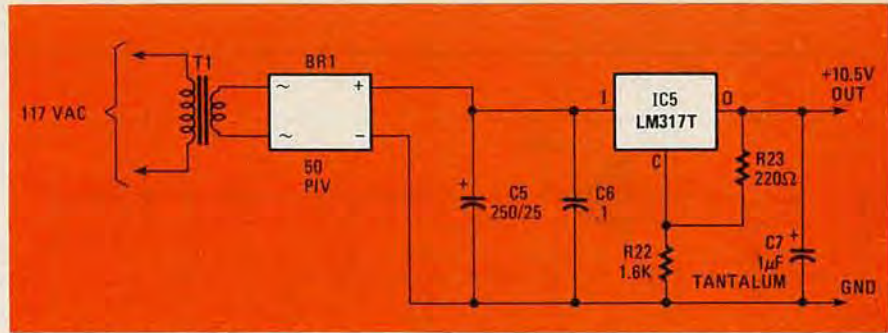


FIG. 3—SCHEMATIC DIAGRAM of the power supply for the PROM Programmer. It provides the 10.5 volts DC required to open the fusible links of the PROM.

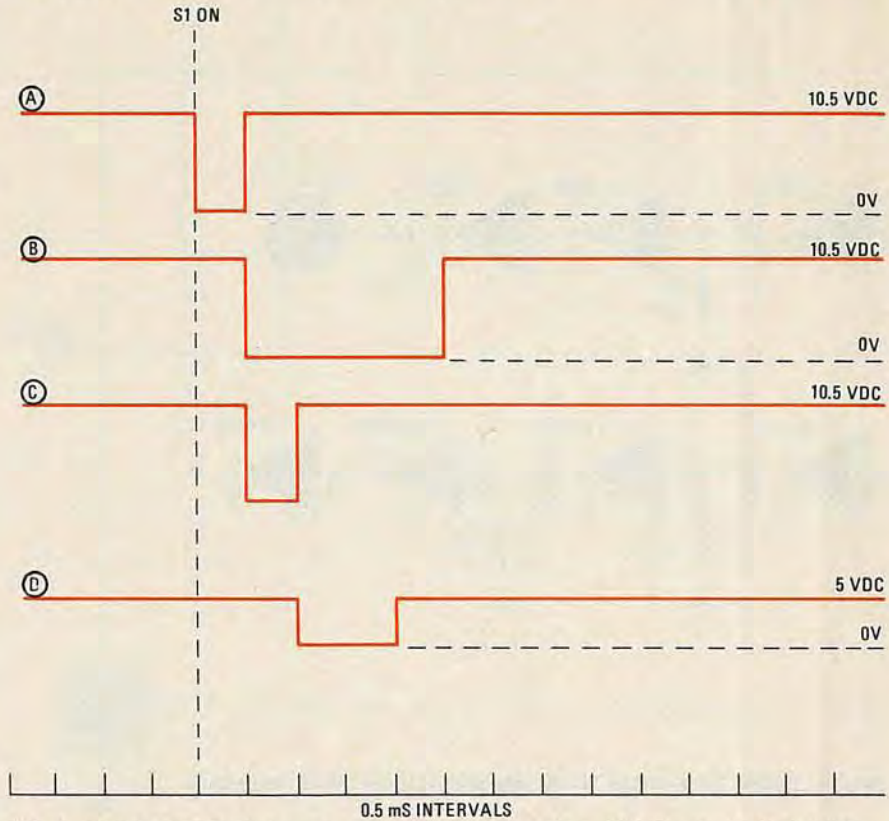


FIG. 4—TIMING DIAGRAM shows waveforms at specific points within the circuit. Circled letters correspond to circled letters in Fig. 2.

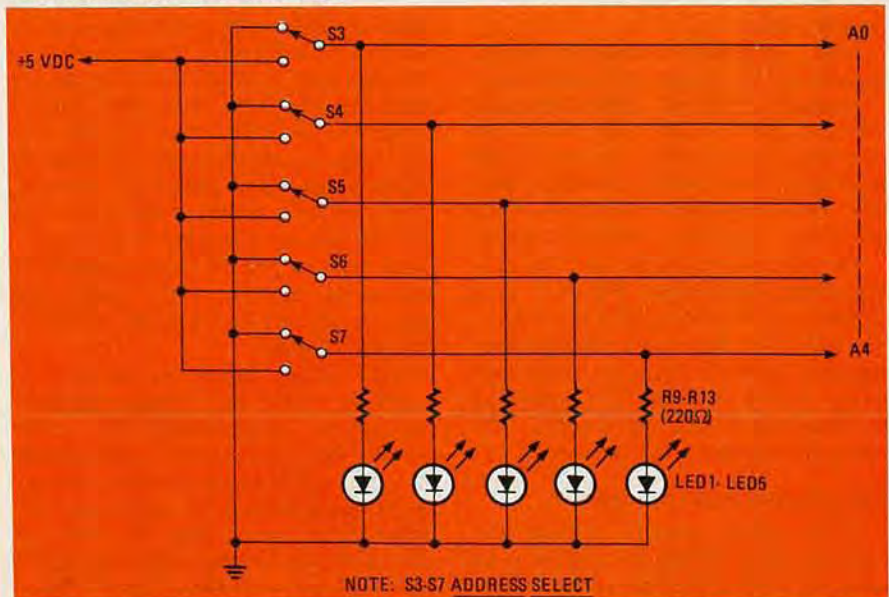


FIG. 5—PROM ADDRESSES are selected by five toggle switches and visual confirmation is provided by discrete LED's.

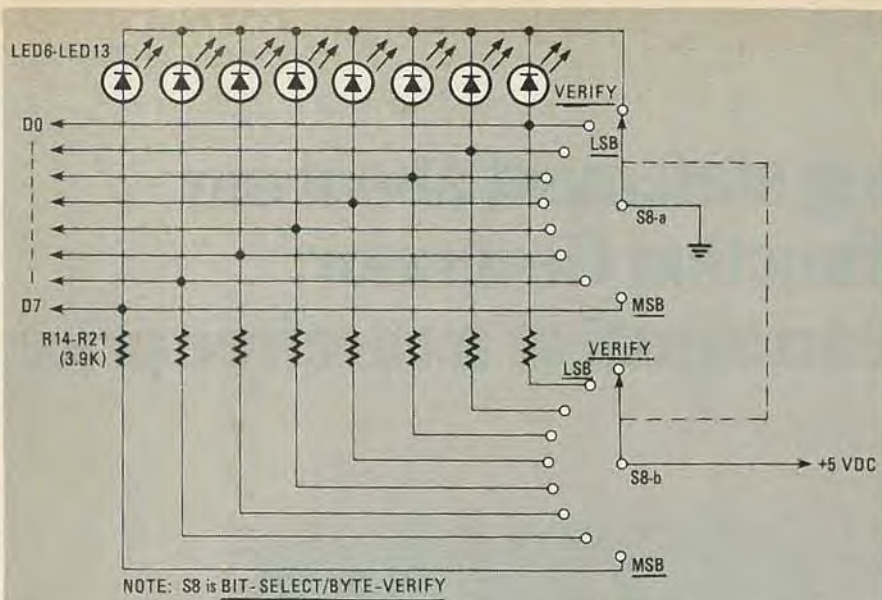


FIG. 6—A WORD IS PROGRAMMED sequentially one-bit at a time via a 9-position rotary switch.

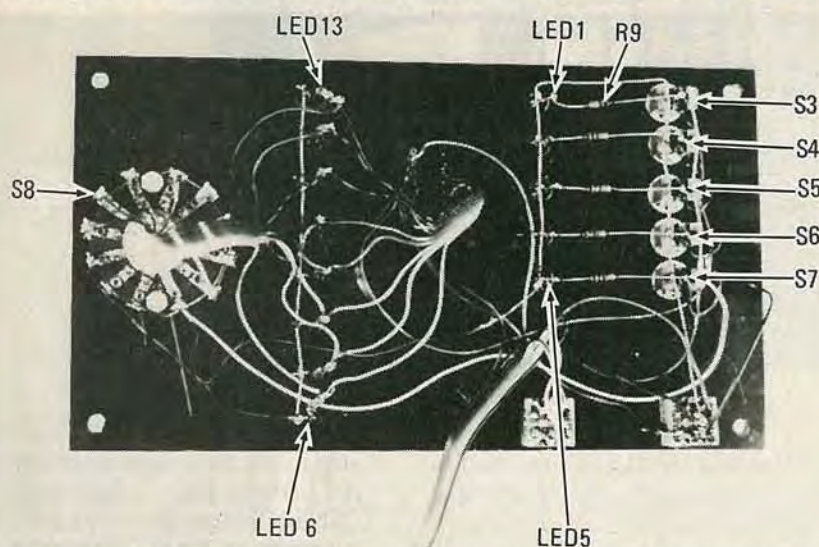


FIG. 7—PLACEMENT OF THE FRONT PANEL mounted components. Power switch S1 is located in the lower right corner and switch S2 is just to the left of S1. Connections to the PROM are made via a front-panel mounted DIP socket.

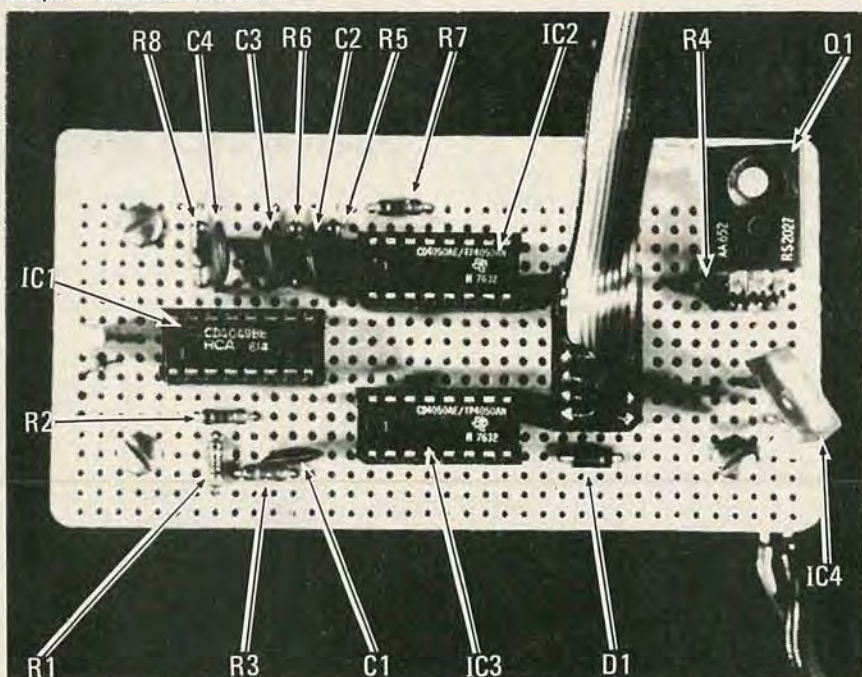


FIG. 8—THE PROTOTYPE used perfboard construction for the bulk of the circuitry.

used to time the programming sequence. One of the 4050 buffer/drivers is powered by 10.5 volts and acts as a waveform shaper for the signals from the 4049. The other is powered from the 5-volt regulator and is used as a level-translator to supply 5 volts to the  $V_{CC}$  and  $\overline{CS}$  pins. The circled letters on the schematic (Fig. 2) correspond to those in Fig. 4, that shows the waveforms.

While the addresses and bit-patterns may be set using as crude a method as alligator clips, the switch circuits shown in Figs. 5 and 6 make programming much simpler.

Figure 5 illustrates an address-selector circuit using five SPDT switches. Each switch is tied to one address bit of the PROM and to an LED, that acts as a status indicator. The LED's allow you to make sure that the address you selected is correct—remember, programming one bit incorrectly will ruin the entire PROM!

To set up the word to be programmed, the circuit in Fig. 6 works quite well. Its major component is a double-pole, nine-position rotary switch. One pole of that switch is tied to the five-volt supply with eight of its positions going to the eight data outputs of the PROM through 3.9K resistors. The other pole of the switch is at ground potential, so that only one of the data outputs is grounded for programming purposes at any time.

The ninth switch position is used for program verification, and removes the data-output pins of the PROM from the 3.9K resistors and grounds the cathodes of the LED's. Any bit at a logic-1 will cause its associated LED to light.

With the switch wired in that manner, it is easiest to program from the most-significant bit to the least-significant bit and to verify the programming, in that order, afterwards. That is the switch is first moved to its most counterclockwise position, bits seven through zero are programmed as the switch is turned clockwise, and the switch is then turned to its final position for obtaining verification of the programming.

### Construction

Assembling the PROM programmer is extremely simple and it may be built on perforated construction board without difficulty. Component placement is not critical. Refer to Figs. 7 and 8 for component placement. A small chassis box can be used to hold the circuit board and a power supply, and to mount the LED's and switches.

With two exceptions—both due to human error—that setup has performed faultlessly. It should work at least as well for you.

R-E