

BUILD THIS



ROBERT N. BEABER

THE 2716 EPROM (ERASABLE PROGRAMMABLE Read Only Memory)—currently available for ten dollars or less—is ideal for microprocessor-based projects. It permits storage of 2K (2048 bytes) of user program and operates from a single 5-volt supply. Because it can be erased by strong ultraviolet light, its contents can be changed if a modification must be made to the program it contains, or it can simply be erased for reuse in another project.

The programmer described here allows the project designer to program the 2716, using hexadecimal code, at each memory location by entering the required data with two thumbwheel switches and pressing a single PROGRAM switch. After programming a given memory location, the device automatically selects the next highest one. It also has a SINGLE STEP or CONTINUOUS RUN option to provide access to address locations at a rate determined by the user. Those options provide the control needed to verify the data contained by the EPROM. Both the memory location addressed and its contents are indicated by 7-segment LED's.

Circuit operation

Figure 1 is a schematic of the EPROM programmer. Refer to it as we discuss how the circuit works.

The programming sequence begins when the PROGRAM switch, S3, is pressed. That switch is debounced by IC11-c, and the resulting pulse is used to clock one-shot IC7-b. The output of the one-shot enables NAND gate IC8-c and allows the 40-Hz oscillator—IC9-b—to clock counter IC14.

Initially, the counter's output is set at 0. As it is clocked by IC9-b its outputs go to a logic-high (+5 volts) state one at a time, in sequence. *Note that only five of the ten possible outputs are used—pins 1, 4, 5, 7 and 11; they correspond to counts of 5, 2, 6, 3 and 9, respectively.* As the outputs of IC14 change state,

they control the actions of latches IC13-a and IC13-b.

When pin 4 of IC14 goes high, pin 1 of IC13-a is latched high. That, through buffer IC2-c, brings pin 20, CS (Chip Select—sometimes referred to as "data enable") of SO1, which contains the EPROM, high, and readies the EPROM for programming.

The output of IC14's pin 4 also turns on Q1 and Q2, which provide the programming voltage (25.5 volts) to pin 21 of SO1, and enables the three-state drivers, IC1 and IC2. The inputs of those two IC's are connected to S1 and S2, the BCD-output thumbwheel switches used to provide the programming data. The outputs of the two IC's are connected to pins 9-11 and 13-17 of SO1, which correspond to the eight data lines of the 2716 EPROM.

After 25 milliseconds— $1/40$ -second, equal to one period of the 40-Hz clock—pin 7 of IC14 goes high and IC13-b is also latched high. That, in turn, takes pin 18 (CE/PGM—CHIP ENABLE/PROGRAM) of SO1 high and the data from the thumbwheel switches is programmed into the EPROM. The address programmed usually starts with 0, but can

be selected by S4, (SINGLE STEP), and S5 (RUN).

When 50 milliseconds have passed, pin 1 of IC14 goes high. That resets IC13-b, removing the logic-high from pin 18 of the EPROM. After another 25 milliseconds, pin 5 of IC14 goes high, resetting IC13-a. That removes the CS voltage, removes the 25.5 volts from pin 21 by turning Q1 and Q2 off, and disables IC1 and IC2, thus removing the thumbwheel-switch data from the EPROM's data lines.

When pin 11 of IC14 goes high, it resets one-shot IC7-b, disabling NAND gate IC8-c and cutting IC14 off from the 40-Hz clock. Pin 11's going high also resets IC14 to 0 and advances counter IC3 to the next address to be programmed.

The remainder of the logic circuitry provides RESET, SINGLE STEP, and RUN functions.

Switch S6 (RESET) is used to reset the cascaded address counters IC3, IC4, and IC5, to zero. Switch S4 provides SINGLE STEP capability—every time the switch is pressed, IC7-a, a one-shot, supplies a pulse to counter IC3, causing the memory location being addressed

PROM PROGRAMMER

It is frequently convenient for the computer or microprocessor user to store his programs in reusable EPROM's (Erasable Programmable Read Only Memories). This programmer for 2K 2716 EPROMS allows the job to be done quickly and efficiently.

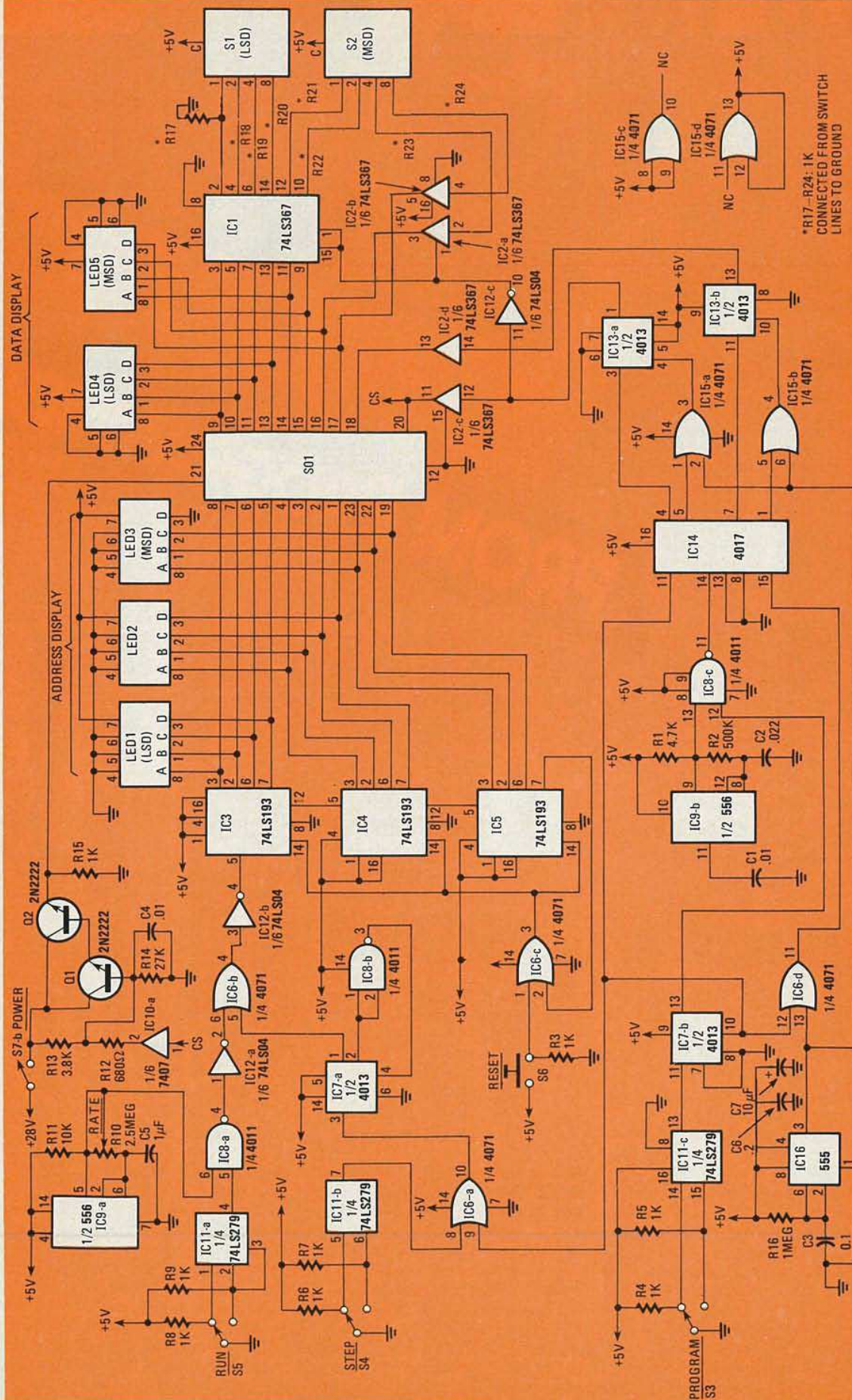


FIG. 1—WHILE ONLY R17 IS SHOWN, resistors R17-R24 are connected from the eight output-lines of S1 and S2 to ground.

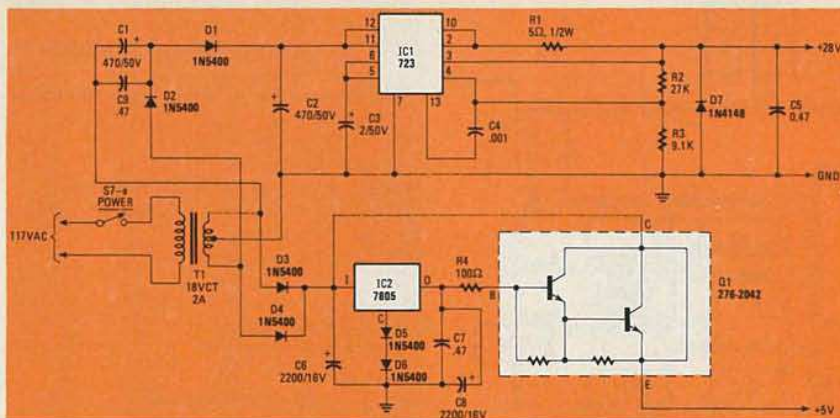


FIG. 2—POWER SUPPLY provides both the 5-volts needed for the logic circuitry and the 25.5-volts used to program the EPROM.

to be incremented by one. Finally, S5 (RUN) allows the variable-frequency oscillator formed by IC9-a and controlled by R10 to clock counter IC3 at a rate determined by the user.

The three switches provide the user with several means for accessing EPROM memory addresses to enter or verify data. The LED displays on the address and data lines provide a continuous indication of the memory address being accessed and of its contents.

Power supply

The power supply shown in Fig. 2 provides all the voltages required by the programmer. Power switch S7 has two sections—one for 117-volts AC (Fig. 2) and one for 28-volts DC (Fig. 1). That is necessary because when the AC voltage is cut off by S7-a, an induced current in the secondary of the transformer will cause a pulse to appear on the 28-volt DC line. Since that pulse can be transmitted to pin 21 (V_{pp}) of the EPROM—a pin used in the program-

PARTS LIST—POWER SUPPLY

All resistors 5%, 1/4-watt unless otherwise specified

R1—5 ohms, 1/2-watt

R2—27,000 ohms

R3—9100 ohms

R4—100 ohms

Capacitors

C1, C2—470 μ F, 50 volts, electrolytic

C3—2 μ F, 50 volts, electrolytic

C4—.001 μ F, ceramic disc

C5—0.47 μ F, ceramic disc

C6, C8—2200 μ F, 16 volts, electrolytic

C7—0.1 μ F, ceramic disc

Semiconductors

IC1—LM723N adjustable voltage regulator

IC2—7805 5-volt regulator

Q1—high-power Darlington, NPN-type
(Radio Shack 276-2042 or similar)

D1-D6—1N5400, 3 amps, 50 PIV

T1—18 volts, center-tapped, 2 amps

Miscellaneous: TO-3 heat sink, PC board or perforated construction board, 14-pin IC socket, hardware, etc.

ming process—erroneous data may be entered into the IC. Therefore, S7-b is used to cut off the 28-volt supply at the same time the main 117-volt supply is turned off.

Construction

The 2716 EPROM programmer can be constructed on perforated construction

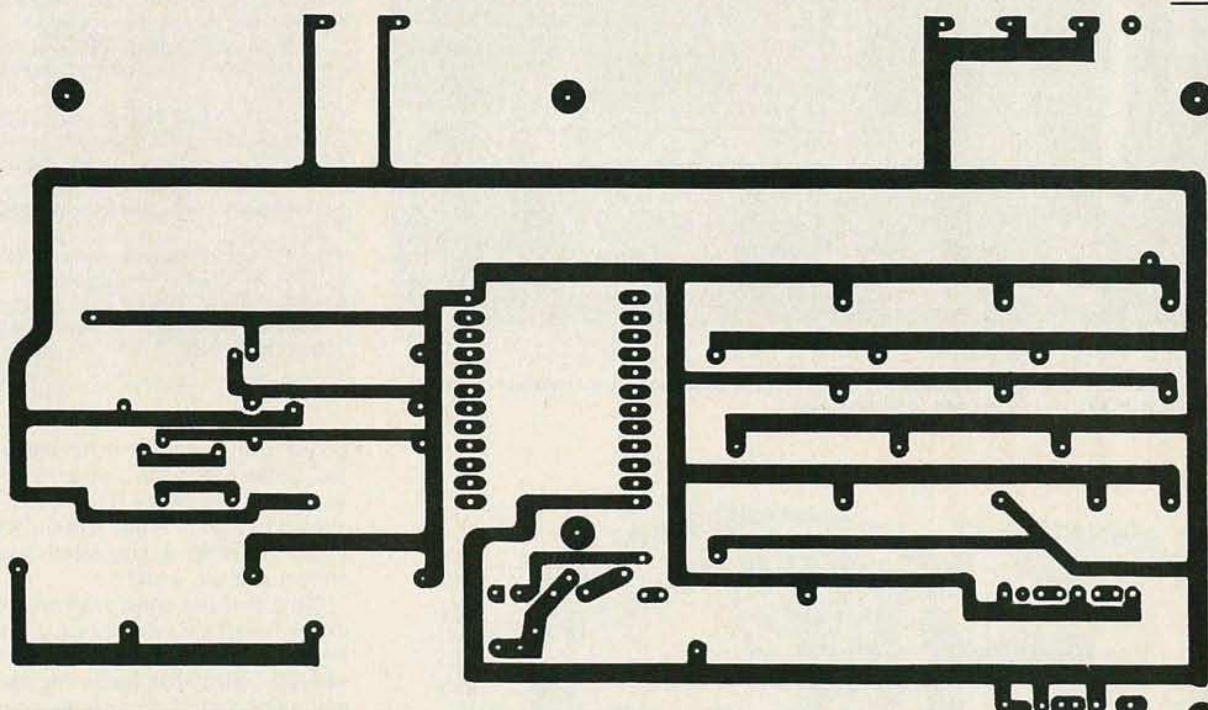


FIG. 3—PERFORATED CONSTRUCTION BOARD is used to mount components. Stick-on copper traces can be applied to serve as power and ground buses.

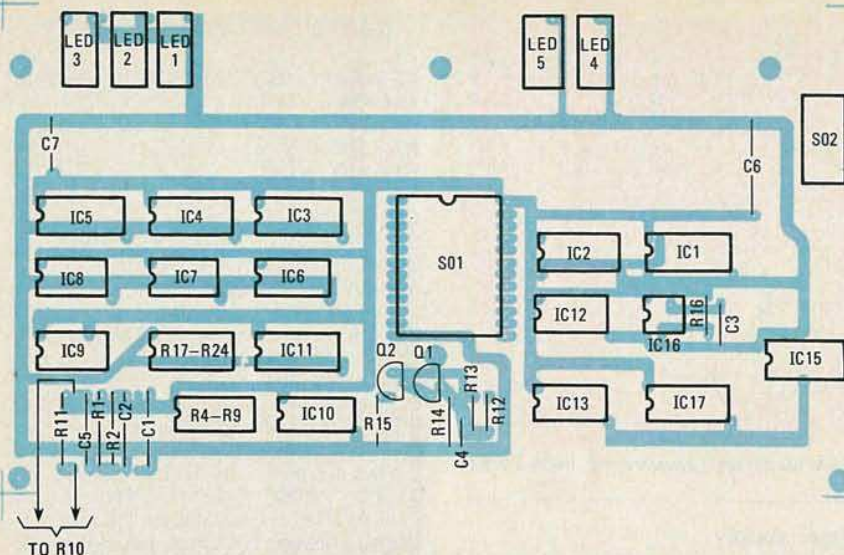


FIG. 4—SOCKET SO1 is a 24-pin zero-insertion-force socket used to hold the 2716 EPROM. Zero-insertion-force sockets allow IC's to be inserted and removed many times without causing wear or damage to either the socket or the IC.

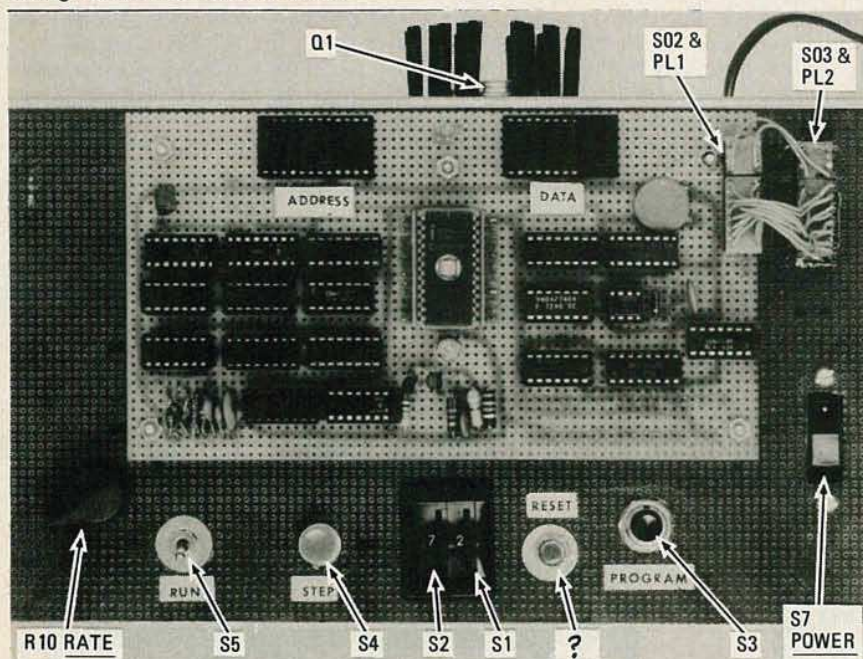


FIG. 5—LOGIC/PROGRAMMING BOARD is mounted on standoffs above board holding switches and controls. Heat sink and Q1 are part of power supply.

PARTS LIST—PROGRAMMER

All resistors 5%, 1/4-watt unless otherwise specified

R1—4700 ohms
R2—500,000 ohms
R3-R9, R15, R17-R24—1000 ohms
R10—2.5 megohms, 1/2-watt, potentiometer
R11—10,000 ohms
R12—680 ohms
R13—3800 ohms
R14—27,000 ohms
R16—1 megohm

Capacitors

C1, C4—.01 μ F, ceramic disc
C2—.022 μ F, ceramic disc
C3—.01 μ F, ceramic disc
C5—1.0 μ F, tantalum

Semiconductors

IC1, IC2—74LS367 or 80C97 three-state hex buffer
IC3-IC5—74LS193 or 74C193 up/down binary counter
IC6, IC15—4071 CMOS quad 2-input or gate
IC7, IC13—4013 CMOS dual-D flip-flop
IC8—4011 CMOS quad 2-input NAND gate
IC9—556 dual timer
IC10—7407 hex buffer, high-voltage, open-collector
IC11—74LS279 quad S-R latch
IC12—74LS04 hex inverter
IC14—4017 CMOS decade divider/counter
IC16—555 timer
Q1, Q2—2N2222 or similar NPN-type
LED1-LED5—7 segment hexadecimal decoder/display (H-P 5082-7340 or similar)
S1, S2—hexadecimal thumbwheel switch, BCD output (Unimax SF-54 or similar)
S3, S4—SPDT momentary pushbutton switch
S5—SPDT toggle switch
S6—N.O. pushbutton switch
S7—DPDT toggle or rocker switch, 125 VAC minimum rating
SO1—24-pin zero-insertion-force IC socket
SO2, SO3—18-pin wire-wrap IC socket
PL1, PL2—18-pin DIP header
Miscellaneous: wire-wrap IC sockets, perforated construction board, chassis-box, wire, etc.

board using wire-wrap techniques. A foil pattern for the power buses and several of the IC-to-IC connections is shown in Fig. 3. While parts-placement is not critical, a suggested layout is shown in Figs. 4 and 5.

Note that the logic/programming circuitry is located on one board, and that board is mounted on spacers over a second board that holds the switches and RATE control. Connections between the two boards are made using SO2, SO3 and PL1 and PL2.

A foil pattern for the power supply is shown in Fig. 7, and a parts-placement diagram for it in Fig. 6. The power supply can be mounted on spacers inside an aluminum chassis-box (Fig. 8). A heat sink should be used for the power supply's Q1.

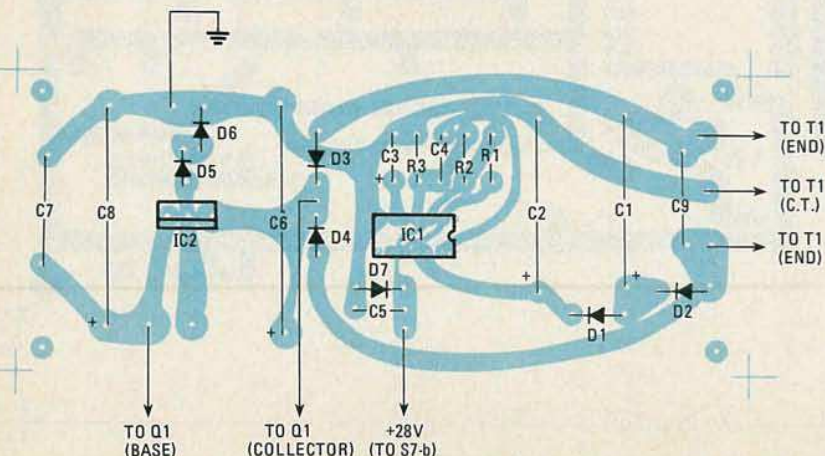


FIG. 6—PADS MARKED "TO T1 (END)" may be connected to either end of transformer's primary winding. Pad marked "C.T." must go to center tap.

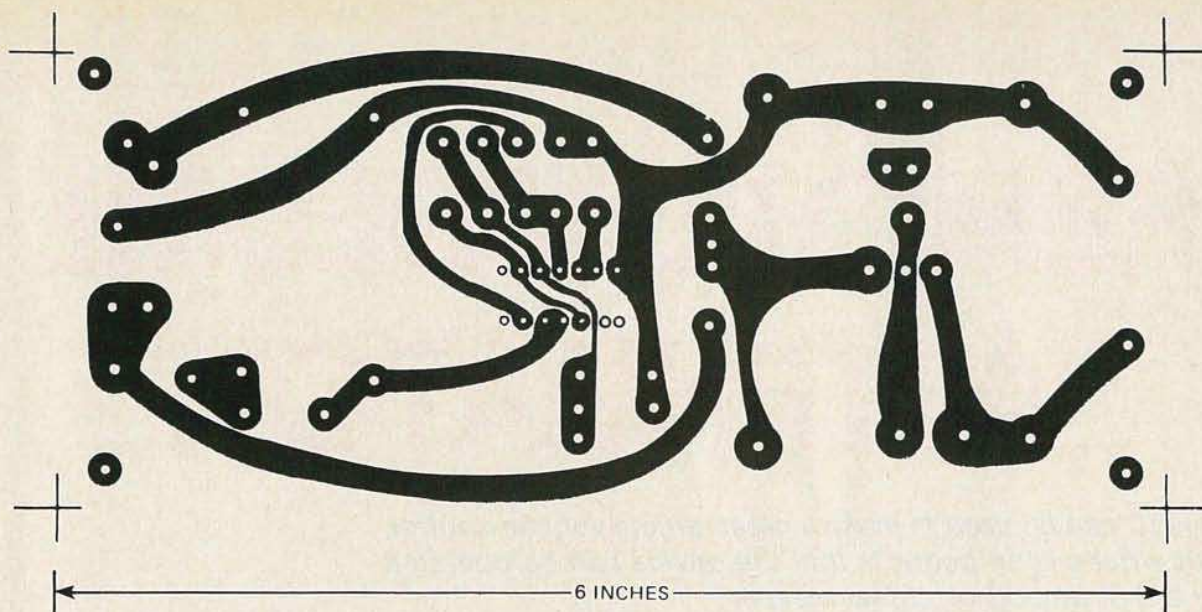


FIG. 7—FOIL PATTERN FOR POWER SUPPLY allows quick and easy construction. Ordinary copper-clad board can be used here.

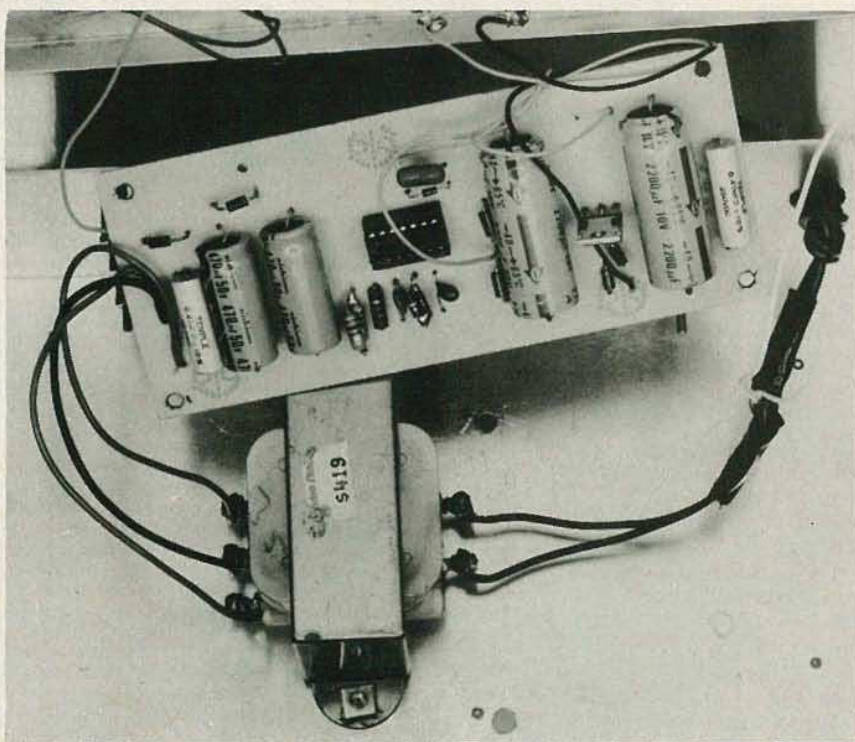


FIG. 8—TRANSFORMER IS MOUNTED on chassis-box bottom; power-supply board on standoffs at enclosure's rear.

Checkout and use

Before any of the logic IC's are installed in their sockets, the usual visual checks for correct component-orientation, solder bridges, etc. should be made. The unit can then be powered up and voltage checks made at the appropriate points. If everything checks out at that point, the IC's can be installed.

Now, with no EPROM in SO1, apply power again. The DATA LED's should show "FF," and the ADDRESS LED's should indicate "000" after the RESET

has been pressed. Each time the SINGLE STEP switch is pressed, the ADDRESS display should advance one count. With the RUN switch in the ON position, the ADDRESS display should advance continuously, at a speed that can be varied by R10, the RATE control.

Still with no EPROM in the socket, set up a data byte on the thumbwheel switches. When you depress the PROGRAM switch, the DATA LED's should show that value briefly, and then return to "FF." If all those conditions are met,

the programmer is ready to go to work.

With the power turned off, insert a 2716 EPROM into SO1. Apply power and depress the RESET switch to start programming at address 000. Use the thumbwheel switches to set the data byte that is to be programmed into that location and press the PROGRAM switch. The DATA LED's should momentarily show this value, and then return to "FF"—the contents of the next memory location (001, shown on the ADDRESS LED's). The data for that address can then be set on the thumbwheel switches and the process repeated until the EPROM is completely programmed.

The EPROM's contents can be verified by resetting the counter to 000 and using the RUN switch and RATE control to automatically sequence through the memory locations. They, and their contents, will be shown on the LED's. Alternately, you can single-step through the addresses at leisure by using the SINGLE STEP switch.

R-E



"I thought that voice synthesizer would tell me my weight—not scream in pain."