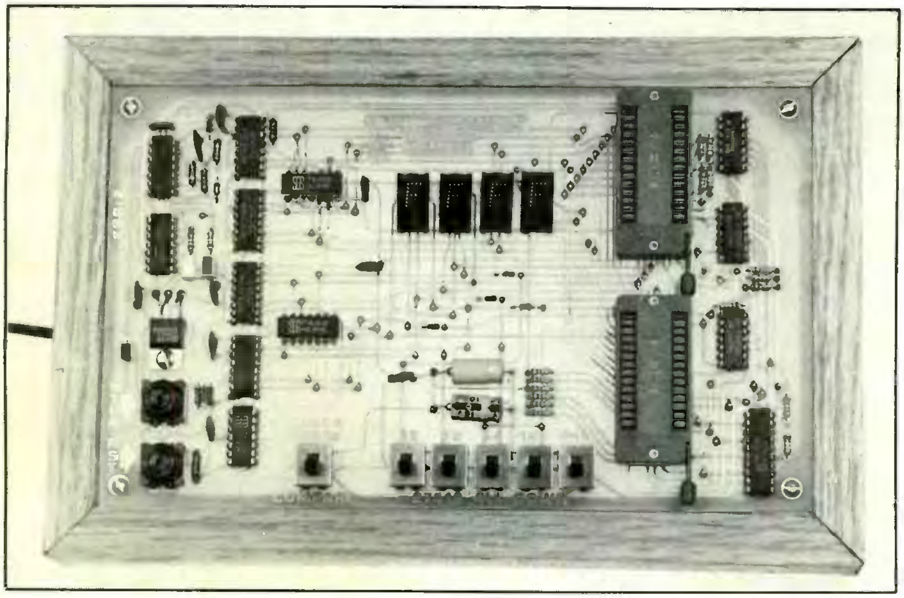
An EPROM Speed Reader/Comparator

Checks 16K to 512K EPROMs for complete erasure and compares a copy with an original EPROM in just seconds



By Walter W. Schopp

Getting half-way through programming an EPROM only to find that a supposedly erased one still contains unwanted data can be a frustrating and time-consuming experience. The same applies to a duplicate EPROM you have made that does not work. If you have ever been in either of these situations, you will certainly appreciate the EPROM Speed Reader to be described. This handy unit is actually two test devices in one. It not only "reads" every memory address location in any 2716 (16K) through 27512 (512K) EPROM in seconds to determine whether or not every cell has been erased, it also compares a copied EPROM against a master to check it for an accurate "take."

Our EPROM Speed Reader is a perfect accessory to the Stand-Alone EPROM Programmer featured in the February and March 1987 issues and the EPROM Eraser featured in the May 1987 issue of *Modern Electronics*. The project uses a double-sided printed-circuit board, zero-insertion-force test sockets and LED displays. You can etch and drill your own pc board (though you probably will not be able to plate-through the holes) or purchase a ready-to-wire board (see Parts List). Cost category for building this project is moderate but well worth the investment if you do a lot of erasing or/and programming of EPROMs.

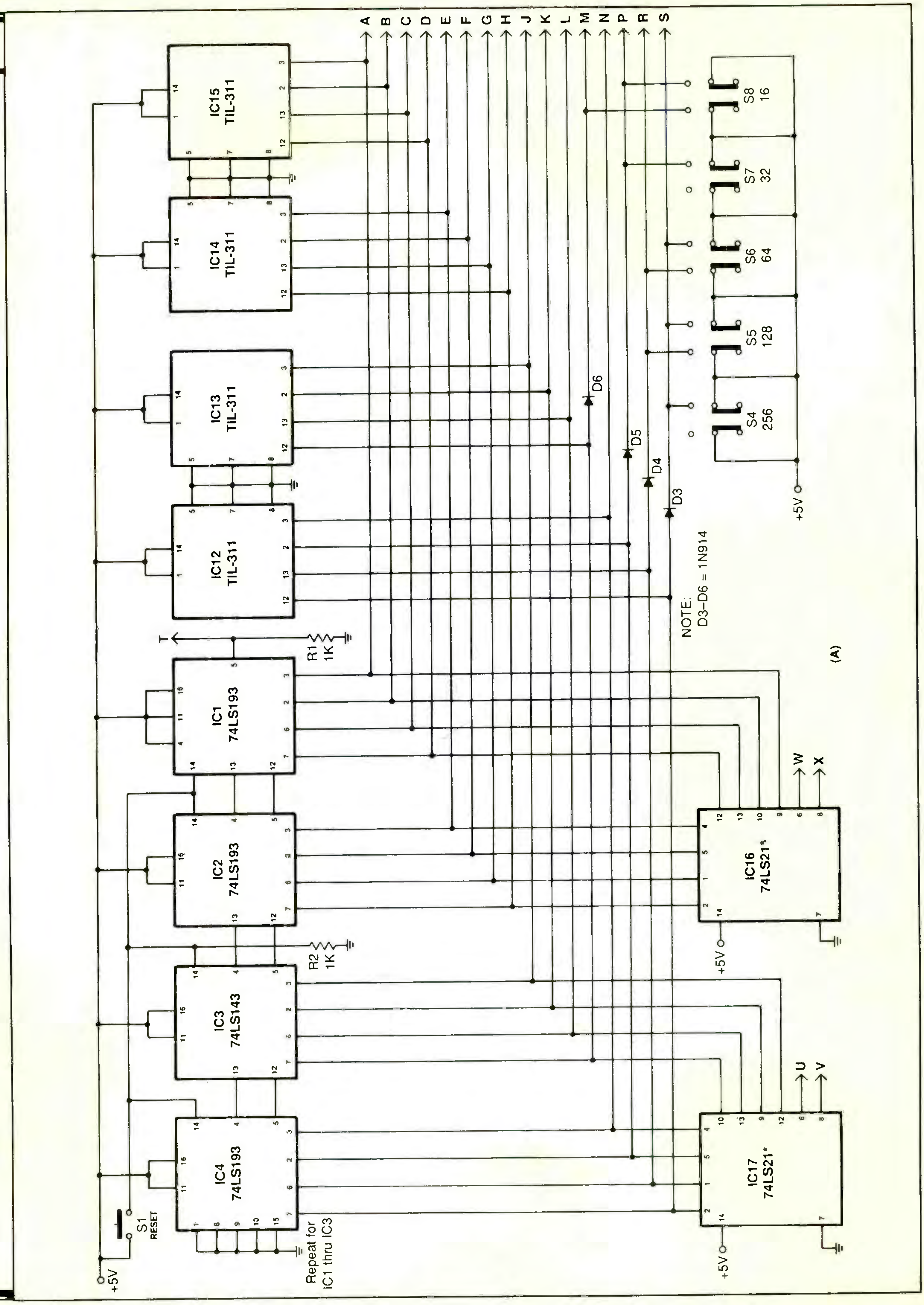
About the Circuit

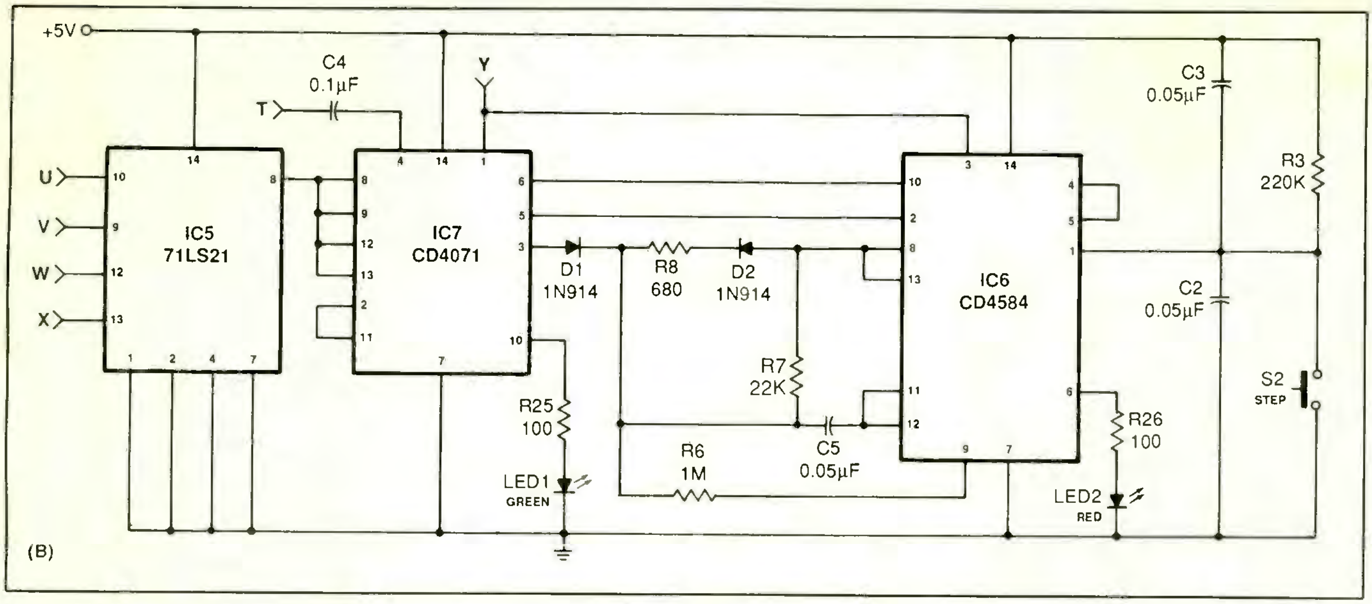
Simply by examining the pinouts of the various members of the 27XX and 27XXX family of EPROMs, you can readily see that all devices in this family are more or less pin-compatible. The differences in pinouts are confined mainly to pins 1, 2, 21, 24, 27 and 28. By switching addresses and voltages on these pins, the entire 27XX/27XXX family of EPROMs can be accommodated by a single test unit, as is done with our EPROM Speed Reader. In this project, the five switches labeled 16, 32, 64, 128 and 256 in Fig. 1(A) are used to accomplish address/voltage switching to accommodate 2716, 2732, 2764, 27128 and 27256 EPROMs. Note that, due to its large size, the main schematic diagram for the EPROM Speed Reader is shown in four parts, designated Figs. 1(A) through 1(D).

Address lines to both the master and copy EPROM are fed from the outputs of cascaded counters *IC1* through *IC4* in Fig. 1(A). The counters are driven by a square wave generator composed of two inverting buffers in the *IC6* package. The output of the generator is applied to the counter through another inverting buffer in *IC6*.

Signal inversion by the feeder inverting buffer puts the correct polar-

Fig. 1. Complete schematic diagram of project is shown here in four parts.


IC15 TIL-311
IC14 TIL-311
IC13 TIL-311
IC12 TIL-311
IC1 74LS193
IC2 74LS193
IC3 74LS143
IC4 74LS193
IC16 74LS21*
IC17 74LS21*
R1 1K
R2 1K
S1 RESET
+5V
Repeat for IC1 thru IC3
D3
D4
D5
D6
S4 256
S5 128
S6 64
S7 32
S8 16
NOTE: D3–D6 = 1N914
A B C D E F G H J K L M N P R S
T
W X
U V
(A)



ity on the input of the counter so that when the counter is stopped by an error or completion of a count sequence, it can be retriggered from STEP pushbutton switch *S2* shown in Fig. 1(B).

Timing for the square-wave generator is controlled by the RC network composed of *C1* and *R7*. If a slower or faster sweep time is desired, the values of these components can be juggled, using the formula 1/(2.2RC). Values specified for *C1* and *R7* were chosen to allow you to see the Reader in operation instead of having to wait for it to run the course of a test or compare or have everything done just as you release RESET pushbutton switch *S1* in Fig. 1(A).

Using 1N914 switching diodes *D1* and *D2* permits the generator to be stopped when a positive voltage is applied to *D1* from an OR gate in *IC7*. This OR gate allows the generator to be halted from two different sources. One of the gate's inputs is fed from the output of the comparison circuit, which supplies a positive output on detecting an error in an EPROM read operation. The other input is fed from the output of dual 4-input AND gates *IC16* and *IC17*. The outputs from these four gates are fed to 4-input NAND gate *IC5*.

PARTS LIST

Semiconductors
D1 thru D6—1N914 switching diode
LED1—Green T-1¾ light-emitting diode
LED2—Red T-1¾ light-emitting diode
IC1 thru IC4—74LS193 binary counter
IC5,IC16,IC17—74LS21 dual 4-input NAND gate
IC6—CD4584 hex Schmitt-trigger inverting buffer
IC7—CD4071 quad 2-input OR gate
IC8—CD 4068 8-input NAND gate
IC9,IC10—CD4077 quad 2-input exclusive-NOR gate
IC11—74C244 octal tri-state buffer
IC12 thru IC15—TIL311 hexadecimal decoder/driver/display
IC18—7805 +5-volt regulator (optional—see text)

Capacitors (10 WV or higher)
C1,C2,C3—0.05-μF disc
C4,C7 thru C14—0.1-μF disc
C5,C6—100-μF, 16-volt electrolytic

Resistors (¼-watt, 5% tolerance)
R1,R2—1,000 ohms
R3—220,000 ohms
R4,R5—Not assigned
R6—1 megohm
R7—22,000 ohms
R8—680 ohms
R9 thru R24—10,000 ohms
R25,R26—100 ohms

Miscellaneous
S1,S2—Spst momentary-action normally-open pushbutton switch(Digi-Key Cat. No. P9951—see Addresses below)
S3 thru S8—Dpdt pc-mount slide switch (C&K Cat. No. 1201-M2-CQE—see Addresses below)
SO1,SO2—28-pin zero-insertion-force socket (Jameco Cat. No. 228-3345—see Addresses below; also see text for option)
Printed-circuit board (see text); 6-volt dc, 300-mA plug-in power supply (see text); materials for building enclosure (see text); machine hardware; No. 6 × ½-inch woodscrews (8); hookup wire; solder; etc.

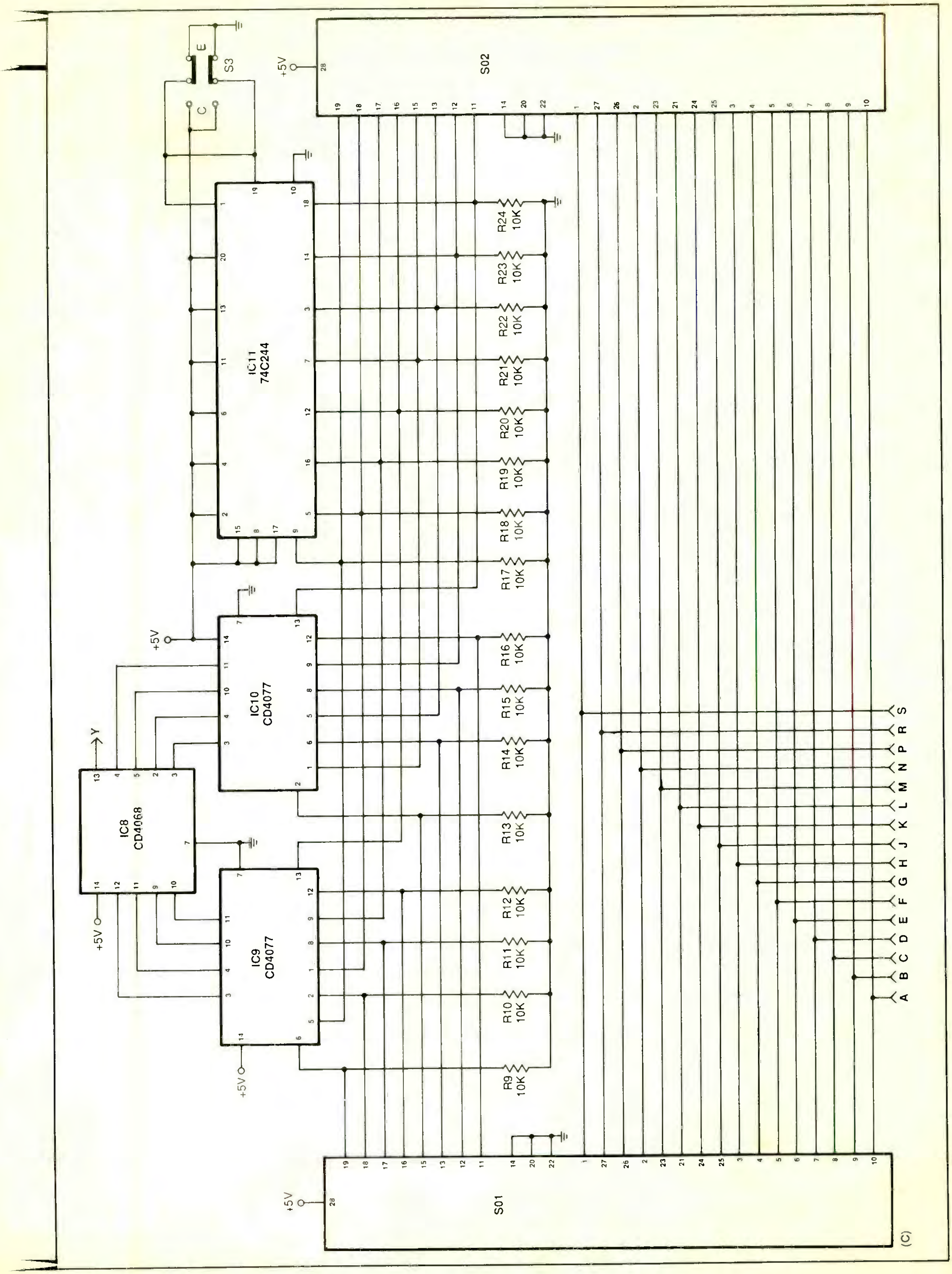
Note: A ready-to-wire, double-sided printed circuit board with plated-through holes, No. ESR-2, is available for $22.50, including P&H, from: Electronic Enterprises, 3305 Pestana Way, Livermore, CA 94550.

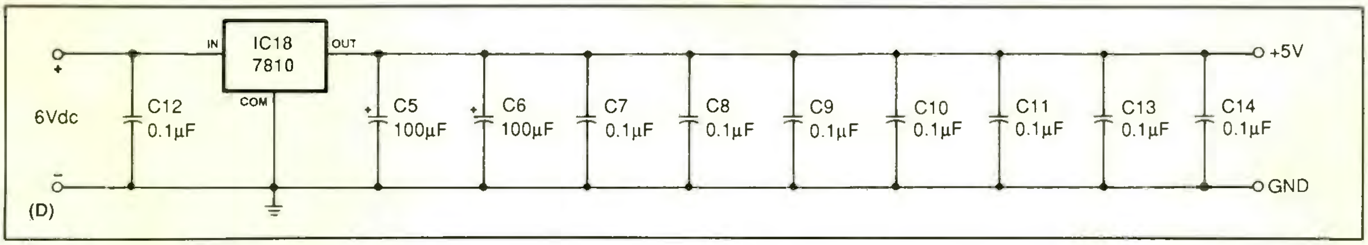
Addresses:

C&K Components
15 Riverdale Ave.
Newton, MA 02158-1082
Tel.: 617-964-6400

Digi-Key Corp.
P.O. Box 677
Thief River Falls, MN 56701
Tel.: 1-800-344-4539

Jameco Electronics
1355 Shoreway Rd.
Belmont, CA 94002
Tel.: 415-592-8097


S02
S01
IC11
74C244
IC10
CD4077
IC9
CD4077
IC8
CD4068
S3
R9 10K
R10 10K
R11 10K
R12 10K
R13 10K
R14 10K
R15 10K
R16 10K
R17 10K
R18 10K
R19 10K
R20 10K
R21 10K
R22 10K
R23 10K
R24 10K
+5V
Y
A B C D E F G H J K L M N P R S
(C)



A positive output from *IC5* occurs when all counters, *IC12* through *IC15* indicate FFFF. This gives the counter a capacity for 65,535 counts on the address lines. When the counter makes one complete pass through all address lines, the square-wave generator stops and green light-emitting diode *LED1* lights to indicate that the pass has been completed and no errors were detected.

To accommodate 2764, 27128 and 27256 EPROMs, 28-pin zero-insertion-force (ZIF) sockets were chosen for *SO1* and *SO2*, as shown in Fig. 1(C). To check a 2716 or 2732, the EPROM must be placed in the sockets with an offset so that its pins plug into the ZIF sockets starting at pin 3 and ending at pin 26. This means that pins 1, 2, 27 and 28 of *SO1* and *SO2* will not be occupied when these 24-pin EPROMs are tested and compared. See Fig. 2 for details.

The circuit is wired so that when type select switches *S4* through *S8* in Fig. 1(A) are set to either 16 or 32, positive voltage is applied to pin 26 of *SO1* and *SO2*. This supplies the V_{cc} bus to the 2716 or 2732 EPROM, which normally require a V_{cc} potential on pin 24.

Diodes *D3* through *D6* block dc voltage from the counters and decoder/driver/display system during address line switching when *S3* through *S6* are toggled from one position to the other.

When type select switches *S3* through *S6* are set up for a 2764, 27128 or 27256 EPROM, pin 26 of both *SO1* and *SO2* becomes another address line and pin 28 is tied to the V_{cc} bus.

As the counter sweeps through the addresses, the outputs of the master and copy EPROMs are compared, address for address and output for output, by putting identical EPROM outputs on the two inputs of exclusive-NOR (XNOR) gates *IC9* and *IC10*. Since each gate in these two ICs is driven by the identical outputs of the master and copy EPROMs, if the outputs are the same, regardless if they are 1s or 0s, a positive output is present at each gate output.

There is one gate for each EPROM output. The outputs from all gates are fed into 8-input NAND gate *IC8*. With all inputs to this gate positive, indicating a proper comparison, there is a zero output from *IC8*. However, if an error is detected in the comparison, one of the outputs from the NOR gates will be negative, making one of the inputs to *IC8* negative. This will produce a positive output from *IC8*, which is fed back to the square-wave generator through *IC7*. When this occurs, the counter will stop at the address at which a mismatch was detected. The defective address can then be read off hex counters *IC12* through *IC15*.

Erasure check of an EPROM is made by putting a positive voltage on one side of all XNOR gates in *IC9* and *IC10* and comparing the outputs of the erased EPROM with this address. If the EPROM has been properly erased, all outputs should be at logic 1 at all addresses. Hence, any address output that shows a 0 indicates that that bit location has not been erased and will be detected as an error. Positive voltage is applied to *SO2* when *S3* is set to E (check erase).

The EPROM to be checked for erasure is placed in *SO1*. The positive voltage is applied to *SO2* through octal tri-state noninverting buffer *IC11*. When a positive voltage is applied to pins 1 and 19, the outputs of the buffer float and the positive voltages at the inputs of the buffers is not present on the outputs. Grounding pins 1 and 19 turns on the buffers and the positive voltage at the buffer inputs is present at the buffer outputs. This applies the positive voltage to one side of all XNOR gates in *IC9* and *IC10*.

When an error signal is detected, the generator stops and the red light-emitting diode *LED2* turns on. This indicates that the counter has stopped at the defective address and the defective address can be read off the displays on *IC12* through *IC15*.

When the counter goes to its maximum count of FFFF, green *LED1* turns on and the counter stops, indicating that the addresses have all been checked and that no errors were detected.

Power for the circuit is supplied by a standard 6-volt dc plug-in power supply rated to deliver at least 300 milliamperes. The power supply schematic diagram is shown in Fig. 1(D). The incoming 6 volts dc is regulated down to the 5 volts dc required by the circuit by +5-volt regulator *IC18*. The 5-volt dc output from *IC18* is smoothed and stabilized by filter capacitors *C5* and *C6*. The remaining capacitors, identified as *C7* through *C14*, are bypass devices used to keep noise off the V_{cc} bus.

Construction

Every part of the EPROM Speed Reader, except the 6-volt dc power supply, mounts directly on a single circuit board. Because of the great number of interconnecting runs required to assemble the circuit, a printed-circuit board is recommended. If you wish, though, you can build the circuit on perforated board that has holes on 0.1-inch centers, using Wire Wrap hardware. However, make certain that you mark off each wire run as you make it on the schematic diagram or a photocopy of it to avoid wiring errors.

Notice in the actual-size etching-and-drilling guides for the project in Fig. 3 that a double-sided printed-circuit board is needed for the project. Ideally, this board should have plated-through holes, which are beyond the means of the typical home builder to make. You can still home-fabricate the pc board, though, by avoiding the use of molded IC sockets and carefully bridging conductors that must continue from one side of the board to the other with lengths of *solid* bare hookup wire.

If you prefer not to fabricate your own board, you can purchase a board with plated-through holes from the source given in the Note at the end of the Parts List.

Before you begin to plug components into a home-fabricated pc board, install the bridging wires as follows. Locate and mark the locations for all wires. These are shown in Fig. 4 as heavy black dots on the top view of the board. There are 96 such dots.

Next, place the board on a sheet of corrugated cardboard on your work surface, component side up, and plug one end of the bare solid wire into one of the marked holes and push until the wire penetrates the cardboard by about 1/16 inch. Solder the wire to the copper pad on the top of the board and clip it close to the board's surface. Repeat for all remaining marked locations. Make sure as you solder these pads and those for the IC sockets that you do not create solder bridges to nearby pads or copper-trace runs.

After soldering the bridging wires to all 96 pads on the component side, flip over the board and solder the wire stubs to the pads on that side. Work quickly, heating the wires and pads only long enough to flow the solder and make good mechanical and electrical connections. Again, clip any excessive-length wires close to the board's surface. When you have done this, use an ohmmeter set to its lowest range or an audible continuity tester to ascertain that all bridging wires are properly soldered to the conductive pattern on both sides of the board. Touch the meter or tester probes to the copper traces —*not* the soldered connections.

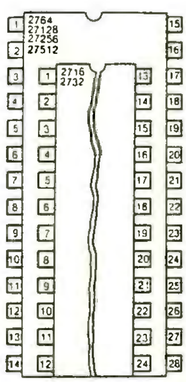
Double check all bridging wire locations against Fig. 4. It is easy to mistake a component hole for a bridging hole.

Regardless of whether you are using a home-fabricated board or the commercial plated-through-hole version, it is a good idea to use sockets for all ICs except voltage regulator *IC18*. If your board does not have plated-through holes, you cannot use standard molded sockets. Instead, use Molex Soldercon® socket strips, which give you soldering access on both sides of the board.

Divide the Soldercon strips into the number needed for each IC. Without removing the metal strip along the tops of the strips, plug one strip into each IC location as shown in Fig. 4 and solder to the pads on *both* sides of the board. Use a fine-pointed soldering iron and only enough solder to make good connections. Work carefully to avoid creating solder bridges to nearby pads and conductors.

You can plug in and solder into place the remaining Soldercon strips for the ICs in the same manner. However, if you have old ICs, it would be better to use them to make sure the second strip in each case is properly aligned with the first. To do this, plug the second strip into its holes in the board and then plug the IC into the receptacle ends of the Soldercons and carefully solder the pins to the copper pads on the bottom of

Pin	2716	2732	Pin	2764	28128	27256	28512
			28	V_{cc}	V_{cc}	V_{cc}	V_{cc}
			27	PG/M	PG/M	A14	A14
24	V_{cc}	V_{cc}	26	N.C.	A13	A13	A13
23	A8	A8	25	A8	A8	A8	A8
22	A9	A9	24	A9	A9	A9	A9
21	V_{pp}	A11	23	A11	A11	A11	A11
20	$\overline{OE}$	$\overline{OE}$	22	$\overline{OE}$	$\overline{OE}$	$\overline{OE}$	$\overline{OE}$
19	A10	A10	21	A10	A10	A10	A10
18	$\overline{CE}$	$\overline{CE}$	20	$\overline{CE}$	$\overline{CE}$	$\overline{CE}$	$\overline{CE}$
17	O7	O7	19	O7	O7	O7	O7
16	O6	O6	18	O6	O6	O6	O6
15	O5	O5	17	O5	O5	O5	O5
14	O4	O4	16	O4	O4	O4	O4
13	O3	O3	15	O3	O3	O3	O3



17512	27256	27128	2764	Pin	2732	2716	Pin
A15	V_{pp}	V_{pp}	V_{pp}	1			
A12	A12	A12	A12	2			
A7	A7	A7	A7	3	A7	A7	1
A6	A6	A6	A6	4	A6	A6	2
A5	A5	A5	A5	5	A5	A5	3
A4	A4	A4	A4	6	A4	A4	4
A3	A3	A3	A3	7	A3	A3	5
A2	A2	A2	A2	8	A2	A2	6
A1	A1	A1	A1	9	A1	A1	7
A0	A0	A0	A0	10	A0	A0	8
O0	O0	O0	O0	11	O0	O0	9
O1	O1	O1	O1	12	O1	O1	10
O2	O2	O2	O2	13	O2	O2	11
GND	GND	GND	GND	14	GND	GND	12

Fig. 2. Connection details for various members of 27XX/XXX family of EPROMs to test sockets and pin address and output identifications.

the board. This done, remove the IC and set it aside. Flex the metal connecting strip on both rows of Soldercons until it parts from the receptacle pins. Then replace the IC and solder the Soldercons to the pads on the component side of the board. Repeat with the remaining strips.

You will notice that no holes are provided for pins 6, 9 and 11 of *IC12* through *IC15*. Therefore, no Soldercons (or socket pins) must be installed in these locations. The best way to handle this is to plug the pins of an ordinary 14-pin IC into two strips of seven Soldercons, flex away the metal connecting strips and remove the Soldercons from pins 6, 9 and 11. Then plug the Soldercons into the holes in the board and solder them to the pads on the bottom of the board, remove and set aside the IC and solder the Soldercons to the pads on the top of the board. (If you are installing the sockets on a board with plated-through holes, simply clip pins 6, 9 and 11 from each of four 14-pin sockets.)

For *SO1* and *SO2* you have two options. You can use Wire Wrap sockets that can be spaced far enough above the surface of the board to provide soldering access. Alternatively, you can use solder-tail sockets that plug into parallel rows of Soldercons as you did for the ICs. If you use Wire Wrap sockets, place a rectangle of single-ply corrugated cardboard under the sockets to raise them enough to provide soldering access on the component side of the board. The cardboard "shim" should be ¼ inch narrower than the distance between the rows of pins on the socket and long enough to fit under both sockets and to protrude about ½ inch from the pin 14/15 end of *SO2*.

With the shim in place, tack solder the four corner pins of both sockets to the pads on the component side of the board. Flip over the board and solder the pins to the pads on the bottom of the board. If desired, clip

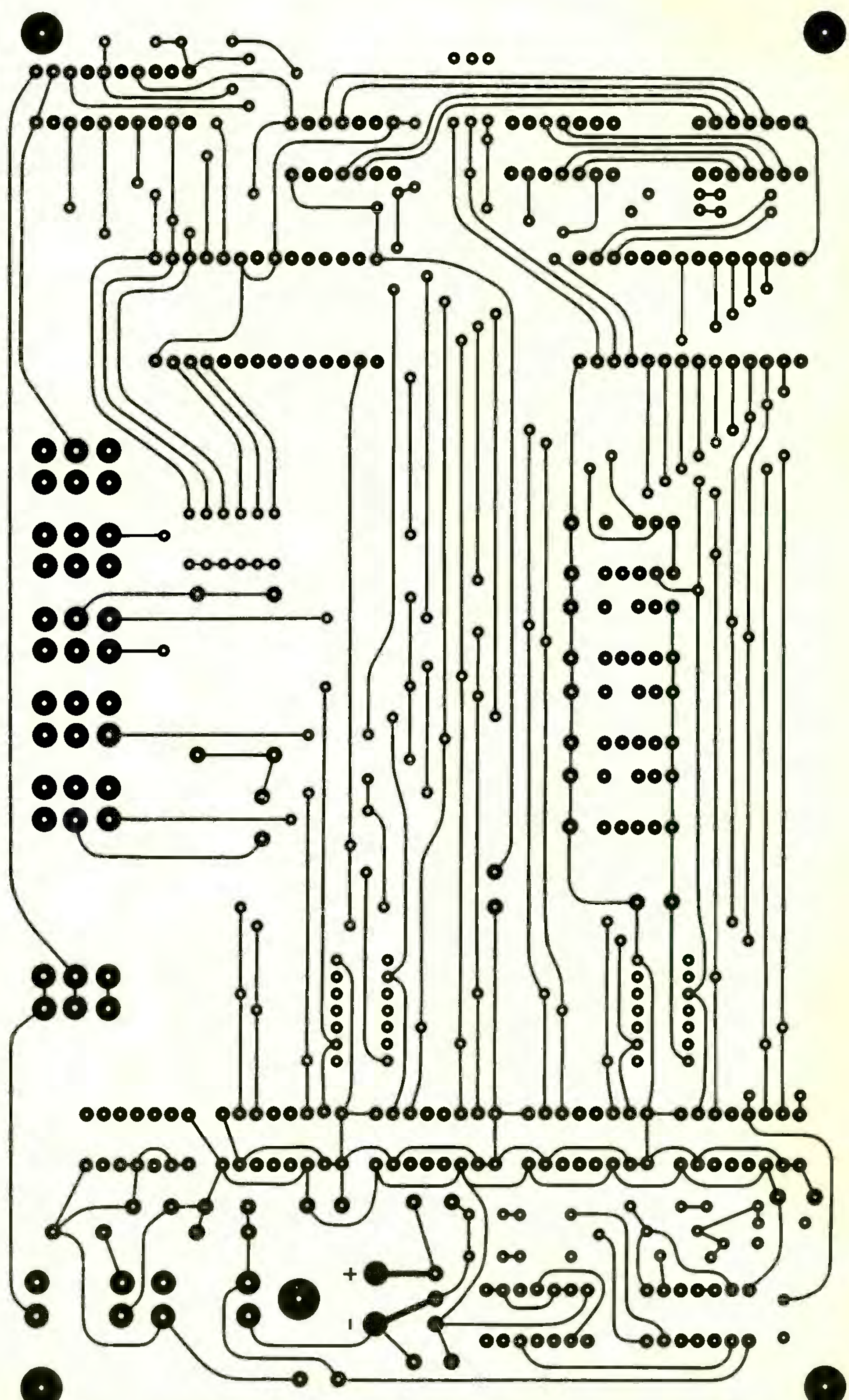
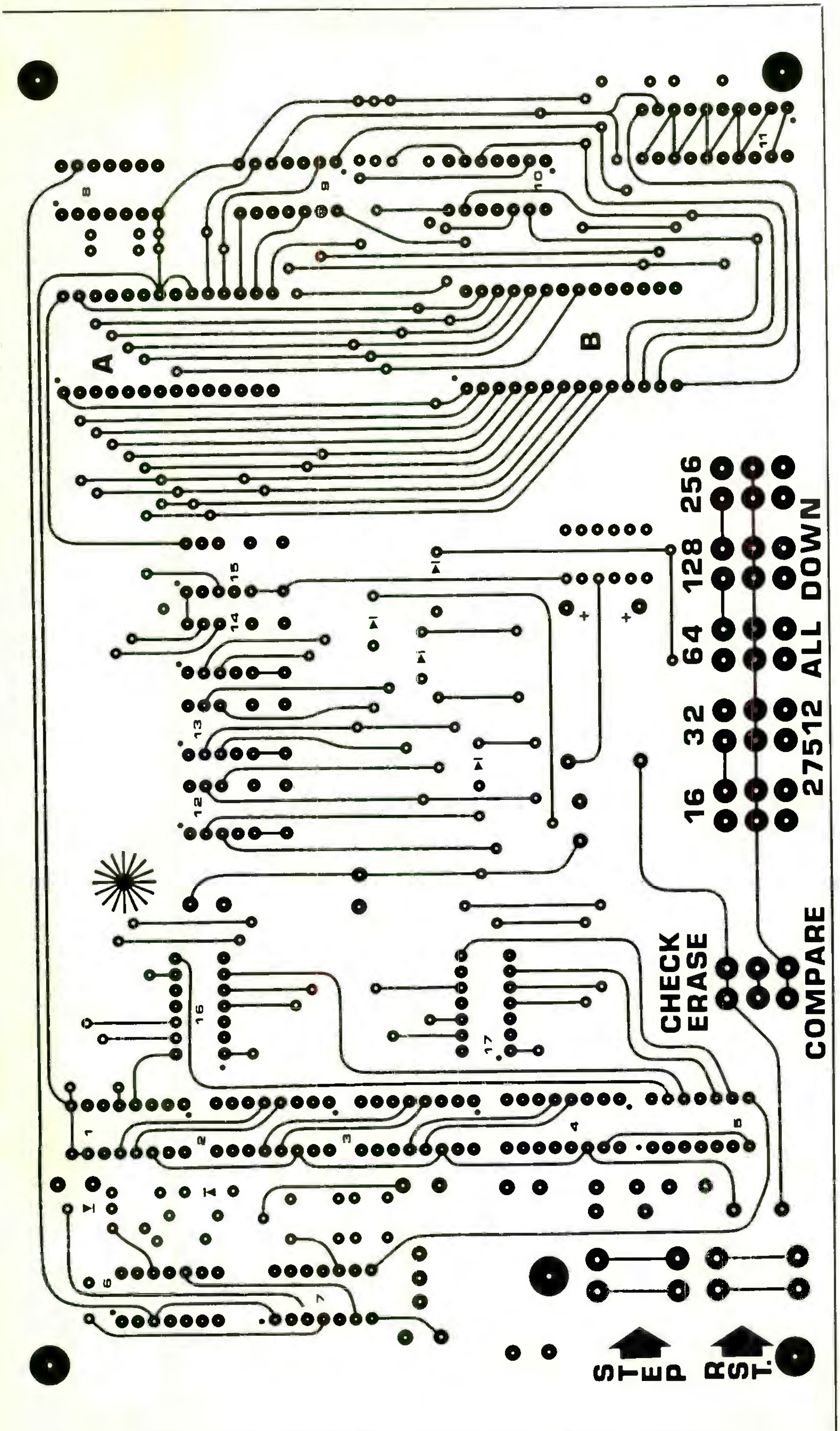


Fig. 3. Actual-size etching-and-drilling guides for both sides of printed-circuit board needed for project.



each pin close to the board's surface. Then flip over the board once again and carefully solder the remaining pins to the pads on the component side of the board. You can leave the cardboard shim in place if you wish or gently but firmly pull it from under the sockets. If you run into any snags, compress the cardboard with the blade of a screwdriver through the slots in the tops of the sockets.

Now mount the resistors in their respective locations, soldering their leads to the pads on both sides of the board. Do the same for the diodes, making sure you properly orient them. Then install and solder into place in the same manner the capacitors, making sure you properly polarize *C5* and *C6*.

Plug the lugs of the switches into the holes in the board in their respective locations and solder the lugs first to the pads on the *component* side of the board and then to the pads on the bottom of the board. It may be necessary to have only a small fraction of an inch of lug protruding through the holes in the bottom of the board to accomplish soldering to the pads on the component side. If you cannot get soldering access with your switches, try to find switches that do provide such access, either with longer lugs or pins that exit from the sides of the switches. In the *S4* through *S8* group, install *S6*, then *S5* and *S7* and end with *S4* and *S8*

Bend the pins of voltage regulator *IC18* at a 90-degree angle toward the rear of the IC. Plug the pins of the regulator into the holes in the board and secure the IC to the board with a 4-40 × ¼-inch machine screw, lockwasher and nut. Solder the pins to the pads on both sides of the board.

Plug the leads of *LED1* and *LED2* into their respective holes in the board (make sure they are properly polarized) and push the LEDs down until the bottoms of their plastic cases are about ¼ inch from the surface of the board. Carefully solder the leads to the pads on the component side of the board. Flip over the board and solder the leads to the pads on the bottom of the board. Clip away any excess lead lengths.

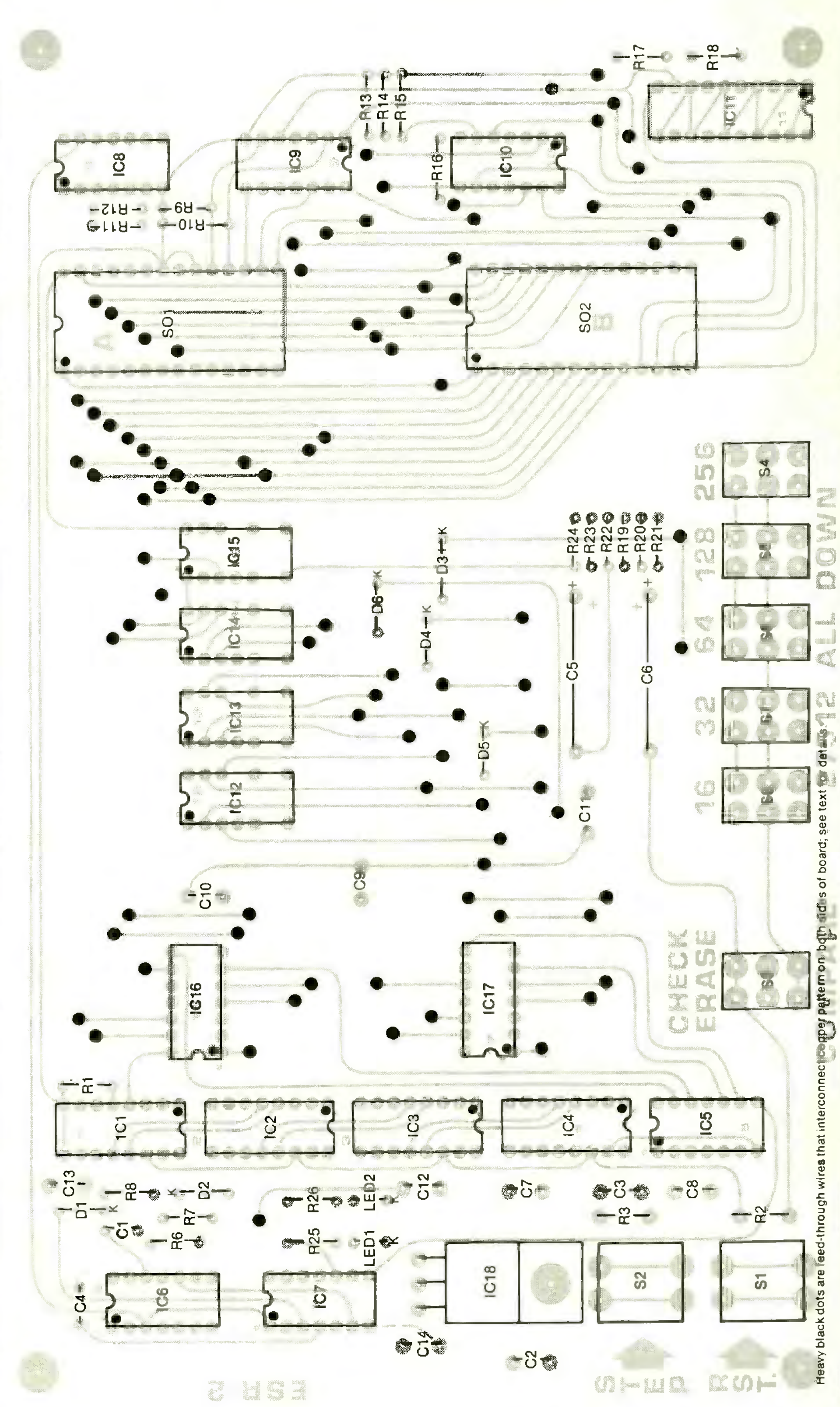
Perhaps the easiest method of housing the EPROM Speed Reader is to mount it in a wood frame made from 1 × 2-inch pine cut to length to make a box just large enough into which to drop the circuit-board assembly. Hence, the inner dimensions of the box should be 8½ inches wide by 5⅛ inches deep. You can either butt- or miter-join the corners of the frame. Use a 1 × 1-inch pine cleat at each corner, recessed about 1/16 inch from the top and about ¼ inch from the bottom to allow the circuit-board assembly and a sheet of Masonite to be dropped into place on top and bottom, respectively.

Decide on whether you want to be able to plug the 6-volt dc power supply into the project for use and unplug it when not in use or you want a permanent hookup arrangement. If the former, you need a mating jack for the plug on the end of the supply's feeder cord. If the latter, cut off and discard the plug on the end of the cord, separate the conductors by about 1 inch and trim ¼ inch of insulation from each conductor. Twist together the fine wires in each conductor and tin with solder.

Drill an entry hole for the cord from the 6-volt dc power supply in the rear wall of the enclosure frame. If you plan on using a plug/unplug arrangement with a power jack, make the hole large enough to accommodate the jack mounted on a piece of sheet metal or thin plastic. Otherwise, make the hole only large enough to pass through the cord and tie a knot in the cord about 4 inches from the prepared end inside the box.

Making sure that the bare conductor wires do not touch each other, plug the power supply into an ac outlet and use a dc voltmeter set to read 10 volts or so full-scale to determine the polarity of the supply's conductors. Mark the +5-volt conductor

Fig. 4. Component installation guide for pc board.



for easy reference. Disconnect the supply from the ac outlet. Then connect and solder the +5-volt conductor directly to the + pad and the unidentified conductor to the − pad on the board.

When using the plug/unplug arrangement, interconnect the power jack with the board with color-coded hookup wires.

If you wish, you can even combine the EPROM Speed Reader in the same enclosure used for the Stand-Alone EPROM Programmer featured in the February and March 1987 issues of *Modern Electronics*, rather than build a separate enclosure for it. This would probably be a more convenient way to go, since the two units are generally used together. If you go this route, the regulated 5 volts dc from the EPROM Programmer can be used to power the EPROM Speed Reader and voltage regulator *IC18* can be omitted from the latter.

At this point, the only integrated circuit that should be installed on the board should be regulator *IC18*. Do *not* install the other ICs in their sockets until after you have completed initial voltage checks.

Checkout & Use

Before you plug any IC into its socket, you must perform a preliminary voltage check, especially if you Wire Wrapped the project, to ascertain that the circuit has been correctly wired and that all points in the +5-volt bus are indeed connected to the bus if you used a pc board with no plated-through holes. For this step, all you need is a dc voltmeter or a multimeter set to read dc on a range that will easily accommodate the maximum +6 volts that should appear in the circuit.

Clip the meter's common lead to circuit ground at the negative (−) lead of either *C5* or *C6*. Plug the 6-volt dc power supply into an ac outlet (and its output cable into the jack on the rear of the enclosure if this is the arrangement you opted for). Now touch the meter's "hot" probe to pin 16 of all 16-pin ICs, pin 14 of all 14-pin ICs, pin 20 of *IC11* and pin OUT of *IC18*. The readings in all cases should be the same +5 volts. Touching the hot probe to pin IN of *IC18* should yield a reading of approximately +6 volts. If you do not obtain the proper reading in any case, power down the circuit and correct the problem before proceeding.

Once you are satisfied the project is wired properly, disconnect it from the ac line and wait a few minutes to allow *C5* and *C6* to discharge. Then, referring back to Fig. 4, install the ICs in their respective sockets. Make sure each is properly oriented and that no pins overhang the socket or fold under between IC and socket as you push each home. Also, since these are CMOS devices, handle them with the same precautions as you would any other MOS device to avoid inflicting damage to them from static electricity.

To use the EPROM Speed Reader to compare the data programmed into a master and a copy EPROM, plug the two EPROMs to be compared into either socket. It does not make any difference which socket is used for which EPROM, but make sure you properly install the EPROMs, both as regards to orientation and offset, if any. That is, if you are comparing 2716s or 2732s that have only 24 pins, place them in the sockets so that the upper two receptacles on both sides of both sockets are unoccupied.

Set *S3* to C (compare) and *S4* through *S8* according to the type of EPROMs being compared. Only one of these switches should be in the up position: *S8* for 2716s, *S7* for 2732s, *S6* for 2764s, *S5* for 27128s or *S4* for 28256s. All other switches should be in the down "off" position. The only exception to this rule is that when comparing or checking 27512 EPROMs, *all* switches must be in the off position.

Keep in mind that there is no way that an EPROM can be reprogrammed or erased by the EPROM Speed Reader. Always begin a read/compare operation with the counter reset to zero by pressing and releasing RESET switch *S1*. Counting begins as soon as *S1* is released.

When or if the counter stops counting as a result of a detected error in the comparison, the error can be recorded and the counter can be single stepped to the next address by pressing and releasing STEP switch *S2*. If no error is present at this address, the counter will resume counting until it detects another error or the count is complete. As mentioned earlier, a detected error stops the counter and turns on the red LED. If no error is detected, the counter will sweep from start to finish, stop counting and light the green LED. The whole process takes only a few seconds.

To check erasure of an EPROM, simply plug the erased device into *SO1* and set *S3* to E (check erase). Set *S4* through *S8* according to the type of EPROM being tested and reset the counter by pressing and releasing *S1*. The procedure for checking erasure is the same as for comparing EPROMs except that you compare the erased EPROM with all 1s on one side of XNOR gates *IC9* and *IC10*. The results will pop up in seconds.

If an error is detected, the red LED will turn on. If the counter runs through the complete range of addresses with no detected error, the green LED will light.

If you do a lot of programming of supposedly erased EPROMs, our EPROM Speed Reader will save you a lot of time and frustration. Its dual-function operation perfectly complements whatever programmer you are using, whether it is the one for which the project was built or a commercial unit. With this project, you will know if an erased EPROM is fully erased *before* you attempt to reprogram it and if a copy is the same as the original. ME