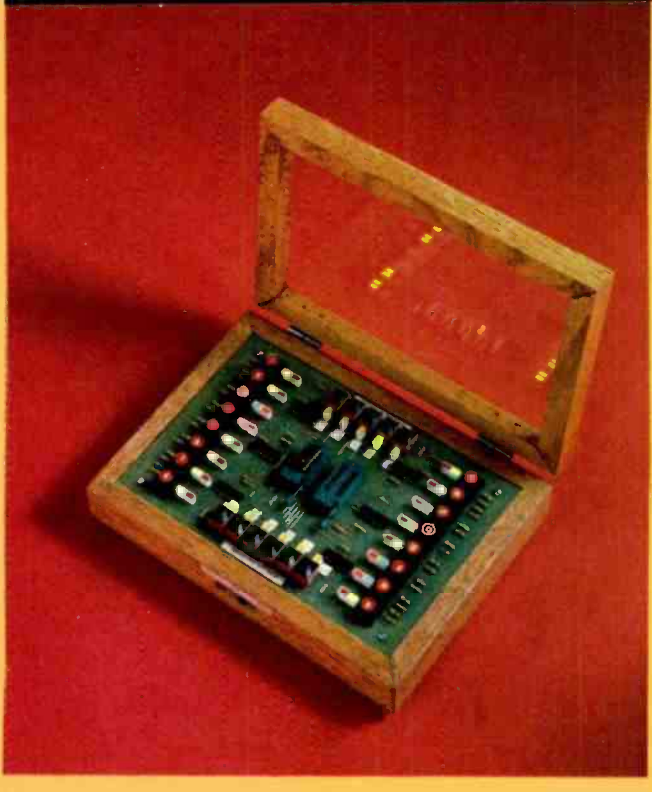
Build the...

DIGI-LYZER IC TESTER

By W. Schopp

Now you can quickly check questionable IC's to determine whether they are worth keeping or not



YOU'VE STRUGGLED FOR DAYS GETTING YOUR CIRCUIT to operate just the way that you want it to. And now it's time to clean up. You put away your tools and meter, fold up your schematics and notes, sweep off your workbench. Suddenly, there they are—those questionable chips. You vaguely remember switching those *chunks of silicon* for new ones when some part of the circuit failed to perform as intended.

But then, suddenly, your memory takes a complete leave of absence; and you can't recall whether changing the chip made any difference. And so the problem becomes painfully clear: You hate to put those chips back into your inventory with the good ones only to give you possible problems at some future date.

You also don't want to throw them away because they not only cost good money (and the cost of survival being what it is these days), but they also might save you a trip to town if you happen to need that particular chip again. Anyone who has designed or built electronic circuits around digital IC's can certainly relate to that situation.

You say to yourself, "I'll just put them in this ash tray and check them later *when I get more time*." But the only problem is that *the time* never seems to materialize. And all too soon you notice that you have an ash tray full of chips from other projects. Does that sound like a familiar tale to you?

The Solution

What is really needed is a simple checker that is able to handle all digital chips. The criteria for such a circuit might include: a zero insertion-force socket, so that all you'd have to do is drop the chip into the socket without damaging the IC pins, or having to do any soldering or breadboarding. There should be a way of applying power to any pin of the *C*hip-*U*nder-*T*est (CUT) regardless of its pin configuration, and you should also be able to apply a voltage to any pin simply by pushing a button.

In addition, it should also have status indicators so that you can tell to which pins voltage is applied and which pins are at ground potential. And how about a way to tell if the voltage on the pin is applied directly through a pushbutton switch, or if it's an output voltage from the CUT? Such a circuit would allow you to turn gates on and off, operate registers, apply pulses to counters, operate flip-flops, thereby enabling you to determine the merit of the chip merely by observing the output indicators.

Well the *Digi-lyzer Digital IC Tester* is just such a circuit, which, with the aid of a CMOS or TTL cookbook, any listed chip can quickly be tested. If that sounds like a handy thing to have around, hang in there—the best is yet to come.

About the Circuit

The circuit (see Fig. 1) is designed around two Zero-Insertion Force (ZIF) integrated-circuit sockets to handle both 14 and 16 pin chips. The two sockets are wired in parallel so that any voltage presented to a particular pin on one socket appears at the same pin on the other (except 15 and 16 on the 14-pin socket). In other words, if +V is applied to pin 14 of SO1, pin 14 of SO2 will be at the same potential.

Each pin of the two ZIF sockets is normally grounded via pull-down resistors (R17 to R32). There are 16 pushbutton switches (PB1 to PB16, which correspond to pins 1 through 16), which are used to apply a logic high to its associated pin. Each of the ZIF sockets' pins are also connected to a double inverting-buffer stage, consisting of six 4049 CMOS hex inverting buffers, U1 through U6. When a pin is at logic low (ground or zero potential), the output of the first buffer goes high and lights the green LED (the even-numbered LED's up to 32), indicating a logic low on that pin. And when a pin has a logic high applied to it, the output from the second buffer goes high and lights the red LED, indicating a logic high (or voltage) on that pin. However, if a red LED lights while you are *not* holding the button down for that particular pin, the LED indicates a logic high output from the CUT. What could be simpler?

The slide switches, S1 to S11, provide a method by which you can cover the power requirements for all of the popular TTL and CMOS chip configurations. Positive voltage can be applied to pins 1, 4, 5, 14, and 16. A direct ground can be made available to pins 7, 8, 10, 11, 12, and 13. The pins with the direct positive and ground connections are indicated by

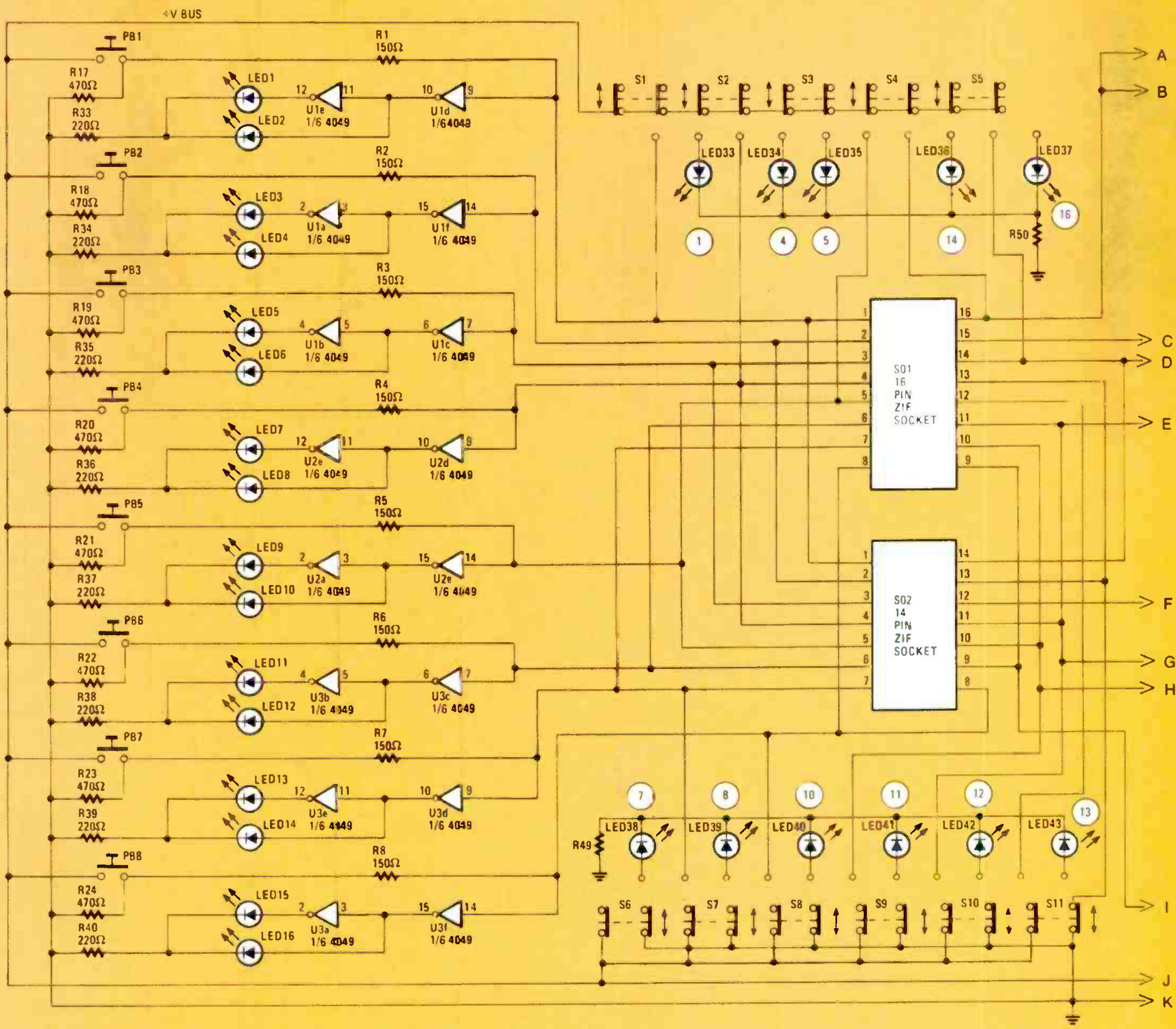


Fig. 1—The Digi-lyzer Digital IC Tester is designed around two zero-insertion force (ZIF) IC sockets wired in parallel. Each pin of SO1 and SO2 is normally grounded through pull-down resistors R17 to R32. Drawing continued on next page.

yellow LED's (LED33 to LED37 for +V and LED38 to LED43 for GND) located in front of each slide switch. Those LED's can be numbered with the pins they represent on the top of the printed-circuit board with a small typewritten number on a small piece of gummed label (see photos).

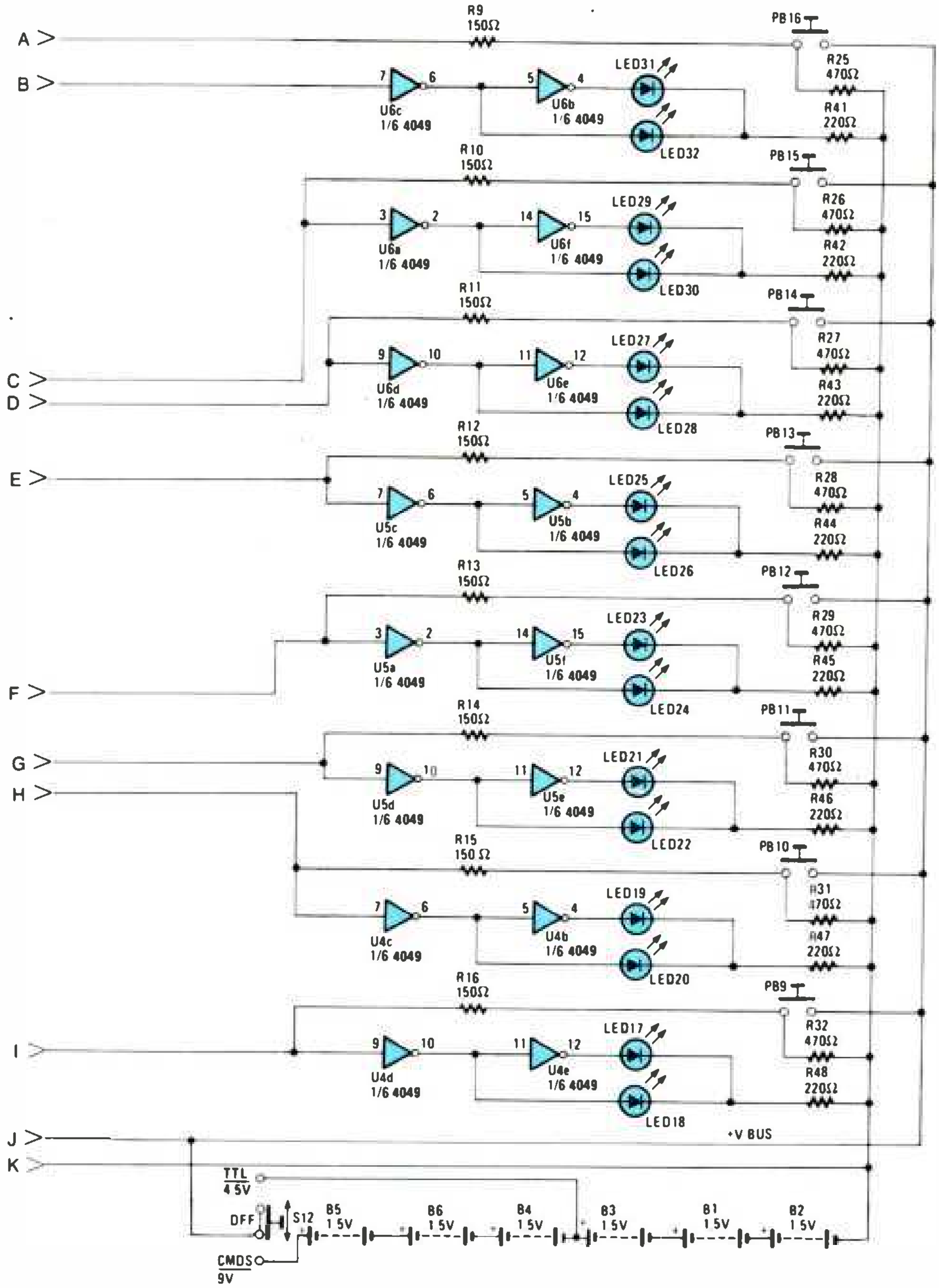
The chip is protected from possible damage by accidentally pushing a button and applying voltage to a directly grounded pin by series resistor (R1 to R16) connected between each pin of the sockets and the pushbutton switches. The circuit is powered by six ordinary "C" or "D" cell flashlight batteries.

The six batteries were split at 4.5 volts by inserting a piece of brass shim stock between the third and fourth battery from ground. Soldering a wire to the shim stock provides the 4.5 volt supply for checking TTL chips, while the 9-volt supply is used for checking CMOS chips. The two voltages are tied to a SPDT center-off, slide or toggle switch. Wired in that manner, the switch provides the voltage selection and on-off function of the unit.

The author used eight "C" cells in his prototype, and wired them as shown in Fig. 2—which provides 4.5 volts for TTL chips and 12 volts for CMOS chips. Since CMOS chips have a much-wider power-supply range (typically from 3 to 15 volts) than do TTL units, the CMOS chips can be safely operated from the higher source voltage. Or a suitable dual-voltage AC-derived DC power supply can be developed and used to operate the Digi-lyzer as a bench model if desired.

Construction

The complete Digi-lyzer can be put together using the method of choice, but as always (well, almost always) it is recommended that the project be built on a printed-circuit board to simplify construction and virtually eliminate errors. Figure 3 shows a full-scale template of the Digi-lyzer's



that the strip does not touch anything else on the bottom of the board except the pads provided.

Next install the parts on the board, beginning with the jumper connections (see Fig. 4, the parts placement diagram) and passive components—resistors, capacitors and switches. The pushbutton switches (PB1 to PB16) on the prototype unit shown in the photographs were numbered with small round tabs glued to the top of the push buttons. They can also be numbered adjacent to the LED pair that each pushbutton controls. For simplicity, the arrangement order of the pushbuttons are in the same configuration as the pins are on the chip when it is put into the ZIF socket, (i.e., pin one at upper left corner).

Moving right along, install the LED's—red (even-numbered LED's up to 32) for +V, green (odd-numbered LED's up to 31) for ground, and yellow (LED33 to LED43) for the power connections. The LED's chosen for the author's prototype are small rectangular units available from many electronic parts suppliers (including mail-order supplier Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002; Tel. 415/592-8097) in a variety of colors. Of course, you don't necessarily have to use that type of LED; the common garden-variety (refracted lens) can be used—it's the builder's choice and up to you.

You'll note that all of the LED's have their cathodes facing toward the center of the board. Since we are dealing with so many LED's (provided that you are using the square units), it is recommended that you mark the cathode end of the package, prior to installation (see photos), to allow for quick visual verification of proper orientation of the LED's.

printed-circuit board. The board can be reproduced from the template or purchased from the supplier given in the Parts List that follows.

The large pads spaced lengthwise across the board are used to solder on a board stiffener (support), so that when you install a chip in the ZIF sockets or press a pushbutton switch, the board doesn't sag and possibly sever a trace or dislodge a solder connection.

The board stiffener can be made from a strip of PC-board material, cut to about ¼-inch to ⅜-inch wide and as long as the distance between the two outside pads. Lay the strip in position across the pads and mark the location of each pad on the strip. At the pad-position markings on the stiffener, cut about ⅛-inch into the edge of the board to form a sort of stand off, and strip off the excess leaving the points where pads are indicated. When the strip is placed on edge, and soldered to all of the pads, it will stiffen the board so that it will not flex in the middle when the pushbuttons are pressed down. Be sure

In the author's prototype, the integrated circuits were soldered directly to the board; however, it might be in your favor to use IC sockets, in the event that it becomes necessary to replace one or more of the chips. Finally, use either the Fig. 1 or Fig. 2 battery-wiring diagram to connect the power supply to the circuit.

Checkout Time

Once you've completed the unit and given it a visual inspection for possible trouble spots—such as solder bridges, cold-solder joints, misoriented components, and the usual battery of common construction defects—you can check out a few basic chips to get familiar with the Digi-lyzer's method of operation.

Let's start with a simple TTL quad two-input AND gate such as the 7408. That particular chip contains four two-input AND gates. Many of the TTL and CMOS chips share a

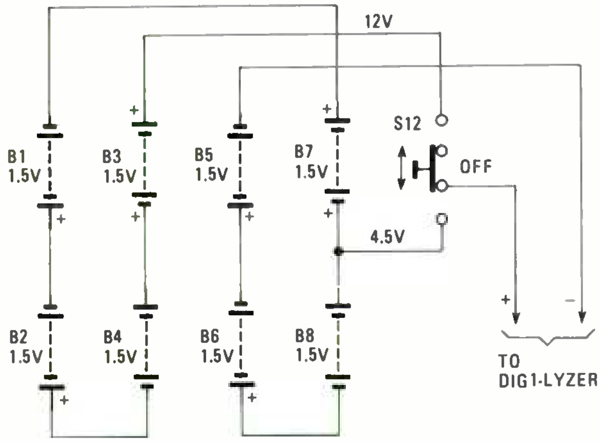


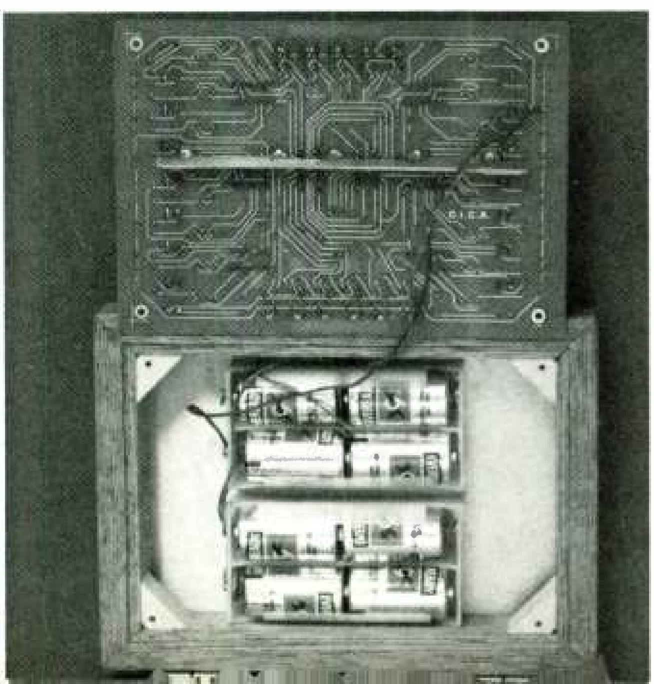
Fig. 2—The author used eight "C" cells in the prototype and wired them as shown to provide 4.5 volts for TTL chips and 12 volts for CMOS chips. A suitable multi-output AC-derived DC power supply can be used if a bench model is desired.

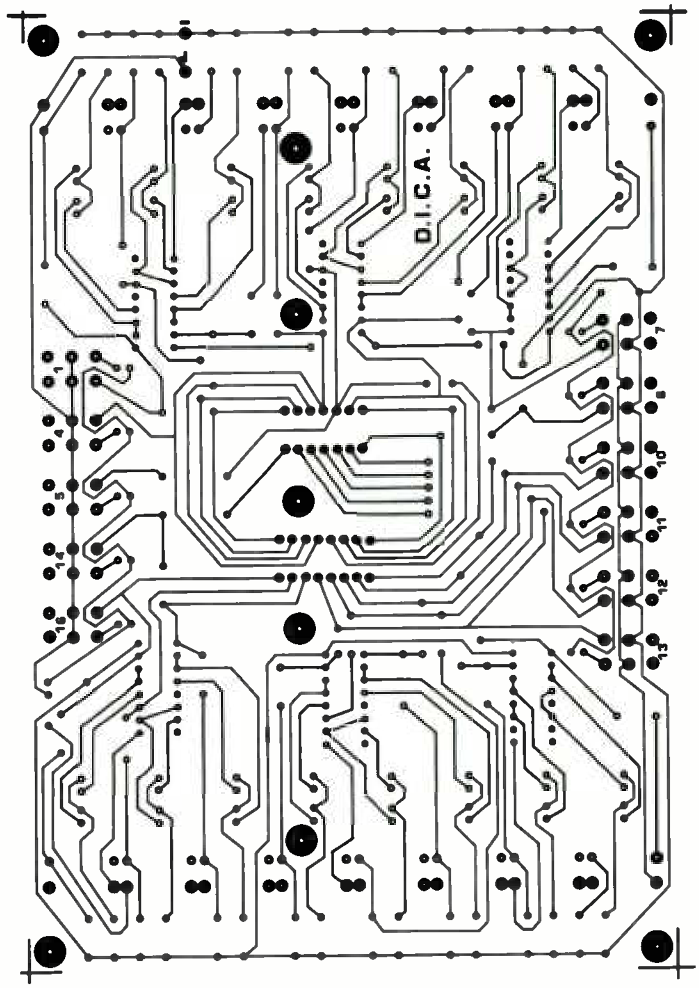
Fig. 3—This half-size template of the Digi-lyzer's printed-circuit traces can be used to produce your own board or, if you prefer, it may be purchased from the supplier given in the Parts List ▶

common pinout diagram. And because of the nature of the two logic families, the CMOS version can replace its TTL cousin, but rarely vice versa.

By looking at the TTL cookbook, we find that the power supply pins for that particular chip are pins 14 for the positive supply and pin 7 is the minus (or ground) pin. We then turn on the slide switches representing pins 7 and 14. The positive supply slide switches are all located at the top of the board while the minus or ground switches are all located at the bottom. We are now ready to test the chip.

Drop the chip into the ZIF socket and lock it in place, with pin 1 of the CUT in the upper-left corner (notch pointing upward). Turn the power switch to the TTL position and the yellow lights will show that power is applied to the chip across pins 7 and 14. All the green LED's should be on except on pin 14, with a red LED lit. That indicates that all the pins on the chip are at ground potential, except 14, which has the supply voltage applied to it.

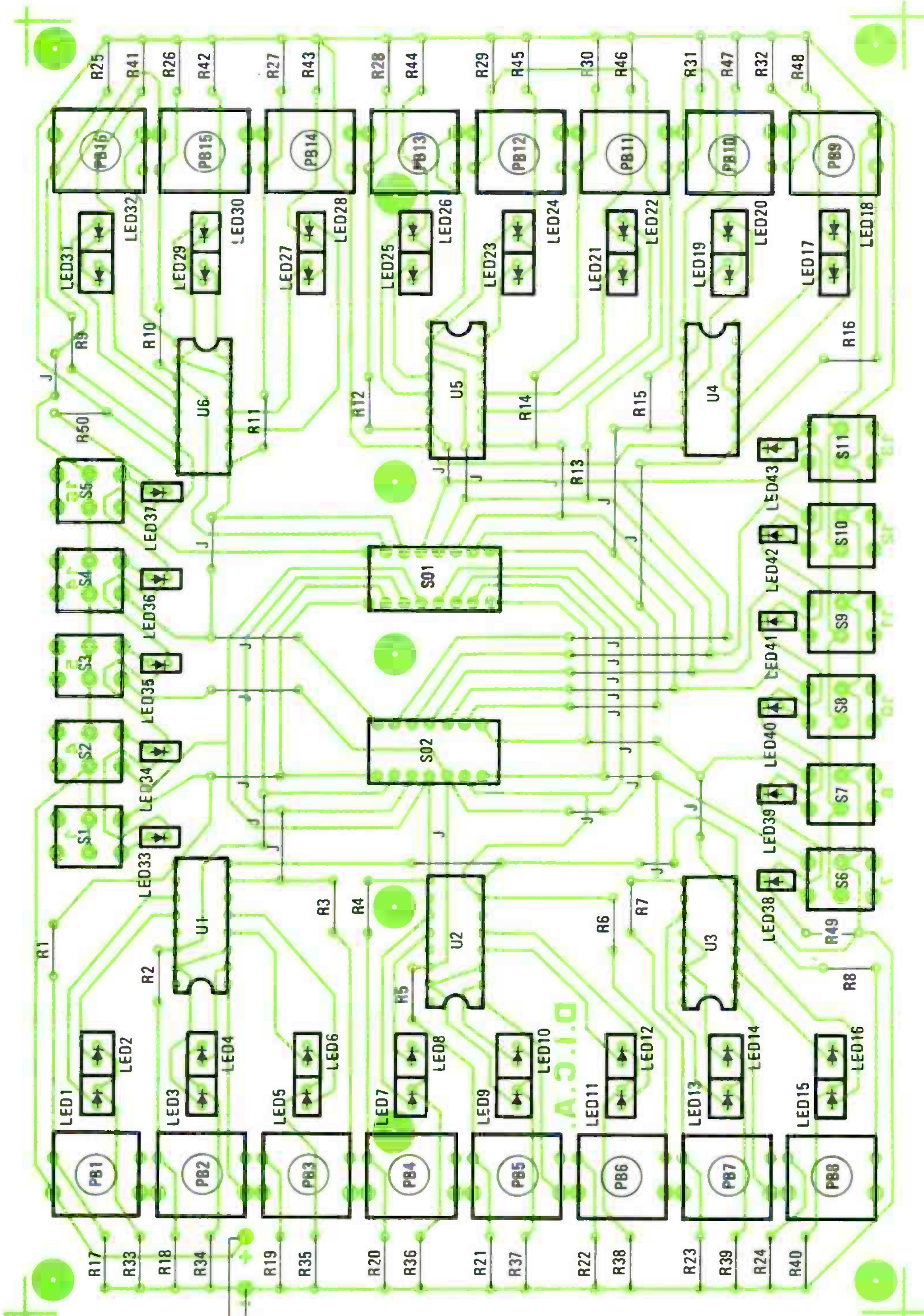




That is as it should be, inasmuch as the 7408 is an AND-gate circuit and no voltage should be present on any of the outputs unless both inputs of any particular gate have positive voltage applied to them. Start by checking the first gate of the chip. By referring to the TTL cookbook, we find that pins 1 and 2 are the inputs to this particular gate and pin 3 is the output. Hold pins 1 and 2 down and the red LED's will show on those two pins. When both of those pins have voltage applied to them, pin 3 will also show a red LED indicating an output from the chip. If an output is seen without buttons 1 and 2 down, or no output is seen when those buttons are pushed down, that particular gate in that chip is defective. You can then check the other three gates in the package the same way. With the information provided on the operation of the chip from the TTL cookbook, and by observing the LED's, you can either pronounce the chip sound and put it with your supply of good ones, or trash it. Either way, it's out of the ash tray. One note of caution: When you are checking TTL chips, never switch the analyzer to the CMOS power-on position. The full 9 volts applied to a TTL IC will prematurely smoke a good chip.

Let's take one more example. Suppose we are checking a CMOS CD4011. We set up the power pins on pins 7 and 14 just as before. We then drop the chip into the ZIF socket and

The author's eight "C"-cell power source (shown here) was wired as shown in Fig. 2 to provide 4.5 volts for TTL chips and 12 volts for CMOS chips, which have a wider power-supply range than do their TTL counterparts.



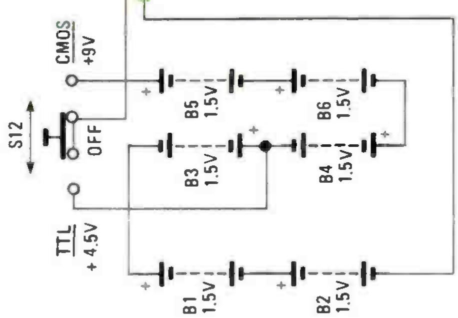


Fig. 4—Install the parts on the board using this parts-placement diagram as a guide. Begin with the jumper connections and then the passive components—resistors, capacitors and switches. Next install the LED's; red (even-numbered LED's up to 32) for + V, green (odd-numbered LED's up to 31) for ground, and yellow (LED33 to LED43) for the power connections.

lock it in place just as before. This time we switch the power on to the CMOS position, which applies the full 9 volts to the chip. This time we are checking a quad 2 input NAND gate. That is also a chip that has four such independent gates in one package. By referring to the CMOS cookbook, we see that on any one gate, with either or both inputs low, the output will be high. When the power is turned on, all the outputs will show voltage on them. That is just as it should be, because all the inputs are at ground potential. Checking the pin layout we find that the first gate has pins 1 and 2 as inputs and pin 3 is the output for one particular gate. By pushing down buttons 1 and 2, thus applying voltage to those pins, pin 3 should return to ground or show a green light. Any deviation from that operation indicates a defective gate. The other three gates are checked in the same manner. With a little experience on the simple chips, more complex chips can be analyzed. The CMOS and TTL cookbooks are invaluable aids when it comes to analyzing the operation of the more complex chips since they explain in advance what should happen under various input conditions.

After a little experience with the unit, you will be able to

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DIGI-LYZER IC TESTER

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check out the more complex chips such as counters, registers, one shots, and flip-flops. The parts count for the unit is minimal, and the cost is modest compared to its usefulness on your test bench. After you are thoroughly familiar with its operation, you can tackle that ash tray full of questionable chips that we all know you have hidden somewhere around your workbench. ■

PARTS LIST FOR THE DIGI-LYZER IC TESTER

RESISTORS

(All resistors ¼-watt, 5% fixed units)
R1–R16—150-ohm
R17–R32—470-ohm
R33–R50—220-ohm

SEMICONDUCTORS

LED1, LED3, LED5, LED7, LED9, LED11, LED13, LED15, LED17, LED19, LED21, LED23, LED25, LED27, LED29, LED31—Light-emitting diode, red
LED2, LED4, LED6, LED8, LED10, LED12, LED14, LED16, LED18, LED20, LED22, LED24, LED26, LED28, LED30, LED32—Light-emitting diode, green
LED33, LED34, LED35, LED36, LED37, LED38, LED39, LED40, LED41, LED42, LED43—Light-emitting diode, yellow
U1–U6—4049 CMOS hex inverting buffer, integrated circuit

SWITCHES

PB1–PB16—Normally-open pushbutton switch, Digi-Key part No. P9951 (Digi-Key Corp., PO Box 677, Thief River Falls, MN 56701; 1-800/344-4539)
S1 to S11—Two-position slide switch, CK Part No. 1201 M2 CQE (C and K Components, 15 Riverdale Ave., Newton, MA 02158-1082; for nearest stocking distributor call: 1-800/243-8160)
S12—Single-pole, double-throw (SPDT) center-off switch

ADDITIONAL PARTS AND MATERIALS

B1–B6—Battery, "C" or "D" cell
SO1—Zero-Insertion Force (ZIF) socket, 14 pin, Part No. 214-3339 (Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002; Tel. 415/592-2503)
SO2—Zero-Insertion Force (ZIF) socket, 16 pin, Part No. 216-3340 (Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002; Tel. 415/592-2503)
Printed-circuit board (see below for supplier), enclosure, batteries, battery holders, hardware, wire, solder, etc.

Note: An etched and pre-drilled printed-circuit board is available priced at $18.50 (including shipping and handling) from Electronic Enterprises, 3305 Pestana Way, Livermore, CA 94550.

CIRCUIT CIRCUS

(Continued from page 91)

fier's gain to vary at the same rate. The depth, or modulation level is controlled by the setting of R11, and the frequency is adjusted via R12.

There's only one way to have fun with those two circuits, and that is, of course, to dig in and experiment with each one until you obtain the sound effect that you desire. And there is no rule against adding your own circuitry to what we have offered. So get to it, and good Luck. ■

PARTS LIST FOR THE TREMOLO CIRCUIT

RESISTORS

R1–R3, R9—10,000-ohm
R4, R5—27-ohm
R6—680,000-ohm
R7, R8, R10—100,000-ohm
R11—50,000-ohm, potentiometer
R12—100,000-ohm, potentiometer

CAPACITORS

C1, C2—100-µF, 16-WVDC electrolytic
C3, C4—.1-µF, 100-WVDC Mylar
C5–C8—.27-µF, 100-WVDC Mylar

ADDITIONAL PARTS AND MATERIALS

D1, D2—1N914 general-purpose silicon diode
U1—LM324 quad-op-amp, integrated circuit
Q1—BS170 N-channel TMOS, (Radio Shack part No. 276-2074 or similar)
IC socket, perfboard or printed circuit materials, etc.

CARR ON HAM RADIO

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even make for a better ground. I remember one amateur who built a home in the late 50's. He went out there and erected an extensive ground-wire grid and radials system before the sod went down (ah, heaven is a low-resistance ground system!).

Well, that about all the space apportioned to us this month. Tune in same time, same station next month. In the meantime, those of you out there with tips, comments, and suggestions to contribute to this column, write to Joe Carr, K4IPV, PO Box 1099, Falls Church, VA 22041. ■

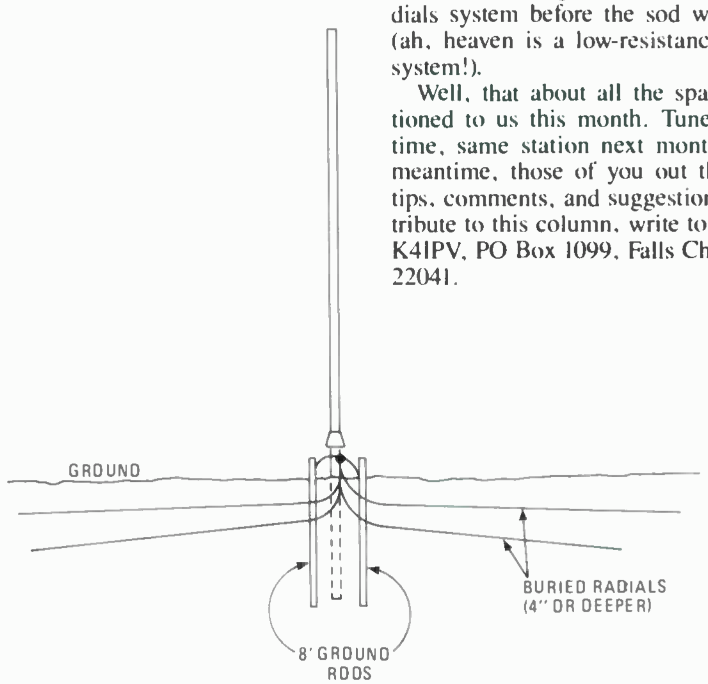

Fig. 4—Shown here are the radials in a ground-mounted situation. The wire radials can be above ground (a common sight in rural areas) or buried using a spade tip to cut a 3- to 4-inch slit, which may make for a better ground.