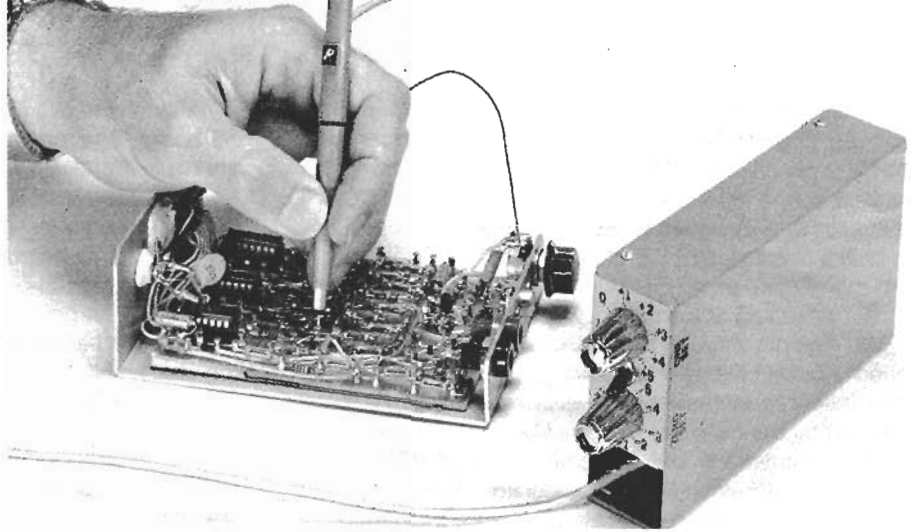


# BUILD A "UNIVERSAL" DIGITAL PROBE



Tests virtually any digital logic family at speeds to 10 MHz.

**M**ANY different designs for digital logic test probes have appeared in the past few years. Most tend to favor a specific logic family, with TTL getting the most attention. Few, if any, are capable of checking ECL and MOS devices and circuits. The logic probe described here is designed for testing virtually all the logic families currently in use, including RTL, DTL, TTL, ECL, and MOS devices and circuits.

The universal logic probe, while larger than "ordinary" testers, is also completely self-contained. It has its own built-in battery power supply to simplify test hookups. (Most popular test probes derive their power from the circuit under test.)

An important factor to be consid-

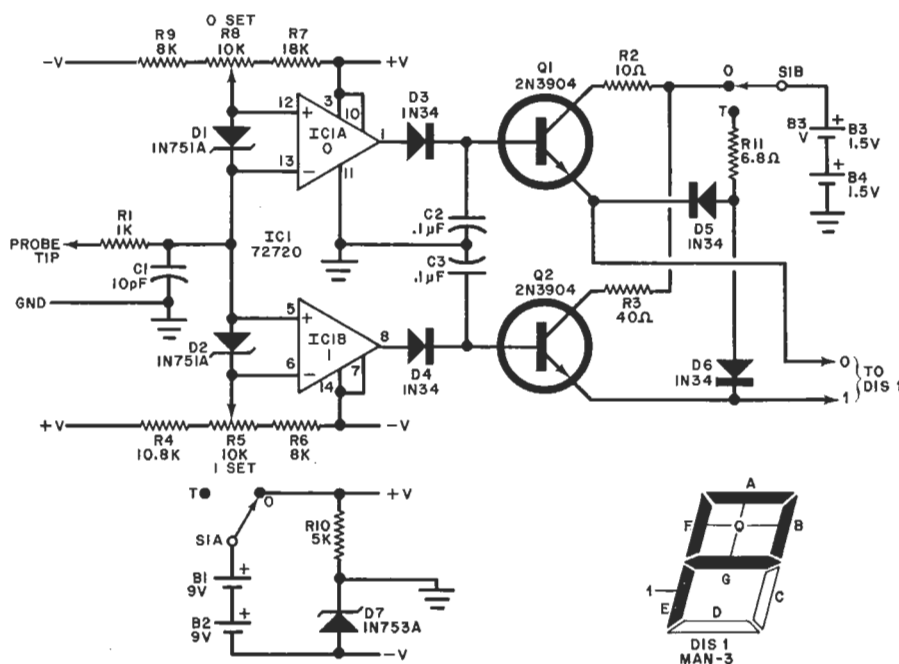
ered in logic probe design is frequency response. Most testers will not respond to high frequencies. Thus extremely short duration pulses are lost and, in some cases, cause signal degradation in the circuit being tested. The universal probe solves this problem by being able to respond to frequencies in excess of 10 MHz. Furthermore, it will check for a logic 1 or logic 0 within 5 mV of a set value.

**About the Circuit.** The tester is made up of two parts: a small case containing all of the electronics (including two controls that permit you to preset the logic levels) and a probe assembly with attached cable. The probe itself contains a 7-segment LED display. The ground lead is at-

tached to the body of the probe for easy connection to the circuit being tested.

The heart of the circuit is dual differential comparator integrated circuit *IC1* in Fig. 1. The *IC1B* half checks for a logic 1. Its pin-8 output is held low until the input on pin 5 from the probe is 5 mV (or greater) above the voltage applied to pin 6. The latter is determined by the setting of *R5* and ranges from -1 V to +5.25 V dc. When the input is greater than the voltage on pin 6, the output of the comparator sends *Q1* into conduction to cause a 1 to be displayed.

The 0 part of the circuit operates in the opposite manner. The input on pin 13 must be more negative than the preset voltage on pin 12, determined



## PARTS LIST

- B1, B2—9-volt battery
  - B3, B4—1.5-volt battery (AA cell)
  - C1—10-pF, 10-volt capacitor
  - C2, C3—0.1- $\mu$ F, 10-volt capacitor
  - D1, D2—1N751A zener diode
  - D3 to D6—1N34 diode (or similar)
  - D7—1N753A zener diode
  - DIS1—Seven-segment LED display (Monsanto MAN-3 or similar)
  - IC1—72720 dual differential comparator
  - Q1, Q2—2N3904 transistor (or similar)
- The following resistors are 1/8 watt:
- R1—1000 ohms
  - R2—10 ohms
  - R3—40 ohms
  - R4—10,800 ohms
  - R6, R9—8000 ohms
  - R7—18,000 ohms
  - R10—5000 ohms
  - R11—6.8 ohms
  - R5, R8—10,000 ohm miniature potentiometer
- Misc.—Length of three-conductor shielded cable, plastic felt-tipped pen, cement, needle tip, knobs (2), press-on type, battery connectors, chassis, mounting hardware, etc.

Fig. 1. Dual comparators sense the voltage at probe tip.

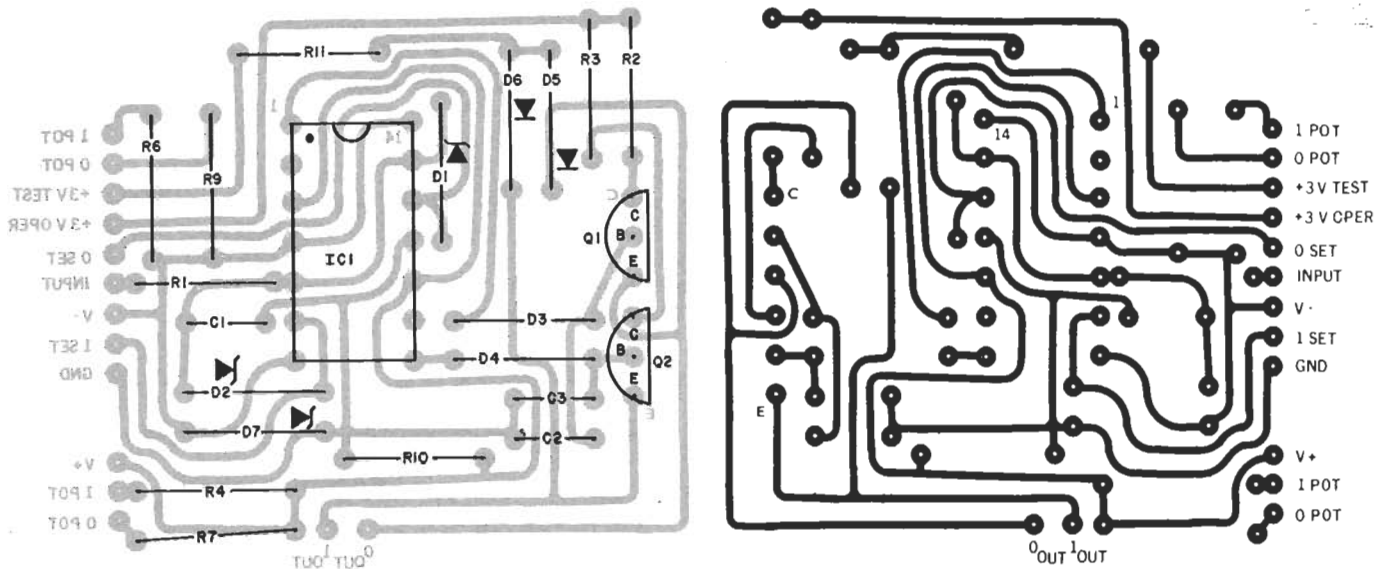


Fig. 2 Foil pattern (right) and component installation.

by the setting of *R8*. The range here is from  $-2\text{ V}$  to  $+3\text{ V}$  dc. When this section of the comparator turns on, *Q1* saturates, and the 0 portion of the display is illuminated.

Diodes *D3* and *D4*, in conjunction with capacitors *C2* and *C3*, ensure that, once the indicator is activated, it will remain on long enough to be seen, even with reasonably high pulse repetition frequencies. Resistors *R2*, *R3*, and *R11* provide current limiting for the display. Diodes *D5* and *D6* form a gate that allows testing the indicator before operation. Diodes *D1* and *D2* protect the IC inputs. Resistor *R10*, with *D7*, converts the 18 V from batteries *B1* and *B2* to  $-6\text{ V}$  and  $+12\text{ V}$  for the IC. Batteries *B3* and *B4* provide the

higher current required for the seven-segment display.

**Construction.** The tester can be assembled on a printed circuit board using the actual-size etching and drilling guide shown in Fig. 2. However, if care is exercised, the circuit could be assembled on perforated board using point-to-point wiring.

Mount the board and batteries in an enclosure approximately  $1\frac{1}{2}\text{''}$  by  $3\text{''}$  by  $5\frac{1}{2}\text{''}$  as shown in Fig. 3. Note that part of the box is used to store the probe and cable when not in use. The two potentiometers and switch are mounted on one end of the chassis

out and wrap it around the plastic case. Feed the tip lead through the front opening on the case. Seat the display in place and cement it securely. Fabricate a needle tip and solder it to the probe tip lead. Cement this in place.

When assembly is complete, connect a voltmeter between the rotor of potentiometer *R5* and ground. Rotate this potentiometer between its two extremes and mark the 1-volt calibration points on the front panel at the rotor of *R5*. Do the same for *R8*. Don't forget to indicate the polarity. Also make sure that the rotor of *R8* is always more negative than the rotor of *R5*.

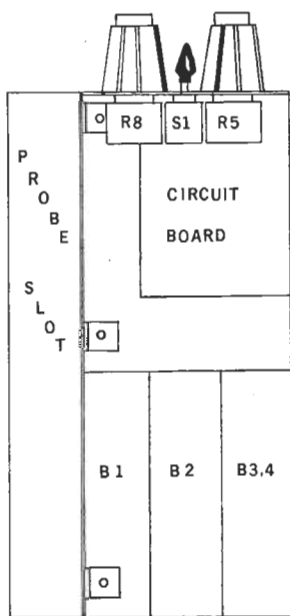
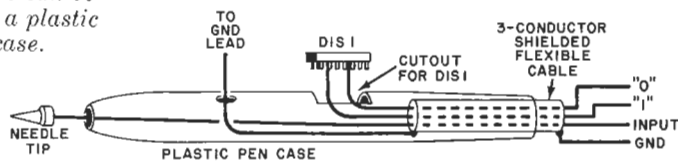


Fig. 3 Layout of chassis as used in prototype.

Fig. 4. The probe can be fabricated from a plastic felt-tipped pen case.



with appropriate identifications made with press-on type.

The probe can be made from a used plastic felt-tipped pen case as shown in Fig. 5. Using a three-conductor shielded flexible cable, identify the leads as 0, 1, and tip. Make the tip lead long enough to go through the end of the plastic case. Cut an opening on the side of the case slightly smaller than the LED display. Feed the 0 and 1 leads through this hole. On the display, interconnect segment leads A, B, F, and G. Solder the 0 lead to this combination. Solder the 1 lead to the E segment. Connect the display common to the coax shield. Feed the shield lead through a small hole below the read-

**Operation.** To check a logic circuit, determine the high and low voltages for the 1's and 0's of the circuit being tested. Set the two potentiometers accordingly. Attach the probe ground to the circuit ground. Place *S1* in the test position (T). The display should indicate both a 0 and a 1 (which looks like the letter P). Place *S1* in the operate position and touch the probe tip to the circuit being tested. A logic 0 or a logic 1 should be properly displayed; or, if the circuit is transitioning between 0 and 1, both sections of the display will light. If the display remains blank, the test point is operating somewhere between 1 and 0, which means something is wrong.