Direct Reading Logic Probe

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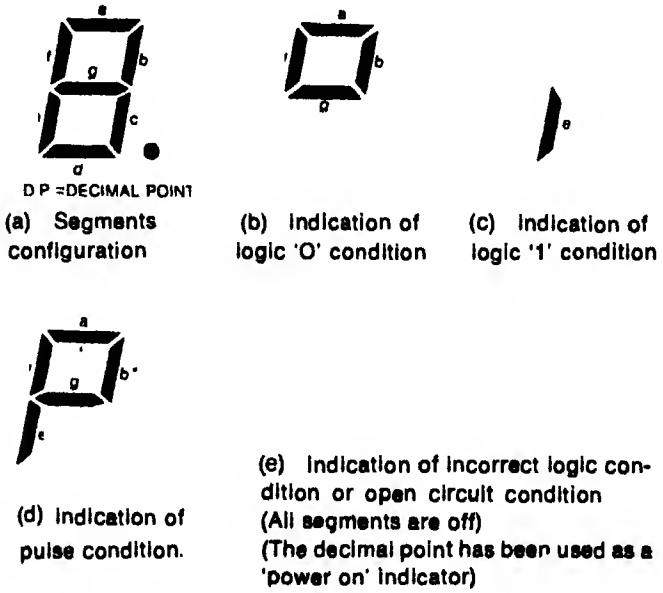
The advent of the digital electronics era in the field of electronics has made a tremendous impact. Most electronic instruments now do not have the conventional moving coil panel meters which have been replaced by the digital readouts, thus eliminating the possibility of taking wrong observations on the meter. Gradually more and more items are being converted into the digital form, and it is quite likely that the coming generations would use a lot of digital systems.

The changing concepts have brought a corresponding change in the servicing techniques also. A number of new test instruments have been developed for fault diagnosis and servicing of digital equipments. One such versatile test equipment, which I have found to be very handy and useful, is the logic probe. A logic probe is used to check the logic states in digital circuits. It can help a lot in diagnosing faulty digital circuits in which the logic states are probed and tallied with the correct or actual conditions that should have been present if the circuit was functioning properly.

This article presents details of one such probe which besides being low-cost is very compact and yet easy to assemble. An important feature of this probe is that it actually displays the logic conditions—a logic zero being indicated by the display of an actual numeral '0' and a logic one state being displayed as an actual numeral '1'. Above all, the presence of a pulse or of a pulse train is displayed by the alphabet 'P'. This probe thus differs from some other commercially available probes in which the presence of a logic zero or logic one is indicated by the glow of LED (light emitting diode) lamps.

The digital probe being discussed has been designed primarily for use in digital circuits based on the most popular TTL logic (transistor transistor logic). The TTL ICs are most widely used and have become a very big trend setter in the field of digital electronics.

In TTL logic the worst case logic zero condition is any voltage between 0V and 0.8V, and the worst case logic one condition is any voltage from 2V to 5V. Voltages greater than 0.8V and less than 2V do not define any logic condition and hence in TTL circuits such voltages can be termed as 'incorrect logic.' The logic probe detects and displays the true logic zero and logic one conditions. For incorrect logic conditions or open circuit conditions the display is simply blanked off, i.e. neither '0' nor '1' is displayed.



(a) Segments configuration

(b) Indication of logic '0' condition

(c) Indication of logic '1' condition

(d) Indication of pulse condition.

(e) Indication of incorrect logic condition or open circuit condition (All segments are off) (The decimal point has been used as a 'power on' indicator)

Fig. 1: Segments configuration and the resultant indications obtained.

For the indications of the logic conditions a 7-segment common cathode LED display has been used in this probe. A

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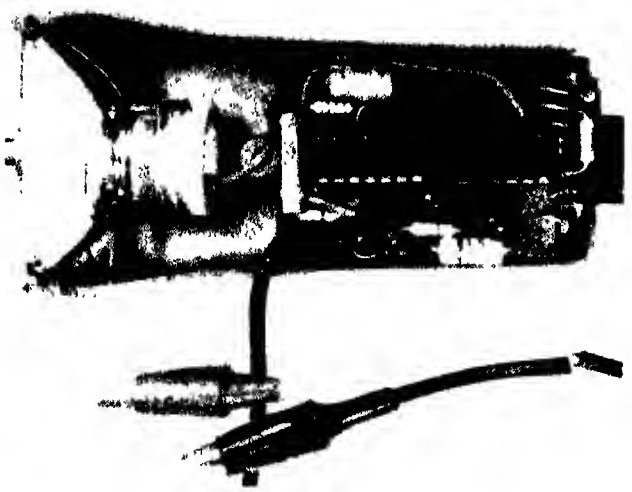
common anode LED display may instead be used with some modifications. The segments configuration and the indications obtained are as shown in Fig. 1. The segments 'a', 'b', 'g' and 'f' glow for the indication of the actual '0' (zero) and segment 'e' glows for the indication of the actual '1' (one). The combined segments 'a', 'b', 'g' and 'f' along with segment 'e' glow to give the indication of a single pulse or a pulse chain. The incorrect logic or open circuit condition (the probe tip not connected anywhere) is indicated if all the segments remain off. The decimal point has been used as a 'power on' indicator.

Fig. 2 shows the complete circuit of the direct reading logic probe. Diode D1 and gates 1, 2 and 3 form the circuit that detects logic zero condition. Diode D1 ensures that for voltages between 0V and 0.8V the logic zero detecting circuit becomes active while for voltages above 0.8V it remains



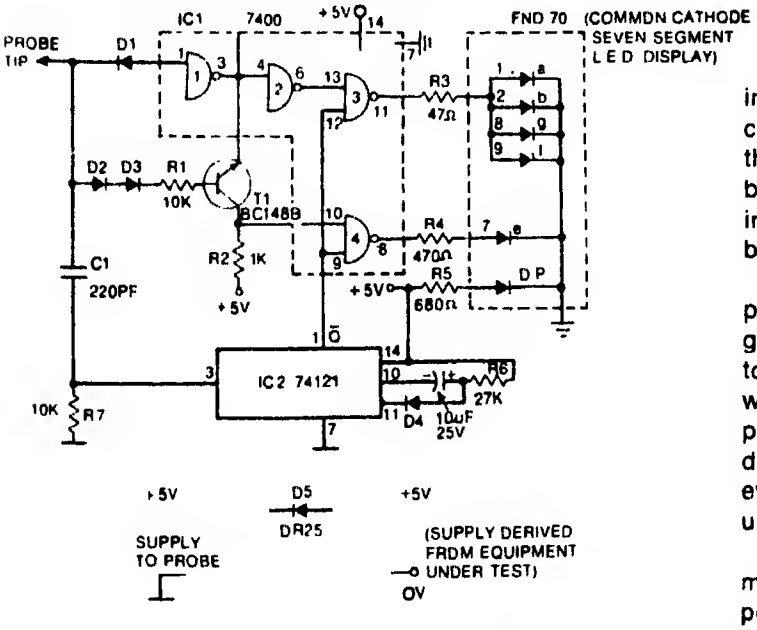


Fig. 2: Complete circuit diagram of the direct reading logic probe.

PARTS LIST

IC1—7400 integrated circuit (Quad two input NAND gate)
IC2—74121 integrated circuit (monostable)
(pin 7 is the ground terminal and pin 14 is for + 5V, for both the ICs)
D1-D4—Any silicon diode like 1N914 or 1N4148
D5—Germanium diode DR25
Display used—FND 70

R1, R7—10 kilohm resistor
R2—1 kilohm resistor
R3—47 ohm resistor
R4—470 ohm reststor
R5—680 ohm resistor
R6—27 kilohm resistor

C1—220 pF ceramic capacitor
C2—10 μF, 25V electrolytic capacitor
Misc: A small needle-like probe tip, enclosure such as a miniature battery case, a small piece of laminate sheet for mounting the components, shielded single-core flexible wire, two small crocodile chips for connecting to power supply

inactive Diodes D2 and D3, transistor T1 and gate 4 form the circuit that detects logic one condition. D1, D2 and T1 ensure that for all voltages between 2V and 5V the logic one circuit becomes active while for voltages below +2V it remains inactive. Thus, for voltages greater than 0.8V and less than 2V both the detecting circuits remain inactive.

The components C1, R7, IC2, C2, R6 and D4 constitute the pulse detecting circuit. Once IC2 becomes active, it causes gates 3 and 4 to drive the segments 'a', 'b', 'g', 'f' and 'e' so as to display the letter 'P' for about half a second—the period for which the monostable IC gives output, once a pulse is applied at its input terminal (pin 3). The monostable IC2 can detect pulse width down to about 50 nano-seconds. Thus, even a single pulse of such a small duration can be detected using this logic probe.

The NAND gates 3 and 4 have been used a bit in an unusual manner—here they are sourcing a large current (about 3 mA per segment of LED display) which has been restricted by the resistors R3 and R4. Diode D5 has been used to save the logic probe from getting damaged in case the supply terminals are connected to the wrong polarities. Supply voltage for the

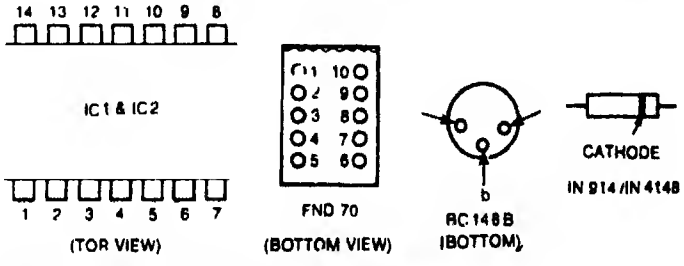


Fig. 3: Pins configuration of devices used.

probe is obtained directly from the equipment under test.

The wiring and layout of the components is not very critical. The prototype was housed in a small plastic torch case, making it very handy and easy to use. □