

# DRAWING BOARD

## A PC board for our audible logic probe.

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Some things are enjoyable and some things aren't. This is true in life and it's just as true in electronics. Going through the whole process of a design—from idea to paper to breadboard—is a great exercise in brain stretching and a chance to let your subconscious do a bit of work. For a lot of people (at least judging by the things I get asked about in the mail), the real hassle starts when they finish all the development work and have to come up with a final version of whatever they have on the bench.

We've been spending the last couple of months on the development of handy dandy bench equipment and the logic probe we just finished up is a really neat piece of gear to have around when you're working on a prototype circuit. Once you put it together, you'll find that it's one of those things you'll always reach for first when you want to do some electron snooping.

That's all well and good but, even though one measure of a tool's worth is how much it can do, another important criterion is how easy it is to use. Companies that make test equipment spend a lot of money designing

the "user interface" since they know all too well that no matter how versatile their products are, if they're not convenient to use as well, people just won't buy them. The more time you spend in the electronics business, the more you'll learn that appearance and convenience is just as important as substance and power.

All this is leading up to the fact that the logic probe we designed is going to be useful only if it's conveniently packaged and securely made. And that means you can't reasonably expect it to be a permanent member of your toolkit unless you put it on a PC board. This is the part of the design process that most people dread. Laying out a board is one of the most tedious and least enjoyable activities you'll ever come across in electronics.

Because I'm a nice guy, I'm going to save you a lot of work and give you a foil pattern for the logic probe. I found the circuit so useful that I did a board for it not too long after the probe was first designed. Since it's not an overly complex circuit, it could be laid out on a single-sided board; we've printed the foil pattern here in case you want to make your own board.

If you trace the circuit as it's laid out on the board, you'll see that I made some changes to the original circuit we finished designing last time. The changes were done to make it easier to design the PC board and don't have any functional effect on the circuit. Some of the comparators have been swapped and the LED's are set up differently so it was simpler to bring their leads out to the edge of the board.

When I did the board a few years ago, I kept the board as small as possible so it could be housed in a hand-held case. I wound up making my own case for the probe but there are several companies that make suitably sized cases.

There's nothing critical about the board—none of the traces are very thin and there's plenty of room on the board to make them all at least a sixteenth of an inch thick. It's an easy board to etch with even the crudest equipment. The parts-placement diagram is shown in Fig. 1 and the only components I haven't put on the board are the switches and the speaker. If you can find a small enough speaker, you can leave space for it on the end of the board.

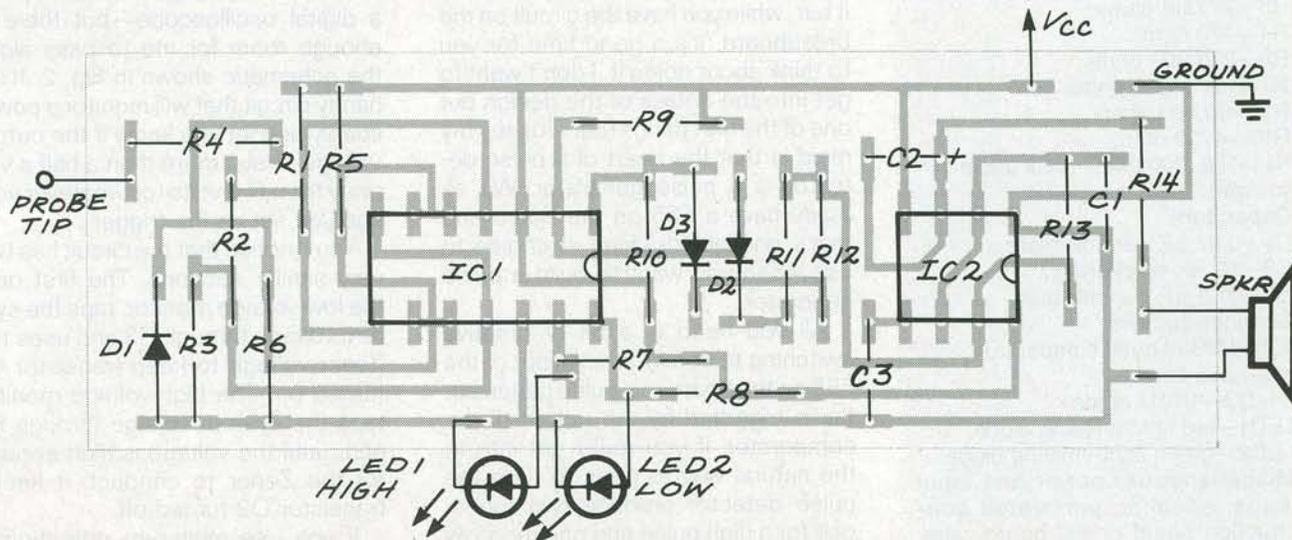


FIG. 1—PARTS-PLACEMENT DIAGRAM. The only components that aren't on the board are the switches and the speaker.

The PC board is the final touch for the probe and, if you plan on using the circuit on the bench, you should give serious thought to making it. Just about the only problems you should have are the common ones that always show up when you're making a board. These are things like solder blobs, bad joints, and backward components. You should use sockets for both the IC's. They add a bit to the

### PARTS LIST

#### All resistors are ¼-watt, 5%.

R1, R6, R12—100,000 ohms  
 R2—39,000 ohms  
 R3—27,000 ohms  
 R4—470 ohms  
 R5—270,000 ohms  
 R7—R10—1000 ohms  
 R11—10,000 ohms  
 R13—4700 ohms  
 R14—50—200 ohms (sets audio volume)

#### Capacitors

C1—0.02 µF, ceramic disc  
 C2—10 µF, electrolytic  
 C3—0.01 µF, ceramic disc

#### Semiconductors

IC1—LM339 quad comparator  
 IC2—555 timer  
 D1—D3—1N914 diode

LED1—red light-emitting diode  
 LED2—green light-emitting diode

**Miscellaneous:** power and input leads, speaker, perforated construction board or PC board, wire, solder, etc.

height of the board but the margin of safety they add is more than worth the extra quarter inch.

The logic probe is a good example of the kind of test equipment you can build yourself that's just as useful as similar stuff you can buy in a store. There are additions that you can make to the probe that will make it even more versatile. One that I've had in the back of my mind for years is to add a pulse detector to the circuit. It's not hard to do since the probe already has a front end that can sense logic levels.

I know myself well enough to be sure that I'll never get around to doing it but, while you have the circuit on the breadboard, it's a good time for you to think about doing it. I don't want to get into the details of the design but one of the first things that crosses my mind is that the heart of a pulse detector is a pulse generator. We already have a 555 on the board and that's one of the chips of choice to use when you want to build a pulse generator.

All you need is a bit of creative switching to convert the layout of the 555 on the board to a pulse generator that's triggered by the output of the comparator. If you really get into it, the natural way to go is to have the pulse detector produce two tones: one for a high pulse and one for a low pulse. If you don't want to fool around with switching the components on

the existing 555, you can replace the chip with a 556 and use one side of it for the original probe and the other side for the pulse detector.

If you add that feature to the probe, or if you think of something else that's particularly slick, let me know about it and I'll put it in the column. As a matter of fact, we'll make a contest out of it and the two best modifications to the circuit will win something. I need some time to figure out what that something will be—either the usual magazine subscription or something else—but I'll let you know what it is.

There's not enough room left this month to run through our next topic—a digital oscilloscope—but there is enough room for me to pass along the schematic shown in Fig. 2. It's a handy circuit that will monitor a power supply and let you know if the output voltage strays more than a half a volt away from five volts (or whatever voltage you set as the trigger).

You'll notice that the circuit has two very similar sections. The first one, the low-voltage monitor, taps the system voltage through R3 and uses the Zener voltage to keep transistor Q1 turned on. The high-voltage monitor taps the system voltage through R4 and, until the voltage is high enough for the Zener to conduct, it keeps transistor Q2 turned off.

If you use multi-turn potentiometers, you can set the low and high thresholds just about anywhere you

