HOBBY CORNER

Testing transistors

EARL (DOC) SAVAGE, K4SDS, HOBBY EDITOR

IN THE FEBRUARY 1984 "HOBBY CORNER," we discussed how to make realistic battery tests. Well, this month we'll turn to another testing problem. Glen Gartner (PA) asked a question about how to test bipolar transistors. He needs a procedure that uses minimal equipment—such as only a multimeter. Since that topic is sure to interest many of you, we'll spend some time on it. We'll start with a look at some transistor basics.

Essentially, a transistor is a couple of diodes that share a common element. That sharing causes one diode to be affected by what happens in the other. Of course, that is an over-simplification—you could not make a transistor using two discrete diodes—but that model does generate a mental picture that is helpful to us.

Current flow in a transistor

You know that a diode is a two-terminal device that passes current in one direction, but has a very high resistance to current flowing in the opposite direction. Conventional current flows freely from the diode's anode to cathode. Figure 1 shows the schematic symbol for a diode—current flows in the direction of the arrow.

Now let's get back to the transistor. You know that there are two bipolar types: PNP and NPN. The symbol for the PNP transistor is shown in Fig. 2-a. Figure 2-b shows how you can *think* of the PNP transistor. In effect, there are two diodes with a common cathode (the base). From our discussion of diodes, it is clear that the PNP transistor has low resistance to current flow from emitter to base and also from the collector to base.

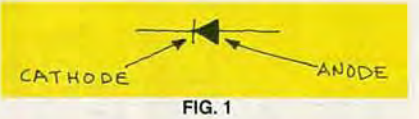

FIG. 1

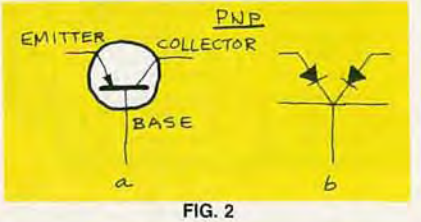

FIG. 2

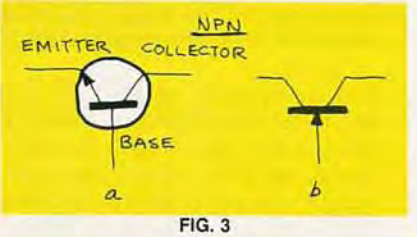

FIG. 3

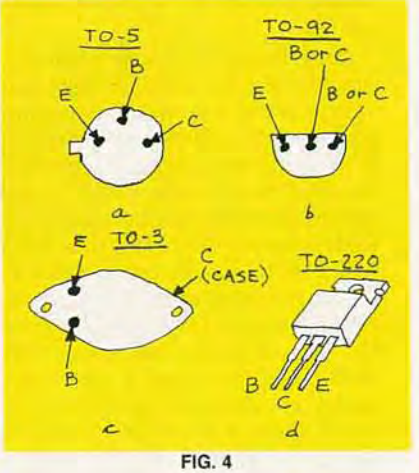

FIG. 4

Figure 3-a shows the symbol for an NPN transistor. Figure 3-b shows how you can *think* of it—two diodes with a common anode (the base). Thus, the NPN transistor should have a low resistance from the emitter to base and also form the collector to base.

Now that we know how to think of the transistors, we can go about testing them. But first we have to be able to identify the leads. Figure 4 shows some common transistor-package types along with their pinouts.

The next task is to determine the polarity of your multimeter probes when it is in the resistance-reading mode. *Do not assume that the black one is negative!* You can test the polarity by tracing the internal wiring of the meter or by using a second meter. Of course, you can use a marked diode and measure its resistance in both directions—the resistance will be greater when the negative probe is on the anode. Once you determine the probe polarities, mark your meter permanently so that you won't have to check it again.

Now you're finally ready to find out whether the transistor is a PNP or NPN type. Before I tell you, think about the information we've gone over so far. You have everything you need to make the test. Can you figure it out?

Connect one meter probe (in the high-resistance range) to the base of the transistor. Measure the resistance to the emitter and, again, to the collector. Then connect the other probe to the base and repeat the measurements. Both of the first two readings will be higher than both of the second set of readings. If not, you either have a defective transistor or you have identified the three leads incorrectly.

Assuming that both readings in one set are greater than both in the other set, apply this rule: If the readings are higher when the negative probe is on the base, the transistor is an NPN type. Otherwise, it is a PNP transistor. Once you get the hang of making this measurement, you can test transistors quickly—at least in less time than it takes to explain it!

Is it good?

Now you have the leads identified and you know the transistor type. However, you still do not know if the transistor works! There are several ways to test a transistor. First you can substitute a transistor known to be good for a suspect one in a circuit. If the circuit then functions, the original transistor is bad. On the other hand, if it doesn't function, you cannot be

AN INVITATION

To better meet your needs, "Hobby Corner" has undergone a change in direction. It has been changed to a question-and-answer form. You are invited to send us questions about general electronics and its applications. We'll do what we can to come up with an answer or, at least, suggest where you might find one.

If you need a basic circuit for some purpose, or want to know how or why one works, let us know. We'll print those of greatest interest here in ""Hobby Corner." Please keep in mind that we cannot become a circuit-design service for esoteric applications; circuits must be as general and as simple as possible. Please address your correspondence to:

Hobby Corner
Radio-Electronics
200 Park Ave. South
New York, NY 10003

sure of the transistor—either it or another component could be bad.

You can also test many transistors with a multimeter. In this procedure, start with the highest resistance scale each time and move down as necessary. Here are the steps:

1. Connect the probes to the base and collector.
2. Note the resistance.
3. Reverse the probes and note the resistance.
4. Connect the probes in the direction of the highest resistance.
5. Short the emitter to the base. If the transistor is good, the reading will decrease.
6. Change the base probe to the emitter.
7. Short the emitter to the base. If the transistor is good, the reading will increase.

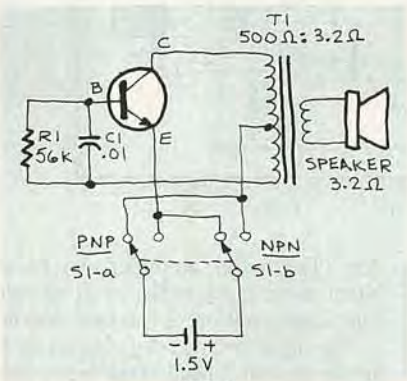

FIG. 5

A simpler and more reliable way to test a transistor is to put it in a test circuit. The simple audio oscillator shown in Fig. 5 will beep softly with every good bipolar transistor that you plug into it. The resistor and capacitor values are not critical—almost anything in the ballpark will work. In addition, the voltage is so low that the transistor won't be damaged if you plug the leads in wrong or if the switch is in the wrong position. For convenience, you can build this little tester in a small utility box, so that it will be on hand whenever you need it.

There is, of course, a fourth way to test transistors. I have admitted my laziness to you in the past, so it will come as no surprise that I use a handy-dandy commercial transistor checker. You, too, might take a look at Radio Shack's *22-025*. It's small, versatile, and costs less than $15. It will check transistors both in-circuit and out-of-circuit, and will even give a relative beta measurement. You can also use it as a continuity checker or as an audio oscillator. Like the checker circuit we built, the tester is safe—you can plug transistors in backward and not damage them.

All right, Glen, you and other readers can surely find one suitable way to do your

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transistor checking. I recommend the methods in this order: 1) commercial tester/test circuit; 2) substitution; 3) multimeter. The multimeter method should be considered only as an emergency measure—that's because it does not work with all transistors.

Cat-birds

Leroy Jack (NE) needs some ideas on how to protect birds from his cats. It seems that they particularly relish wrens and Leroy wants to give the birds more of an even chance. He says that he has tried attaching bells to the cat's collars but that has produced only limited success. He wonders about putting a small audio oscillator on those collars.

Sure, you could do that, Leroy, but battery weight could be a problem if the oscillator is to operate very long. We would be more inclined to use a little 3909 IC—usually referred to as an "LED flasher."

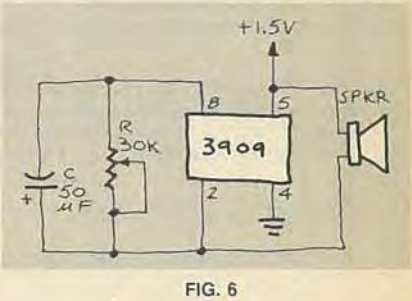

FIG. 6

If you put the 3909 in the circuit shown in Fig. 6, you can get sound with a low current requirement. We're not sure as to what kind of sound will be most effective in this application. Probably an occasional "click" will work as well as anything else. That is what you will get from the circuit shown. Other frequencies can be generated by varying the value of potentiometer and the capacitor.

That's all we have room for this time. Hang in there—your question may be coming up next month.

By the way, you may be wondering how the questions are chosen for answering here in the column. What I try to do is to select those questions that will be of the greatest interest to the greatest number of readers. That depends on the subject to the question and the range of the possible applications of the answer.

I am sure that you know that your questions are appreciated by all of us. Keep them coming. Oh yes, you don't have to wait until you have a question before you write—I'll be glad to see your comments and suggestions, too. **R-E**