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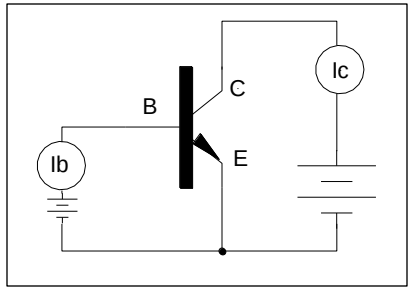
Lab 08

Bipolar and Field Effect Transistors

A. Bipolar Transistors



1. Here is what we are going to do.

   a. We are going to force some current into the B-E diode junction of a bipolar transistor and call it "base current" (Ib). We are going to look to see how much "collector current" (Ic) that causes the transistor to create. We are going to divide the collector current by the base current and call that the transistor's current gain, or beta (β).

   b. We are going to then see if the transistor's current gain changes as the collector current changes (it should). The transistor manufacturer can optimize beta for a particular current by black magic and powdered bat wings to have a rather broad "peak" at a particular collector current.

   c. Just like we saw with resistors, there is a universal standard for transistors. If the manufacturer wants to call their transistor, for example, a 2N4400, there are published specifications using the "2N" prefix that the manufacturer has to meet. In particular, the 2N4400 SHOULD have a beta peak somewhere around 100 milliamperes. That may or may not occur with our lab transistors (I'll tell you why verbally, not to be repeated).

2. Beta. Take one transistor of each of the two different styles. The small black transistor ("Flat Face") package is called a "TO-92" (once again, an industry standard). The large ("Metal Tab") is an industry standard called a "TO-220".

   a. Procedure:

      1. Obtain one of the two types of transistor. Identify it (if possible) by the 2N number (i.e. 2N918, 2N2222, and so on).

      2. Use this

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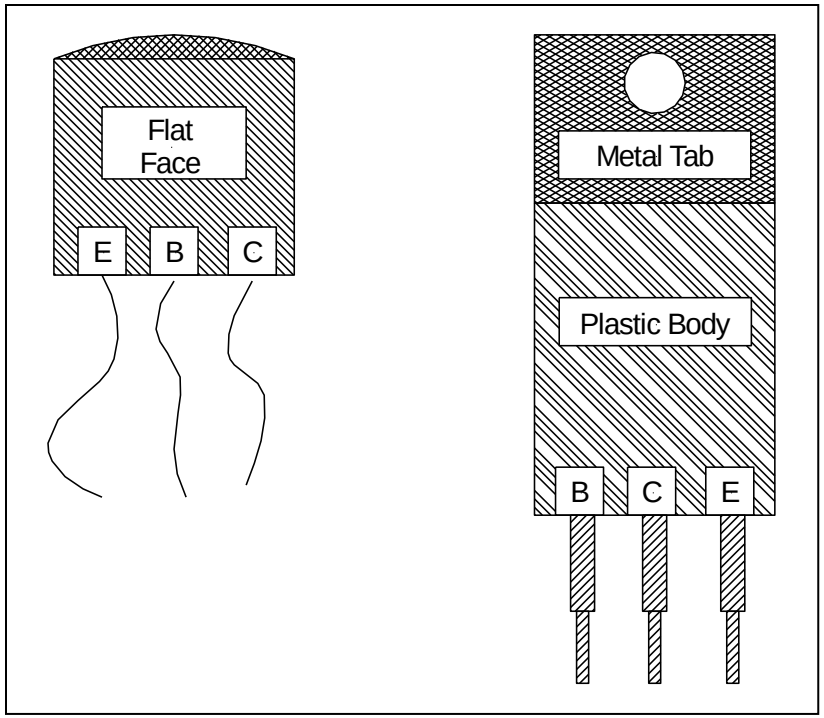
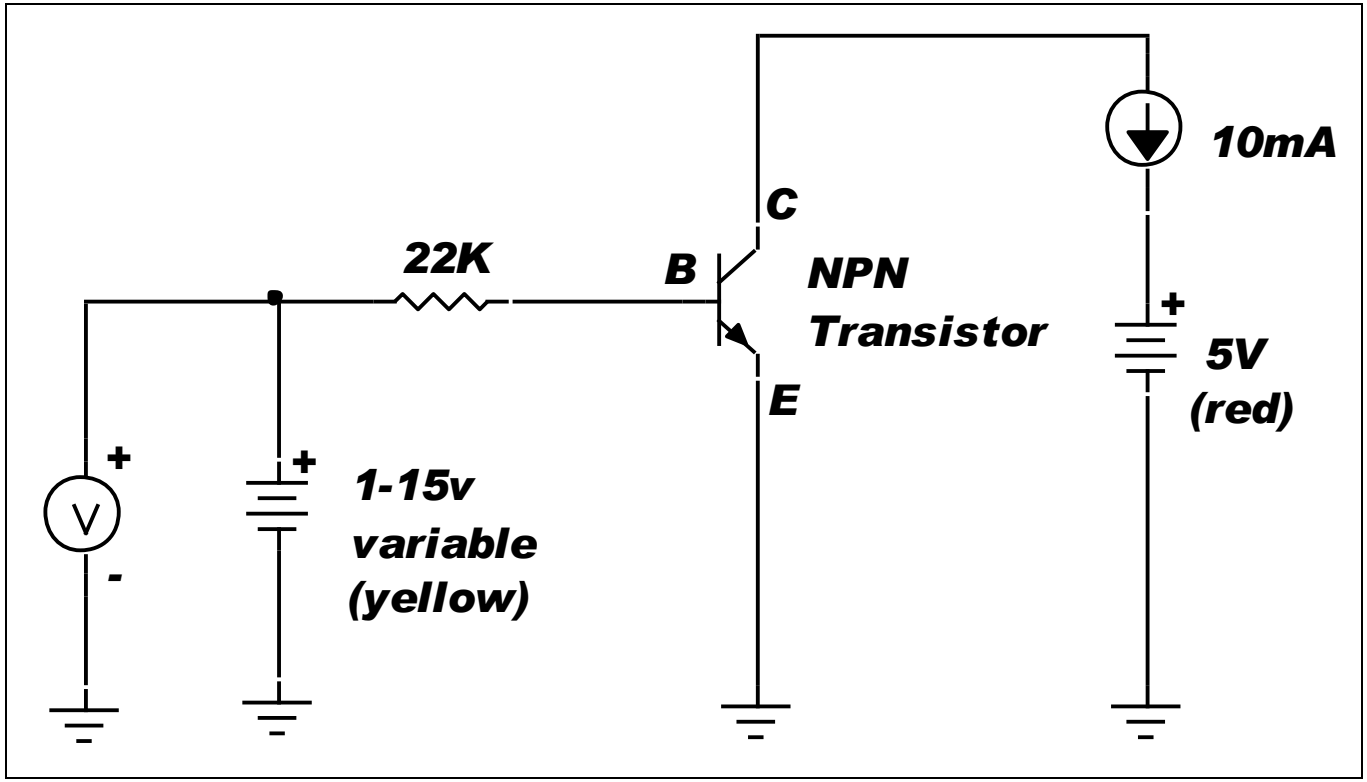
         drawing to identify emitter, base, and collector.



3. Hook the circuit up as shown.



4. Adjust the 1-15v variable voltage until the collector current meter reads 1.0 mA.

5. Read the voltmeter across the variable supply.

6. Subtract 0.6 volts from the voltmeter reading (for the forward voltage diode drop of the silicon E-B diode of the transistor)

7. Divide (Ohm's Law) this modified voltmeter reading by 22,000 to get the base current. (It should be in VERY small microamperes [μA])

8. Divide 1.0 mA by the base current to get beta. It should be a value between 50 and 500, probably somewhere around 150.

9. What does this mean in the real world? It means that for every signal we put in to the base, we can get beta times that signal at the output.

10. For those of you who know how to work in Excel, make a spreadsheet that takes collector current and base voltmeter values and gives beta as a result.

11. Now do the beta tests for 10 mA, 20 mA … up to 100 mA in 10 mA steps. A lot faster with the spreadsheet, isn't it? You can use the bottom of page 4 for scribble-scratch recording of your data if you like.

12. .Now that you've done the beta testing for ONE of the two types of transistor, do the experiment all over for one of the OTHER types of transistor. In general, we use the little ones for "signal" operation for currents in the low milliampere range and the metal-tab transistors for high power operation in the hundreds of milliamperes to several amperes.