Lab 7 Bipolar Transistors II

Transistors can be used to obtain stable sources of constant voltage. The following sections trace the development of simple voltage sources using one or two transistors. Items marked with an asterisk (*) should be done before coming to lab.

1. The pass transistor

Build the emitter follower circuit below, called the "pass-transistor" circuit.

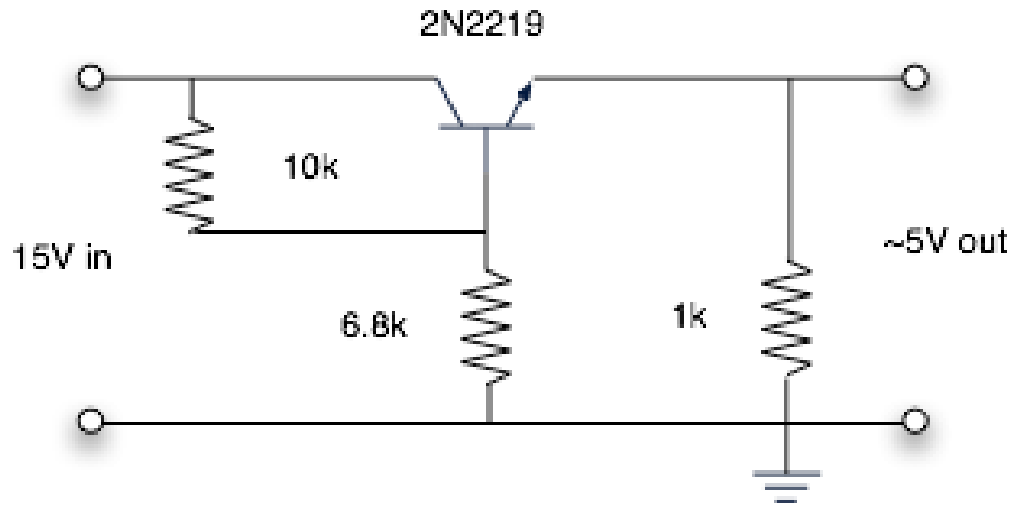


Figure 1: Emitter Follower Circuit.

(a) *Calculate the output impedance. Assume β=200. (Hint: It is approximately equal to the output impedance of the circuit that supplies the base current divided by β.) [4 p]
(b) Measure the output impedance by finding the change in voltage when the circuit is loaded by 150 ohms. [4 p]
(c) Reduce the input voltage from 15 volts to 10 volts, a 33% change. What is the percentage change in the output voltage? [4 p]

2. The Zener-regulated pass transistor

Replace the 6.8k resistor by a reverse-biased 5.6 volt Zener diode, 1N4734, (Fig. 2), and replace the 10-kohm base resistor by 1-kohm. Other components are unchanged.
(a) Measure the output impedance as above. [4 p]
(b) Find the change in output voltage when the input voltage changes from 15 to 10 volts. [4 p]

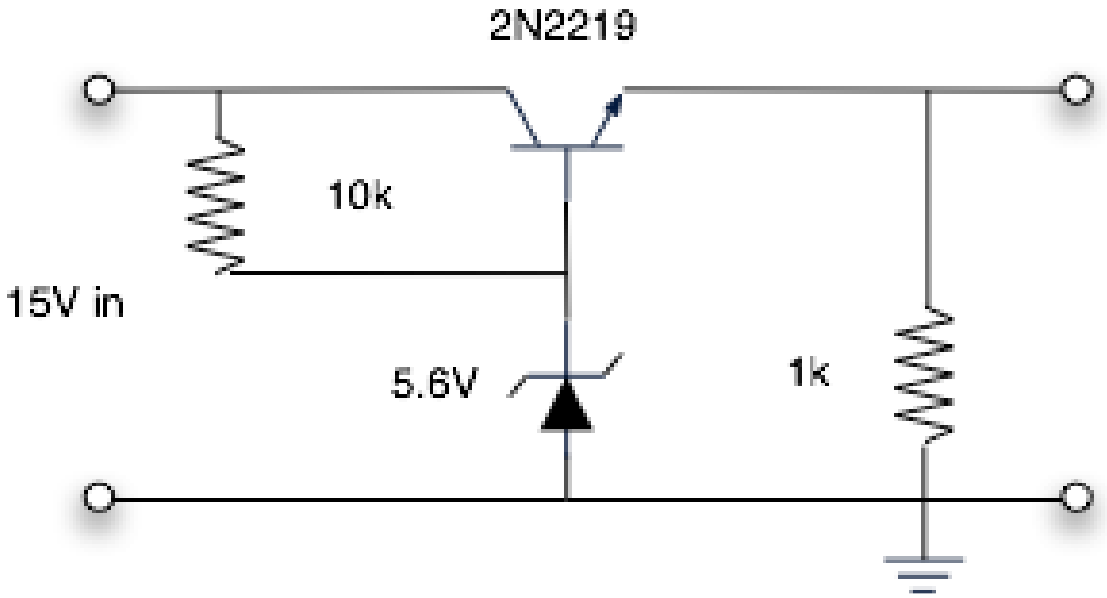


Figure 2: Zener biased power supply.

3. Construction of a power supply

(a) Still using the protoboard, add a bridge rectifier and a capacitor as shown in Fig. 3. The rectangular box in Fig. 3 stands for an integrated bridge rectifier (full wave) WL02F (alternatively RB152). It has 4 leads, two for AC inputs (opposite each other unless otherwise marked) and two for DC outputs (+ and – opposite each other unless otherwise marked). The long lead of the capacitor is positive. Be sure to get this polarity right. Connect the transformer to the AC inputs of the bridge. Demonstrate correct operation of the power supply to your instructor. [6 p]

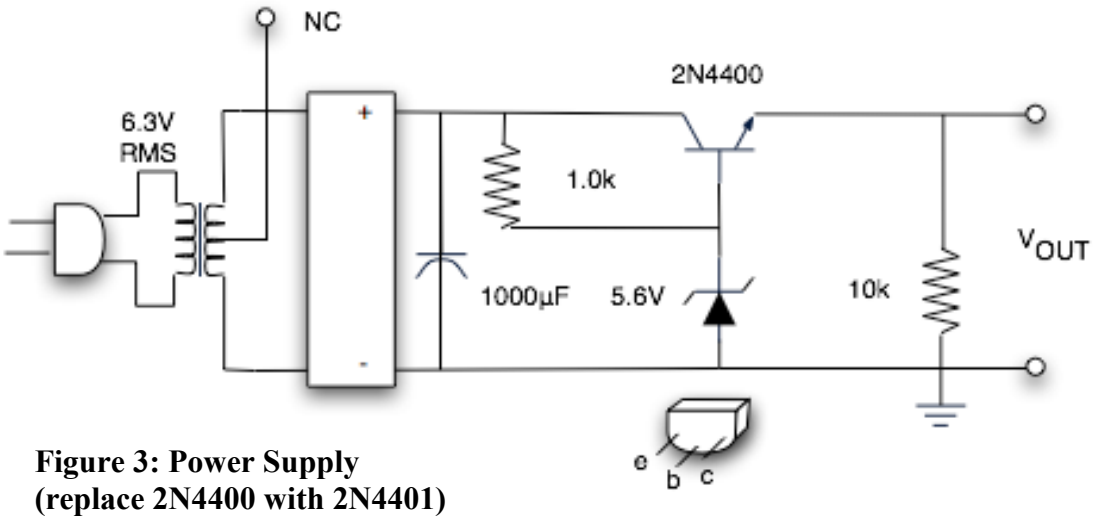


Figure 3: Power Supply
(replace 2N4400 with 2N4401)

(c) Transfer all the components (except the transformer) from the protoboard to a perforated board. Place the components on one side of the board and solder on the opposite side—the metallic side.

When you are done, you may take your construction home with you.

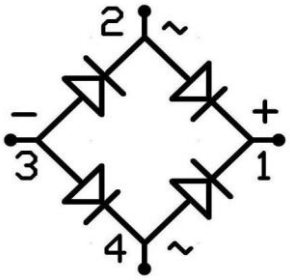
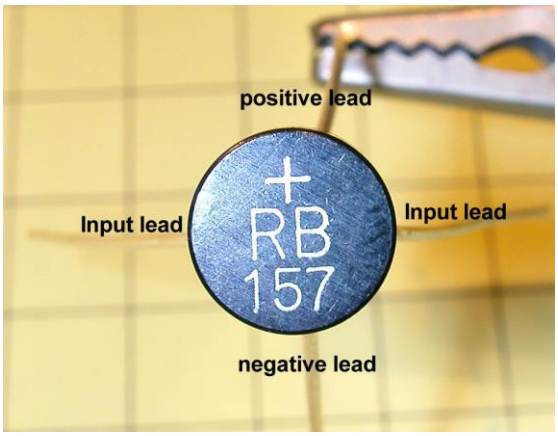


Fig. 4



Question: Are there any connections among the holes in your perforated board? If not, you will need to make the connections on the back side of the board (or the front).

Soldering tips: 1) Soldered junctions (leads of components, wire ends, terminal posts, PCB pads) need to be free from any contaminants – solder rosin core and/or soldering paste serve to remove grease and oxidation. Clean the iron tip by rubbing it against a wet sponge. 2) It is advisable to tin the junctions separately by solder, before soldering them together. The tip of the iron should be kept tinned and shiny at all times. 3) When applying solder to a junction, the junction should be kept at a high temperature, just as the solder. One way to ensure that is by touching the junction, instead of the solder, with the iron tip and to melt the solder only through the heat coming from the junction. 4) Tweezers or pliers can be used to secure parts in place during soldering and to protect both the fingers and components from excessive heat.

Connect your complete circuit to a transformer as shown in Fig. 3. "NC" means no connections to the center tap on the transformer. The transformer output is nominally 12.6 VAC = 6.3 + 6.3. Actually, it is 15 VAC = 7.5+7.5. Depending on the working voltage of the electrolytic capacitor you may need to use a centertap connection.

(a) Demonstrate the operation of the completed power supply to your instructor who will evaluate the operation of the circuit as well as the skill exhibited in the construction. The instructor will give a grade from 0 to 8 and initial the drawing of the circuit in your lab notebook. [8 p]

(b) Plot V vs. I for your supply by loading it. Choose several load resistors from 2kΩ to 100Ω. As the current increases do you note any qualitative change in the curve? If yes, comment on possible reasons. [6 p]

4. Two-transistor voltage regulator

Note: The zener-regulated pass transistor developed in this lab is an acceptable source of

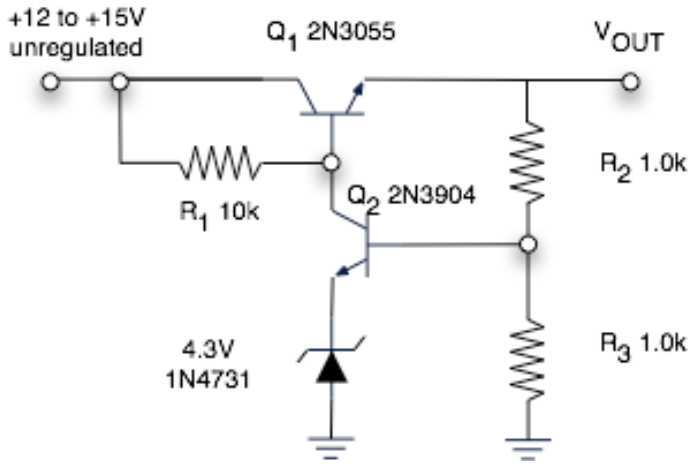


Figure 4: Feedback Voltage Regulator.

stable voltage to be used when circumstances are not demanding. Transistorized power supplies with two or three transistors in a fast negative feedback circuit are used when the load conditions are variable. These can give output impedances less than an ohm and high stability against temperature variation. Figure 4 is a common example of a negative-feedback circuit. Transistor Q_1 is normally conducting because of the bias current through R_1. When the output voltage reaches 10 volts, Q_2 begins to conduct, shunting current away from the base of Q_1 and preventing further rise of the output voltage.

*Explain why Q2 behaves in this way. [5 p]