Transistors III

Physics 251

Fall 2022

In this lab, you will make and evaluate several transistor circuits: an Emitter-Follower, a Push-Pull Follower, and a Current Mirror.

Part 1: Emitter-Follower

In the circuit shown (Figure 1), choose the three resistors so the input impedance is 10k to 15k. Assume there will be a load of about 5.1k connected between the output and ground. Choose the input and output capacitors so signal frequencies of 1000 Hz or greater will be passed. The power supply bypass capacitor can be several μF. Use a 2N3904 or 2N4401 for this circuit. An emitter follower is supposed to have a gain of 1.0. With a 5.1k resistor as a load, what is the gain of your circuit at 1 kHz, 10 khz, 100 khz and 1 MHz? The output impedance is supposed to be "low" The input signal will be supplied by a 50Ω function generator, so you can calculate the output impedance of the follower. Using a small input signal (say 0.05 V_{pp}) try to measure the output impedance, or at least get an upper bound.

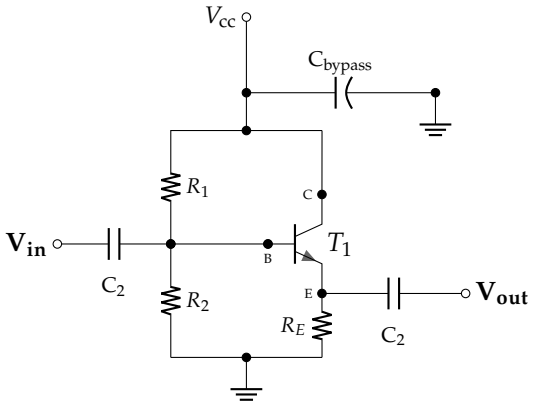

Figure 1: The common emitter amplifier circuit you will build. The transistor T_1 should be either a 2N3904, or a 2N4401 npn transistor. You will have to do some thinking about what values to use for R_1, R_2, and R_E in order to drive a 5.1 kΩ load resistor.

Part 2: Common Push-Pull Follower

Later in the course, you will need a circuit that will deliver two or so watts to an 8 Ω load. One choice to perform this function is to use a push-pull circuit (Figure 2). Today, you will make a lower power version - one that can deliver about 1/4 W to a 200 Ω load. The circuit uses an npn transistor (a 2N3904) and a pnp transistor (a 2N3906). Not shown are two power supply bypass capacitors, between the +15 V and ground and between the -15 V and ground. Use several μF and be very careful with polarity, especially on the -15 V line. Check this circuit out with a 15 or 20 V_{pp} signal at 1 kHz, 10 kHz, 100 kHz and 1 MHz. You should be able to observe

what is called crossover distortion. This might be easier to see with a smaller signal - try 2 or 3 V_{pp} at 10 kHz. Ways to reduce or eliminate crossover distortion are discussed in section 2.4.1 in the book.

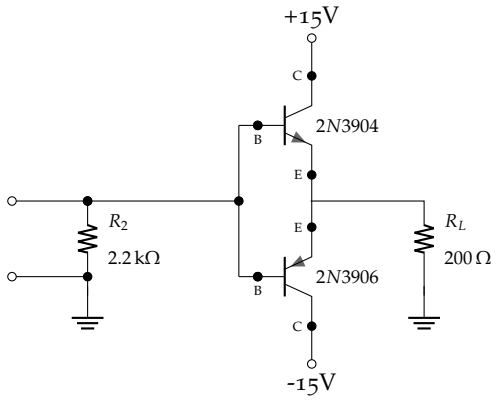

Figure 2: A push-pull circuit. Don't forget to include power supply bypass capacitors on the +15 V and -15 V terminals; use several μF, and be careful about polarity!

Part 3: Current Mirror

Set up the current mirror shown in Figure 3. Ideally, the transistors should be matched - same V_{BE}—but that will not be the case for your circuit. However, with two randomly chosen 2N3904's, you should get the same current through any load from 0 Ω up to 10k. Using your DMM as an ammeter, check this out by using 10 different load resistances and recording the current which passes through the load. How constant is the current? A simple plot of current vs load resistance is a useful visual to add to your report.

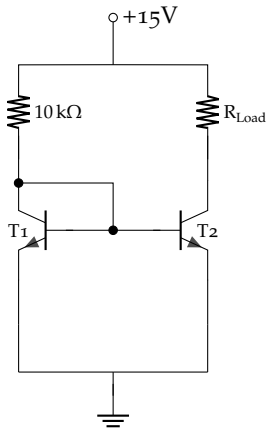

Figure 3: A current mirror. Ideally, transistors T_1 and T_2 would have identical V_{BE} values.