Mixed Electronics Lab 6
Transistors

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1 Introduction

By testing and confirming the characteristic behavior of different transistor devices, students will gain more experience with analog electronics and will be able to recognize how these devices are used in various circuits.

2 Background

Transistors are made with a combination 3 of doped silicon layers. They come as both P type and N types, depending on the arrangement of layers. Figure 1 shows an approximate representation of a bipolar junction transistor. By controlling the voltage at the base of a transistor, the flow of current can be modified, creating a simple amplifier with a near infinite resistance. Note that the different regions of the transistor have different names if you are referring to a MOSFET (drain, gate, source) or a BJT (base, collector, emitter).

3 Analysis

3.1 MOSFET

Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) is a device that is more or less conductive given the voltage at the gate. MOSFETs are used to amplify a signal or create a switching effect. Spend some time reading about the function of MOSFETs and be able to explain why they are of particular interest.

1. Find the data sheet for your MOSFET device and find any test procedures it includes.
2. Determine if your MOSFET requires external protection, and look up how a Zener diode can be used to provide external protection.
3. How would you know if your MOSFET is defective? Prove that it is not.

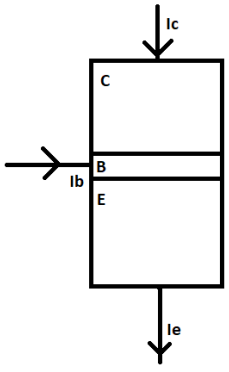

Figure 1: A simplified model of a bipolar junction transistor

4. Build a biasing circuit, refer to your textbook for examples. Measure relevant voltages and confirm you are operating in the saturation region.
5. Set up a circuit that will let you determine the voltage transfer characteristic of your MOSFET. Determine the operating point Q.
6. Use measurements of drain current vs the drain source voltage to confirm you are operating in the saturation region, use these findings to determine the load line and the operating point.

3.2 Bipolar Junction Transistors

1. Find the data sheet for your BJT device and find any test procedures it includes.
2. Measure the VTCs of your BJT, pay attention to the temperature of the device, and avoid overheating.
3. Measure base current vs collector-emitter voltage in order to confirm you are operating in the saturation region.
4. Build a diode connected BJT and characterize its performance.
5. Experimentally recreate the current vs voltage plots seen in the data sheet, and discuss any differences.
6. With a partner, build a Darlington Pair, and investigate its behavior.

4 Questions to Consider

1. Where would you want to use a MOSFET rather than a BJT or Darlington Pair? How about the reverse?

Lab 7: Design Challenge

Use the skills developed in previous labs to design a light detection circuit for photo diode in a closed shoe box. Determine a method to amplify the output of the diode. Filter noise from the amplified signal, being careful not to reduce the quality of your sensor data. Create an output system using colored LEDs to represent 3 levels of light, low, medium and high, consider different methods of comparing values and setting thresholds. Determine what elements will improve the accuracy of your light detection system, and how you will evaluate the performance of the system.