

Week 3: LEDs, Phototransistors and Motor Control

It is **HIGHLY RECOMMENDED** that you read through this week's lab and familiarize yourself with all the material before attending the lab session—there is a lot of content in this week's lab and all these materials are closely related to the underlying control and sensing mechanism of your line-following robot project starting from the next lab!

1. Draw the circuit schematic symbol of a diode and label the anode and cathode.



2. When a diode is forward biased, the anode is at a (circle one) higher / lower voltage than the cathode.
3. When looking at the diode itself, what are the two methods for telling which side of an LED is the anode and which side is the cathode?

Anode: longer leg, rounded side

Cathode: shorter leg, flat side

4. Fill in the blank: When a high voltage relative to the emitter is applied to the base of an NPN transistor, current is allowed to flow from the collector to the emitter.

5. What is the unit of the RC time constant (in SI unit)? Why? Show your reasoning below:

$$RC \rightarrow (\Omega) (\text{Farad})$$

$$V = \frac{\text{kg} \cdot \text{m}^2}{\text{A} \cdot \text{s}^3}$$

$$F = \frac{\text{s}^4 \cdot \text{A}^2}{\text{m}^2 \cdot \text{kg}}$$

$$\Omega = \frac{\text{kg} \cdot \text{m}^2}{\text{A}^2 \cdot \text{s}^3}$$

$$\frac{\text{kg} \cdot \text{m}^2}{\text{A}^2 \cdot \text{s}^3} \times \frac{\text{s}^4 \cdot \text{A}^2}{\text{m}^2 \cdot \text{kg}} = \text{s}$$

Seconds

6. Single ended vs Differential Probing: If you were to use an oscilloscope in lab, the most common probe type you will use is the single ended probe as pictured:

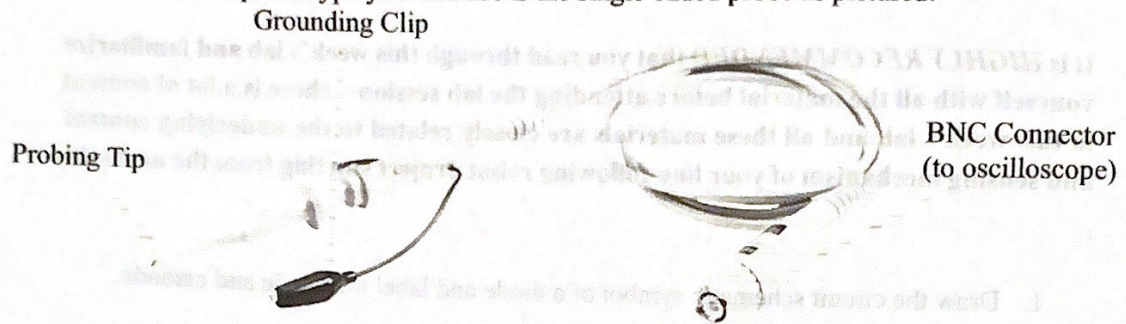
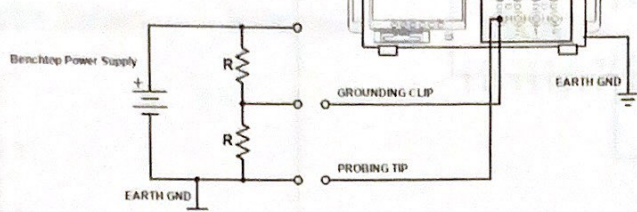
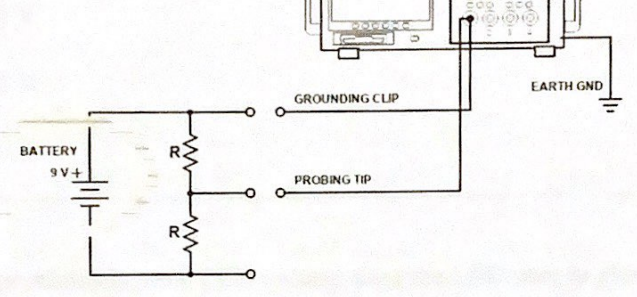


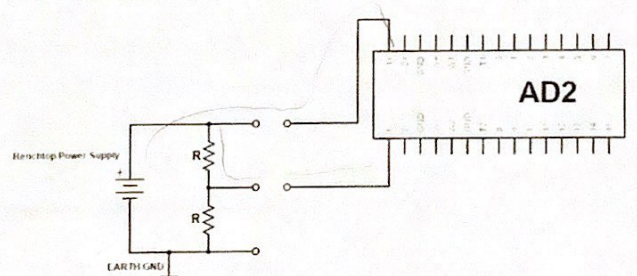
Figure P3-1: Single Ended Probe

In this image, the probing tip is what you'd attach to the node whose voltage you want to measure in reference to the oscilloscope's ground. The grounding clip is indeed what the name suggests; it is a connection to the oscilloscope's ground which is also a connection to earth ground (since the oscilloscope is powered by mains)! **Please understand the importance of this distinction.** To illustrate, if you have a circuit that is powered by mains and you wish to probe it, attaching the grounding clip to the wrong point will create a short. This will likely result in damage to you, the circuit, and your oscilloscope! For this reason, when you are measuring a circuit powered by mains, you must attach the probe's grounding clip to the ground of the circuit (AND NO OTHER PLACE). With this knowledge, determine if the following circuits have the oscilloscope connected in a safe manner:

Circuits	Correct? (Yes or No)
	Yes

	No
	Yes (NOTE THE CIRCUIT'S VOLTAGE SOURCE)

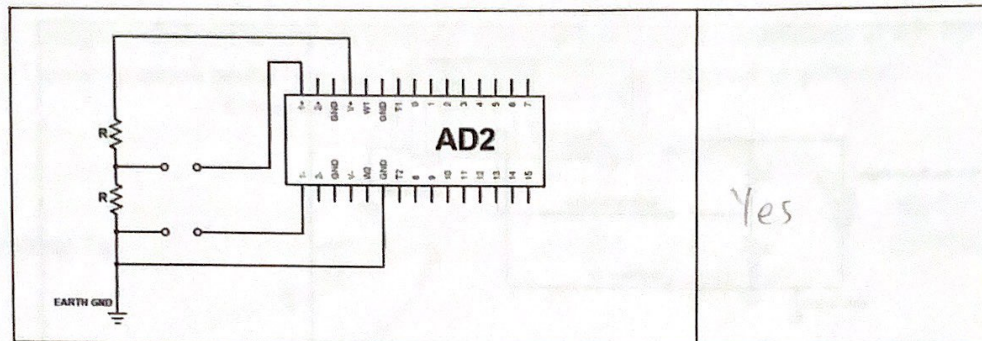
When using the AD2, you will find that the input channels are labeled 1+, 1- and 2+, 2- with no mention of ground. This is because the AD2 uses *differential probing*, not single ended probing. This means the AD2 measures a voltage at the (+) terminal and compares it to the voltage at the (-) terminal to get a voltage measurement. So here, ground is completely separate from the (-) terminal. With this knowledge, determine if the following circuits are connected in a safe manner:

Circuits	Correct? (Yes or No)
	Yes

Channel 1 input pins : 1+, 1-

Channel 2 input pins : 2+, 2-

V^+ : positive voltage supply



Yes

Note: A DMM uses differential probing as well. This makes sense since DMMs are often handheld, battery powered devices so they cannot have a connection to earth ground.

Week 3 Prelab End