PreLab 1: Linear Regulator

• GOAL

The overall goal of Lab 1 is to demonstrate a linear voltage regulator to drive a 5V DC brushless fan (e.g. a computer fan). This is a two-week lab.

- ➢ Lab 1a is a simple power supply based on a Zener follower.
- ➢ Lab 1b explores improved power supply circuits using negative feedback to produce a stable output voltage.

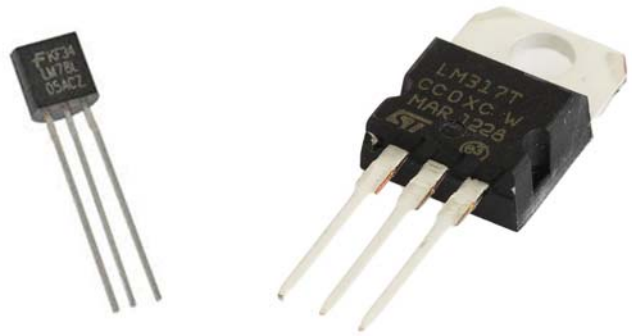

Fig. 0: (Left) 78L05 linear regulator (+5V @ 100 mA) (Right) LM317 adjustable linear regulator (1.5A).

• GENERAL GUIDELINES

1) Each student must turn in his/her own PreLab assignment (include calculations, schematics, and waveforms).
2) Students are allowed (even encouraged) to work together. However, you must turn in your own work!
3) SAVE ALL SCHEMATIC AND WAVEFORM FILES – you will need them later.

• INTRODUCTION

The Zener follower from Lab 1a works pretty well, but its output V_{OUT} does change slightly with load current. In other words, the Zener follower has pretty good "***load regulation***", but it could be better. Improved performance is possible by including ***negative feedback*** (see Lecture 02 notes), which is a major topic of Lab 1b!

In most practical situations involving a voltage regulator, the most cost-effective and best performing option is to use a convenient integrated circuit (IC) chip. During Lab 1b, we will explore three regulators: (1) a modified circuit based on the Lab 1a Zener follower (2) a fixed +5V regulator (78L05 chip) (3) an adjustable regulator (LM317 chip).

• ZENER FOLLOWER WITH FEEDBACK

In class, we discussed how to add an op amp and a voltage divider to produce a more stable voltage regulator. However, we only discussed the case when $V_{OUT} > V_Z$.

- o **TASK 1**: Sketch (by hand) a modification of the Lab 1a circuit (see Fig. 1), where you add an op amp and 10 kohm potentiometer to produce a +5V output. Some comments:
  - ▪ Use HW 1 (Problem 10) to decide where to put the voltage divider.

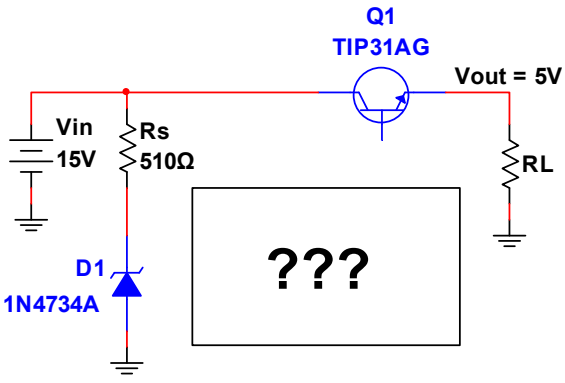

Fig. 1: Figure out how to add an op amp and 10 kohm potentiometer to make a 5V voltage regulator.

- Use the Lecture 02 notes (page 2.2) to figure out how to use a potentiometer.

- **TASK 2:** Simulate your circuit in Multisim. Some comments:
  - Use V_{IN} = 15V.
  - The 1N4734A is the 5.6V zener.
  - Use the TIP31AG transistor.
  - Use the LF356N op amp. You only need to connect the following pins:
    - Pin 2 = (-) input, Pin 3 = (+) input,
    - Pin 4 = GND, Pin 6 = output, Pin 7 = V_{IN}
  - Use a 10 kohm potentiometer.
    - Double-click on the potentiometer, go to the "Value" property and make sure "Resistance = 10 kohm" and "Increment = 1%".
    - If you want the potentiometer wiper to be on the right side, use "flip horizontal" rather than "rotate"!
    - Fig. 2(top) shows the correct orientation using "flip horizontal". ☺
    - Fig. 2 (bottom) shows the incorrect orientation using "rotate". ☹

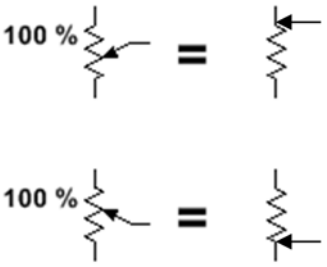

Fig. 2: The correct (top) and incorrect (bottom) orientation of the potentiometer in Multisim.

  - Initially use a load resistor R_L = 2.2 kohm.
  - Place voltage and current probes on V_{OUT}.
  - Perform either an "Interactive Simulation" or "DC Operating Point Analysis" to find the correct potentiometer setting to achieve V_{OUT} = 5V (within 0.02V). What setting (e.g. 64%) works for you?
  - Next, make the measurements to complete Table 1.

Table I: V_{OUT} vs R_L

R_L	2.2 kohm	220 ohm	22 ohm
V_{OUT}			
I_{OUT}			

- **TASK 3:** Data Analysis
  - Compute the load regulation (see Lab 1a handout) for your AWESOME voltage regulator.
  - How does it compare to your measurement from Lab 1a (Task 3d)? It should be better.

❖ **Submit answers to all TASKS (show all work!) and your Multisim circuit schematic.**

(End of PreLab 1)