

Lab 5: Diff-Amp Application

Introduction

"Courage is more exhilarating than fear and in the long run it is easier."
- Eleanor Roosevelt

"Never interrupt someone doing what you said couldn't be done."
- Amelia Earhart

Lab procedure - Voltage Regulator

1. Below is a voltage regulator using a differential BJT pair as the *error amplifier*. In a voltage regulator, the error amplifier takes as inputs a reference voltage and a desired output voltage. Its output controls a *pass transistor* which controls the current the load is allowed to consume. This in turn sets the output voltage of the regulator. Draw the schematic in your lab notebook labeling all parts and node names.

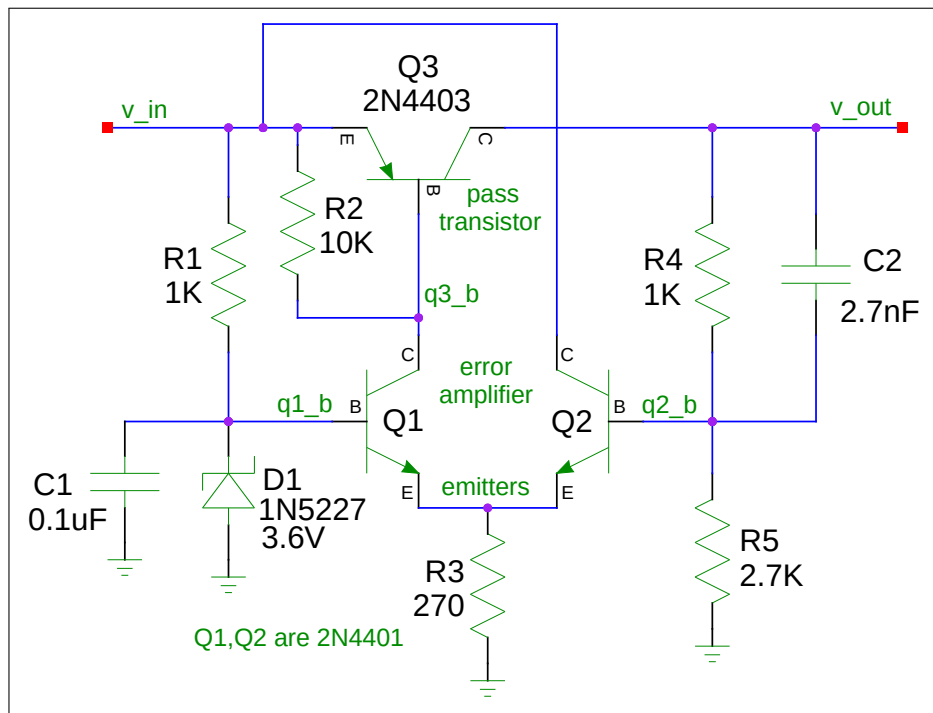


Figure 1: Voltage Regulator

2. With a load resistor of 100 ohms connected to v_{out} and 12V at v_{in} , create a spice file for the circuit and run a Ngspice simulation of it to check its operation. You will need the spice model files available at: [2n4403.mod](#), [2n4401.mod](#), [1n5227.mod](#). Ignore the unrecognized parameter warnings from Ngspice.
 - (a) Print the output steady-state values from Ngspice. Include this in your lab notebook.
 - (b) Roughly, at what voltage is v_{out} regulated?
 - (c) How far can you lower the input voltage before the regulated voltage drops 5%?
 - (d) At an input voltage of 12 volts, how small can the load resistor go before the output voltage drops 5%?
 - (e) At that value of load resistor, what is the dissipation of Q3? Show your calculations.
3. Modify your spice file. Instead of a steady DC input voltage, build a composite input voltage from a pulsed source with a ramp and a sine wave source with 1vpp amplitude at 120Hz. Use a load resistor of 100 ohms. See below and check the spice file for strong hints. Rerun the simulation with this new input source.

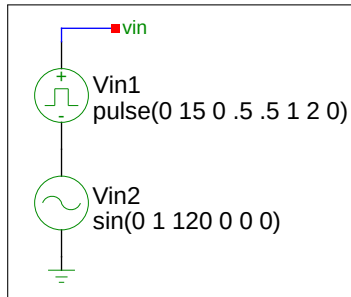


Figure 2: Composite Input Source

- (a) Put a copy of your altered netlist and simulation plot in your lab notebook.
 - (b) Briefly comment on the input waveform at v_{in} and the output voltage v_{out} . What is the composite input voltage doing? What function is the voltage regulator performing other than what its name implies.
4. Build the power supply circuit on the protoboard with a 100 ohm resistor. Make sure it regulates correctly by wiggling the power supply voltage adjust knob from 8-15 volts. The output voltage should not vary and should be identical (within reason) to your simulated results.
 - (a) How much power is the pass transistor dissipating as measured by your DMM with $v_{in} = 12V$? Is the transistor warm or hot (use caution)?
 - (b) How much power is the load resistor dissipating as measured by your DMM? Is it warm or hot?
 - (c) If the input voltage v_{in} is increased to 15V, how much power will the pass transistor dissipate? Will it be hotter? Touch carefully and see. Will the load resistor be any hotter?

Your lab notebook should have the following:

- The initial schematic you used to simulate the voltage regulator.
- The values from the initial voltage regulator simulation. (2a)
- Your data from the initial simulation. (2b, 2c, 2d and 2e).
- The netlist and plot with the composite input voltage source. (3a).
- Comments about the new simulation of step 3. (3b).
- Note any measurements taken of the altered circuit that are important.
- Comments on the physically constructed prototype. Does it work roughly the same as your initial simulation?
- Comments/data per 4a, 4b, 4c.