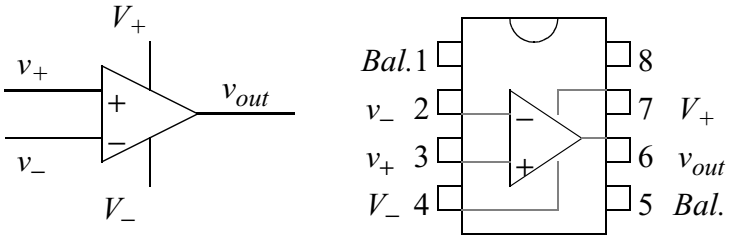
Physics 475, Laboratory 16
Power Supplies

Overview

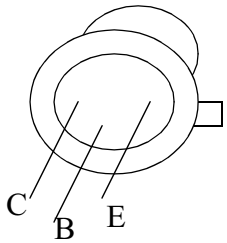
The purpose of these experiments is to use integrated circuits to generate power sources of fixed DC voltage from unregulated sources.

Components

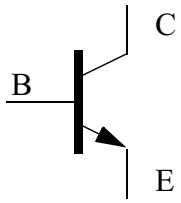
The TL071 op-amp is an integrated circuit based on JFET technology that comes in an 8-pin dual in-line package (DIP). The connections for the chip looking down with the notch facing up is:



The 2N2222 is a general purpose npn transistor. The 2N2222 comes in a TO-18 metal case with leads for emitter, base and collector.



2N2222

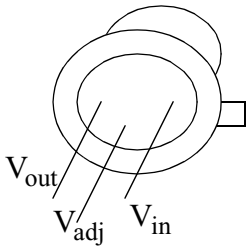


The 2N2222 has maximum ratings as follows:

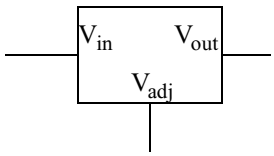
$V_{CE} < 40$ V, $V_{CB} < 60$ V, $V_{EB} < 6.0$ V

$I_C < 0.8$ A, $P = I_C V_{CE} < 1$ W

The LM317 is 3-terminal adjustable voltage regulator. The LM317 comes in a TO-39 metal case with leads for V_{in}, V_{out}, and V_{adj}.



LM317



The LM317 regulates the voltage difference between V_{out} and V_{adj} such that it stays at 1.25 V, as long as $V_{in} > V_{out} + 2$ V.

1. DC Supply with Short Circuit Protection

Design a +5 V DC supply based on an op-amp as in figure 1.

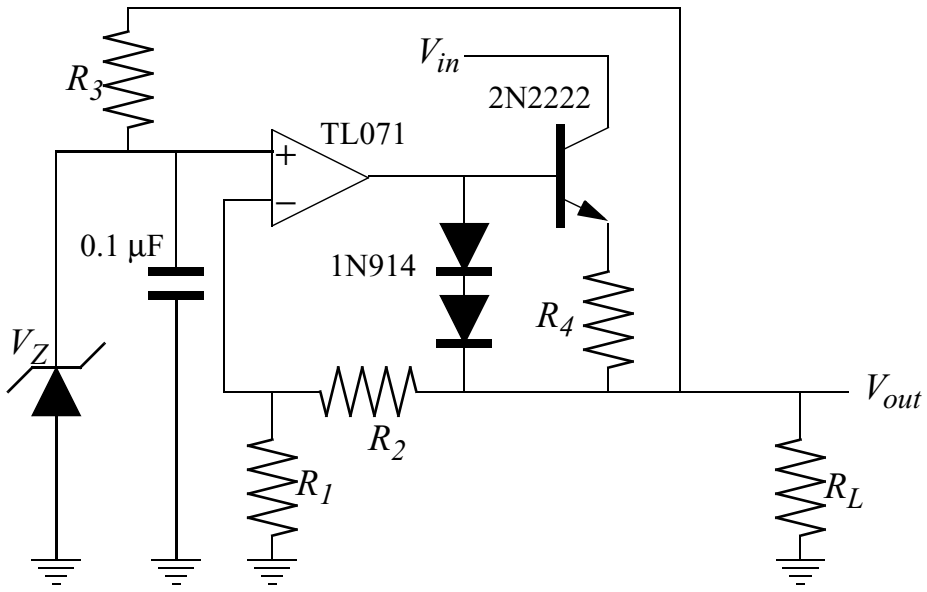


Figure 1: DC Voltage Supply

Begin by identifying the reference voltage for the zener diode V_Z and the maximum current permitted through the transistor I_{Cmax}. Select R_1 and R_2 so that $V_{out} = (1+R_2/R_1)V_Z$. Select R_3 so that $I_Z = 20$ mA. Select R_4 so that $R_4 > 0.6\ \text{V}/I_{Cmax}$. Use the function generator to create V_{in} with an amplitude of 1 V and a DC offset of 9 V. With $R_L = 100$ kΩ, measure V_{out} with the DMM to get a precise voltage and with the oscilloscope to determine the ripple (in -dB). Repeat the measurement with $R_L = 10$ kΩ, 1 kΩ, 100 Ω, and 22 Ω (1W), and compare with a calculated value of I_L. Short R_L with a wire and measure the maximum current.

2. Adjustable Voltage Regulator

Use an LM317 adjustable voltage regulator and 1N4003 diodes to build the circuit in figure 2.

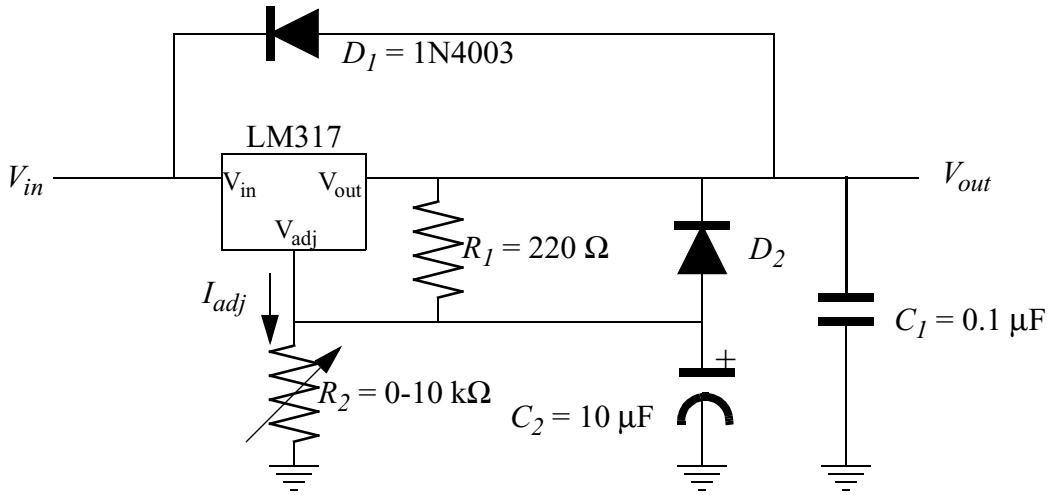


Figure 2: Adjustable Voltage Regulator

The output voltage is given by:

$$V_{out} = \left(1 + \frac{R_2}{R_1}\right) V_{ref} + I_{adj} R_2$$

where V_{ref} = 1.25 V.

Use the function generator to provide V_{in}. Vary R_2 to set the output voltage to 5 V. Measure the output voltage and ripple for a variety of load resistors as in part 1. The two diodes are short circuit protection. What short circuits are they specifically protecting against?