

## Project #1 DC Power Supply

**DUE:** PSpice Simulations      *Friday 2/13/2009 by 5pm in HOMEWORK LOCKER*

Circuit Demonstration      *Week of 2/20/2009 by end of lab session*

### CAUTION!

- **BE CAREFUL DURING THIS EXPERIMENT!**
- **HAZARDOUS VOLTAGES WILL BE PRESENT WHEN YOU PERFORM YOUR MEASUREMENTS!**

- ✓ Do your own work.
- ✓ Clearly present your work.
- ✓ All printouts must be readable.

### **OBJECTIVE:**

- Design a dual rail, regulated, DC power supply to supply enough current to operate the microphone and speaker circuit from **Lab #2**.

### **REQUIREMENTS:**

- Design a dual rail, any voltage, regulated, DC power supply capable of supplying enough current and voltage to operate the microphone and speaker circuit from **Lab #2**.
- The power supply is to be powered from the wall outlet.
- The supply must have a maximum voltage ripple of 1%.

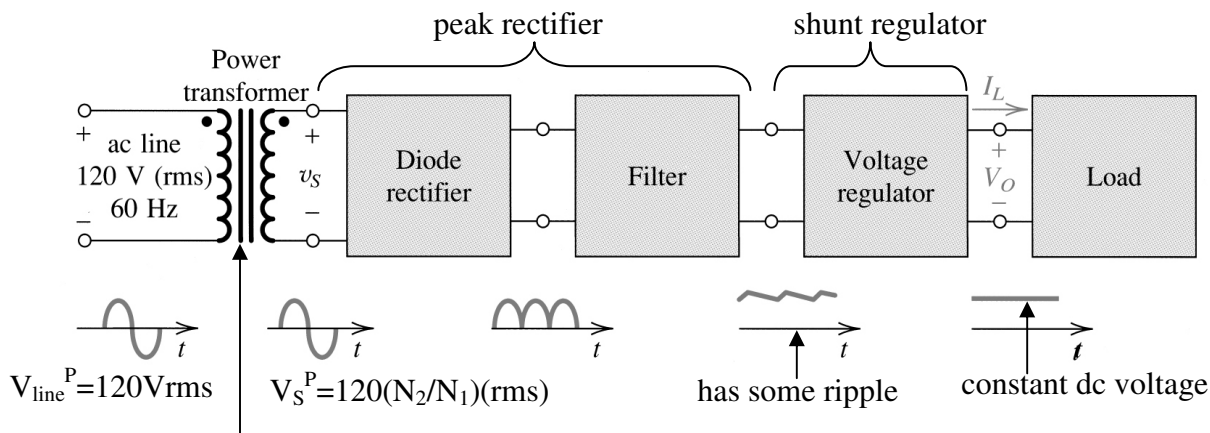
## **BACKGROUND INFORMATION:**

DC power supplies are extremely common in the world of electronics. They are used for almost every type of electronic equipment (i.e. computers, TVs, stereos, cell phones, etc.). In addition to requiring a DC voltage, most equipment requires that the voltage be well controlled or regulated.

You may approach this design any way you desire. You may attempt a simple power supply that meets the requirements above or attempt a more complex design. A switch power supply with the cover off is located in the stockroom if you desire a look at a more complex design.

A block diagram of a simple power supply is shown below in **Fig.1**. The following circuit components staged together as shown in **Fig. 1** make a DC power supply:

- **Transformer** - The transformer provides the necessary voltage reduction for the DC circuit as well as isolation from the AC line.
- **Rectifier** - A full or half wave rectifier could be employed to convert the AC output from the transformer to DC.
- **Filter** - Filtering will be required to limit the voltage ripple.
- **Regulator** - An ideal regulator provides a constant voltage regardless of the load on the power supply. Your voltage regulator must provide the specified level of regulation under no-load and full-load conditions.



**Fig. 1: Power Supply Block Diagram**

## **Suggestions for Circuit Components:**

These are suggestions for parts that are possible to use in your design. These are a guideline only and any part may be used so that the specifications are achieved.

- **Transformer** – A transformer that is around 25Vrms can be checked out from the stockroom. I would suggest writing down the number of the one you work with since they are all different. Depending on how you design your power supply, a test of the voltages and currents from the transformer will need to be measured to allow the completion of the design. Take voltage measurements and current measurements for several loads so that a feel for how a change of a load will effect your current and voltage from the transformer.
- **Rectifier** - The rectifier can be constructed using diode(s) in a rectifier configuration.

- Filter – A capacitor can be used to achieve filtering. Polarity of electrolytic capacitors is important and all are marked.
- Regulator - Zener diodes and/or an IC regulator chip(s) are available for regulation.
- Resistors - Most common values of resistors are supplied. Very important: note that resistors (and capacitors) only come in discrete values, with the step sizes depending on the % tolerance. See Table G.1 in the Sedra/Smith text for more details.

**General Guidelines:**

Your course textbook will serve as a good starting point for the design process. (Example 3.10 of your book shows a 5V design). You will need to measure the transformer you plan to use for your design so that you can use that in the simulation. A starting circuit for simulation is provided on the website. Again this is only a guideline and changes will need to be made to have it operate correctly and within specifications.

**WARNING:**

- **CONNECT THE OSCILLOSCOPE ONLY TO THE SECONDARY!**
- **NEVER CONNECT THE SCOPE TO THE PRIMARY!**
- **THE NEGATIVE LEAD ON THE SCOPE PROBE IS GROUND.**
- **IF YOU CONNECT THIS LEAD TO THE PRIMARY, YOU WILL CAUSE 120 VRMS AT 20 AMPS TO SHORT THROUGH YOUR PROBE TO GROUND!**

The transformer is modeled as a voltage sinusoid in the schematic. Therefore, you would change the amplitude of the voltage sinusoid based on your measurements. Modify the values in the schematic based on your hand calculations. Use Section 3.5.

**Note:** There is a tradeoff between current (Eq. 3.32) for the power supply and ripple voltage (Eq. 3.29). You need to make sure that there is enough current going to the complete speaker microphone circuit.

**PSpice Requirements:**

- Get power supply from downloaded schematic to operate correctly and within the specifications of the project.
- Connect your designed and working power supply to a Thevenin equivalent circuit of the speaker/microphone in PSpice (the whole microphone/speaker circuit is too big to simulate in the student version).
- Get complete circuit to simulate correctly and meet specifications. (Hint: use parametric simulation (at the end of the PSpice Tutorial) to design for C of the power supply so that there is not too much of a current spike).

### **Prototype Circuit:**

1. First, do your sketches and design calculations in your lab book.
2. Perform the spice simulation.
3. Obtain device characteristics from spec sheets and/or through measurement with curve tracer and LCR meter. Ensure that maximum ratings are not exceeded in any component.
4. Design your power supply to maintain regulation for a minimum line voltage of 115 Vrms yet not exceed the maximum power dissipation in any component up to a line voltage of at least 130 Vrms.
5. Build your entire circuit using standard discrete components. Make sure it meets all design specifications. Check off the working circuit with your Lab TA.

**DO NOT DISCONNECT THIS CIRCUIT. IT IS NEEDED FOR THE REST OF THE PROJECTS.**

### **Test requirements:**

- Measure the full-load and no-load operation of your circuit. Some of the measurements may include: curve tracer volt-ampere characteristics of both diode devices, load current, load voltage, voltage ripple, voltage regulation, component power dissipation, component voltages and currents. This is not a complete list. You must decide which measurements are relevant to your design and important to a potential user of your power supply. In many cases it is necessary to record AC waveforms; measurement with a multi-meter is not sufficient (use the oscilloscope).
- Record the power dissipation in the various components. Is this a significant factor? How would this affect the long-term operation of the circuit?
- Observe the AC waveforms in the circuit. Is there any distortion or other unexpected results? Explain why such anomalies may exist.
- Ensure that all component values in your circuit diagrams reflect the actual component values used.
- Have a Lab TA inspect, approve, and mark your final design.