

UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Electrical and Computer Engineering

ECE 137A

WINTER 2009

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Laboratory Assignment #1

Dual Rail Regulated DC Power Supply

Prelab due: Friday 01/16/2009 2PM in Homework Box

Lab checkout: Friday 01/23/2009

Lab report due: Tuesday 01/26/2009

The power supply is an important building block in any circuit design. You are to design and build a regulated DC power supply using Zener diode in this lab, which will be used in subsequent lab assignments.

Specifications

Regulated output voltage	$\pm 12\text{V}$
Maximum ripple at the output of the rectifier	5% at load current of 150mA
Output current	150mA

Part I

Design and build a full-wave dual rail DC power supply with the specifications given above. Hand calculate the capacitance required for an output current of 150mA. We will test the rectifier's output with a load resistor that draws 150mA out of the rectifier.

Prelab

Draw a schematic of your design with component values that you have calculated. Show all hand calculations and list all your assumptions. Answer the prelab questions. Keep in mind that you are dealing with relatively high voltages and currents, so make your circuit components have the necessary power handling capability. The best way to do that is check the specification sheet of the particular component that you're using and make sure that the maximum power it will handle in your circuit does not exceed the maximum rated operation condition.

Prelab questions:

1. Calculate the load resistance needed to draw an output current of 150mA. What is the

power dissipation?

2. What is the theoretical conduction angle of the diode? In other words, find out how long the diode will conduct current, and the frequency, the product of the two is the conduction angle in radian.
3. What is the maximum voltage across the diode. Is your diode rated for this voltage?

Build the rectifier circuit that you have designed in the prelab. Remember that you will be using this same power supply for your subsequent labs, so solder it neatly on a vector board so that you can carry it around. You will be graded on your circuit board's organization. Also you need to plan for lab check out (Placing and removing loads) as well as having the circuit ready for the next lab. We will discuss more in detail about the board layout in lab session.

Questions:

4. Measure the built-in voltage of the rectifier diode. Is it the same as the value given by the manufacturer's specification sheet? If so, why or why not.
5. Measure the conduction angle of the rectifier circuit. Compare and comment on your observation with your calculation.
6. Design an experiment to measure the current through the diode without using an ammeter. How does the current waveform look like?
7. Derive the Fourier transform of the current waveform. From the Fourier transform, how will this affect your circuit performance?

Part II

Design and build a regulated DC power supply using the rectifier circuit you built in part I. We will use Zener diode to regulate the output voltage (how does it work?). The desired output voltage is 12V at a maximum load current of 3 mA.

Questions

8. How much ripple compression do you expect? Derive an expression for the ripple compression. In other words, for every volt of ripple at the output of the rectifier, how much will appear at the output of the regulated supply?
9. Change the load resistance from infinity (open circuit) to a load that draws a maximum of 3mA of output current. What is the expected variation of the output voltage as the load varies, compare and comment on your measurement result. Derive a theoretical expression relating the change in output voltage as the load varies.

Lab Report

Turn in a typed report with all the questions answered along with your hand calculations and circuit schematics. Comment on key design considerations and your circuit's performance compared to your calculations.