Analog Electronic Devices
(ESI038 / SE047)

Lab Experiment 1
Diodes: A Regulated DC Power Supply

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Objectives

The objectives of this lab experiment are:

a) to design a practical procedure to measure the Shockley equation parameters for a real diode

b) to combine several applications of typical diode circuits

c) to design a simple DC regulated power supply using resistors, capacitors, rectifier diodes, zener diodes, and a transformer

Components and Instrumentation

Several general purpose diodes and one or more zener diode

A transformer

Several resistors, capacitors and perhaps inductors

A digital multi-meter (DMM) with 2½ or more digits

An oscilloscope with x10 or x1 probes

A circuit simulation software: OrCad, WinSpice, Electronic Work Bench, or something similar.

Theoretical Procedure

1. Design a procedure to measure the parameters of the Shockley equation (η and I_S) for a general purpose rectifier diode. Show the circuit that you propose, and indicate the measurement instruments that you will need, as well as the way they will be connected. Derive the equations that you will use to calculate η and I_S from the DC measurements (measuring or estimating the ambient temperature).
2. Design a DC regulated power supply without using IC regulators or transistors. Choose a supply voltage of either 9V, 12V or 18V. The power supply must be connected to the AC power line (60Hz-110Vrms) through a transformer. Select the transformer according to the DC supply voltage chosen and the maximum load current. Use either a half-wave or full-wave rectifier. Design the peak detector (or filter) such that the maximum transient peak current does not exceed the maximum rating of the diodes used. Design the voltage regulator using a Zener diode (or a combination of them), so that the output DC voltage remains regulated for a load current variation from 0 to 25mA, assuming that the AC power line voltage can have a 20% variation.

Lab and Simulation Procedure

1. Implement in the lab the circuit and procedure you designed to measure the Shockley equation parameters. Since accuracy is important, measure with a DMM the resistors you are using (i.e., do not assume that a nominal 1KΩ resistor will have 1000 ohms), as well as the voltages your are applying. Report your results.
2. For the DC power supply:
   a. Simulate your complete power supply using SPICE. Observe its transient and steady-state performance. Make sure the output voltage remains regulated when the AC power line voltage and the load resistance change. "Measure" its regulation percentage and its ripple percentage [1].
   b. Implement in the lab your already designed and simulated power supply. Re-adjust your design and simulation if necessary. Using a DMM, measure its regulation percentage. Using an oscilloscope, measure its ripple percentage.

Report

Write a report including all the theoretical, simulation and lab procedures as well as your conclusions. Since it is a design problem, it is very important to justify all the critical decisions during the design process (related to calculations as well as to selection of components). The report must include the schematic of the complete final circuit, indicating the tolerances for the passive components (and their exact values if they were measured).

Deadline and Assessment

The deadline for submitting the report is on Friday February 2, 2007. The report can be written either in English or in Spanish.

This lab experiment can be realized in teams of up to 3 students. The evaluation of the report will be as follows:

Quality of the report	30%
Accuracy of the theoretical analysis	30%
Lab measurements and procedures	40%

If the report is written in acceptable English, an extra 10% can be granted.

[1] If necessary, you have to find out what is the regulation percentage and the ripple percentage of a DC power supply.