ELEC 313 Lab 3
Diode Circuits

REFERENCE: Appropriate chapters of ELEC 306 text.

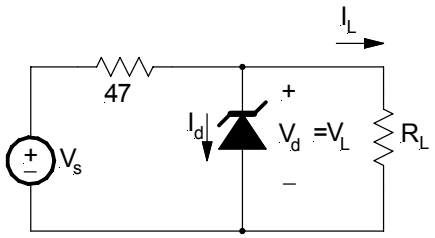
OBJECTIVE: The objective of this experiment is to construct, measure and observe the behavior of a diode rectifier circuit and voltage regulator circuit.

EQUIPMENT: Diode 1N4007
Zener Diode 1N5231
Resistors 47 Ω
Capacitor 1 μF,
Resistive decade box 10 – 100K Ω
Power Supply (Vdc) , Function Generator, Multi Meter, Oscilloscope

PRIOR PREPARATION (Pre-Lab):

A) Go onto the internet (e.g., www.fairchildsemi.com) and find the nominal Zener voltage of a 1N5231B diode.

B) For the voltage regulator circuit shown in Figure 1, with V_s = 9 V, calculate the open-circuit voltage at the diode terminals for each value of load resistance below. In other words, what would be the voltage across the nodes when the diode is removed? Which of these open circuit voltages are greater the breakdown voltage of the 1N5231B?



R_L = 100, 330, 1000 Ω, and infinity (no load).

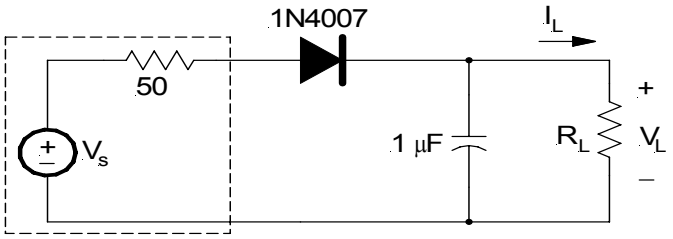
Figure: 1 Zener diode voltage regulator.

C) For each value of R_L , and with the diode removed, calculate the value V_s that would make the open-circuit voltage equal to the nominal Zener voltage of the 1N5231B.

PROCEDURE: Laboratory experiments

Rectifier

1) Obtain the capacitor and diode needed to build the following circuit. The voltage source and its 50 Ω resistance represent a function generator. Use a decade resistance box for the load resistance.



2) Measure the capacitance value using the capacitance meter and compute the error from nominal.
3) Build the circuit on a breadboard. Set an initial value of load resistance of 10K.
4) Connect one channel of the oscilloscope to the output of the function generator, and the other channel to measure the voltage across the load.
5) Set the function generator to produce a sine wave at 400 Hz with a peak amplitude of 1 V *as measured with the (V_{pk}) function on the oscilloscope*.
6) Measure the dc voltage on the load using the multi-meter.
7) Using channel 2 of the oscilloscope, measure V_{max} and V_{min} voltages at the output to determine the ripple.
8) Repeat steps 5, 6, and 7 for measured peak amplitudes of 2, 3, 4, and 5V.
9) Leaving the input voltage from the function generator at 5 Vpk, repeat steps 6 and 7 for load resistance values of 1K, and 100K.

Voltage Regulator

1) Obtain and measure a 47 Ω resistor.
2) Build the circuit shown in Figure 1, use a 1N5231B for the Zener diode, the HP power supply for the voltage source and the decade resistance box, set to 1K, for the load resistance. Set V_s to 9 V. TO PREVENT COMPONENT OVER-HEATING, DO NOT USE LOAD RESISTANCES LESS THAN 100 Ω.
3) Measure the load voltage and current for R_L values of : 1K, 330, 100 Ω.
4) Remove the Zener diode and measure the open-circuit voltage for each value of R_L.
5) Reinstall the Zener diode. For R_L values of : 1K, 330, 100 Ω determine the point at which the source drops out of regulation. Increase V_s to the range where the output voltage is relatively constant near the Zener voltage; then decrease V_s to the point where the output voltage begins to drop quickly with V_s. The value of V_s at this threshold is the dropout voltage.
6) Unhook the load resistor and set V_s to 9 V. Measure the voltage across the Zener diode in the no-load case.

Data Analysis

Rectifier

1) Make a graph of the dc voltage measured in step 6 versus the peak voltage from the function generator. Use MATLAB, Excel, or any other program of your choice to plot the data.
2) Discuss the effect of load resistance on the percent ripple of the rectifier.
3) Compute and discuss how the percent ripple would change if the input frequency were 20K Hz.

Voltage Regulator

Compute the percent regulation between the no-load (step 6) and the R_L=100 Ω voltages.

$$\%reg = \frac{V_{load} - V_{no-load}}{V_{no-load}} \times 100\%$$

LAB REPORT:

Your report should be completed in the format requested by the instructor. The lab report should be written in standard format, containing: Cover page, Purpose of experiment, Test configuration, Circuit tested, Test procedure, Measured results, Comparison of results, and Conclusions.
Specifically it should also include;

1) Measured results of rectifier circuit in tabular form, and the graph from the data analysis section.

2) Measured results of the voltage regulator in tabular form and the % regulation.

3) Comparison of the computed open-circuit voltages (prelab–part B) and the measured ones (step 4) over the range of R_L.

4) Comparison of the measured drop out voltage (step 5) with the computed values from the prelab–part C over the range of R_L.

5) Explain the relationship between frequency and ripple size in the rectifier. Explain the relationships among dropout voltage, open-circuit voltage, and the Zener diode voltage.