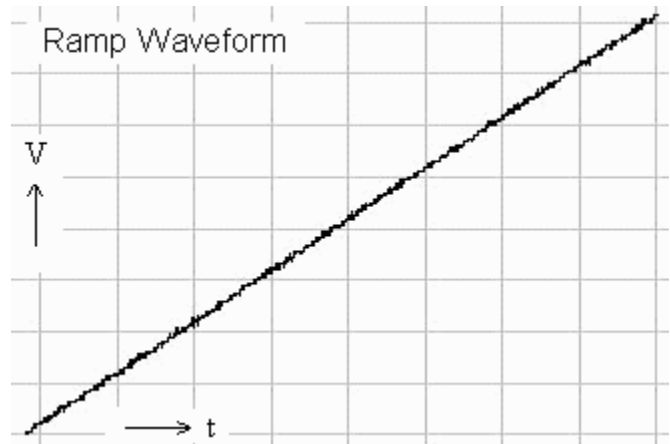


ECE 3254 PreLab 6 notes

Edited 09-29-05

A **Ramp waveform** (also called a sawtooth if repeating) begins at one voltage and increases or decreases linearly with time to another voltage.

When this ramp is applied to the diode clipper of Fig 5-1, you must remember the voltage divider formed by R_S and R_L will reduce the voltage seen by the diode. Assume that the diodes have a sharp forward turn-on voltage of 0.6V.

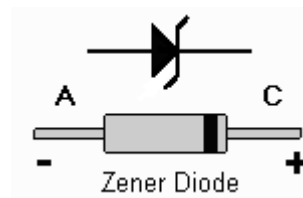
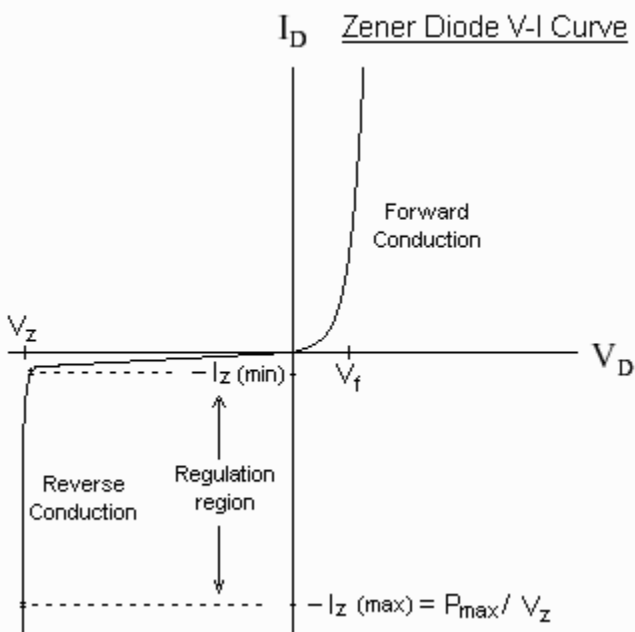


Zener Diode – Unlike the rectifier diode, a Zener diode is designed to operate in reverse conduction. Zener breakdown occurs at a precisely defined voltage, allowing the diode to be used as a voltage reference or clipper. While Zener diodes are usually operated in reverse conduction, they may also be operated in cutoff and forward conduction.

There are two different effects that are used in “Zener diodes”. The only practical difference is that the two types have temperature coefficients of opposite polarities.

- Zener breakdown – Occurs for breakdown voltages greater than approximately 6V when the electric field across the diode junction pulls the electrons from the atomic valence band into the conduction band, causing a current to flow.
- Impact ionization (also called avalanche breakdown) – Occurs at lower breakdown voltages when the reverse electric field across the p-n junction causes a cascading ionization, similar to an avalanche, that produces a large current.

A reference diode is a special Zener diode designed to use both conduction modes, which cancels the temperature coefficients and produces a temperature stable breakdown voltage.



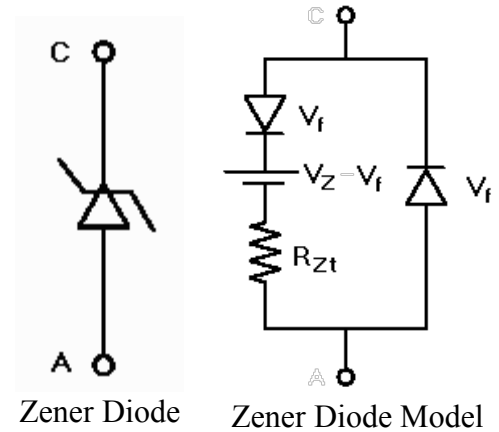
Zener diode ratings include:

- Zener Voltage ($V_z@I_{zt}$)
- Power Dissipation (P_d)
- Max Current (I_{zm})
- Zener Impedance (Z_{zt})
- Max Leakage Current ($I_R@V_R$)
- Temperature Coefficient (α_{VZ})

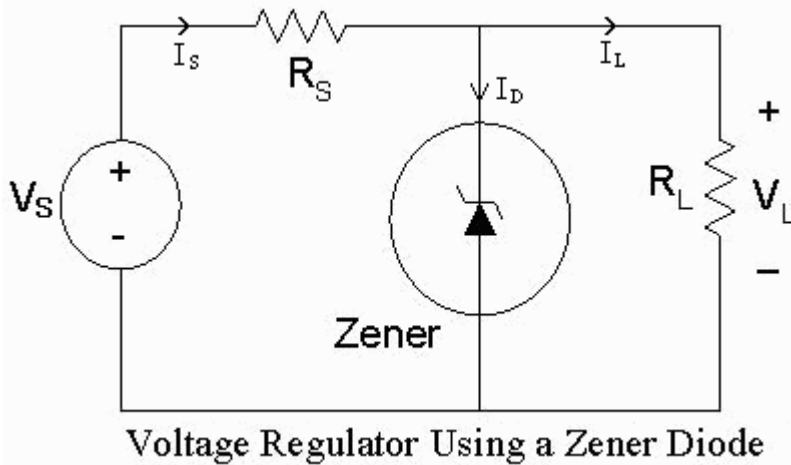
Prelab 5 notes (continued)

The model for a reverse biased Zener diode (on the left side of the model) can be represented as a series circuit consisting of a regular diode with voltage drop V_f , a bias voltage source to provide a total drop of V_Z across the Zener diode terminals, and a resistor to represent the Zener impedance (R_f represents the slope of the reverse conduction V-I curve). For this lab, we will neglect the effects of R_{zt} .

The forward biased Zener diode would simply be a regular diode (on the right side of the model).



The most common use for a Zener diode is a voltage regulator or reference.



If the output voltage is to remain constant, the current through R_S must remain constant. Current not used by the load passes through the Zener diode. When there is no load current, all the source current flows through the Zener diode and diode must be able to dissipate this power.

For regulation:

- $V_L = V_Z$
- $I_L \leq I_S = V_Z / R_{Lmin}$
- $R_S = V_S - V_Z / I_S$
- $P_{Dmax} = I_S * V_Z$ (at $R_L = \infty$)

The reverse conduction voltage of a Zener diode is specified as V_Z at a reverse current I_Z , and the Zener's reverse voltage will be fairly constant over a reasonable current range. Also specified is the Zener diode's power dissipation rating. Excessive reverse current will exceed the dissipation rating and overheat the Zener diode, leading to diode failure.

What happens if the diode power rating is less than the P_{Dmax} above?

You will have a maximum resistance for R_L , above which the diode is dissipating too much power. The maximum diode current is given by $I_{zm} = P_d / V_Z$. If $I_{zm} < I_S$, then the minimum load current is $I_{Lmin} = I_S - I_{zm}$ and the maximum load resistance is $R_{Lmax} = V_Z / I_{Lmin}$.

Lab 6 note:

There is a bug in the Labview control software. To set the frequency to 200Hz in the Function Generator menu, you must use the "down" arrow in the frequency box to step the frequency to 900, 800, etc, 200Hz. If you enter 200Hz with the keyboard, it will change to 0Hz when you hit the GO button.