Zener Diodes

BASIC ELECTRONICS

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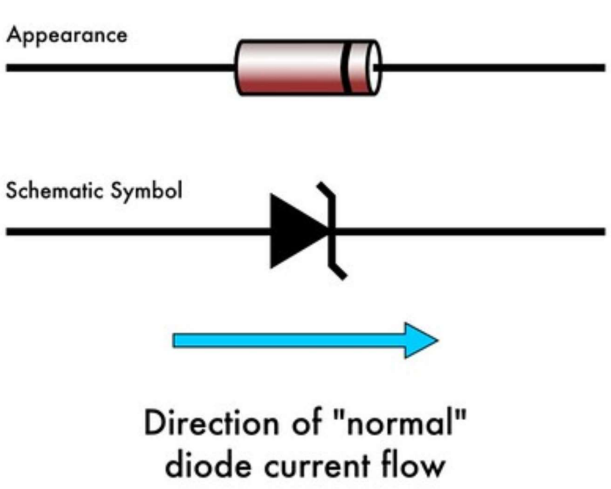
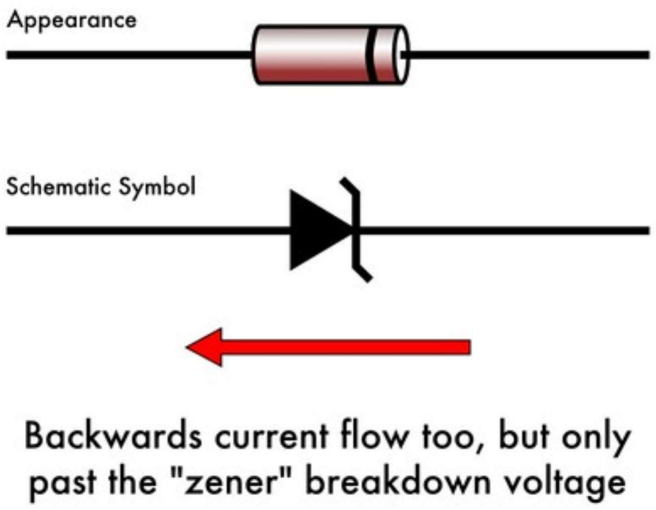
Introduction

- The Zener diode behaves just like a normal general-purpose diode consisting of a silicon PN junction.
- When it is biased in the forward direction, that is Anode positive with respect to its Cathode, it behaves just like a normal signal diode passing the rated current.
- When it is reverse biased, that is the Cathode becomes more positive than the Anode, as soon as the reverse voltage reaches a pre-determined value, the Zener diode begins to conduct in the reverse direction.
- Therefore, Zener Diode also call as a “Breakdown Diode”.

Introduction Cont.

- The schematic symbol for a Zener diode is shown below. It is very similar to that of a regular diode, but with bent edges on the bar.
- The Zener still conducts electricity in the forward direction like any other diode, but also conducts in the reverse direction, if the voltage applied is reversed and larger than the Zener breakdown voltage.

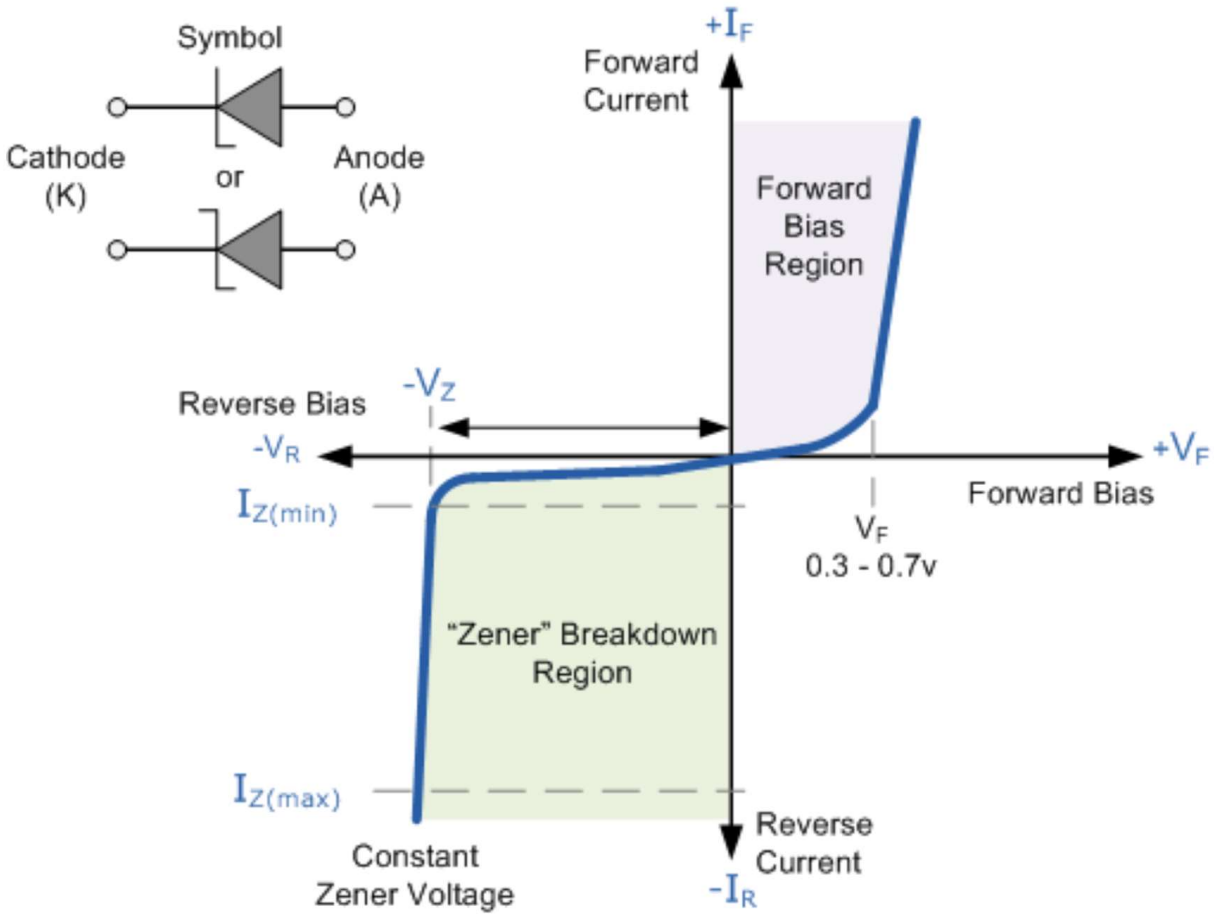




Process of Zener Diode

- ***Avalanche Breakdown Process :*** When the reverse voltage applied across the Zener diode exceeds the rated voltage of the device a current starts to flow through the diode to limit this increase in voltage.
- The current now flowing through the Zener diode increases dramatically to the maximum circuit value and once achieved, this reverse saturation current remains fairly constant over a wide range of reverse voltages.
- The voltage point at which the voltage across the Zener diode becomes stable is called the "Zener Voltage" or " Zener breakdown voltage (V_z) ".
- The Zener breakdown voltage on the I-V curve is almost a vertical straight line (when consider Zener resistant of the Zener diode is zero).

Zener Diode I-V Characteristics



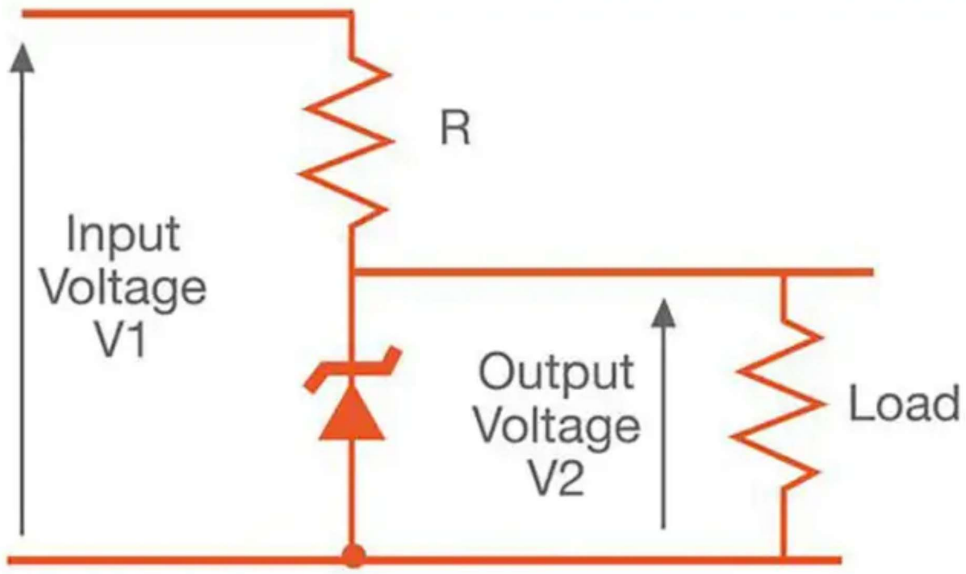
Zener Diode I-V Characteristics : Explanation

- From the I-V characteristics curve above, we can see that the Zener diode has a region in its reverse bias characteristics of almost a constant negative voltage regardless of the value of the current flowing through the diode.
- This voltage remains almost constant even with large changes in current providing the Zener diodes current remains between the breakdown current $I_{Z(min)}$ and its maximum current rating $I_{Z(max)}$.
- This ability of the Zener diode to control itself can be used to great effect to regulate or stabilise a voltage source against supply or load variations
- Therefore, it can be used in the simplest types of voltage regulator applications.

Zener Diode Voltage Regulator

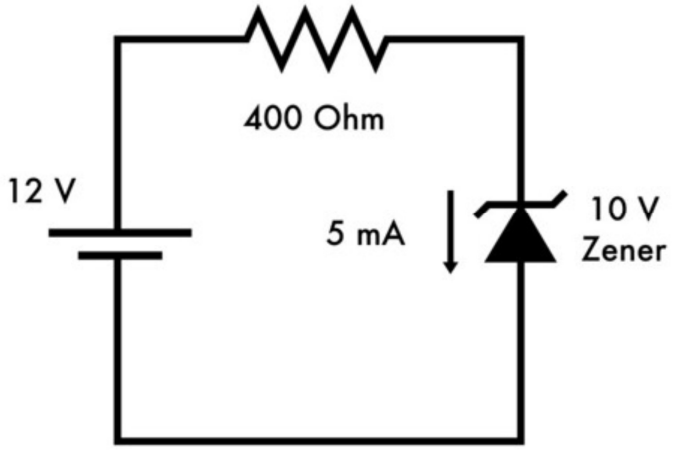
- The voltage across the Load is equals breakdown voltage V_Z of the diode.

- The series resistor limits the current through the diode and drops the excess voltage when the diode is conducting.



Zener Diode Regulator: Example 1

- A 10 V Zener diode is placed in series with a resistor and a fixed 12 V power supply.
- Then the stabilised output voltage V_{out} is taken from across the Zener diode.
- Since the supply voltage (12v) is larger than the Zener voltage (V_z) the Zener diode works in the breakdown region which is 10v according to this example..
- In the circuit above, there is 10 V across the Zener diode, and 2 V across the resistor. With 2 V across a 400 ohm resistor, the current through that resistor (and the diode, in series) is 5 mA.



Zener Diode Clipping

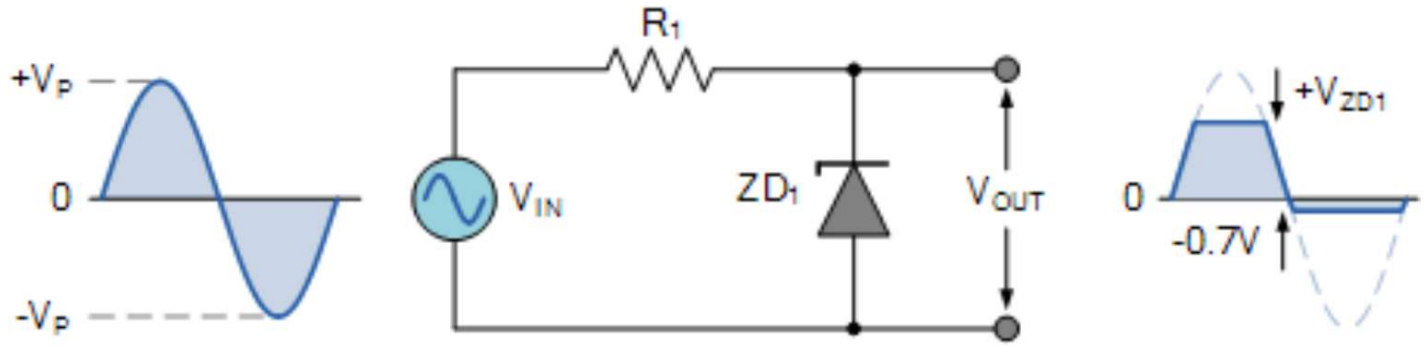


Figure 1

V_{ZD1} Break Down voltage of Zener Diode ZD1

Let's assume that the Zener diode is a non real diode and it has a threashold voltage of 0.7v.

Zener Diode Clipping : Explanation

- The Zener diode is acting like a biased diode clipping circuit with the bias voltage being equal to the Zener breakdown voltage.
- In this circuit during the positive half of the waveform the Zener diode is reverse biased so the waveform is clipped at the Zener voltage, V_{ZD1}.
- During the negative half cycle the Zener acts like a normal diode with its usual 0.7V junction value.

Full-wave Zener Diode Clipping

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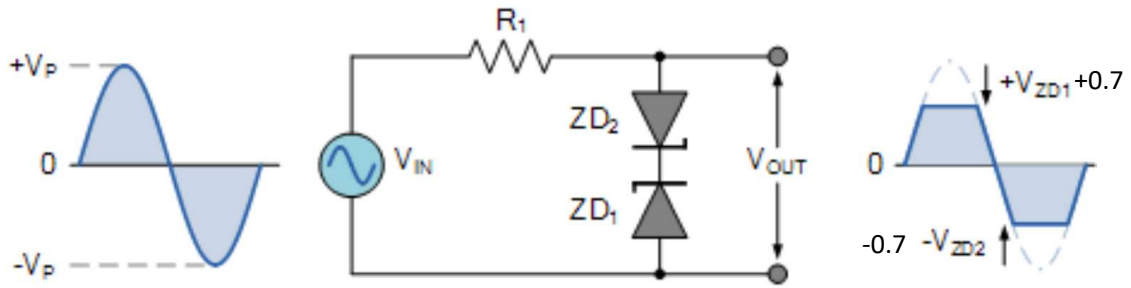

- The output waveform from full wave Zener diode clipping circuits resembles that of the previous voltage biased diode clipping circuit.
- The output waveform will be clipped at the Zener voltage plus the 0.7V forward volt drop of the other diode.
- So for example, the positive half cycle will be clipped at the sum of Zener diode, ZD_1 plus 0.7V from ZD_2 and vice versa for the negative half cycle

THANK YOU