PES UNIVERSITY

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UNIT-2 Semiconductor Diode Applications

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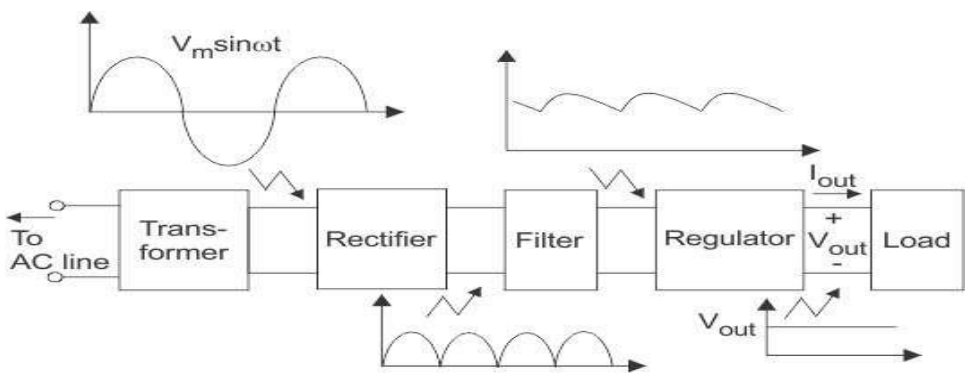
Unit-II Semiconductor Diode Applications

Today's technology, almost all electronic equipment includes a circuit that converts ac supply into dc supply. The part of equipment that converts AC into DC is called DC power supply. In general at the input of the power supply there is a power transformer. It is followed by a rectifier (a diode circuit) a smoothing filter and then by a voltage regulator circuit.

From the below block diagram, the basic power supply is constituted by four elements viz a transformer, a rectifier, a filter, and a regulator put together. The output of the dc power supply is used to provide a constant dc voltage across the load. Let us briefly outline the function of each of the elements of the dc power supply.



Components of typical linear power supply

Transformer is used to step-up or step-down (usually to step-down) the-supply voltage as per need of the solid-state electronic devices and circuits to be supplied by the dc power supply. It can provide isolation from the supply line-an important safety consideration. It may also include internal shielding to prevent unwanted electrical noise signal on the power line from getting into the power supply and possibly disturbing the load.

Rectifier is a device which converts the sinusoidal ac voltage into either positive or negative pulsating dc. P-N junction diode, which conducts when forward biased and prac•tically does not conduct when reverse biased, can be used for rectification i.e. for conver•sion of ac into dc.

The output voltage from a rectifier circuit has a pulsating character i.e., it contains unwanted ac components (components of supply frequency f and its harmonics) along with dc component. For most supply purposes, constant direct voltage is required than that furnished by a rectifier. To reduce ac components from the rectifier output voltage a filter circuit is required.

Thus filter is a device which passes dc component to the load and blocks I ac components of the rectifier output. Filter is typically constructed from reactive circuit I elements such as capacitors and/or inductors and resistors. The magnitude of output dc voltage may vary with the variation of either the input ac voltage or the magnitude of load current. So at the output of a rectifier filter combination a voltage regulator is required, to provide an almost constant dc voltage at the output of the regulator. The voltage regulator may be constructed from a Zener diode, and or discrete transistors, and/or integrated circuits (ICs). Its main function is to maintain a constant dc output voltage. However, it also rejects any ac ripple voltage that is not removed by the filter. The regulator may also include protective devices such as short-circuit protection, current limiting, thermal shutdown, or over-voltage protection.

Rectifiers

A rectifier is an electrical device that converts an Alternating Current (AC) into a Direct Current (DC) by using one or more P-N junction diodes.

One of the most important applications of a P-N junction diode is the rectification of Alternating Current (AC) into Direct Current (DC). A P-N junction diode allows electric current in only forward bias condition and blocks electric current in reverse bias condition. In simple words, a diode allows electric current in one direction. This unique property of the diode allows it to acts like a rectifier.

Types of rectifiers

The rectifiers are mainly classified into two types: Half wave rectifier & Full wave rectifier

Half wave rectifier: As the name suggests, the half wave rectifier is a type of rectifier which converts half of the AC input signal (positive half cycle) into pulsating DC output signal and the remaining half signal (negative half cycle) is blocked or lost. In half wave rectifier circuit, we use only a single diode.

Full wave rectifier: The full wave rectifier is a type of rectifier which converts the full AC input signal (positive half cycle and negative half cycle) to pulsating DC output signal. Unlike the half wave rectifier, the input signal is not wasted in full wave rectifier. The efficiency of full wave rectifier is high as compared to the half wave rectifier.

i) Construction & Working of Half Wave Rectifier

The half wave rectifier conducts current only during the positive half cycles of the input supply voltage. The negative half cycles of the AC. supply are suppressed. So no current is conducted and hence no voltage appears across the load. So current always flows in one direction (i.e. DC) through the load.

Circuit Connections of Half wave Rectifier: The AC supply is applied in series with the diode D and load resistance R_L. The AC supply is normally applied through a transformer. It gives two advantages. First it allows us to step up or step down the AC input voltage as required. Secondly, the transformer isolates the rectifier circuit from power line and thus reduces the risk of electric shock. Fig (1) shows the circuit connection of a half wave rectifier. Fig (2) shows the input and output waveform of a half wave rectifier.

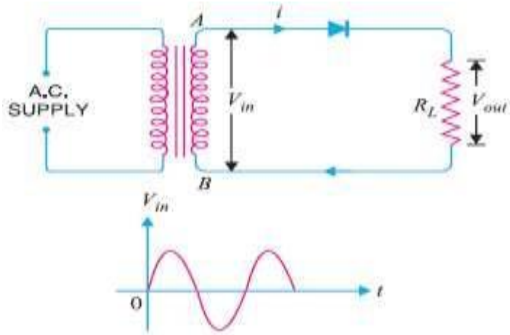


Fig.1

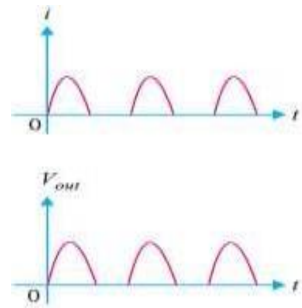


Fig. 2

Operation of Half Wave Rectifier:

During the positive half cycles of input supply voltage, end A becomes positive with respect to end B. This makes the diode D forward biased and hence it conducts current.

During negative half cycles, end A becomes negative with respect to end B. So the diode D is reverse biased and hence conducts no current. Hence the current flow through the diode only during the positive half cycles of the input AC voltage.

Hence current flows through the load R_L always in the same direction and DC output is obtained across R_L. In half wave rectifier, output across the load is pulsating. So a filter circuit is used to smoothen the output.

Output Frequency: The output frequency of a half wave rectifier is equal to the input frequency i.e 50 Hz.

$$\mathbf{f_{out} = f_{in}}$$

Rectifier Efficiency

The ratio of d.c. power output to the applied input a.c. power is known as rectifier efficiency.

Rectifier efficiency

$$\eta = \frac{d.c. power output}{input a.c. power}$$

Let the input supply voltage which appears across the secondary winding

$V_{IN} = V_m \sin\theta$

Diode resistance = r_f

Load resistance = R_L

The diode conducts only during the positive half cycles of the a.c. supply.

D.C. Power Output:

The output current is pulsating direct current.

Iav = I_{DC} $= \frac{1}{2\pi}\int_0^{\pi} i d\theta = \frac{1}{2\pi}\int_0^{\pi}\frac{V_m sin\theta}{r_f + R_L}d\theta = \frac{V_m}{2\pi(r_f + R_L)}\int_0^{\pi} sin\theta d\theta = \frac{V_m}{2\pi(r_f + R_L)}[-cos\theta]_0^{\pi}$

$$= \frac{V_m}{r_f + R_L} \times \frac{1}{\pi} \qquad = \frac{I_m}{\pi}$$

D.C. Power: $P_{dc} = I_{dc}{}^2 R_L = \left(\frac{I_m}{\pi}\right)^2 \times R_L = \frac{I_m{}^2 R_L}{\pi^2}$

A.C. Power input: $P_{ac} = I_{rms}{}^2 (r_f + R_L) \qquad I_{rms} = \frac{I_m}{2} \qquad P_{ac} = \left(\frac{I_m}{2}\right)^2 (r_f + R_L)$

Rectifier Efficiency:

$$\eta = \frac{\frac{I_m{}^2 R_L}{\pi^2}}{\frac{I_m{}^2 (r_f + R_L)}{4}} \qquad = \frac{0.406 R_L}{r_f + R_L} = \frac{0.406}{1 + \frac{r_f}{R_L}}$$

η will be maximum if r_f is negligible as compared to R_L. Hence maximum efficiency = 40.6%. This means in Half wave rectifier has the maximum of 40.6% of AC Power is converted into DC Power.

Ripple Factor: In half-wave rectification,

$$I_{rms} = \frac{I_m}{2} \ ; \ I_{dc} = \frac{I_m}{\pi}$$

hence,

$$Ripple\ factor = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1} \qquad = \sqrt{\left(\frac{I_m/2}{I_m/\pi}\right)^2 - 1} \qquad = 1.21$$

Hence it is clear that AC component exceeds the DC component in the output of a half wave rectifier. It results more pulsation in the output. So half wave rectifier is ineffective for conversion of AC into DC.

Full wave Rectifier

In full wave rectifier , current flows through the load in the same direction (i.e. d.c.) for both the half cycles of input a.c. supply voltage. There are two types of circuits commonly used for full-wave rectifications:

i) Centre-tap full wave rectifier ii) Full wave bridge rectifier

Construction & working of Centre-Tapped Full Wave Rectifier

The circuits uses two diodes D1 and D2. A centre-tap secondary winding AB is connected with the two diodes such that each diode uses one half-cycle of input a.c. voltage. That means diode D1 utilises the the upper half of secondary winding for rectification and diode D2 uses the lower half. Fig. 3 shows the circuit diagram of a Centre-tap full wave rectifier and Fig. 4 shows the input and output waveform of a centre-tap full wave rectifier .

Fig. 3

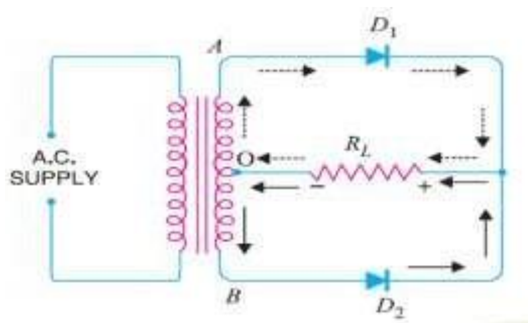
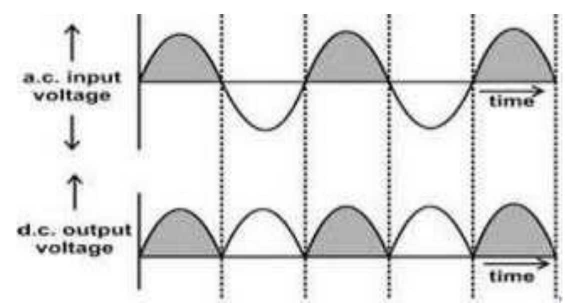


Fig. 4



Operation: During the positive half cycle of secondary voltage, the end A of the secondary winding becomes positive and end B negative. So diode D1 is forward biased and diode D2 is reverse biased. Hence, diode D1 conducts and diode D2 does not. The current flows through diode D1, load resistance R_L and the upper half of the secondary winding OA. This is shown by the dotted arrows.

During the negative half cycle of secondary voltage, the end A of the secondary winding becomes negative and end B positive. So diode D2 is forward biased and D1 is reverse biased. Hence D2 conducts while D1 does not. The conventional current flows through diode D2, load resistance R_L and the lower half of through secondary winding OB as shown by the solid arrows. As we can see that current in the load R_L flows in the same direction for both the half cycles of input supply voltage. So DC is obtained across R_L.

Peak Inverse Voltage: Let V_m is the maximum voltage across the half secondary winding. Fig. 3 shows the circuit at the instant secondary voltage reaches its maximum value V_m in the positive direction. At this instant diode D1 is conducting and D2 is not conducting. So whole of the secondary voltage appears across the non-conducting diode. Hence the peak inverse voltage is twice the maximum voltage across the half secondary winding. i.e. PIV = 2 Vm

Disadvantages:

- It is difficult to locate the centre tap on secondary winding.
- The DC output is low as each diode utilizes only half of the secondary voltage.
- The diodes must have high peak inverse voltage.

Construction & working of Full Wave Bridge Rectifier

The full wave bridge rectifier circuit contains four diodes D1, D2, D3 and D4, connected to form a bridge as shown in Fig. 5 and Fig. 6 shows the input and output waveform of full-wave bridge rectifier. The AC supply to be rectified is applied to the diagonally opposite ends of the bridge through the transformer. Between other two ends of the bridge, the load resistance R_L is connected.

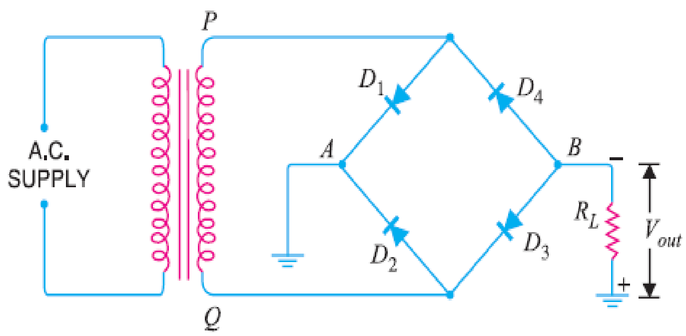


Fig. 5

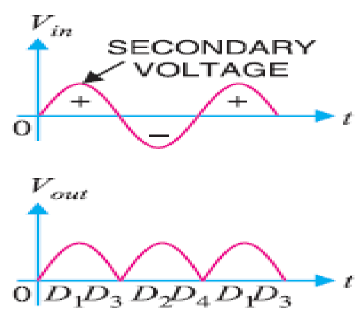


Fig. 6

Operation: During the positive half-cycle of secondary voltage, the end P of the secondary winding becomes positive and end Q negative. This makes diodes D1 and D3 forward biased while D2 and D4 are reverse biased. Hence only diodes D1 and D3 conduct.

These two diodes will be in series through the load R_L as shown in Fig. 7. The conventional current flows through load RL is shown by the dotted arrows. It may be seen that current flows from A to B through the load R_L.

Fig. 7

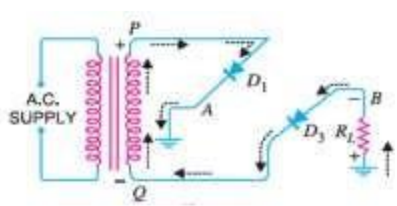
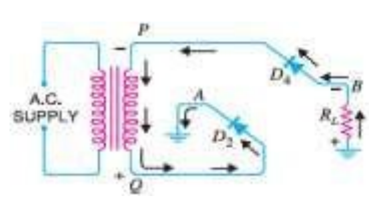


Fig. 8



During the negative half cycle of secondary voltage, end P becomes negative and end Q positive. This makes diodes D2 and D4 forward biased and diodes D1 and D3 are reverse biased. Hence only diodes D2 and D4 conduct. These two diodes will be in series through the load RL as shown in Fig. 8. The conventional current flow through load RL is shown by the solid arrows. It may be seen that again the current flows from A to B through the load i.e. in the same direction as for the positive half-cycle. Therefore, DC output is obtained across load R_L.

Peak Inverse Voltage: The peak inverse voltage (PIV) of each diode is equal to the maximum secondary voltage of transformer i.e. Vm. Hence, PIV = Vm

Advantages:

- There is no need of centre taped transformer in full-wave bridge rectifier
- The output is twice that of centre-tap circuit for the same secondary voltage
- The PIV is half that of the centre-tap circuit

Output Frequency of Full Wave Rectifier

The output frequency of a full wave rectifier is double the input frequency.

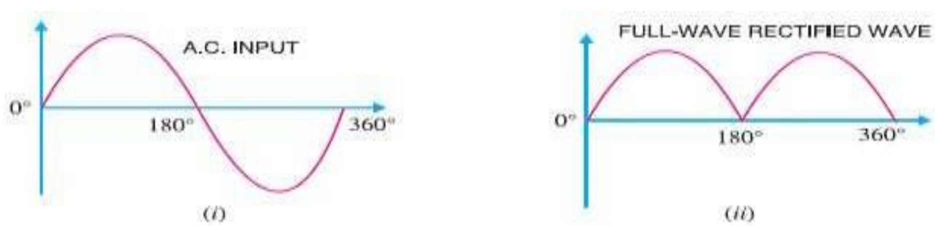


Fig. 9

As we know, a wave has a complete cycle when it repeats the same pattern. In Fig. 9 (i), the input AC completes one cycle from 0° – 360°. However, the full-wave rectified wave completes 2 cycles in this period as shown in Fig. 9 (ii). Therefore, output frequency is twice the input frequency i.e. **fout= 2fin**

Efficiency of Full Wave Rectifier:

Let V_{IN} = Vm Sinθ (the AC voltage to be rectified)
r_f = diode resistance
R_L= Load resistance
i= instantaneous current

$$i = \frac{v}{r_f + R_L} = \frac{V_m sin\theta}{r_f + R_L}$$

Efficiency η: $\eta = \frac{P_{dc}}{P_{ac}}$

DC output power:

The output current is pulsating direct current. Therefore, in order to find the d.c. power, average current has to be found out.

Let $I_{dc} = I_{av}$ = average current

$$I_{dc} = I_{av} = \frac{1}{\pi}\int_0^{\pi} i d\theta$$

$$= \frac{1}{\pi}\int_0^{\pi} \frac{V_m sin\theta}{r_f + R_L} d\theta$$

$$= \frac{V_m}{\pi(r_f + R_L)}\int_0^{\pi} sin\theta d\theta$$

$$= \frac{V_m}{\pi(r_f + R_L)}[-cos\theta]_0^{\pi}$$

$$= \frac{V_m}{\pi(r_f + R_L)} \times 2$$

$$= \frac{2I_m}{\pi}$$

So DC power output, $P_{dc} = {I_{dc}}^2 \times R_L = \left(\frac{2I_m}{\pi}\right)^2 \times R_L$

AC input power: The AC input power is given by, $P_{ac} = {I_{rms}}^2 (r_f + R_L)$

For a full-wave rectified wave, $I_{rms} = \frac{I_m}{\sqrt{2}}$ $\quad P_{ac} = \left(\frac{I_m}{\sqrt{2}}\right)^2 (r_f + R_L)$

Full-wave rectification efficiency η is : $\eta = \frac{P_{dc}}{P_{ac}} = \frac{(\frac{2I_m}{\pi})^2 R_L}{\left(\frac{I_m}{\sqrt{2}}\right)^2 (r_f + R_L)} = \frac{8}{\pi^2} \times \frac{R_L}{(r_f + R_L)} = \frac{0.812 R_L}{r_f + R_L}$

$$= \frac{0.812}{1 + \frac{r_f}{R_L}}$$

The efficiency will be maximum if r_f is negligible as compared to R_L

So Maximum Efficiency = 81.2%

This is double the efficiency of a half wave rectifier .Therefore; a full wave rectifier is twice as effective as a half-wave rectifier.

Ripple Factor: The output of a rectifier consists of a DC component and an AC component, which is also known as ripple.

The AC component is undesirable and accounts for the pulsations in the rectifier output. The effectiveness of a rectifier depends upon the magnitude of AC component in the output. i.e., the smaller this component, the more effective is the rectifier. The ratio of r.m.s. value of AC component to the d.c. component in the rectifier output is known as ripple factor i.e.

Ripple factor = r.m.s. value of AC component/value of d.c. component = Iac /Idc

In full-wave rectification,

$$I_{dc} = \frac{2I_m}{\pi} \qquad I_{rms} = \frac{I_m}{\sqrt{2}} \qquad Ripple\ factor = \sqrt{\left(\frac{I_m/\sqrt{2}}{2I_m/\pi}\right)^2 - 1} \quad = 0.48$$

It is clear that d.c. component exceeds the AC component in the output of a full wave rectifier .This results in lesser pulsation in the output of a full wave rectifier as compared to a half wave rectifier . Therefore, full-wave rectification is invariably used for conversion rectification.

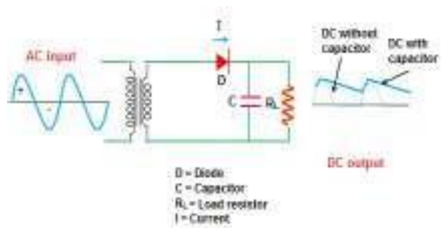
Filter

An electronic circuit which passes desired electrical component & blocks/reduces unwanted is called as filter.

The filter is an electronic device that allows dc components and blocks the ac components of the rectifier output. The filter is made up of a combination of components such as capacitors, resistors, and inductors. The capacitor allows the ac component and blocks the dc component. The inductor allows the dc component and blocks the ac component.

SHUNT CAPACITOR FILTER:

In the below circuit diagram, the capacitor C is connected in shunt with load resistor (R_L).



Half wave rectifier with capacitor filter

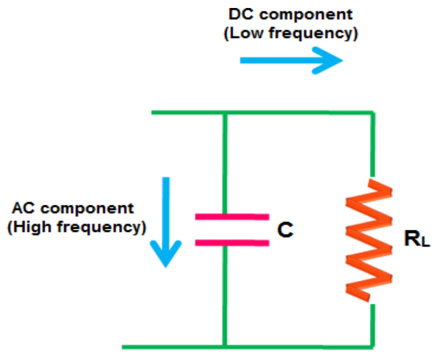
Ripple Factor for a capacitor = 1/ (2√3 f R_LC)

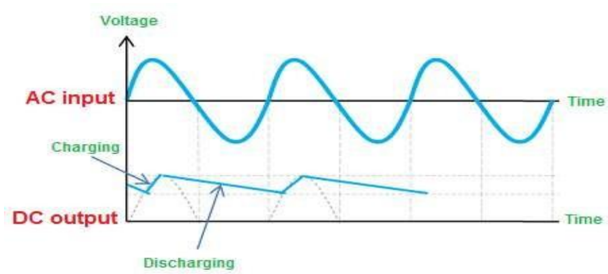
(For a half wave rectifier)

When AC voltage is applied, during the positive half cycle, the diode D is forward biased and allows electric current through it. As we already know that, the capacitor provides high resistive path to dc components (low-frequency signal) and low resistive path to ac components (high-frequency signal).

Electric current always prefers to flow through a low resistance path. So when the electric current reaches the filter, the dc components experience a high resistance from the capacitor and ac components experience a low resistance from the capacitor.

The dc components do not like to flow through the capacitor (high resistance path). So they find an alternative path (low resistance path) and flows to the load resistor (R_L) through that path.





Half wave rectifier with filter o/p waveforms

On the other hand, the ac components experience a low resistance from the capacitor. So the ac components easily pass through the capacitor. Only a small part of the ac components passes through the load resistor (R_L) producing a small ripple voltage at the output. The passage of ac components through the capacitor is nothing but charging of the capacitor.

In simple words, the ac components are nothing but an excess current that flows through the capacitor and charges it. This prevents any sudden change in the voltage at the output.

During the conduction period, the capacitor charges to the maximum value of the supply voltage. When the voltage between the plates of the capacitor is equal to the supply voltage, the capacitor is said to be fully charged.

When the capacitor is fully charged, it holds the charge until the input AC supply to the rectifier reaches the negative half cycle.

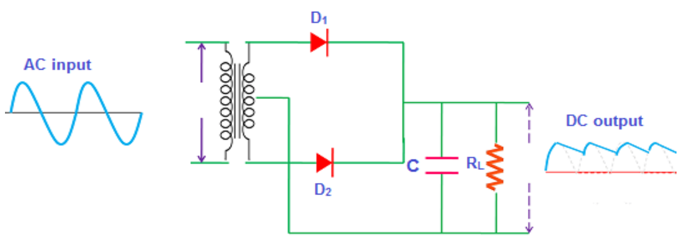
When the negative half cycle is reached, the diode D gets reverse biased and stops allowing electric current through it. During this non-conduction period, the input voltage is less than that of the capacitor voltage. So the capacitor discharges all the stored charges through the load resistor RL. This prevents the output load voltage from falling to zero. The capacitor discharges until the input supply voltage is less than the capacitor voltage. When the input supply voltage is greater than the capacitor voltage, the capacitor again starts charging. When the positive half cycle is reached again, the diode D is forward biased and allows electric current. This makes capacitor to charge again.

The capacitor filter with a large discharge time constant will produce a very smooth DC voltage. Thus, a smooth and steady DC voltage is obtained by using the filter.

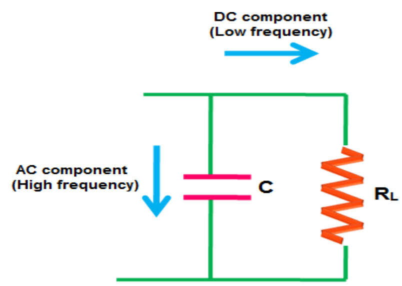
Full wave rectifier with Capacitor filter:

The working of the full wave rectifier with filter is almost similar to that of the half wave rectifier with filter. The only difference is that in the half wave rectifier only one half cycles (either positive or negative) of the input AC current will charge the capacitor but the remaining half cycle will not charge the capacitor. But in full wave rectifier, both positive and negative half cycles of the input AC current will charge the capacitor.

The main duty of the capacitor filter is to short the ripples to the ground and blocks the pure DC (DC components), so that it flows through the alternate path and reaches output load resistor R_L.



Full wave rectifier with capacitor filter



The pulsating Direct Current (DC) produced by the full wave rectifier contains both AC and DC components. We know that the capacitor allows the AC components and blocks the DC components of the current. When the DC current that contains both DC components and AC components reaches the filter, the DC components experience a high resistance from the capacitor whereas the AC components experience a low resistance from the capacitor.

Electric current always prefers to flow through a low resistance path. So the AC components will flow through the capacitor whereas the DC components are blocked by the capacitor. Therefore, they find an alternate path and reach the output load resistor RL. The flow of AC components through the capacitor is nothing but the charging of a capacitor. Thus, the filter converts the pulsating DC into pure DC.

Bridge Rectifier (Full wave rectifier) with Capacitor filter:

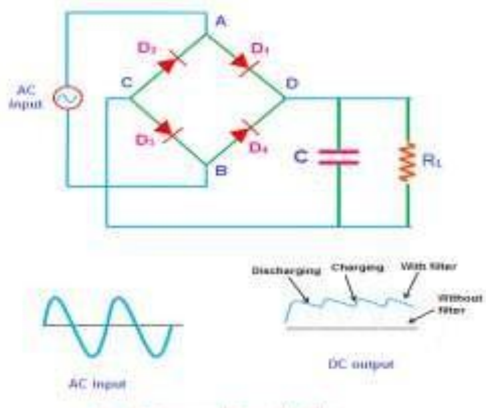


Fig: Bridge rectifier with filter

Ripple Factor for a capacitor = 1/ (4√3 f R_LC)

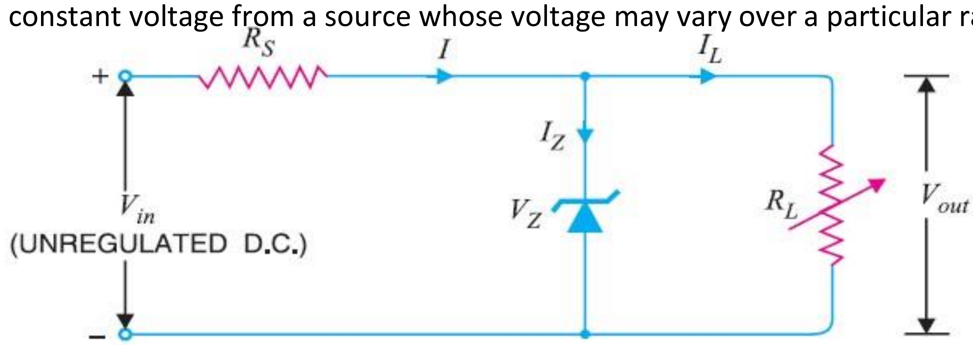
(For a full wave rectifier)

Like the center tapped full wave rectifier, the bridge rectifier also rectifies both positive and negative half cycles of the input AC signal. However, the construction of bridge rectifier is different from the center tapped full wave rectifier. In bridge rectifier, the diodes are arranged in the bridge circuit configuration. The AC components fluctuate with respect to time while the DC components remain constant with respect to time. So the AC components present in the pulsating DC is an unwanted signal. The capacitor filter present at the output removes the unwanted AC components. Thus, a pure DC is obtained at the load resistor R_L.

Voltage Regulator:

An electronic Circuit which has ability to maintain output voltage to be constant, even there is variation of input voltage or output current known as Voltage regulator.

Zener Diode as Voltage Regulator: A Zener diode can be used as a voltage regulator or voltage stabilizer, to provide a constant voltage from a source whose voltage may vary over a particular range.



The Zener diode of Zener voltage V_Z is connected reversely across the load resistance R_L across which constant output voltage V_{OUT} is required. The series resistance R is used to absorb the output voltage fluctuations, so as to maintain constant output voltage across R_L. When the circuit is properly designed, the output voltage V_{OUT} remains constant even though the input voltage Ei and load resistance R_L may vary over a wide range.

Case 1: V_{IN} Variable and R_L constant: Suppose the input voltage V_{IN} increases, since the Zener is in the breakdown region, the Zener diode is equivalent to a battery of voltage VZ as shown in Fig.2 and the output voltage remains constant at V_Z (V_{OUT} =V_Z). The excess voltage is dropped across R. This will cause an increase in the value of total current I. The Zener will conduct the increase of current in I, while the load current remains constant. Hence the output voltage remains constant irrespective of the change in input voltage V_{IN}

Summary (Case 1): Suppose V_{IN} increases

Since Zener is in breakdown region, V_Z remains constant
$V_O = V_Z$ So V_O remains constant Excess voltage drops across R
So I increases, since I_L remains constant, I_Z increases
$\uparrow I = \uparrow I_Z + I_L$ (constant)

Excess current is conducted by the Zener diode and V_{OUT} remains constant irrespective of the change in E_I

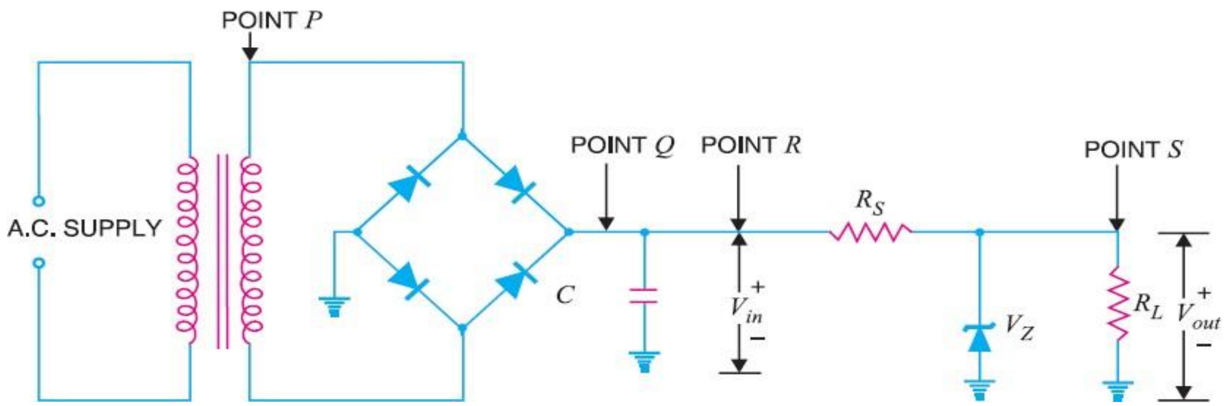
Case 2: V_I Constant and R_L Variable: Now suppose the input voltage V_I is constant but R_L decreases
Since the Zener diode is in breakdown region, voltage across it will remain constant at V_Z. As the output voltage V_{OUT} is equal to the Zener voltage, So V_{OUT} will also remain constant at V_Z.
When R_L decreases, in order to maintain EO constant, current through the load resistance I_L will increase. Since $\mathbf{V_I}$ is constant, total current I is also constant. So the increase in load current I_L will come from a decrease in Zener current I_Z.

$I(\text{constant}) = \uparrow I_L + \downarrow I_Z$

Voltage drop across R = $V_I - V_O$; Current through R, $I = I_Z + I_L$

PRACTICAL APPLICATIONS:

Conversion of AC to pure DC is most necessity in operating many electronic devices. The said requirement is achieved by using the step-down transformer, rectifier, filter & voltage regulation by Zener diode all combined together to form a circuit called as regulated power supply. The circuit of the same is as shown below.



The regulated power supply consists of four circuits:

- Transformer
- Bridge rectifier
- Capacitor filter C
- Zener voltage regulator

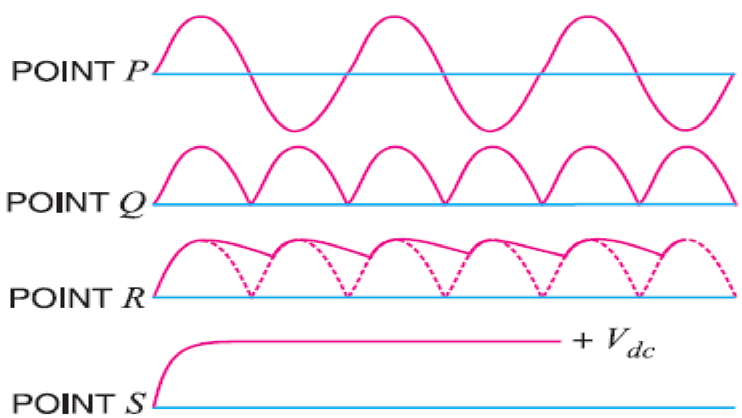
The function of transformer is converting 230V to step-down voltage of desired lower voltage value.

The purpose of the bridge rectifier is to convert the transformer secondary a.c. voltage (point *P*) into pulsating voltage (point *Q*). Again this pulsating D.C. voltage is applied to the capacitor filter.

The purpose of the capacitor filter is to reduce the pulsations in the rectifier D.C. output voltage (point *R*).

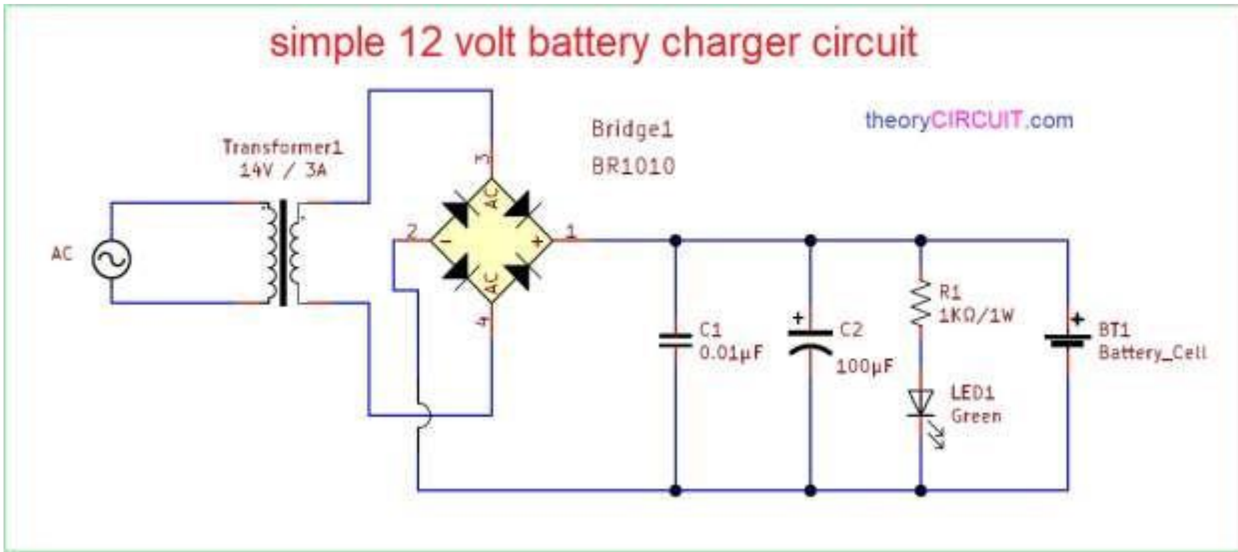
Thus main functions of the Zener voltage regulator are: Reducing the variations in the filtered output voltage. Keeping the output voltage (*Vout*) almost constant despite changes in the load current or input a.c. voltage.

To see the waveforms at various stages of a regulated power supply see the figure below:



This converted DC energy can be supplied many electronic loads like mobile battery, computer SMPS, rechargeable batteries & Battery eliminators and many more.

Below is the circuit of an 12V battery charger:



The Need of Regulated Power Supply:

In an unregulated power supply, that is, under ordinary power supply conditions, the voltage regulation is not good. Changes in the load current cause the output voltage to change as well. Again, the variation in the input a.c. voltage causes the output voltage to change as well.

This happens due to the following reasons:

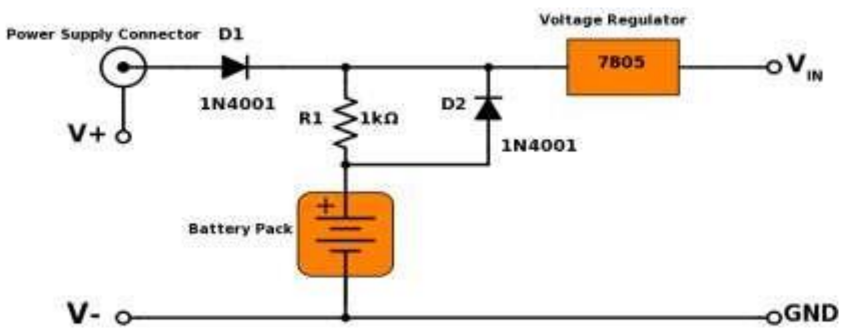
- Under practical situations, there are a lot of factors; there are a lot of variations in a.c. line voltage that are not in our control. This causes the D.C. output voltage to fluctuate. Most of the electronic circuits wouldn't work properly on such output voltage fluctuations. Hence we need a regulated dc power supply.
- The internal resistance of ordinary power supply is relatively large (> 30 Ù). This in turn affects the load current drawn from the supply. These variations in D.C. voltage may result in the erratic operation of electronic circuits. Hence we need a regulated dc power supply.

Controlled Battery – Powered Backup:

There are a lot of electronics that need to be reliably on all the time. Alarm clocks are a good example of this. If the power goes out in the middle of the night and alarm doesn't go off, one could miss a very important appointment. The simplest solution to this problem is a battery backup system. That way, if the grid power drops below a certain threshold, the batteries will automatically take over and keeps everything running until the grid power is restored.

Circuit & Construction a Power Backup:

There are many different kinds of battery backup systems, and the type that one use is largely dependent on what are the power requirements of the user. A simple circuit that can use to power low power electronics that runs at 12 volts or less is designed & its circuit as shown below.



These are very common and come in a variety of voltages and current ratings. The power supply connects to the circuit with a DC power connector. This is then connected to a blocking diode. The blocking diode prevents electricity from the battery backup system from feeding back into the power supply. Next, a rechargeable battery is connected using a resistor and another diode. The resistor allows the battery to be slowly charged from the power supply, and the diode provides a low resistance path between the battery and the circuit so that it can power the circuit if the voltage of the power supply ever drops too low. If the circuit that the user is driving requires a regulated power supply then user can simply add a voltage regulator onto the end.

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