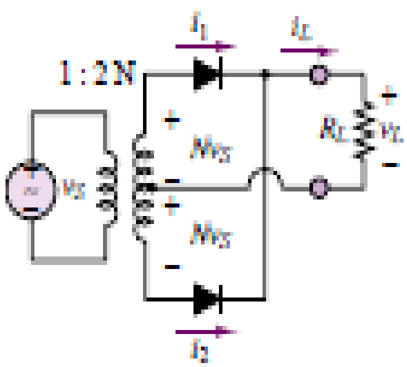
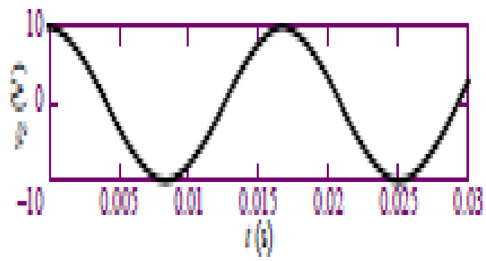
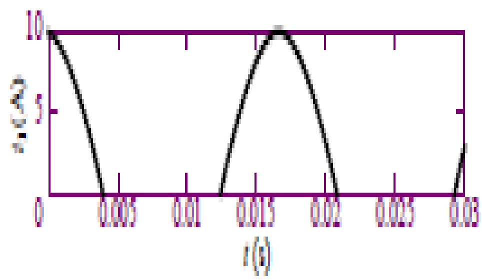
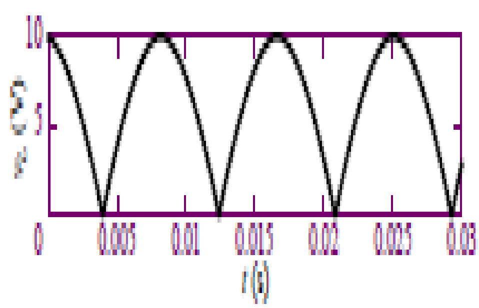
Full -wave Rectifier

The full wave rectifier circuit using two diodes and a center tapped transformer is shown in fig.3. The centers tap. is usually taken as the ground or zero voltage reference point.









(a) Working:

When input ac supply is switched on, the ends of the transformer secondary become +Ve and negative alternately. During the positive half cycle of the ac input. Hence, being forward biased diode D_1 conducts (but not D_2 which is reverse biased). As a result, positive half cycle of the voltage appears across R_L. In the negative half cycle D_2 conducts (but not D_1). So we find that current keeps of following through R_L in the same direction in both half cycles of the ac input. Also, the frequency of the rectified output voltage is twice the supply frequency.

(b) Average values:

(i) $V_{dc} = \frac{2V_m}{\pi}$

$$= 0.636\, V_m \quad \textit{twice the half wave recifier value}$$

$$= \frac{2\sqrt{2}V}{\pi} = 0.9\, V$$

Where V_m is the maximum voltage across each half of the secondary winding.

$V = \frac{V_m}{\sqrt{2}}$

=rms voltage across each half of the secondary winding.

(ii) $I_{dc} = \frac{2I_m}{\pi} = \frac{2}{\pi}\frac{V_m}{R_L}$

$$= 0.636\, I_m$$

$$= \frac{V_{dc}}{R} = \frac{2.\sqrt{2}}{\pi} . \frac{V}{R_L}$$

$$= 0.9 \frac{V}{R_L}$$

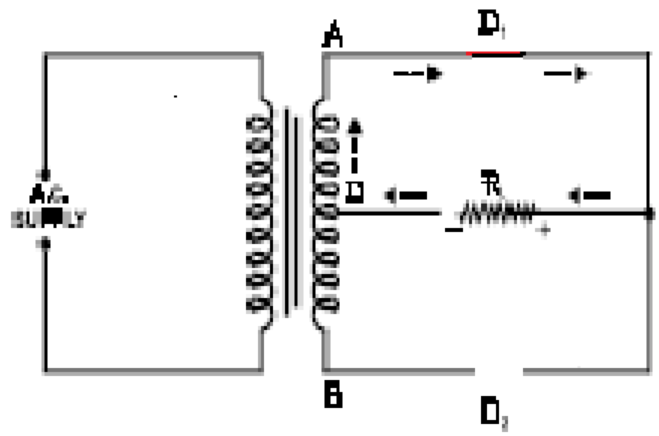
(iii) $I_{rms} = 0.707\, I_m$

(iv) $form\ factor, F = \frac{I_{rms}}{I_{av}} = \frac{I_{rms}}{I_{dc}}$

$$= \frac{0.707\, I_m}{0.636\, I_m} = 1.11$$

(c) PIV:

In this case, PIV rating of each diode is 2 V_m. consider the positive half cycle of the input ac supply when D_1 acts as short and D_2 acts as open since it is reverse biased. A voltage V_m develops across R_L. As seen from fig. below, voltage across D_2 is equal to the sum of voltages across the lower half GN of the transformer secondary and the load resistor. Hence PIV of D_2=2 V_m.



(d) **<u>Ripple factor (γ):</u>**

For full wave rectifier circuit $\gamma = \frac{V_r(rms)}{V_{dc}} = \frac{0.305\,V_m}{0.636\,V_m} = 0.482$

Is much less than that of half wave rectifier. The relation between V_m and V_{dc} is the same as HW rectifier.

<u>(e) Efficiency:</u>

$$\eta = \frac{P_{out}}{P_{in}}$$

$$= \frac{{I_{dc}}^2 * R_L}{{I_{rms}}^2 (r_d + R_L)}$$

Substituting and simplifying, we get

$$\eta = \frac{81.2\%}{1 + \frac{r_d}{R_L}} = 81.2\% \quad if\, r_d = 0$$

It is twice the value for half wave rectifier.

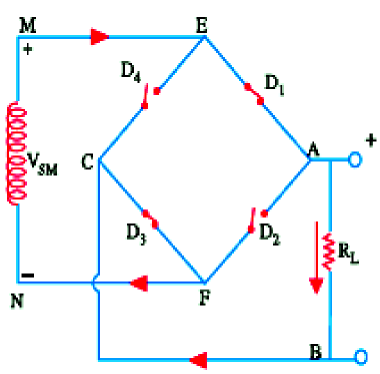
Full-Wave Bridge Rectifier

It is the most frequently-used circuit for electronic dc power supplies. It requires four diodes but the transformer used is not centre-tapped and has a maximum voltage of Vsm.

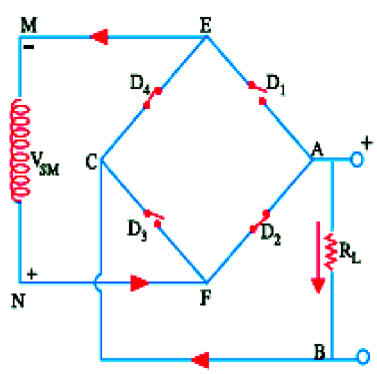
(*a*) Working

During the positive input half-cycle, terminal *M* of the secondary is positive and *N* is negative as shown separately in Fig. below (*a*). Diodes *D*1 and *D*3 become forward-biased (ON) whereas *D*2 and *D*4 are reverse-biased (OFF). Hence, current flows along *MEABCFN* producing a drop across *RL*.

During the negative input half-cycle, secondary terminal *N* becomes positive and *M* negative. Now, *D*2 and *D*4 are forward-biased. Circuit current flows along *NFABCEM* as shown in Fig. below (*b*). The current keeps flowing through load resistance *RL* in the same direction *AB* during both half-cycles of the ac input supply. Consequently, point *A* of the bridge rectifier always acts as an anode and point *C* as cathode.



(*a*)



(*b*)

(*b*) Average and RMS Values

(i) $V_{dc} = 0.636\, V_m$

$= 0.9V$

$(ii)\quad I_{dc} = \frac{2}{\pi}\frac{V_m}{R_L}$

$= 0.636\, I_m$

$= 0.9 \times \frac{V}{R_L} = 0.9\, I_{rms}$

$(iii)\quad I_{rms} = 0.707\, I_m$

$(iv)\quad form\, factor, F = \frac{I_{rms}}{I_{av}} = \frac{I_{rms}}{I_{dc}}$

$= 1.11$

(c) PIV:

In a full wave bridge rectifier, the PIV rating of each of the four diodes is V_m (not $2V_m$ as the case for ordinary full wave rectifier).

(d) Ripple factor (γ):

It is the same of for ordinary full wave rectifier

$$\gamma = 0.482$$

(e) Efficiency:

It is the same of for ordinary full wave rectifier

$\eta = 81.2\%.$ $\quad$ *if diode resistance is neglected.*

<u>(*f*) Advantages:</u>

1. No centre-tap is required on the transformer.
2. Much smaller transformers are required.
3. It is suitable for high-voltage applications.
4. It has less *PIV* rating per diode.

The obvious disadvantage is the need for twice as many diodes as for the centre-tapped transformer version.

Diode Applications

<u>Diode Clipper and Clamper Circuits</u>

These are diode wave-shaping circuits *i.e*. circuits meant to control the shape of the voltage and current waveforms to suit various purposes. Each performs the wave-shaping function indicated by its name. The output of the clipping circuit appears as if a portion of the input signal were clipped off. But clamper circuits simply lams (*i.e*. lift up or down) the input signal to a different dc level.

<u>Clippers</u>

A clipping circuit requires a minimum of two components *i.e*. a diode and a resistor. Often, dc battery is also used to fix the clipping level. The input waveform can be clipped at different levels by simply changing the battery voltage and by