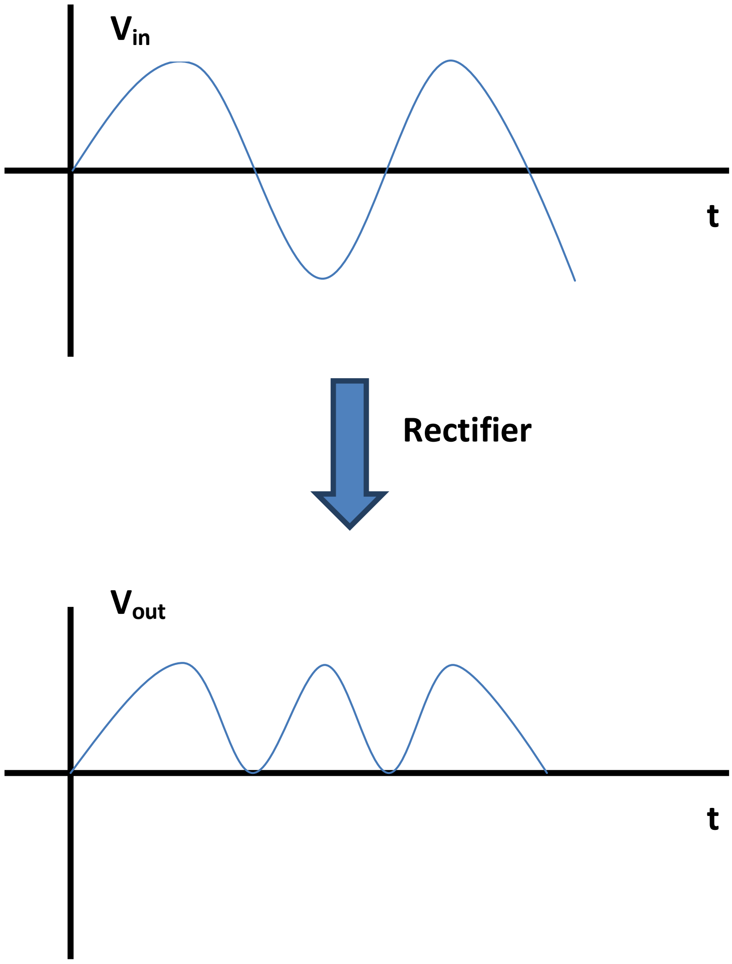
Rectification

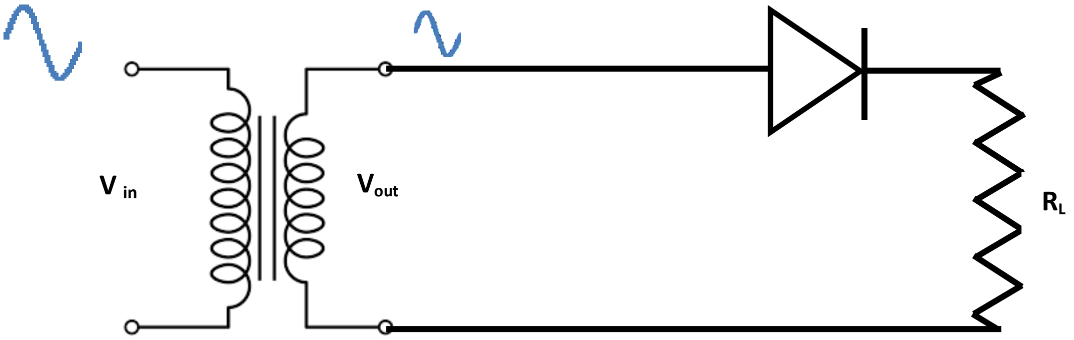
Rectification is the conversion of alternating current to direct current. Rectification is performed by a diode that allows current to flow in one direction but not in the opposite direction. Direct current that has only been rectified, however, has various changes in voltage (ripples) lingering from the alternating current.



Types of Rectifiers

1. Half Wave Rectifier
2. Full Wave Bridge Rectifier
3. Full Wave Center-tapped Rectifier

Half Wave Rectifier



The Half wave rectifier is a circuit, which converts an AC voltage to DC voltage. It can be used to obtain the desired level of DC voltage (using step up or step down transformers). It provides isolation from the power line.

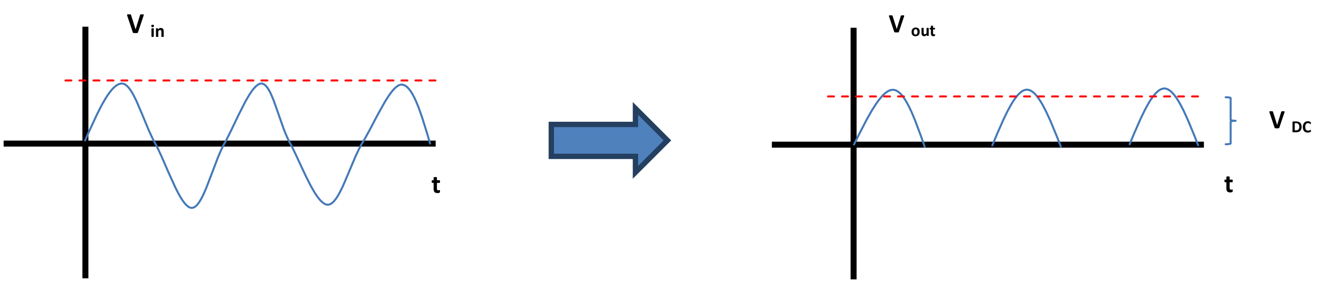
The primary of the transformer is connected to AC supply. This induces an AC voltage across the secondary of the transformer.

During the positive half cycle of the input voltage the polarity of the voltage across the secondary forward biases the diode. As a result a current flows through the load resistor, R_L. The forward biased diode offers a very low resistance and hence the voltage drop across it is very small. Thus the voltage appearing across the load is practically the same as the input voltage at every instant.

During the negative half cycle of the input voltage the polarity of the secondary voltage gets reversed. As a result, the diode is reverse biased.

Practically no current flows through the circuit and almost no voltage is developed across the resistor. All input voltage appears across the diodeitself.

Hence we conclude that when the input voltage is going through its positive half cycle, output voltage is almost the same as the input voltageand during the negative half cycle no voltage is available across the load. This explains the unidirectional pulsating DC waveform obtainedas output. The process of removing one half the input signals to establish a DC level is aptly called half wave rectification.



In half wave rectifier the rated voltage of the transformer secondary is $\frac{V_m}{\sqrt{2}}$

RMS voltage/Current at the load resistance in Half wave rectifier;

$$V_{rms} = \frac{V_{Peak}}{2}$$

$$I_{rms} = \frac{I_{Peak}}{2}$$

$$V_{DC} = \frac{V_{Peak}}{\pi}$$

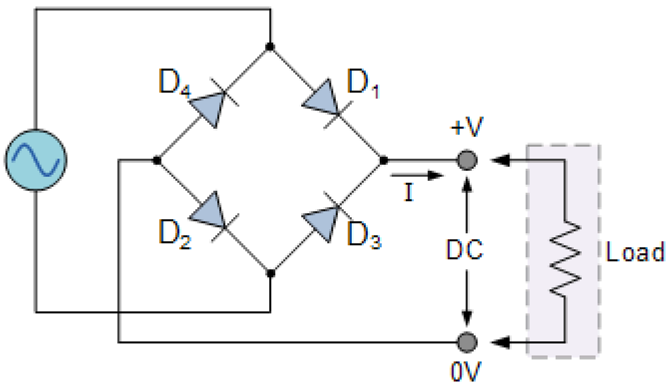
$$I_{DC} = \frac{I_{Peak}}{\pi}$$

Full Wave Bridge Rectifier

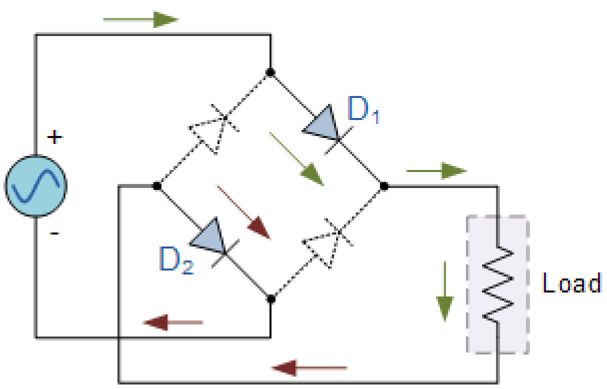
The half-wave rectifier chopped off half our signal. A full-wave rectifier does cleverer trick: it flips the - half of the signal up into the + range. When used in a power supply, the full-wave rectifier allows us to convert almost all the incoming AC power to DC.

A full-wave rectifier uses a diode bridge, made of four diodes, like this:

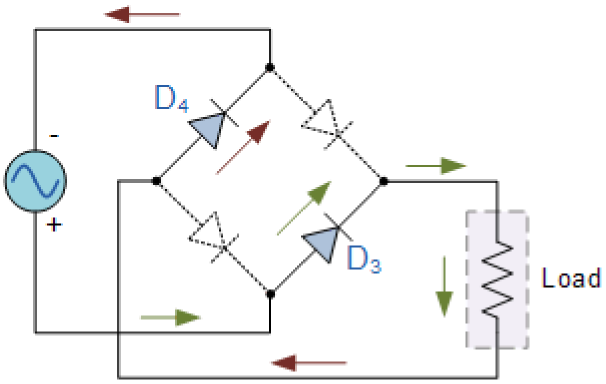
This type of single phase rectifier uses four individual rectifying diodes connected in a closed loop "bridge" configuration to produce the desired output. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown below.



The four diodes labeled D_1 to $D_4$are arranged in "series pairs" with only two diodes conducting current during each half cycle. During the positive half cycle of the supply , diode D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below.

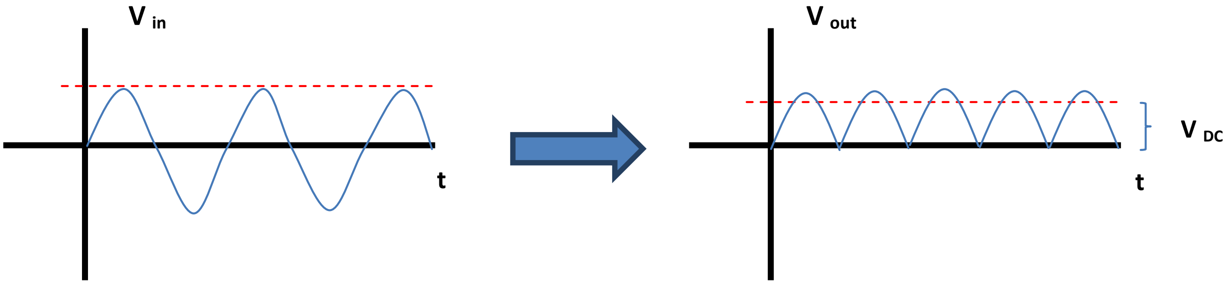


During the negative half cycle of the supply, diodes D3 and D4 conduct in series, but diodes D1 and D2 switch “OFF” as they are now reverse biased. The current flowing through the load is the same direction as before.



As the current flowing through the load is unidirectional, so the voltage developed across the load is also unidirectional the same as for the previous two diode full-wave rectifier , therefore the average DC voltage across the load is $0.637V_{max}$.

However in reality, during each half cycle the current flows through two diodes instead of just one so the amplitude of the output voltage is two voltage drops (2x 0.7 = 1.4 v) less than the input V_{max}amplitude.



$$V_{rms} = \frac{V_{MAX}}{\sqrt{2}}$$

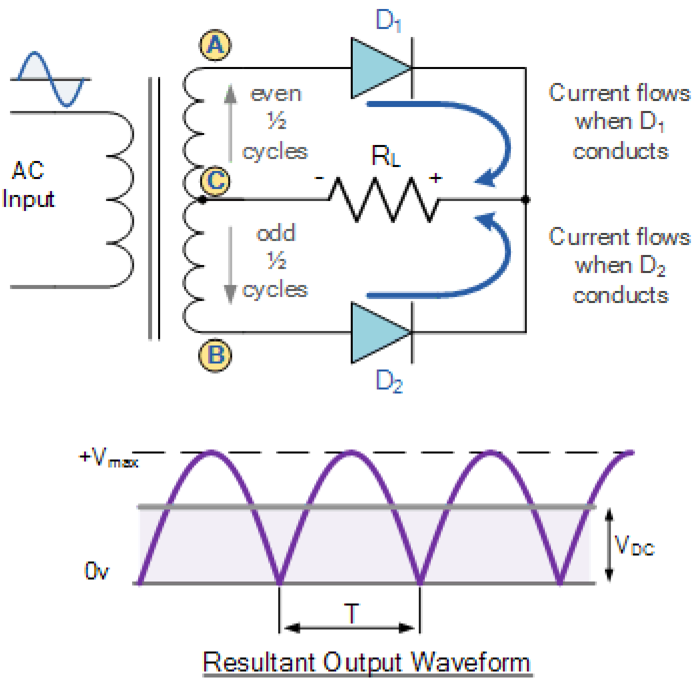
$$I_{rms} = \frac{I_{MAX}}{\sqrt{2}}$$

$$V_{DC} = \frac{2V_{MAX}}{\pi}$$

$$I_{DC} = \frac{2I_{MAX}}{\pi}$$

Full Wave Center-tapped Rectifier

In a full wave rectifier circuit two diodes are now used, one for each half of the cycle. A multiple winding transformer is used whose secondary winding is split equally in to two halves with a common centre tapped connection, (C). This configuration results in each diode conducting in turn when its anode terminal is positive with respect in each diode conducting in turn when its anode terminal is positive with respect to the transformer centre point C producing an output during both half-cycles, twice that for the half wave rectifier so it is 100% efficient as shown below,



The full wave rectifier circuit consists of two power diodes connected to a single load resistance (R_L) with each diode taking it in turn to supply current to the load. When point A of the transformer is positive with respect to point C, Diode D_1conducts in the forward direction as indicated by the arrows.

When point B is positive (in the native half of the cycle) with respect to point C, diode D_2conducts in the forward direction and the current flowing through resistor R I in the same direction for both half cycle. As the output voltage across the resister R I the phasor sum of the two waveforms combined, this type of full wave rectifier circuit is also known as a “bi-phase” circuit.

As the spaces between each half-wave develop by each diode is how being filed in by the other diode the average DC output voltage across the load resister is now double that of the single half-wave rectifier circuit and is about 0.637 V_{max} of the peak voltage, assuming no losses.

$$V_{DC} = \frac{2V_{MAX}}{\pi}$$

Where V_{MAX} is the maximum peak value in one half of the secondary winding and $V_{RMS}$is the rms (Root Mean Square) value. The peak voltage of the output waveform is the same as before for the half-wave rectifier provided each half of the transformer windings have the same rms voltage value. To obtain different DC voltage output different transformer ratios can be used. The main disadvantage of this type of full wave rectifier circuit is that a larger transformer for a given power output is required with two separate but identical secondary winding making this type of full wave rectifying circuit costly compared to the “Full Wave Bridge Rectifier” circuit equivalent.