LINEAR POWER SUPPLY

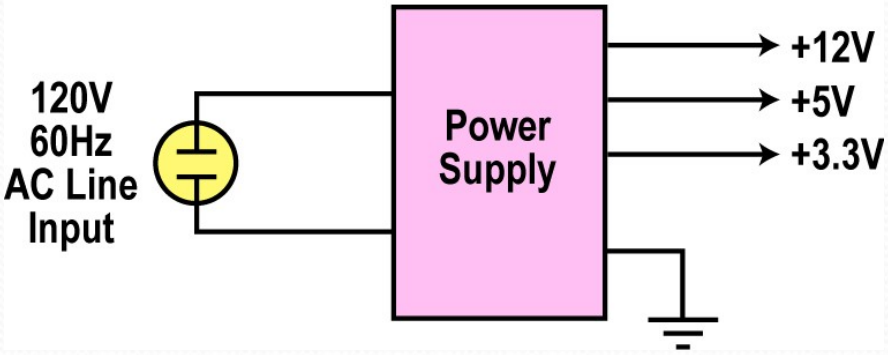
- Block diagram and functions of a transformer, rectifier, filter, voltage regulator and voltage divider.
- Types of rectifier, filter and regulator circuits

Power Supply

- All electronic circuits need a power source to work.
- For electronic circuits made up of transistors and/or ICs, this power source must be a DC voltage of a specific value.
- A battery is a common DC voltage source for some types of electronic equipment especially portables like cell phones and iPods.
- Most non-portable equipment uses power supplies that operate from the AC power line but produce one or more DC outputs.

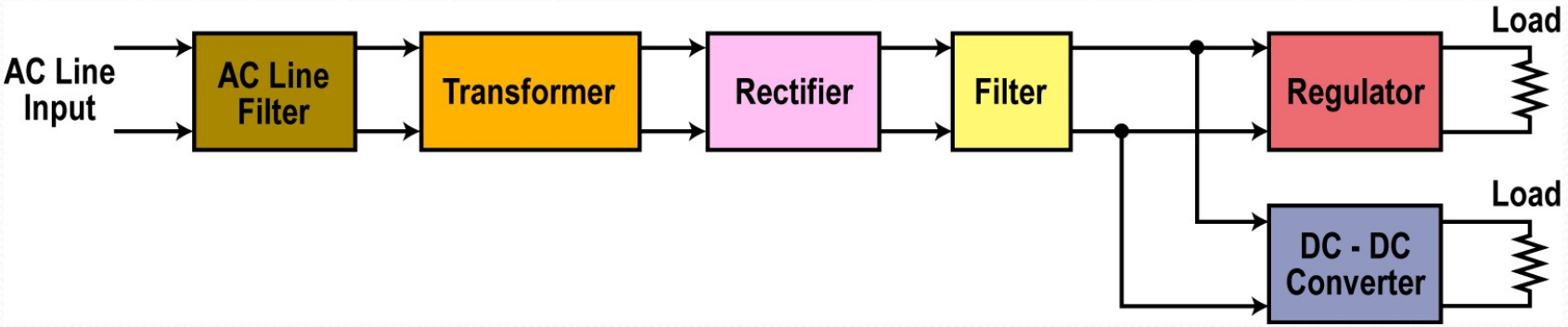
Power Supply Characteristics

- The input is the 120 volt 60 Hz AC power line.
- The power supply converts the AC into DC and provides one or more DC output voltages.
- Some modern electronic circuits need two or more different voltages.
- A good example of a modern power supply is the one inside a PC that furnishes 12, 5, 3.3 and 1.2 volts.

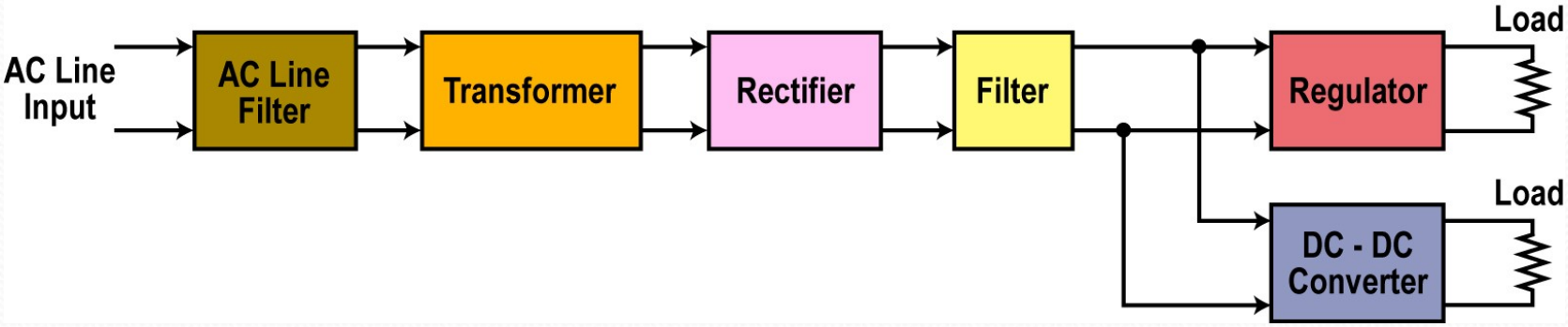


Components of a Power Supply

- Main circuits in most power supplies.



Transformer



- A transformer is commonly used to step the input AC voltage level down or up. Most electronic circuits operate from voltages lower than the AC line voltage so the transformer normally steps the voltage down by its turns ratio to a desired lower level.

- For example, a transformer with a turns ratio of 10 to 1 would convert the 120 volt 60 Hz input sine wave into a 12 volt sine wave.

Rectifier

- The rectifier converts the AC sine wave into a pulsating DC wave.
- There are several forms of rectifiers used but all are made up of diodes.
- Rectifier types and operation will be covered later.

Filter

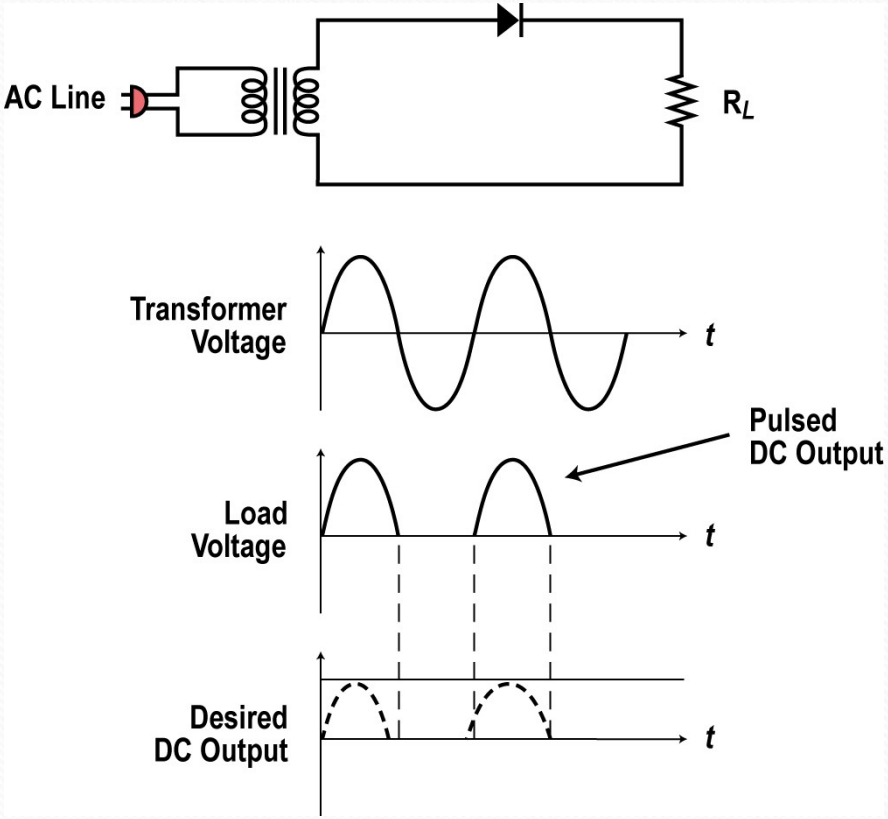
- The rectifier produces a DC output but it is pulsating rather than a constant steady value over time like that from a battery.
- A filter is used to remove the pulsations and create a constant output.
- The most common filter is a large capacitor.

Regulator

- The regulator is a circuit that helps maintain a fixed or constant output voltage.
- Changes in the load or the AC line voltage will cause the output voltage to vary.
- Most electronic circuits cannot withstand the variations since they are designed to work properly with a fixed voltage.
- The regulator fixes the output voltage to the desired level then maintains that value despite any output or input variations.

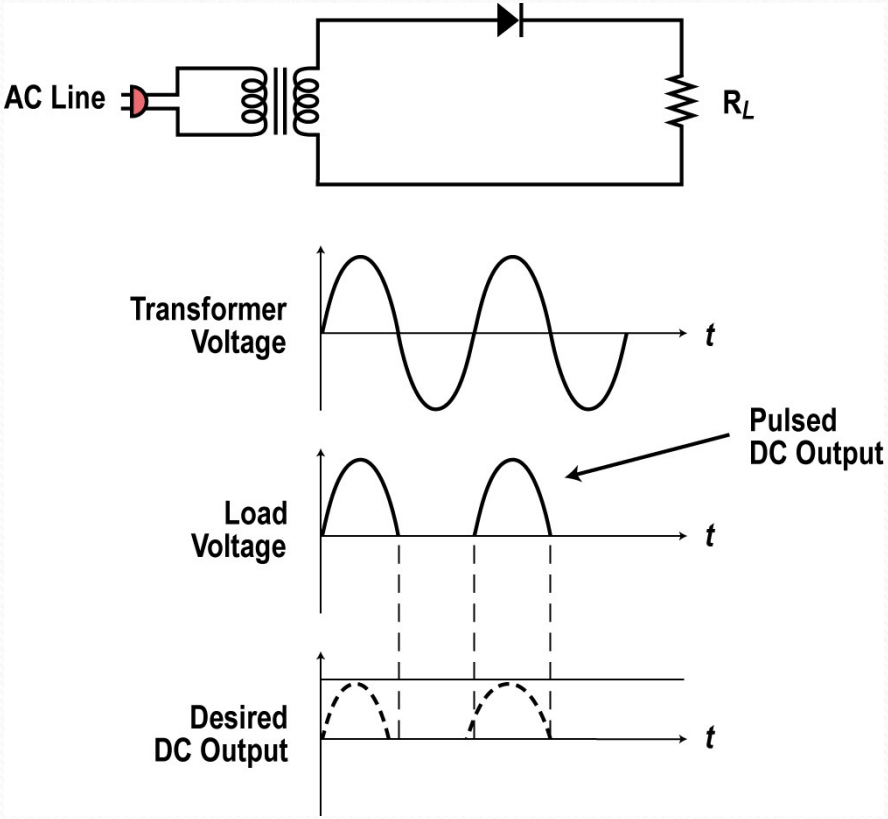
How Rectifiers Work

- The simplest form of rectifier is the half wave rectifier shown.
- Only the transformer, rectifier diode, and load (R_L) are shown without the filter and other components.
- The half wave rectifier produces one sine pulse for each cycle of the input sine wave.
- When the sine wave goes positive, the anode of the diode goes positive causing the diode to be forward biased. The diode conducts and acts like a closed switch letting the positive pulse of the sine wave to appear across the load resistor.



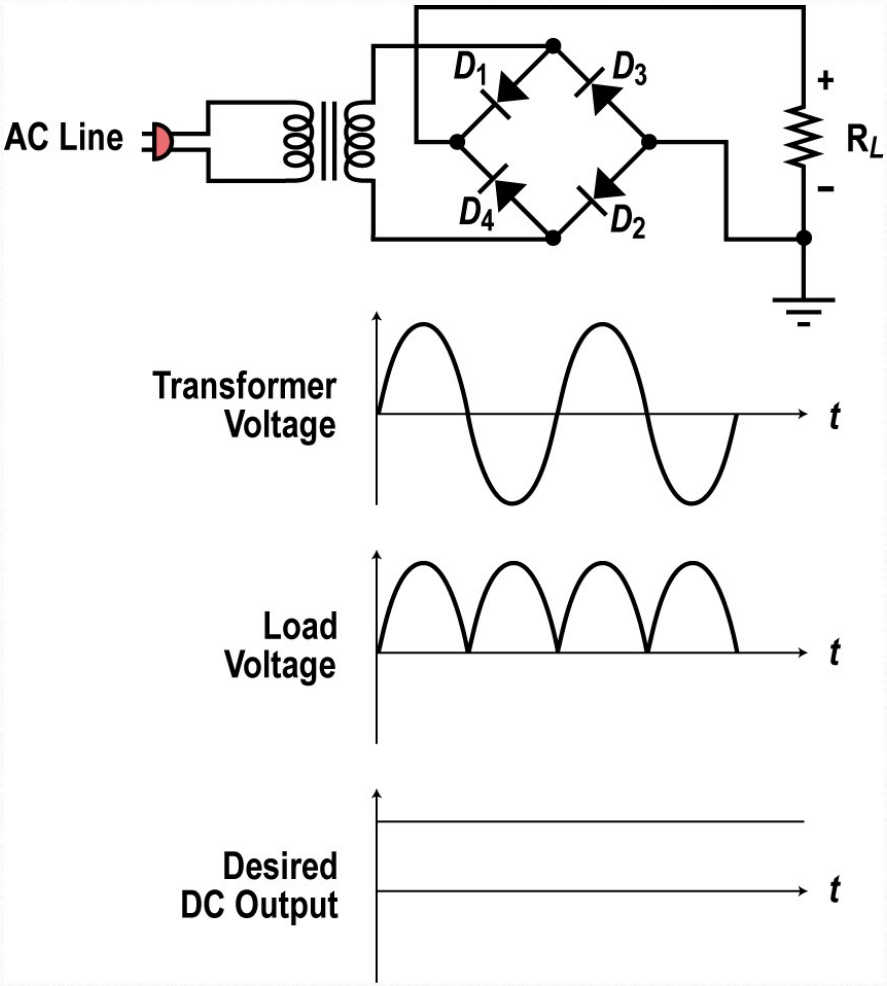
How Rectifiers Work (continued)

- When the sine wave goes negative, the diode anode will be negative so the diode will be reverse biased and no current will flow.
- No negative voltage will appear across the load. The load voltage will be zero during the time of the negative half cycle.
- See the waveforms that show the positive pulses across the load. These pulses need to be converted to a constant DC.



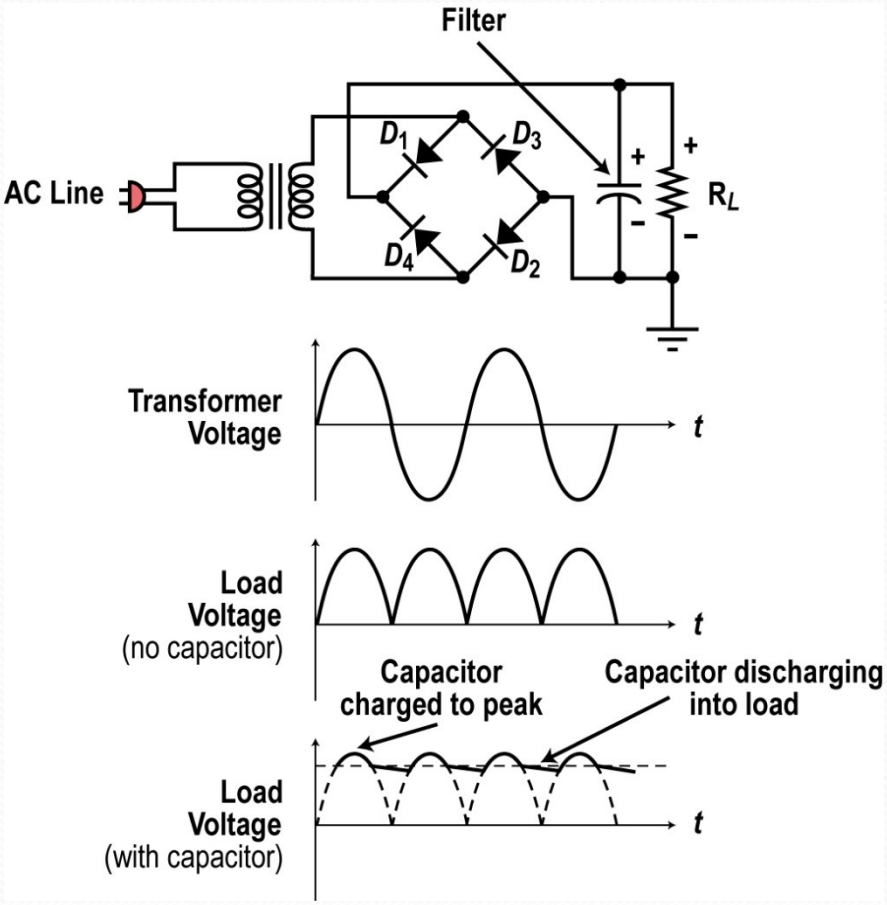
Bridge Rectifier

- Another widely used rectifier is the bridge rectifier. It uses four diodes.
- This is called a full wave rectifier as it produces an output pulse for each half cycle of the input sine wave.
- On the positive half cycle of the input sine wave, diodes D1 and D2 are forward biased so act as closed switches appearing in series with the load.
- On the negative half cycle, diode D1 and D2 are reverse biased and diodes D3 and D4 are forward biased so current flows through the load in the same direction.



How the Filter Works

- A large capacitor is connected across the load resistor. This capacitor filters the pulses into a more constant DC.
- When the diode conducts, the capacitor charges up to the peak of the sine wave.
- Then when the sine voltage drops, the charge on the capacitor remains. Since the capacitor is large it forms a long time constant with the load resistor. The capacitor slowly discharges into the load maintaining a more constant output.
- The next positive pulse comes along recharging the capacitor and the process continues.



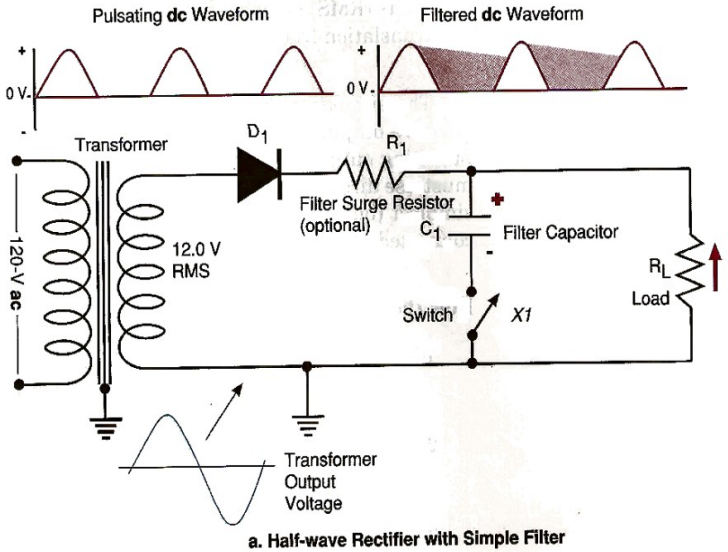
The Regulator

- Most regulators are ICs .
- These are feedback control circuits that actually monitor the output voltage to detect variations.
- If the output varies, for whatever reason, the regulator circuit automatically adjusts the output back to the set value.
- Regulators hold the output to the desired value.
- Since ripple represents changes in the output, the regulator also compensates for these variations producing a near constant DC output.

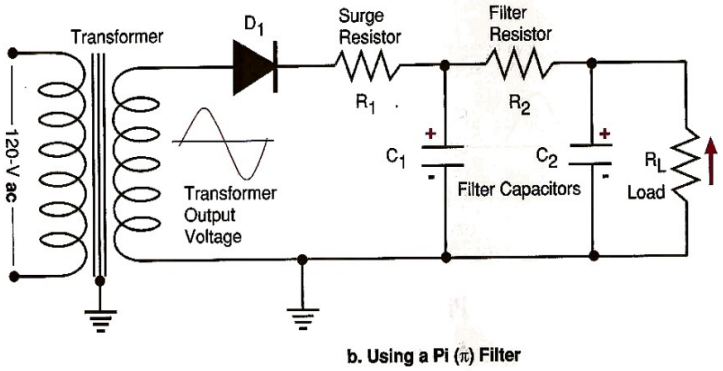
RC pi Filter

ii) RC pi Filter

- C1 performs the same function that it did in the single capacitor filter. It is used to reduce the percentage of ripple to a relatively low value.
- C2 offers infinite impedance (resistance) to the dc component of the output voltage. Thus, the dc voltage is passed to the load, but reduced in value by the amount of the voltage drop across R2. However, R2 is generally small compared to the load resistance. Therefore, the drop



a. Half-wave Rectifier with Simple Filter



b. Using a Pi (π) Filter

RC pi Filter

- C2 offers very low impedance to the ac ripple frequency. Thus, the ac ripple senses a voltage divider consisting of R2 and C2 between the output of the rectifier and ground. Therefore, most of the ripple voltage is dropped across R2.
- The RC filter has some disadvantages, however. First, the voltage drop across R2 takes voltage away from the load. Second, power is wasted in R2, R1 and is dissipated in the form of unwanted heat.
- The input capacitor (C1) has the greatest pulsating voltage applied to it and is the most susceptible to voltage surges. As a result, it is frequently subject to voltage breakdown and shorting. The shunt capacitor (C1 and C2) in the filter circuit is not subject to voltage surges because of the protection offered by the series filter resistor.