

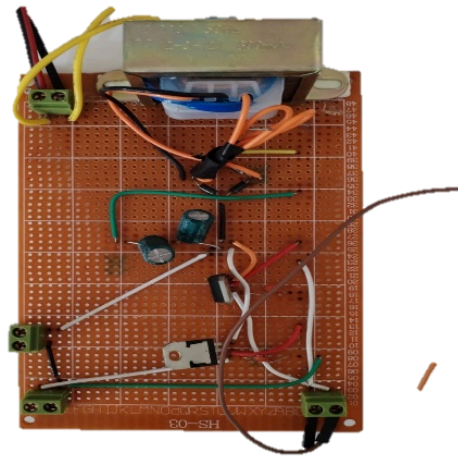
Power supply

What is the power supply?

The power supply system is an essential unit in the design of electronic systems since there is only a small category of appliances that can be developed without the aid of power supply systems. In the case of some small appliances, the power supply system consists of a simple connection cable, while for more complex equipment, the power supply becomes more sophisticated.

A good example of highly complex systems is variable frequency drive systems. Also, the power supply system can be the most expensive subsystem of the total cost, especially in the case of advanced equipment. The system should also be subject to high reliability, must have high efficiency, and should not compromise the overall functionality of the device, in the sense of introducing disturbances such as those performed on the device at the time of switching on or off.

The technological developments verified in power semiconductor devices and other electrical and electronic elements allowed the development of several new architectures for power supply systems, as well as the deployment of switching techniques in the design of new systems.



Types of power supply:

Based on various aspects like packaging, power processing method, output type etc., some popular types of power supplies are:

1. Variable AC Power Supply
2. Unregulated Linear Power Supply
3. Regulated Linear Power Supply (Regulated Power Supply)
4. Switch Mode Power Supply (SMPS)
5. Uninterruptible Power Supply (UPS Power Supply)
6. Programmable Power Supply
7. DC Power Supply
8. Computer Power Supply

Each type has distinct working principles, features, applications and advantages over others. Their selection depends on parameters like power levels, cost, efficiency, size and other design considerations.

What are the main components of a power supply?

1. Transformer

2. Resistors

3. Rectification Circuit

4. capacitor

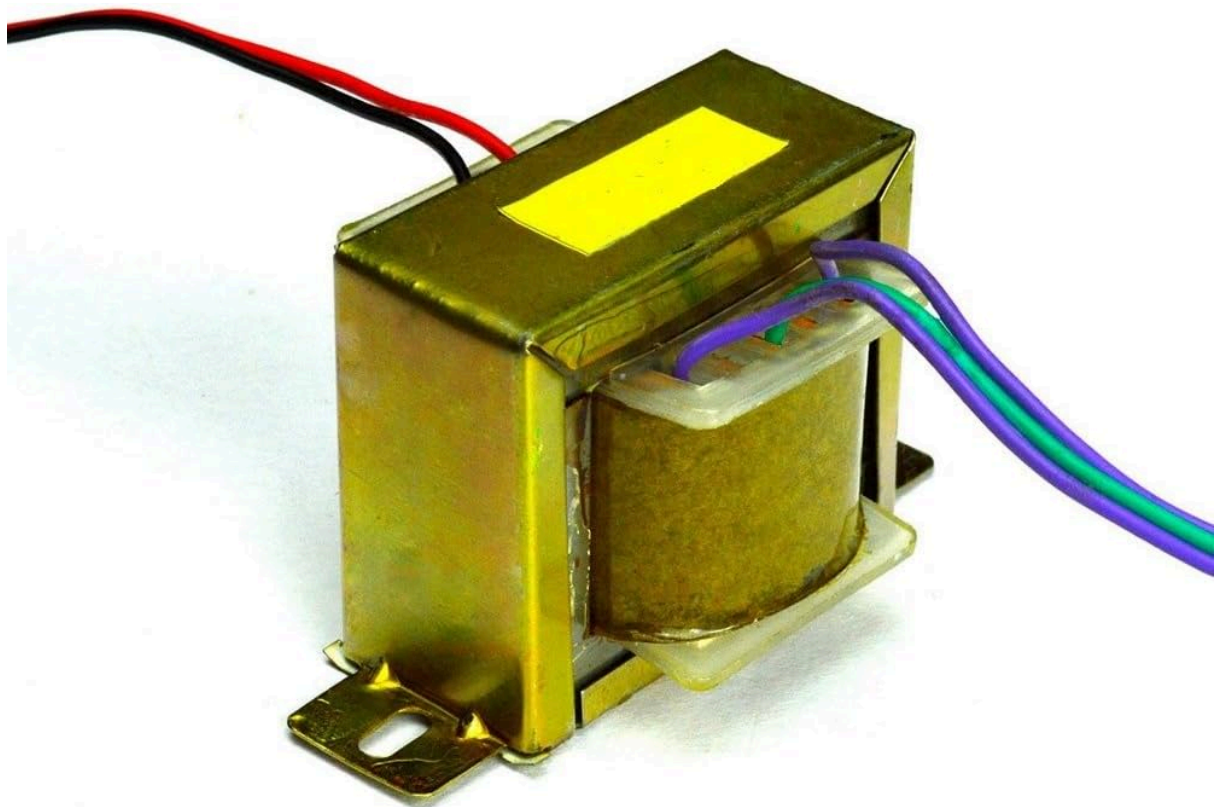
5. Filter

What is the function of the transformer?

Where you use alternating current (AC) electrical energy, you may notice the use of transformers. In direct current (DC) systems, industrial power supplies are used to transform AC voltage into low DC voltage. Transformers, on the other hand, convert AC voltage to AC voltage or current without impacting power.

Transformers are made from an iron core. On the high voltage side of the core, the coil is wrapped many times, and on the lower voltage side of the transformer, the coil is wrapped fewer times. As electricity enters the coil on one side, it induces a magnetic field that produces a higher or lower voltage in the other coil

There is a type of transformer that steps down the electricity to 120 V when it enters your home or office. At 120 V, the electricity can be used to power some devices and electrical outlets. You may also use an adapter to convert to DC for some devices, like computers.



What is the purpose of resistors and capacitors?

Resistors

1. **Current Limiting:** Resistors can limit the current flowing through a circuit, protecting sensitive components from excessive current that could cause damage.
2. **Voltage Division:** They can create voltage dividers that allow for the extraction of lower voltages from a higher voltage supply.
3. **Load Balancing:** Resistors help in balancing the load in various parts of the circuit, ensuring that components operate efficiently.

Capacitors

1. **Filtering:** After the AC voltage is rectified (converted from AC to DC), the output is typically a pulsating DC. Capacitors smooth out this pulsation by charging during the peaks and discharging during the troughs, resulting in a more stable DC voltage.
2. **Energy Storage:** Capacitors store electrical energy temporarily, which helps maintain a steady voltage level during fluctuations in load.
3. **Decoupling:** They can decouple AC noise from the output, ensuring that the DC supply remains clean and stable for sensitive electronic components.

What is the role for rectifier circuits?

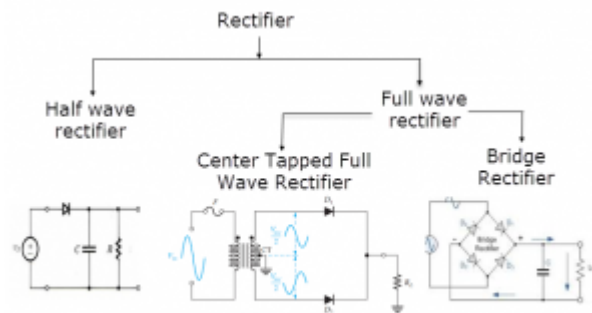
A rectifier circuit is crucial in a power supply for several reasons:

1. **AC to DC Conversion:** Most power supplies receive alternating current (AC) from the mains. Rectifiers convert this AC into direct current (DC), which is required for most electronic devices to operate.
2. **Voltage Regulation:** Rectifiers help in maintaining a steady voltage level. After rectification, additional filtering can smooth the DC output, reducing voltage fluctuations that could harm sensitive electronic components.
3. **Efficiency:** Rectification allows for more efficient use of the power supplied. By converting AC to DC, devices can operate more effectively, improving overall energy efficiency.
4. **Power Factor Correction:** In some applications, rectifiers can help improve the power factor, making the power supply system more efficient and reducing losses in the electrical distribution system.

5. **Protection:** Rectifiers can also provide some level of protection against voltage spikes and transients, helping to safeguard the connected electronic devices.

In summary, rectifier circuits are essential for transforming AC power into usable DC power, ensuring stability, efficiency, and protection for electronic devices

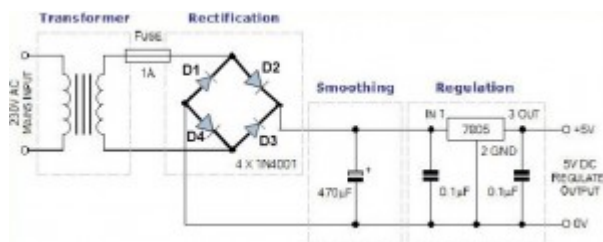
And there is type of rectifier:



And for this project we use the Bridge Rectifier

A bridge rectifier circuit can be built with four diodes which are used to change both input AC half-cycle to DC output. So, in this kind of rectifier, the four diodes are mainly connected in an exact form.

In the positive half cycle of the bridge rectifier, the two diodes like D1 & D2 will become forward bias whereas diodes D3 & D4 will become reverse bias. From a closed loop, the diodes D1 & D2 will provide a +Ve output voltage across the RL (load resistor).



In the negative half cycle of the bridge rectifier, the diodes like D3 & D4 will become forward bias whereas D1 & D2 diodes will become reverse bias. However, the polarity across the RL stays the same & gives a positive o/p across the load.

The full-wave rectifier's output includes fewer ripples as compared to the half-wave rectifier although it's not level and stable. To make the o/p voltage level, a capacitor is used at the output of the circuit. The charge and discharge of this capacitor will make level transitions among the half cycles

The role of Filterin:

Rectifier circuits provide DC-like output but when we use a Bridge rectifier then the output will include some AC component with DC component. So to decrease the AC component, different types of filters are used at the output face of the rectifier. The filters which are used in rectifiers mainly include capacitors and inductors.

In a filter circuit, the connection of a capacitor can be done in parallel because it allows AC and blocks DC. At the output, any AC component will go by the capacitor in the direction of the ground & we acquire the low amount of ac within the output.

In a filter circuit, the connection of an inductor can be done in series as Inductor includes inductive reactance. This reactance is an opposition toward any changes & it provides high impedance toward AC & low impedance to DC as DC is a stable signal whereas AC will change over time.

Based on the arrangement of a capacitor and inductor, we can use an L-Section filter. This kind of filter includes one inductor connected in series & a capacitor connected in parallel. Pi section filter mainly includes two capacitors in parallel through an inductor which is connected in series.

After we talk about its components, we can tell how it works

How Does a Regulated Power Supply Work?

After the current leaves the filter, the power supply's task ends in an unregulated model. While unregulated power supplies suffice for general use, when you need entirely stable electricity that does not change when the load does, you need regulated power. Regulated power supplies

How Does a Linear Regulated Power Supply Work?

A linear power supply uses a simple, straightforward operation method to convert electricity and nearly eliminate ripple voltage. The design starts with a transformer to reduce the voltage. The device then converts AC to DC power. Then, the DC power goes through a regulator that cleans it by reducing the ripple voltage.

This regulated power supply option weighs more because the large transformer must step down the power. Fortunately, linear power supplies have a low-noise operation, making them a better choice when you need low power and a clean, consistent supply. Medical settings, laboratories, and communications facilities benefit most from this type of regulated power supply.

What Is The Use Of A Power Supply?

Given below are some key applications of power supplies:

1. **Desktop computers, laptops, servers** - Converts AC mains to various DC levels like 5V, 12V required by different components.
2. **Communication systems** - Provides steady DC to sensitive circuits in routers, switches, cellular towers, etc.
3. **Industrial equipment** - Ensures reliable operation of machines, and automation systems with large power requirements.
4. **Medical devices** - Deliver precise voltage levels for instruments, monitors, and implants avoiding fluctuations.
5. **Transportation** - Popular in electric vehicles, aircraft, boats for efficient energy distribution.
6. **Backup power** - UPS solutions provide temporary power during outages via batteries to save data, and prevent downtime.

Power supplies are necessary building blocks in all kinds of electronic and electrical systems, catering to their diverse power needs.