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6. **Power Supplies**

A computer power supply, also known as a power supply unit (PSU), is a critical component of a computer system responsible for converting the alternating current (AC) from a wall outlet into the direct current (DC) required to power various components within the system. The power supply ensures that the computer's components receive the appropriate voltage and current levels needed to function properly. A stable and efficient power supply is essential for the smooth operation and longevity of the computer's hardware

Every power supply has a power input connection, which gets energy from a source, and single or multiple power output connections that transmit current to the electrical load.

The power source could be from the electric power grid, which generally provides AC, such as an electrical outlet and energy storage devices, which commonly offer DC, such as solar power devices, batteries, generators, or another power supply.

Most modern desktop personal computer power supplies conform to the [ATX specification](https://en.wikipedia.org/wiki/ATX), which includes form factor and voltage tolerances. While an ATX power supply is connected to the mains supply, it always provides a 5-[volt](https://en.wikipedia.org/wiki/Volt) standby (5VSB) power so that the standby functions on the computer and certain peripherals are powered. ATX power supplies are turned on and off by a signal from the [motherboard](https://en.wikipedia.org/wiki/Motherboard). They also provide a signal to the motherboard to indicate when the DC voltages are in spec, so that the computer is able to safely power up and boot. The most recent ATX PSU standard is version 3.0 as of mid-2022.

The power supply is located at the back of the computer, usually at the top. However, many more recent [tower](https://www.computerhope.com/jargon/t/tower.htm) computer cases house the power supply at the bottom back of the case.

While the computer is on, the fan(s) inside a power supply should always be running. If the fan is not running (spinning), either the computer is not working or the fan has failed and the power supply should be replaced.

**Components and Functions:**

1. **Transformer**: The transformer is the primary component responsible for converting the high voltage AC from the wall outlet into a lower voltage AC. The conversion happens through a process called electromagnetic induction, where the current running through the primary coil generates a magnetic field that induces a current in the secondary coil.

**2.** **Rectifier**: The rectifier is responsible for converting the lower voltage AC output from the transformer into DC. This is achieved through a process called rectification, which uses diodes to allow the flow of current in one direction only, thereby converting the AC waveform into a unidirectional DC signal.

**3**. **Filter Capacitors**: Filter capacitors smooth out the DC signal, removing any residual AC ripples or fluctuations present after rectification. This ensures a stable and continuous DC supply for the computer's components.

**4. Voltage Regulators:** Voltage regulators are responsible for maintaining a consistent voltage level for the different components in the computer. They adjust the output voltage based on the demands of the system and ensure that the voltage stays within a safe and optimal range.

**5. Cooling Fan:** Most power supplies come with a built-in cooling fan that helps dissipate heat generated by the PSU during the conversion process. Proper cooling is essential to prevent overheating, maintain efficiency, and extend the life of the power supply.

**Efficiency and Ratings:**

Computer power supplies are rated based on their efficiency, which is the ratio of the output power to the input power. The higher the efficiency, the less energy is wasted as heat and the lower the overall energy consumption. The 80 PLUS certification is an industry standard that rates power supplies based on their efficiency at 20%, 50%, and 100% loads. The certification has various levels, including 80 PLUS, Bronze, Silver, Gold, Platinum, and Titanium. A higher certification level indicates a more efficient power supply.

**Conclusion:**

A computer power supply is an essential component that ensures the stable and efficient operation of a computer system. It converts AC power from a wall outlet into the DC power required by the computer's components. Understanding the different types, components, and efficiency ratings of power supplies can help users make informed decisions when selecting a power supply for their computer systems.

1. **Types of power supply**

There are several types of power supply used in various application. Some common type include:

Unregulated linear power supply

Unregulated linear power supplies are simple AC-to-DC power supplies. These are designed using a step-down transformer, rectifier, filter capacitor, and bleeding resistor. First, a transformer converts line voltage to the required voltage level in AC. The stepped-down AC voltage is then converted to DC voltage using a half-wave or full-wave rectifier. The rectifier is designed using diodes. The pulsating DC from the rectifier is smoothed using filter capacitors. A bleeding resistor may be connected in parallel to the filter capacitor for protection.

Unregulated power supplies are simple and durable. However, their output voltage may vary due to variation in input voltage or load current. So, these are not much reliable. Also, these can be only designed to output a fixed voltage and current.

Linear regulated power supply

Linear regulated power supplies are AC-to-DC power supplies. These are the same as unregulated power supplies except that they use a transistor circuit operating in an active or linear region in place of bleeding resistor. This active transistor stage enables output to different accurate DC voltage levels. There are several voltage-regulator ICs available that have an active transistor circuit integrated within them. Linear regulated power supplies are stable, safe, reliable, and noise-free. There are voltage regulator ICs available for a wide range of input and output voltages and they output fixed DC voltages. The major disadvantages of these supplies is their cost, size, and energy efficiency. These supplies lose a lot of energy due to power dissipation and may need the use of heat sink with regulator ICs.

Switching regulated power supply

Switching regulated power supplies are complex AC-to-DC power supplies that tend to combine the advantages of unregulated and regulated power supplies. In SMPS, the line voltage is rectified to DC, and then it is again converted to square wave AC with the help of switching transistors. This high-frequency square wave is then stepped down or stepped up and then again rectified. The rectified DC voltage is filtered before supplying it to a load.

DC-to-DC converters

DC-To-DC converters are used to step up or step-down DC voltages. DC-to-DC converters can be semiconductor, electromechanical, or electrochemical types. DC-to-DC SMPS like push-pull converter, buck converter, boost converter, buck-boost converter are some examples of semiconductor type DC-to-DC converters. These supplies are generally used to convert DC (rectified from mains electricity or other AC source) to provide different DC levels rather than using many AC-to-DC supplies in a device.

DC-to-AC power supplies

These types of power supplies are generally used for power backup. Inverters, UPS, and generators are examples of such power supply systems.

Electronic hobbyists and engineers most commonly use linear regulated power supplies and battery power supplies. Other types of power supplies are generally designed and produced for specific applications or circuits. Some circuits may require designing a power supply using solar panel

Programable power supply

A programmable power supply (PPS) is one that allows remote control of its operation through an analog input or digital interface such as RS-232 or GPIB. Controlled properties may Unregulated linear power supply include voltage, current, and in the case of AC output power supplies, frequency. They are used in a wide variety of applications, including automated equipment testing, crystal growth monitoring, semiconductor fabrication, and x-ray generators.

Programmable power supplies typically employ an integral microcomputer to control and monitor power supply operation.

1. **Batteries**

Batteries are tools that store chemical energy and transform it into electrical energy when needed. They are frequently used to power portable electronics like computers, cell phones, and other gadgets. A positive electrode, a negative electrode, and an electrolyte make up electrochemical cells, which are the basic building blocks of batteries. When the battery is in use, an internal chemical process causes electrons to flow from the negative electrode to the positive electrode, producing electrical energy.

**Here are the most common types of batteries**

1. **Alkaline Batteries**: Alkaline batteries are non-rechargeable batteries that are commonly used in household devices such as flashlights, remote controls, and toys. They are typically made of a zinc negative electrode and a manganese dioxide positive electrode, with an alkaline electrolyte in between.

Alkaline batteries are known for their long shelf life and relatively high energy density. The AA battery, which has a nominal voltage of 1.5 volts and is used in a variety of consumer gadgets including toys, flashlights, and remote controls, is the most widely used form of alkaline battery. There are more sizes of alkaline batteries, including AAA, C, D, and 9-volt. Alkaline batteries are a great option for gadgets that need a continuous, dependable source of power because of their well-known extended shelf life and high energy density. Additionally, they are readily accessible and reasonably priced. The negative electrode, which is normally composed of zinc, and the positive electrode, which is typically made of manganese dioxide, engage in a chemical reaction to power alkaline batteries. The electrolyte, usually a potassium hydroxide solution, permits the electrolyte to conduct

1. **Lithium-ion Batteries**: Lithium-ion batteries are rechargeable batteries that are commonly used in portable electronic devices such as cell phones, laptops, and cameras. They are typically made of a lithium-cobalt oxide positive electrode and a carbon-based negative electrode, with a lithium electrolyte in between.

Lithium-ion batteries are known for their high energy density, low self-discharge rate, and relatively long cycle life. The AA battery, which has a nominal voltage of 1.5 volts and is used in a variety of consumer gadgets including toys, flashlights, and remote controls, is the most widely used form of alkaline battery. There are more sizes of alkaline batteries, including AAA, C, D, and 9-volt. Alkaline batteries are a great option for gadgets that need a continuous, dependable source of power because of their well-known extended shelf life and high energy density. Additionally, they are readily accessible and reasonably priced. The negative electrode, which is normally composed of zinc, and the positive electrode, which is typically made of manganese dioxide, engage in a chemical reaction to power alkaline batteries. The electrolyte, usually a potassium hydroxide solution, permits the electrolyte to conduct

1. **Nickel-Metal Hydride (NiMH) Batteries**: Rechargeable NiMH batteries are frequently used in flashlights, power tools, and other high-drain gadgets.

They typically consist of a potassium hydroxide electrolyte, a hydrogen-absorbing negative electrode, and a nickel oxide positive electrode. The advantages of NiMH batteries include their high energy density, low cost, and low self-discharge rate. A nickel oxide hydroxide positive electrode, a hydrogen-absorbing alloy negative electrode, and an alkaline electrolyte, typically potassium hydroxide, make up the basic components of a NiMH battery. Nickel ions are oxidized in the positive electrode during charging, while hydrogen ions are absorbed into the negative electrode, storing energy. The process is reversed when the battery is discharged, releasing the hydrogen ions from the negative electrode back into the electrolyte and creating electrical energy. Portable electrical devices including digital cameras, toys, and portable music players frequently use NiMH batteries. They are employed in HEVs and other applications that require rechargeable batteries with high energy densities and minimal toxicity.

1. **Lead-Acid Batteries**: Automobiles, motorcycles, and other vehicles frequently use lead-acid batteries. Typically, they consist of an electrolyte of sulfuric acid, a lead negative electrode, and a positive electrode constructed of lead dioxide. Lead-acid batteries are renowned for their high peak current, inexpensive price, and capacity to supply large amounts of power quickly. A positive electrode made of lead dioxide, a negative electrode made of lead, and an electrolyte made of diluted sulfuric acid make up the basic components of a lead-acid battery.

The lead electrode is decreased and the lead dioxide electrode is oxidized when the battery is charged, storing energy. The lead electrode is oxidized and the lead dioxide electrode is decreased during discharge, which results in the generation of electrical energy. Lead-acid batteries are renowned for their exceptional durability and comparatively inexpensive cost. They are perfect for situations where a lot of power is required for brief periods of time because they can also produce a high current output. However, when compared to other forms of rechargeable batteries, they are hefty and bulky.

1. **Nickel-Cadmium (NiCd) Batteries**: Rechargeable NiCd batteries are frequently found in portable electronics like remote controls and cordless phones. Typically, they consist of a potassium hydroxide electrolyte, a cadmium negative electrode, and a nickel oxide positive electrode.

NiCd batteries are renowned for their high self-discharge rate and comparatively low energy density, as well as for their relatively long cycle life and capacity to produce significant power for brief periods of time. The fundamental components of a NiCd battery are an alkaline electrolyte, typically potassium hydroxide, and a positive electrode made of nickel oxide hydroxide, a negative electrode composed of cadmium, and other components. When the battery is charged, nickel ions are oxidized in the positive electrode and store energy while cadmium ions are reduced and absorbed into the negative electrode. The process is reversed when the battery is discharged, releasing the cadmium ions from the negative electrode back into the electrolyte and producing electricity in the process.

1. **Common problems and solutions of power supply**
2. Input overvoltage and undervoltage

Both input [undervoltage and overvoltage](https://www.allaboutcircuits.com/technical-articles/circuit-protection-ic-solution-overvoltage-undervoltage-reverse-polarity/) can be extremely problematic for power supplies, and they are among the most common issues encountered.

One of the most notorious sources of both over and undervoltage is incorrectly setting the 120/240 V switch on non-universal inputs. This switch enables or disables a voltage-doubler inside the power supply, so the internal circuits operate at 240 V in either case

**Solution to this problem**

1. Use voltage regulators: Voltage regulators are electronic devices that help stabilize the voltage supplied to the power supply unit. They can prevent overvoltage and undervoltage by adjusting the input voltage to the desired level.

2. Install surge protectors: Surge protectors are devices that can protect the power supply unit from sudden spikes or surges in voltage. They can absorb the excess voltage and prevent it from reaching the power supply unit.

3. Use an uninterruptible power supply (UPS): A UPS can provide backup power in case of an overvoltage or undervoltage event. It can also regulate the voltage supplied to the power supply unit, ensuring that it stays within safe levels.

2. Output Overpower and Overcurrent

Output overpower and overcurrent are problems that can occur in a power supply unit when too much power is being supplied to the output load. This can cause the output voltage to exceed safe levels and potentially damage the connected devices.

Solution to this problem

Output overpower and overcurrent problems in a power supply unit can also lead to serious issues, including damage to components and even fire hazards. Here are some possible solutions to these problems:

Use a current limiting device: A current limiting device can help regulate the amount of current flowing through the power supply unit, preventing overpower and overcurrent events.

1. Use a fuse or circuit breaker: Fuses and circuit breakers are safety devices that can protect the power supply unit from overpower and overcurrent events. They can detect when the current exceeds safe levels and disconnect the power supply unit from the circuit.

2. Check and maintain the power supply unit: It's important to regularly check the power supply unit for any signs of wear or damage. Replacing worn or damaged components can prevent overpower and overcurrent events.

3. Reversed Polarity

Reversed polarity refers to incorrectly connecting the positive and negative inputs or outputs of a power supply. Many components, such as electrolytic capacitors, cannot tolerate reverse polarity and will fail if subjected to it.

**Solution to this problem**

Reversed polarity in a power supply unit can also cause problems, including damage to components and potentially dangerous electrical shocks. Here are some possible solutions to this problem:

1. Use a polarized plug: A polarized plug has one prong that is larger than the other, ensuring that the plug is inserted in the correct orientation. This can prevent reversed polarity events.

2. Use a reverse polarity protection device: A reverse polarity protection device can detect and protect against reversed polarity events. It can automatically shut down the power supply unit to prevent damage.

3. Check and maintain the power supply unit: It's important to regularly check the power supply unit for any signs of wear or damage. Replacing worn or damaged components can prevent reversed polarity events.

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