

How PC Power Supplies Work

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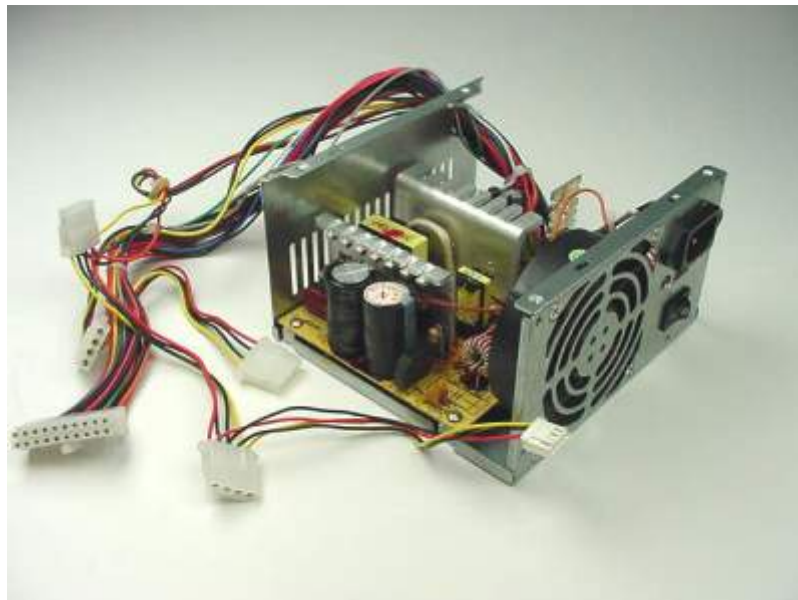
If there is any one component that is absolutely vital to the operation of a computer, it is the power supply. Without it, a computer is just an inert box full of plastic and metal. The power supply converts the alternating current (AC) line from your home to the direct current (DC) needed by the personal computer. In this edition of [How Stuff Works](#), we'll learn how PC power supplies work and what the [wattage](#) ratings mean.

Power Supply

In a personal computer (PC), the power supply is the metal box usually found in a corner of the case. The power supply is visible from the back of many systems because it contains the power-cord receptacle and the cooling fan.



This is a power supply removed from its PC case. The small, red switch at right, above the power-cord connector, is for changing line voltages in various countries.



The interior of a power supply.

Power supplies, often referred to as "switching power supplies", use switcher technology to convert the AC input to lower DC voltages. The typical voltages supplied are:

- 3.3 volts
- 5 volts
- 12 volts

The 3.3- and 5-volts are typically used by digital circuits, while the 12-volt is used to run motors in [disk drives](#) and fans. The main specification of a power supply is in **watts**. A watt is the product of the **voltage** in volts and the **current** in amperes or amps.

If you have been around PCs for many years, you probably remember that the original PCs had large red toggle switches that had a good bit of heft to them. When you turned the PC on or off, you knew you were doing it. These switches actually controlled the flow of 120 volt power to the power supply.

Today you turn on the power with a little push button, and you turn off the machine with a menu option. These capabilities were added to standard power supplies several years ago. The operating system can send a signal to the power supply to tell it to turn off. The push button sends a 5-volt signal to the power supply to tell it when to turn on. The power supply also has a circuit that supplies 5 volts, called VSB for "standby voltage" even when it is officially "off", so that the button will work.

Switcher Technology

Prior to 1980 or so, power supplies tended to be heavy and bulky. They used large, heavy transformers and huge capacitors (some as large as soda cans) to convert line voltage at 120 volts and 60 hertz into 5 volts and 12 volts DC.

The switching power supplies used today are much smaller and lighter. They convert the 60-Hertz (Hz, or cycles per second) current to a much higher [frequency](#), meaning more cycles per second. This conversion enables a small, lightweight transformer in the power supply to do the actual voltage step-down from 110 volts (or 220 in certain countries) to the voltage needed by the particular computer component. The higher-frequency AC current provided by a switcher supply is also easier to rectify and filter compared to the original 60-Hz AC line voltage, reducing the variances in voltage for the sensitive electronic components in the computer.



In this photo you can see three small transformers (yellow) in the center. To the left are two cylindrical capacitors. The large finned pieces of aluminum are heat sinks. The left heat sink has transistors attached to it. These are the transistors in

charge of doing the switching -- they provide high-frequency power to the transformers. Attached to the right heat sink are diodes that rectify AC signals and turn them into DC signals.

A switcher power supply draws only the power it needs from the AC line. The typical voltages and current provided by a power supply are shown on the label on a power supply.



Personal computer power supply label.
VSB is the standby voltage provided to the power switch.

Switcher technology is also used to make AC from DC, as found in many of the automobile power inverters used to run AC appliances in an automobile and in [uninterruptible power supplies](#). Switcher technology in automotive power inverters changes the direct current from the auto battery into alternating current. The transformer uses alternating current to make the transformer in the inverter step the voltage up to that of household appliances (120 VAC).

Power Supply Standardization

Over time, there have been at least six different standard power supplies for personal computers. Recently, the industry has settled on using ATX-based power supplies. ATX is an industry specification that means the power supply has the physical characteristics to fit a standard ATX case and the electrical characteristics to work with an ATX motherboard.

PC power-supply cables use standardized, keyed connectors that make it difficult to connect the wrong ones. Also, fan manufacturers often use the same connectors as the power cables for disk drives, allowing a fan to easily obtain the 12 volts it needs. Color-coded wires and industry standard connectors make it possible for the consumer to have many choices for a replacement power supply.



A PC power supply removed from its PC case. Cables and connectors at right supply DC voltages.

Advanced Power Management

Advanced Power Management (APM) offers a set of five different states that your system can be in. It was developed by Microsoft and Intel for PC users who wish to conserve power. Each system component, including the [operating system](#), [basic input/output system \(BIOS\)](#), [motherboard](#) and attached devices all need to be APM-compliant to be able to use this feature. Should you wish to disable APM because you suspect it is using up system resources or causing a conflict, the best way to do this is in the BIOS. That way, the operating system won't try to reinstall it, which could happen if it were disabled only in the software.

Power Supply Wattage

A 400-watt switching power supply will not necessarily use more power than a 250-watt supply. A larger supply may be needed if you use every available slot on the motherboard or every available drive bay in the personal computer case. It is not a good idea to have a 250-watt supply if you have 250 watts total in devices, since the supply should not be loaded to 100 percent of its capacity.

According to [PC Power & Cooling, Inc.](#), some power consumption values (in watts) for common items in a personal computer are:

PC Item	Watts
Accelerated Graphics Port (AGP) card	20 to 30W
Peripheral Component Interconnect (PCI) card	5W
small computer system interface (SCSI) PCI card	20 to 25W
floppy disk drive	5W
network interface card	4W
50X CD-ROM drive	10 to 25W
RAM	10W per 128M
5200 RPM Intelligent Drive Electronics (IDE) hard disk drive	5 to 11W
7200 RPM IDE hard disk drive	5 to 15W
Motherboard (without CPU or RAM)	20 to 30W

550 MHz Pentium III	30W
733 MHz Pentium III	23.5W
300 MHz Celeron	18W
600 MHz Athlon	45W

Power supplies of the same **form factor** ("form factor" refers to the actual shape of the motherboard) are typically differentiated by the wattage they supply and the length of the warranty.

Power Supply Problems

The PC power supply is probably the most failure-prone item in a personal computer. It heats and cools each time it is used and receives the first in-rush of AC current when the PC is switched on. Typically, a stalled cooling fan is a predictor of a power supply failure due to subsequent overheated components. All devices in a PC receive their DC power via the power supply.

A typical failure of a PC power supply is often noticed as a burning smell just before the computer shuts down. Another problem could be the failure of the vital cooling fan, which allows components in the power supply to overheat. Failure symptoms include random rebooting or failure in Windows for no apparent reason.

For any problems you suspect to be the fault of the power supply, use the documentation that came with your computer. If you have ever removed the case from your personal computer to add an adapter card or memory, you can change a power supply. Make sure you remove the power cord **first**, since voltages are present even though your computer is off.

Power Supply Improvements

Recent motherboard and chipset improvements permit the user to monitor the revolutions per minute (RPM) of the power supply fan via BIOS and a Windows application supplied by the motherboard manufacturer. New designs offer fan control so that the fan only runs the speed needed, depending on cooling needs.

Recent designs in [Web servers](#) include power supplies that offer a spare supply that can be exchanged while the other power supply is in use. Some new computers, particularly those designed for use as servers, provide redundant power supplies. This means that there are two or more power supplies in the system, with one providing power and the other acting as a backup. The backup supply immediately takes over in the event of a failure by the primary supply. Then, the primary supply can be exchanged while the other power supply is in use.