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The Coolest PCs Around

What keeps your PCs that cool?

PCs are basically bundles of hardware equipment placed inside a case. Now, each of those pieces of hardware equipment, depending on the sustained workload, produces large amounts of heat during operation. Just imagine all those components in full load... it would be like a small-scale burning hell inside the PC case. UNLESS we use some cooling stuff to keep all the hardware running in good condition. And that's what we'll talk about today: PC cooling techniques. **Keep it cool**What do we really use to dissipate all that burning hell? The most common equipment includes heat sinks to increase the surface area which dissipates heat, fans to speed up the exchange of air heated by the computer parts for cooler ambient air, and in some cases, softcooling - a technique that throttles computer components via some special software provided by the OS in order to decrease heat generation.But how do we exactly know that the PC interior is cool enough? Do any of the hardware components give sporadic problems resulting in system freezes or crashes? If so, you really need to improve the airflow inside your case.Of course, you, as a careful PC maniac that you are aren't to be blamed about the imminent disasters that might occur inside your PC case. But then, what exactly is leading to all those heat problems? Blame it on the circuits! It's a matter of their design efficiency, the technology used in their construction and the frequency and voltage at which they operate. We need to keep a sufficiently low equilibrium temperature between hardware components and the ambient of the PC case in order for this pesky circuitry to work as long as possible.Keep in mind that there are more "enemies of coolness" out there: * Dust acting as a thermal insulator and impeding airflow, thereby reducing heat sink and fan performance. * Poor airflow (including turbulence) due to friction that reduces the amount of air flowing through a case, possibly causing stable whirlpools of hot air in certain areas. * Poor heat transfer due to a lack or poor application of thermal compounds.In order to identify threatening heat problems, many hardware components come with heat sensors that corroborate with software and shut down the computer if reasonable bounds are exceeded. But these solutions are not always reliable. **Cooler and the gang**If you decided to improve the overall stability of your system by adding more cooling stuff, you should know that there are a bunch of standardized techniques to help you deal with the nasty heat problems. **1. Air cooling**This technique is most commonly achieved with fans. The term computer fan usually refers to fans attached to computer cases, but may also be intended to signify any other computer fan, such as a CPU fan, GPU fan, a chipset fan, PSU fan, HDD fan, or PCI slot fans. Common fan sizes include 60, 80, 92 and 120 mm. Desktop computers typically use more fans for heat management. Almost all desktop power supplies have at least one fan to exhaust air from the case. Most manufacturers recommend bringing cool, fresh air in at the bottom front of the case, and exhausting warm air from the top rear.**2. Spot cooling** Various individual components usually have their own cooling systems in place. Components which are individually cooled include CPUs, GPUs, hard disks and the Northbridge chips. Spot cooling equipment usually includes smaller fans or heat sinks. There are two types of heat sinks:- Passive heat sinks - involve attaching a block of machined metal to the part that needs cooling. A clamp is used to affix the heat sink tight over the chip, with a thermally conductive pad or gel spread in-between. This block usually has fins and ridges to increase its surface area. The heat conductivity of metal is much better than that of air, and its ability to radiate heat is better than that of the component part it is protecting. Until recently, fan cooled aluminum heat sinks were the norm for desktop computers. However, the trend today is to include copper base-plates. You can usually find passive heat sinks on older CPU or parts that do not get very hot, such as chipsets. - Active heat sinks - these use the same principle as a passive heat sink cooler, with the only difference being that a fan is directed to blow over or through the heat sink. This results in more air being blown through the heat sink, increasing the rate at which the heat sink can exchange heat with the ambient air. Active heat sinks are the primary method of cooling current CPUs.**3. Phase-change cooling**A phase-change cooler is a unit which should sit underneath the PC, with a tube leading to the processor. Inside the unit there is a compressor, something that you would usually find inside a freezer. The compressor compresses a gas which is cooled (most often with fans and air) condensing it to liquid state. Then, the liquid is pumped up to the processor, which heats it, causing the liquid to evaporate, thereby absorbing the heat from the processor. This evaporation can produce temperatures reaching around minus 30 degrees Celsius. The gas flows down to the compressor and the cycle begins over again. This way, the processor can be cooled to temperatures ranging from minus 15 to minus 100 degrees Celsius, depending on the load, type and speed of the processor and the refrigeration system.**4. Liquid nitrogen cooling** Physics and chemistry teach us that liquid nitrogen evaporates at minus 196 °C, far below the freezing point of water. This makes liquid nitrogen the ultimate phase-change coolant, bringing the additional advantages of being non-toxic and non-combustible. In a typical installation of liquid nitrogen cooling, fans blow air onto the heat sink of the CPU, as water is pumped through a pipe which ends over the heat sink, and similarly, liquid nitrogen can be pushed out of a dewar through a pipe which ends over the heat sink. The short, yet wide nitrogen exhaust ends in a basing on the floor of the housing. Evaporating nitrogen pushes away water, which would otherwise condense and lead to shortcuts or form ice. Too deep cooling will freeze out the dopant states and the semiconductors will stop working.By welding an open pipe onto a heat sink, and insulating the pipe, it is possible to cool the processor either with liquid nitrogen, which has a temperature below −196° C, or dry ice. However, after the nitrogen evaporates, it has to be refilled. In the realm of personal computers, this method of cooling is seldom used in other contexts than overclocking trial-runs and record-setting attempts, as the CPU will usually expire within a relatively short period of time due to temperature stress caused by changes in internal temperature.**5. Softcooling**Softcooling is the practice of utilizing software to take advantage of CPU power saving technologies to minimize energy use. This is done using halt instructions to turn off or put in standby state CPU subparts that aren't being used. **6. Liquid Cooling**Due to the actual process of adopting water cooling as a standard over heat sinks, we will concentrate more on this technique. You've probably noticed that, while the PC is running, you can hear some whirling noise coming from the system and component fans. In most computers, fans do a pretty good job of keeping electronic components cool. But for people who want to use high-end hardware, overclock their PCs into running faster or simply get rid of that whirling noise, they should look into liquid cooling solutions. It might seem quite counterintuitive to put liquids near delicate electronic equipment, but cooling with water is far more efficient than cooling with air. A liquid-cooling system for a PC works similarly to a car's cooling system. Both take advantage of a basic principle of thermodynamics - that heat moves from warmer objects to cooler objects. As the cooler object gets warmer, the warmer object gets cooler. Liquid cooling is a very common process. A car's cooling system circulates water, usually mixed with antifreeze, through the engine. Hot surfaces in the engine warm the water, cooling themselves off in the process.The water circulates from the engine to the radiator, a system of fins and tubes with a lot of exterior surface area. Heat moves from the hot water to the radiator, causing the water to cool off. The cool water then heads back to the engine. At the same time, a fan moves air over the outside of the radiator. The radiator warms the air, cooling itself off at the same time. In this way, the engine's heat moves out of the cooling system and into the surrounding air. Without the radiator's surfaces making contact with the air and dispelling the heat, the system would just move the heat around instead of getting rid of it.Just like a car cooling system, the PC liquid-cooling kits include: a pump, a radiator, a fan, a coolant reservoir and conduits. In addition, a PC water-cooling system includes: * A pump that moves coolant through the system. * A radiator that dispels heat into the air. * A fan that moves air over the radiator. * A coolant reservoir that holds extra fluid and allows easy addition of coolant. * Hoses that connect the different parts of the system. Instead of directly injecting cool water over the hot components, which can be seriously affected by fluids, a liquid-cooled PC uses water blocks. A water block is a piece of heat-conductive metal, like copper or aluminum, that's filled with hollow tubes and channels. The bottom of the water block is a flat piece of metal that sits directly on top of the chips which need to be cooled. There's a thin layer of thermal paste between the chip and the block, which improves the heat transfer between the two surfaces. The chip heats the block, and the water absorbs the heat as it flows through all the channels.A piece of advice for those who want to make the move towards liquid-cooling kits: if you decide to install a liquid-cooling system in your computer, it's a good idea to let the pump circulate the fluid for a while so you can check for leaks. Keep your computer turned off during this test period so you'll be less likely to damage your hardware if a leak does occur.Are you a hardcore overclocker that wants to go beyond any record set? You sure want to cool your PC's parts even more and you can do this by using Peltier devices in place of standard water blocks. A Peltier device is a thermoelectric device. When you apply electricity to it, heat moves from one side to the other. In other words, one side of the Peltier device gets very cold while the other gets very hot. The cold side of the Peltier device can cool a microchip, while water from the liquid-cooling system draws the heat away from the hot side. Some overclocking enthusiasts prefer systems that use these devices because they cool a PC's components well below ambient temperature. However, they do require extra precautions. Since the cold side of a Peltier device is colder than the surrounding air, it's prone to accumulating condensation. Without ample protection against condensation, a Peltier system can lead to a short circuit, so be very careful. That's it for a quick look at PC cooling devices. The next article will present the variety of PC printing technologies and how they work.