**CPU Cooler Basics**

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**What is a CPU Cooler?**

A CPU Cooler is a device that attaches to the CPU of a computer to ensure the processor temperature remains within operational standards. The cooling device typically consists of aluminum or copper manufactured into a heatsink with the addition of a fan. Although more exotic methods, like water cooling, exist as well.

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**Why is a CPU Cooler Necessary?**

The CPU is a high-activity component in any computer system. As such, it generates large amounts of heat that will degrade performance and could potentially damage the computer system if left unchecked. Most modern computer systems have built-in safeguards that will shut the system down if the temperature exceeds a specific limit, but this is obviously an inconvenient alternative to effective CPU thermal management. A CPU Cooler will help ensure the stability and longevity of a computer system as well as allow for performance gains depending on how aggressive the thermal management is.

**Types of CPU Coolers**

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**Passive CPU Cooling**

This type of cooler solely consists of a heatsink. The heat spreader on the CPU makes contact with the heatsink, which draws the heat from the heat spreader to help it dissipate across a larger surface area. To assist the thermal conductivity from the heat spreader to the heatsink, a thermal compound is typically applied on the CPU to ensure proper contact. Pure passive CPU Coolers (those requiring no airflow at all, like from a case fan) are not recommended for modern CPUs since they do not exchange heat at a high enough rate to keep current CPUs within acceptable operational temperatures.

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**Active CPU Cooling**

This type of cooler also consists of a heatsink and fan. Active CPU Coolers come in a variety of shapes, sizes and configurations. Most modern Active CPU Coolers offer heat pipes for faster heat exchange from the heat spreader to the heat sink. When the heatsink fins absorb the heat, the attached fan circulates air over the fins to facilitate faster cooling. A CPU Cooler can still be considered as using active cooling if case fans provide adequate airflow.

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**Heat Pipe Technology**

Heat pipes typically act as a heat conductor throughout heatsinks. Heat pipes are filled with liquid that absorbs heat from the heat spreader, evaporating the liquid, which moves towards the heatsink fins on the other side of the heat pipe. When the heatsink cools the gas, it returns to the heat spreader side of the heat pipe as liquid to repeat the process.

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**Water Cooling**

This type of cooler is an aggressive type of active cooling that uses coolant and a radiator setup. In water cooling configurations, a water block is attached to the CPU heat spreader in a similar fashion as passive or active cooling. The water block is specifically designed to allow coolant to pass through it via two openings. Tubes are attached to those openings to create a closed system with a pump and radiator. The coolant is then cycled through the system, exchanging heat from the CPU to the radiator. A main advantage to water cooling is the ability to cool other components, like GPUs and hard disks, by adding appropriate water blocks and routing extra tubing to extend the system. Disadvantages include cost, labor and potential for leaks that could destroy the computer system.

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**Exotic CPU Cooling**

Other cooling methods exist, such as thermoelectric cooling, liquid nitrogen/helium, liquid immersion and more. Depending on the solution, electric charges are introduced, special CPU housing must be constructed or specific, non-conductive liquid must be used. Due to the extra cost, labor and potential danger to computer systems, exotic cooling is not recommended for most computer builders.

**Basic CPU Cooler Considerations**

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**Overview**

Unless a CPU is an OEM component bought separately (not pre-installed in a ready-built system), the CPU will probably already have a stock cooler that is rated to work specifically with that model CPU. Aftermarket CPU Coolers can typically provide better cooling performance, which is why many computer builders replace their stock coolers. When choosing an aftermarket CPU Cooler, two basic features need to be considered.

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**CPU Compatibility**

Currently, there are two major CPU manufacturers: Intel and AMD. In addition to providing similar, but different technologies, their components also have different specifications. A CPU Cooler that is rated for an Intel CPU may not offer enough cooling for an AMD CPU. Also consider that both AMD and Intel require different attachment configurations for their Coolers due to differing motherboard configurations. Finally, both manufacturers offer several lines of CPUs that have different cooling needs. Therefore, an Intel Core i7 processor will need more performance cooling than an Intel Atom. Ensure that the CPU Cooler is compatible before purchasing by checking the packaging for compatible CPU models.

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**Dimensions**

CPU Coolers come in all shapes and sizes. As such, it’s important to ensure that the CPU Cooler will fit inside the computer system it’s going to cool. This is especially important in small form factor cases. The CPU Cooler should not be so tall that it comes into contact with the side panel or any attached fans. On the other hand, it should provide enough clearance for other onboard components. For instance, the memory modules may have heatsinks that may extend into and interfere with wide, low profile CPU Coolers.

**Related Products**

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* [CPU Cooler Brackets](http://www.newegg.com/Product/CategoryIntelligenceArticle.aspx?articleId=284#topic3)

**Thermal Compound**

Also known as thermal paste, this compound is applied between the CPU heat spreader and the CPU Cooler. Its purpose is to facilitate better thermal conductivity by filling in the small imperfections in the surfaces of the CPU heat spreader and the heatsink, allowing heat to transfer more efficiently.

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**CPU Cooler Fans**

Many active CPU Coolers have fans attached to the heatsink. They can be replaced by other CPU Cooler fans. This is especially useful if a builder wants to exchange a stock CPU Cooler fan with one that offers LED lighting. Additionally, some passive CPU Coolers can be upgraded to active cooling with the addition of a CPU Cooler fan and appropriate bracket.

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**CPU Cooler Brackets**

These devices secure the CPU Cooler to the CPU. In some cases, older CPU Coolers may be unofficially rated to perform adequately as a Cooler for newer socket types. Unfortunately, as CPU sockets change, so do their mounting configurations, e.g. socket 775 CPU Cooler brackets do not fit socket 1366 CPU Cooler mounting holes. The solution is to replace the old mounting bracket with a new one that accommodates the new socket type. Computer building enthusiasts may also want to purchase new brackets to replace the stock brackets that came with their Cooler, which sometimes don’t offer the best stability – especially true on some very large and heavy CPU Coolers.

**Choosing the Right CPU Cooler**

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**Overview**

Ultimately, if the CPU Cooler is compatible with your CPU and fits inside the case, then that’s all that really matters. However, there are special considerations that should be addressed before settling on a CPU Cooler. Here are some factors that may affect your decision.

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**Sound**

Passive cooling is an attractive solution for noise-sensitive environments, like shared bedrooms or offices, because there is no fan to generate sound with constant spinning. Passive cooling, however, will limit the choice of CPU since more powerful CPUs require high performance cooling. Builders using active cooling CPU Coolers should consider how many fans the cooler uses and whether or not those fans will be automatically or manually controlled. Automatic control allows the computer system to increase or decrease fan speed as necessary to cool the CPU, but won’t consider noise levels. Manual control allows the user to control fan speed via a fan controller.

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**Style**

Even after narrowing down CPU Coolers to those that are compatible with specific CPUs, there is still a wide selection to choose from. CPU Coolers come in different colors and configurations and can mesh or clash with the style of a particular computer system. This is especially true for computer building enthusiasts who often color-coordinate their internal components. Builders who use computer cases with a see-through side panel should consider the visual aspect of the CPU Cooler since it is one of the most eye-catching internal pieces.

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**Overclocking**

Computer builders always want to maximize the power of their systems, which often times leads to overclocking. Doing so may exceed the performance of passive coolers and even many active air coolers. The solution is to use water cooling. If overclocking is a future plan for a current system, then having a CPU Cooler that will allow for that growth is definitely something to consider.