AL FURAT AL AWSAT TECHNICAL UNIVERSITY

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PC MAINTENANCE

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Lecturer

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Introduction

The processor, motherboard, memory modules, expansion cards, and other components in the case produce heat, and, if they get overheated, the system can get unstable and components can fail or be damaged. As a hardware technician, you need to know how to keep a system cool. Devices that are used to keep a system cool include CPU fans, case fans, coolers, heat sinks, and liquid cooling systems. In this lecture, you learn about these several methods to keep the system cool. We begin with keeping the processor cool.

1- Processor Coolers, Fans, and Heat Sinks

Because a processor generates so much heat, computer systems use a cooling assembly designed for a specific processor to keep temperatures below the processor maximum temperature. If a processor reaches its maximum temperature, it automatically shuts down. Good processor coolers maintain a temperature of 90–110 degrees F (32–43 degrees C). The **cooler** (see Figure 1) sits on top of the processor and consists of a fan and a heat sink. A **heat sink** is made of metal that draws the heat away from the processor into the fins. The fan can then blow the heat away.

Figure (1) A cooler sits on top of a processor to help keep it cool

A cooler is made of aluminum, copper, or a combination of both. Copper is more expensive, but does a better job of conducting heat. For example, the Thermaltake (*www.thermaltake. com*) multi socket cooler shown in Figure (2) is made of copper and has an adjustable fan control.

Recall that the cooler is bracketed to the motherboard using a wire or plastic clip and thermal compound is placed between the bottom of the cooler heat sink and the top of the processor. To get its power, the cooler fan power cord connects to a 4-pin fan header on the motherboard (see Figure 3). The fan connector will have three or four holes. A three-hole connector can fit onto a 4-pin header; just ignore the last pin. A 4-pin header on the motherboard supports

pulse width modulation (PWM) that controls fan speed in order to reduce the overall noise in a system. If you use a cooler fan power cord with three pins, know that the fan will always operate at the same speed.

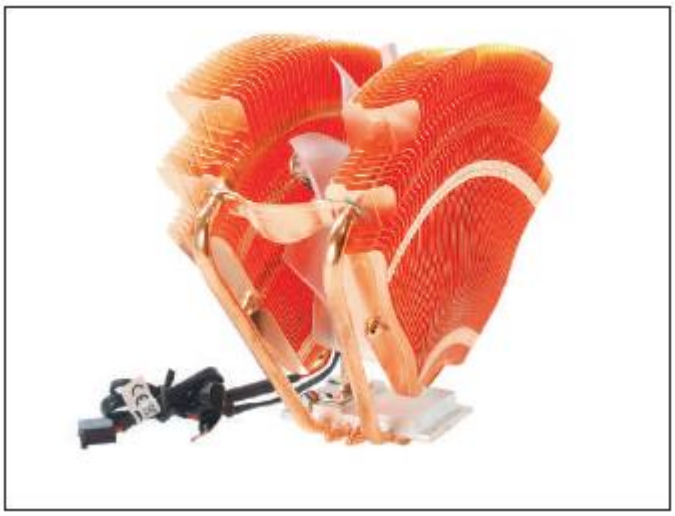

Figure (2) The Thermaltake V1 copper cooler fits Intel LGA1366 and LGA775 and AMD AM2 and AM2+ sockets

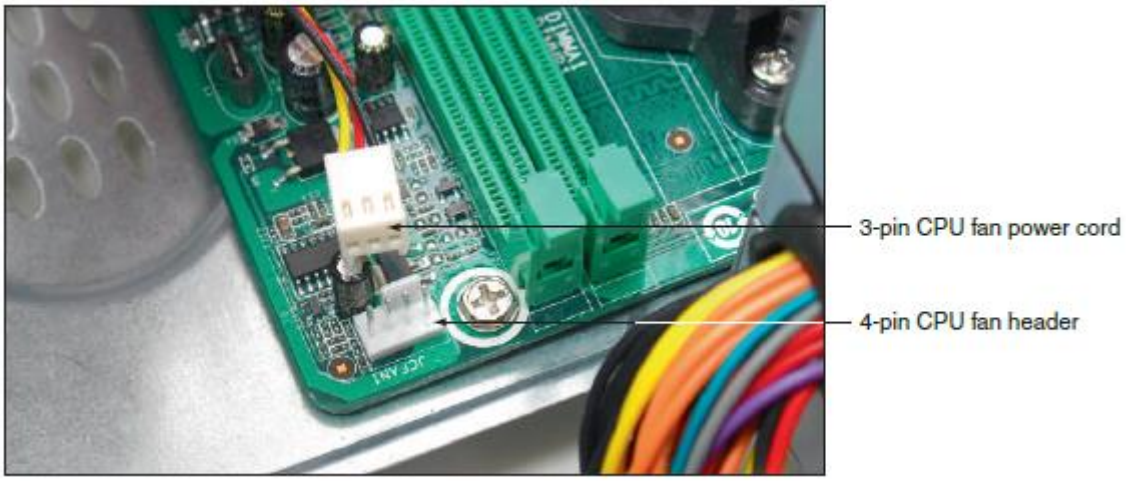

Figure (3) A cooler fan gets its power from a 4-pin PWM header on the motherboard

For enthusiasts trying to run a desktop computer with less noise, a **fanless CPU cooler**, also called a **passive CPU cooler**, can help (see Figure 4). These coolers contain heat pipes, which contain a small amount of liquid that becomes a vapour when heated, and the vapour draws the heat away from the CPU toward the fins on the cooler. There the heat can be blown away by case fans. Most passive CPU coolers are very large, so before you buy one, be sure it will fit in your computer case with all other components installed. Also, most motherboards give a startup error if a cable is not attached to the CPU fan header. Because these coolers don't have a fan cable, you will need to attach

another cable to the header. For some systems, you can connect a case fan to the header.

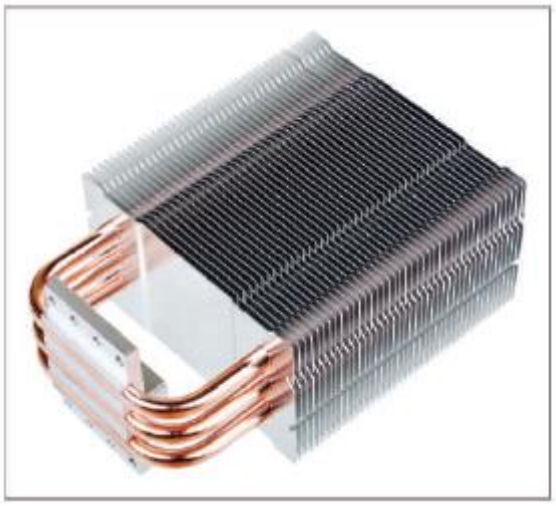

Figure (4) A passive or fanless cooler uses heat pipes to dissipate heat from the CPU

2- Case Fans and Other Fans and Heat Sinks

To prevent overheating, you can also install additional case fans. Most cases have one or more positions on the case to hold a **case fan** to help draw air out of the case. Figure (5) shows holes on the rear of a case designed to hold a case fan.

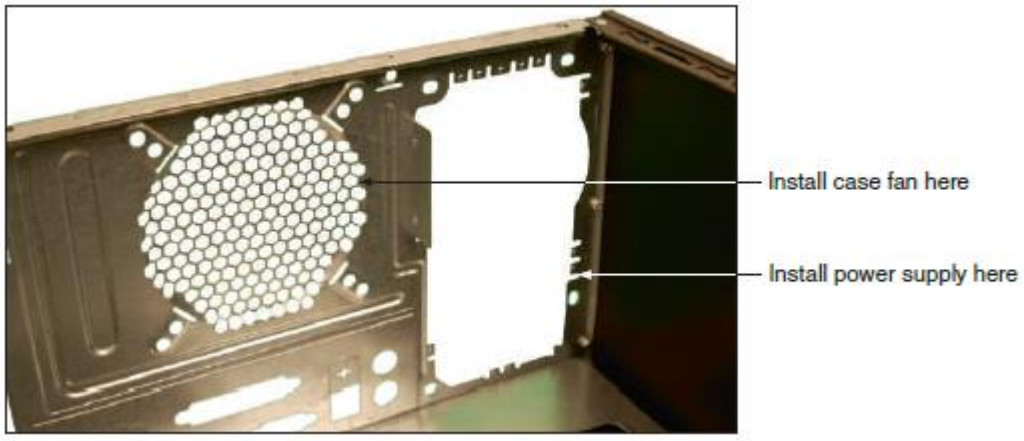

Figure (5) Install a case fan on the rear of this case to help keep the system cool

A computer case might need as many as seven or eight fans mounted inside the case; however, the trend is to use fewer and larger fans. Generally, large fans tend to perform better and run quieter than small fans. Processors and video cards, also called graphics cards, are the two highest heat producers in a system.

Some graphics cards come with a fan on the side of the card. You can also purchase heat sinks and fans to mount on a card to keep it cool. Another solution is to use a fan card mounted next to the graphics card. Figure (6) shows a PCI fan card. Be sure you select the fan card that fits the expansion slot you plan to use, and make sure there's enough clearance beside the graphics card for the fan card to fit. For additional cooling, consider a RAM cooler such as the one shown in Figure (7). It clips over a DIMM. A fan might be powered by a SATA power connector or 4-pin Molex power connector. The fan shown in Figure (7) uses a Molex connector. You can use an adapter to convert a SATA or Molex connector to whichever the power supply provides.

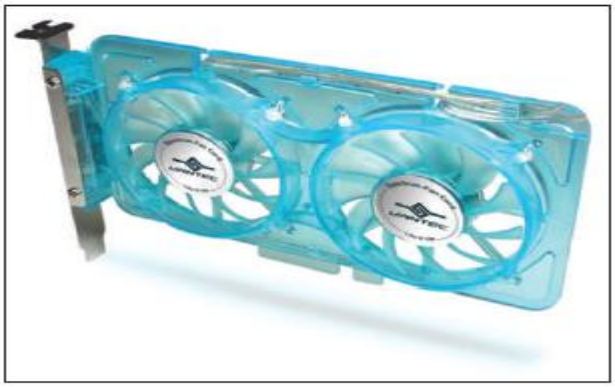

Figure (6) A PCI fan card by Vantec can be used next to a high-end graphics card to help keep it cool

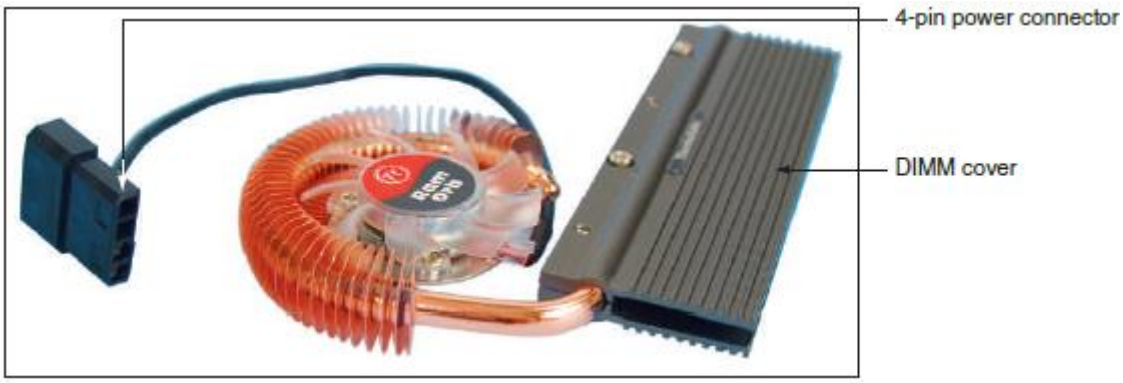

Figure (7) A RAM cooler keeps memory modules cool

When selecting any fan or cooler, take into consideration the added noise level and the ease of installation. Some coolers and fans can use a temperature sensor that controls the fan. Also consider the guarantee made by the cooler or fan manufacturer.

3- Liquid Cooling Systems

In addition to using fans, heat sinks, and thermal compound to keep a processor cool, a liquid cooling system can be used. For the most part, they are used by hobbyists attempting to overclock to the max a processor in a gaming computer. For example, Intel recommends a liquid cooling system for processors that use the LGA2011 socket, which is typically used on hobbyist and gaming computers. Liquid cooling systems tend to run quieter than other cooling methods. They might include a PCIe or PCI card that has a power supply, temperature sensor, and processor to control the cooler. Using liquid cooling, a small pump sits inside the computer case, and tubes move liquid around components and then away from them to a place where fans can cool the liquid, similar to how a car radiator works. Figure (8) shows one liquid cooling system where the liquid is cooled by fans sitting inside a large case. Sometimes, however, the liquid is pumped outside the case, where it is cooled.

Figure (8) A liquid cooling system pumps liquid outside and away from components where fans can then cool the liquid

4- Types and Characteristics of Power Supplies

As you select the right power supply for a system, you need to be aware of the following power supply features:

4.1- ATX or microATX form factor. The form factor of a power supply determines the size of the power supply and the placement of screw holes and slots used to anchor the power supply to the case.

4.2- Wattage ratings. A power supply has a wattage rating for total output maximum load (for example, 500 W, 850 W, or 1000 W) and individual wattage ratings for each of the voltage output circuits. These wattage capacities are listed in the documentation and on the side of a power supply, as shown in Figure (9).

Figure (9) Consider the number and type of power connectors and the wattage ratings of a power supply

When selecting a power supply, pay particular attention to the capacity for the +12 V rail. (A *rail* is the term used to describe each circuit provided by the power supply.) The +12 V rail is the most used, especially in high-end gaming systems. Notice in Figure (9), the +12 V rail gets 360 W of the maximum 525 W load. Sometimes you need to use a power supply with a higher-than-needed overall wattage to get enough wattage on this one rail. Also, a PSU rated 1000 W and higher might have a second +12 V rail and is called a **dual rail** power supply. The extra rail is used for safety to ensure that a single +12 V rail is not overloaded.

4.3- Number and type of connectors. Consider the number and type of power cables and connectors the unit provides. Connector types are shown in Table 1-2 in the First Lecture. Table (1) lists some common connectors and the voltages they supply. Some power supplies include detached power cables that you can

plug into connectors on the side of the unit. By using only the power cables you need, extra power cables don't get in the way of airflow inside the computer case.

Connector	Voltages	Description
SATA	+3.3 V, +5 V, +12 V	Power to SATA drives, 5 pin
Molex	+5 V, +12 V	Power to older IDE drives and used with some older SATA drives, 4 pin
4/8-pin 12 V	+12 V	Auxiliary power to CPU
PCIe 6/8 pin	+12 V	Auxiliary power to PCIe cards
20-pin P1	+3.3 V, ±5 V, ±12 V	Older main power connector to motherboard
24-pin P1	+3.3 V, ±5 V, ±12 V	Newer main power connector to motherboard

Table (1) Power supply connectors and voltages

If a power supply doesn't have the connector you need, it is likely you can buy an adapter to convert one connector to another. For example, Figure (10) shows an adapter that converts two Molex cables to one 12 V 6-pin PCIe connector.

Figure (10) This adapter converts two Molex cables to a single 12 V 6-pin PCIe connector

4.4- Fans inside the PSU. Every power supply has a fan inside its case; some have two fans. The fan can be mounted on the back or top of the PSU. Fans range in size from 80mm to 150mm wide. The larger the fan, the better job it does and the quieter it runs. Some PSUs can automatically adjust the fan speed based on the internal temperature of the system.

Notes Some power supplies are designed without fans so that they can be used in home theater systems or other areas where quiet operation is a requirement.

4.5- Dual voltage options. Expect a power supply to have a dual-voltage selector switch on the back where you can switch input voltage to 115 V for the United States or 220 V for other countries.

4.6- Extra features. Consider the warranty of the power supply and the overall quality. Some power supplies are designed to support two video cards used in a gaming computer. Two technologies used for dual video cards are SLI by NVIDIA and Crossfire by AMD. If you plan to use dual video cards, use a PSU that supports SLI or Crossfire used by the video cards. Know that more expensive power supplies are quieter, last longer, and don't put off as much heat as less expensive ones. Also, expect a good power supply to protect the system against overvoltage. A power supply rated with Active PFC runs more efficiently and uses less electricity than other power supplies.

5- How to Calculate Wattage Capacity

When deciding what wattage capacity you need for the power supply, consider the total wattage requirements of all components inside the case as well as USB and FireWire devices that get their power from ports connected to the motherboard. Keep these two points in mind when selecting the correct wattage capacity for a power supply:

5.1- Video cards draw the most power. Video cards draw the most power in a system, and they draw from the +12 V output. If your system has a video card, pay particular attention to the +12 V rating. The current trend is for the motherboard to provide the video components and video port, thus reducing the overall wattage needs for a system. Video cards are primarily used in gaming computers or other systems that require high-quality graphics.

5.2- The power supply should be rated about 30 percent higher than expected needs. Power supplies that run at less than peak performance last longer and don't overheat. In addition, a power supply loses some of its capacity over time. Also, don't worry about a higher-rated power supply using too much electricity. Components only draw what they need. For example, a power supply rated at 1000 W and running at a 500 W draw will last longer and give off less heat than a power supply rated at 750 W and running at a 500 W draw.

To know what size power supply you need, add up the wattage requirements of all components, and add 30 percent. Technical documentation for these components should give you the information you need. Table (2) lists appropriate wattage ratings for common devices. Alternately, you can use a wattage calculator provided on the website of many manufacturers and

vendors. Using the calculator, you enter the components in your system and then the calculator will recommend the wattage you need for your power supply.

Devices	Approximate Wattage
Motherboard, processor, memory, keyboard, and mouse	200–300 W
Fan	5 W
SATA hard drive	15–30 W
DVD/CD drive	20–30 W
PCI video card	50 W
PCI card (network card, FireWire card, or other PCI card)	20 W
PCIe ×16 video card	150–300 W
PCIe ×16 card other than a video card	100 W

Table (2) To calculate the power supply rating you need, add up total wattage

LEACTURE SUMMARY

- Devices that are used to keep a processor and system cool include CPU coolers and fans, thermal compound, case fans, heat sinks, and liquid cooling.
- Liquid cooling systems use liquids pumped through the system to keep it cool and are sometimes used by hobbyists when overclocking a system.
- Important features of a power supply to consider when purchasing it are its form factor, wattage capacity, number and type of connectors it provides, and warranty.
- To decide on the wattage capacity of a power supply, add up the wattage requirements for all components in a system and then increase that total by about 30 percent. The wattage provided by the +12 V rail is also important.