Fans, heat sinks, and Other cooling components

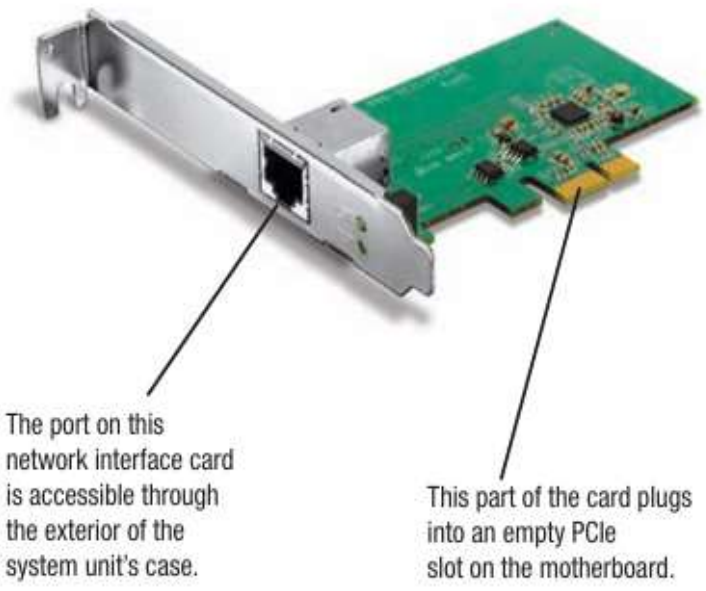
One by-product of packing an increasing amount of technology into a smaller system unit is heat, an ongoing problem for CPU and computer manufacturers. Because heat can damage components and cooler chips run faster, computers and mobile devices today employ cooling techniques to cool the inside of the system unit. Computers traditionally use fans and heat sinks (small components typically made out of aluminum with fins that help to dissipate heat).

- For instance, desktop computers often include a fan on the power supply that can be seen on the back of the computer, a fan on the video graphics board, and a fan and a heat sink on top of the CPU. As devices continue to shrink in size, however, finding room for cooling components is an issue.
- The newest and thinnest notebook computers (such as the MacBook), as well as smartphones and other mobile devices, don't include a fan. Instead, these devices often use mobile CPUs (such as the Intel Core M) that run cooler than desktop CPUs, as well as thermal transfer materials (such as sheets of metal or graphite) inside the system unit to spread out the heat generated by the device components.

- For servers and other computers that require a greater degree of cooling, liquid cooling systems can be used. Conventional liquid cooling systems consist of liquid (often a water solution) filled tubes that draw heat away from processors and other critical components. While more expensive than fans and requiring more room inside the system unit, these systems can cool specific components to a greater degree than fans, can significantly reduce air-conditioning costs in server rooms, and are quieter.
- An emerging possibility for cooling the servers in large data centers—such as the ones used to pro vide cloud services—is immersion cooling where the hardware is actually submerged into units filled with a liquid cooling solution.
- Notebook computers and smartphones may use a thin liquid-filled heat pipe to transfer heat from the CPU and other hot areas to cooler areas inside the system unit. To cool the underside of a notebook computer—one of the problem areas—a notebook cooling stand

Expansion slots and expansion cards

- **Expansion slots** are locations on the motherboard into which **expansion cards** (also called interface cards) can be inserted to connect those cards to the motherboard. Expansion cards are used to give computers additional capabilities, such as to connect a computer to a network, to connect a smartphone or external hard drive to a computer, or to connect a monitor to a computer. Today, some basic capabilities (such as the necessary connectors for speakers and monitors) are often integrated directly into the motherboard instead of requiring the use of an expansion card. However, an expansion card can be added and used when needed. For instance, a video graphics card can be added to a computer to add additional capabilities not allowed by the computer's integrated graphics feature. Most new desktop computers come with a few empty expansion slots on the motherboard so that new expansion cards can be added when new capabilities are needed.



FULL-SIZED PCIe CARDS
(for desktop computers)

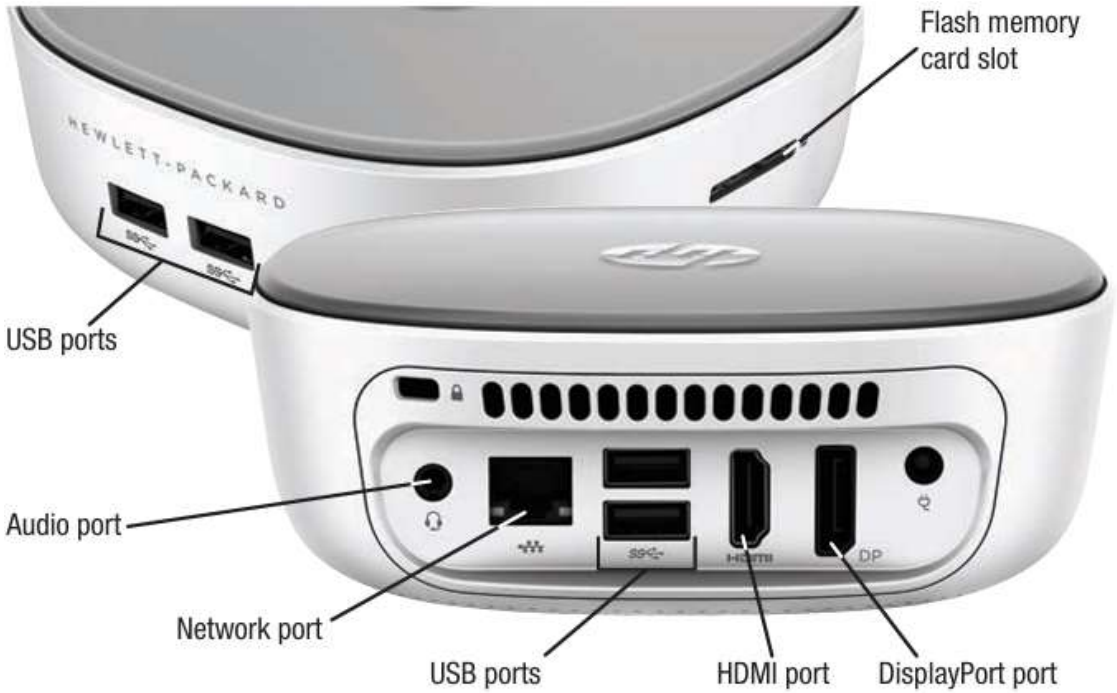
M.2 MINI CARDS
(for portable computers)

USB ADAPTERS
(for any device with an available USB port)

Activate W
Go to Setting

Ports and connectors

Ports are the connectors located on the exterior of a system unit that are used to connect external hardware devices. Each port is attached to the appropriate bus on the motherboard so that when a device is plugged into a port, the device can communicate with the CPU and other computer components. Several of the original ports used with desktop computers—such as the parallel ports traditionally used to connect printers, as well as the keyboard and mouse ports traditionally used to connect keyboards and mice—are now considered legacy ports and so are not typically included on newer computers.


Flash memory card slot
USB ports
Audio port
Network port
USB ports
HDMI port
DisplayPort port

- ***Monitor ports*** are used to connect a monitor to a computer. Traditionally, monitors connected via a VGA connector or Digital Video Interface (DVI) connector. Today, monitors more commonly connect to a desktop or notebook computer via an HDMI (High-Definition Multimedia Interface); to connect an additional monitor to a tablet or other mobile device, a Mini-HDMI port or the even smaller Micro-HDMI port is often used instead.

Monitor (HDMI)

Monitor (VGA)

- **Network ports** are used to connect a computer to a computer network via a networking cable—typically a cable using an RJ-45 connector, which looks similar to a telephone connector.

Network (RJ-45)

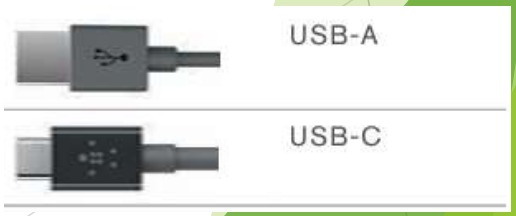
- **IrDA (Infrared Data Association)** ports and Bluetooth ports are used to receive wireless transmissions from devices; because the transmissions are wireless, these ports do not use a plug. IrDA ports are commonly used to "beam" data from a portable computer or mobile device to a computer. Bluetooth ports are most often used with wireless keyboards, mice, speakers, and headsets.
- **Flash memory card slots** are used to connect flash memory cards or other hardware using a flash memory card interface.
- **Audio ports** are used to connect speak ers, headphones, or a microphone to the computer.
- **eSATA (external SATA) ports** are used to connect external SATA devices (most com monly, an external hard drive). External hard drives that connect via eSATA are much faster than external hard drives that connect via a USB.

- **USB ports are used to connect USB devices** (such as keyboards, mice, printers, hard drives, and digital cameras) to a computer via a USB connector. Smaller mini-USB ports or the even smaller micro-USB ports are often included on mobile devices instead of a full-sized USB port to connect USB devices.

In addition to the traditional USB-A ports, there is now a newer USB-C port that is a different size and shape.

To connect multiple USB devices to a single USB port, a **USB hub** can be used. USB hubs are growing in importance as an increasing number of computers and mobile devices are including only USB ports and not many of them.

For example, the newest MacBook has only a single USB-C port that is used to connect peripheral devices as well as to power the device.



- **Thunderbolt ports (available primarily on some Apple devices)** are used to connect peripheral devices (such as storage devices and monitors) via Thunderbolt cables. At 40 Gbps, the latest version of Thunderbolt, Thunderbolt 3, is extremely fast. Up to six devices can be daisy-chained together to connect them via a single Thunderbolt port, and adapters are available to connect USB devices to a Thunderbolt port and vice versa.

- USB and Thunderbolt devices are hot-swappable, meaning they can be plugged into their respective ports while the computer is powered up.

- Tablets have ports similar to desktop and notebook computers, but they often have fewer of them, connecting a tablet to a tablet dock (**a docking station containing ports that can be used with the tablet whenever the tablet is connected to the dock**) can provide additional connectivity options. Smartphones tend to have a more limited amount of expandability. However, they almost always have a USB port; some also have a flash memory card slot.

Source: Microsoft Corporation

Source: Toshiba