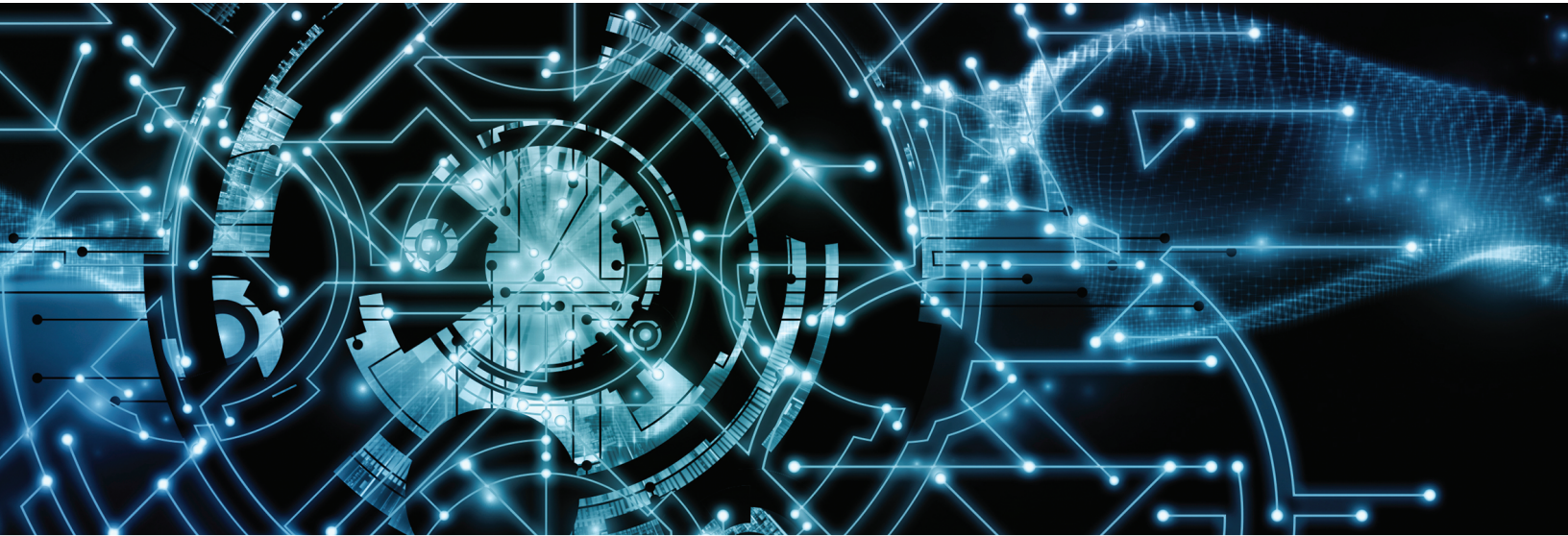


2 Connectivity



In this chapter you will learn:

- > The purpose of various computer ports
- > What types of devices connect to specific ports
- > Symbols and colors associated with particular ports
- > What to do if you don't have a particular port

CompTIA Exam Objectives:

What CompTIA A+ exam objectives are covered in this chapter?

- ✓ 901-1.7 Compare and contrast various PC connection interfaces, their characteristics and purposes, including physical connections, wireless connections, and characteristics of each.
- ✓ 901-1.11 Identify common PC connector types and associated cables including display connector types, display cable types, device cables and connectors, adapters, and converters.
- ✓ 902-5.4 Demonstrate proper communication techniques and professionalism.

Introduction to Connectivity

Now that we know what the basic parts of a PC are, we dive into the technical details. This chapter explores wired and wireless connectivity—specifically, how to connect input and output devices to specific ports. This chapter also explores what to do when things go wrong. Some of the ports may be a challenge at first, but it is important that people going into the IT field know how to connect devices to PCs and mobile devices.

External Connectivity

A **port** is a connector on a motherboard or on a separate adapter that allows a device to connect to a computer. Sometimes a motherboard has ports built directly into the motherboard. A technician must be able to identify these ports readily to ensure that (1) the correct cable plugs into a port and (2) the technician can troubleshoot problems in the right area. All IT professionals should be able to recognize and identify the common ports used today.

Many port connections are either male or female. Male ports have metal pins that protrude from the connector. A male port requires a cable with a female connector. Female ports have holes in the connector into which the male cable pins are inserted.

Some connectors on integrated motherboards are either D-shell connectors or DIN connectors. A **D-shell connector** (sometimes called a D-sub) has more pins or holes on top than on the bottom, so a cable connected to the D-shell connector can be inserted in only one direction and cannot be accidentally flipped upside down. Many documents represent a D-shell connector by using the letters DB, a hyphen, and the number of pins—for example, DB-9, DB-15, or DB-25.

A **mini-DIN-6 connector** is round with small holes and is normally keyed. When a connector is **keyed**, the cable can be inserted only one way. Keyboard and mouse connectors, commonly called PS/2 ports, are examples of mini-DIN connectors. Today, a keyboard and mouse most often connect to USB ports (shown later). Figure 2.1 shows the back of a computer with a motherboard and some of the ports (DVI and VGA) covered later in this chapter. You can see a DIN and two D-shell connectors on the motherboard.

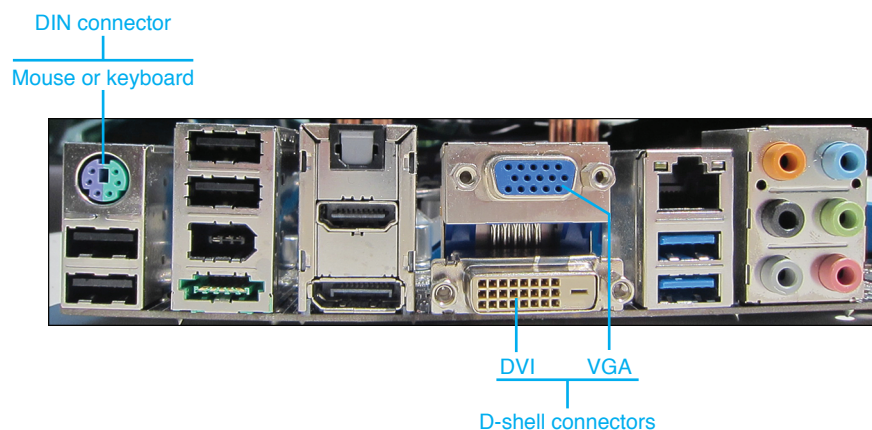


FIGURE 2.1 Mini-DIN and D-shell connectors

Mouse and Keyboard Ports

Mouse and **keyboard ports** have traditionally been 6-pin mini-DIN ports that are sometimes called **PS/2 ports**. Otherwise, USB ports are used for mouse and keyboard connectivity. Many manufacturers color code the PS/2 mouse port as green and the PS/2 keyboard port as purple or they may put a small diagram of a keyboard or a mouse by each connector. Figure 2.2 shows mouse and keyboard connectivity options.

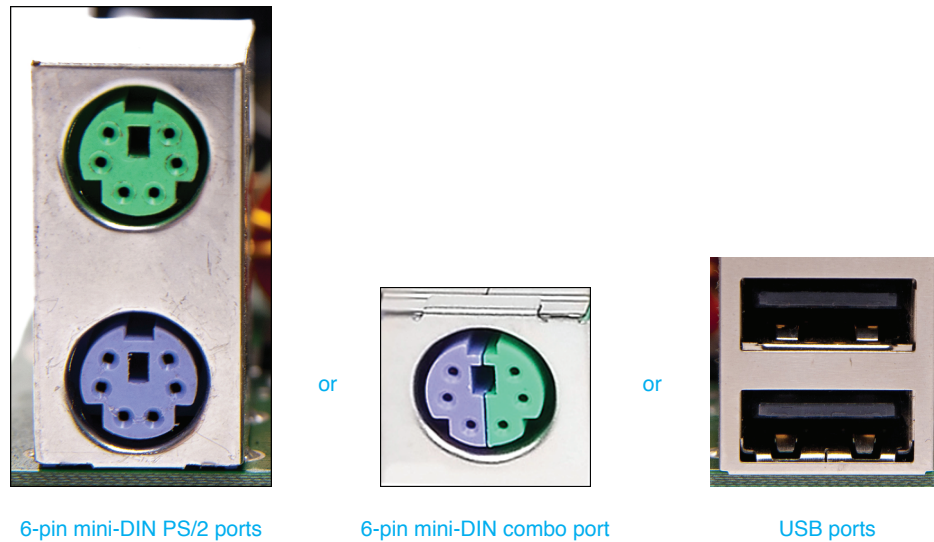


FIGURE 2.2 Mouse and keyboard ports

TECH TIP

Don't confuse the mouse and keyboard ports

On motherboards that have two PS/2 ports, the mouse and keyboard ports are not interchangeable, even if they use the same pin configuration (unless, of course, you have that 6-pin mini-DIN combo port).

Video Ports

A video port is used to connect a display. Video output can be the older method of **analog signal** (varying levels, such as seen with an audio signal) or the newer output method of **digital signal** (1s and 0s). Because the computer uses all digital signals, sending 1s and 0s is more efficient than having to convert the 1s and 0s to an analog signal. This is relevant because there are still video ports around that are designed for analog signals. Figure 2.3 shows the difference between analog and digital signals.

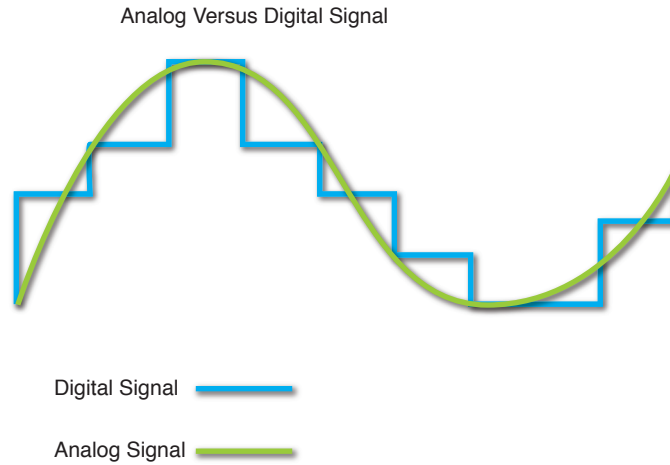


FIGURE 2.3 Analog and digital signals

Cathode ray tube (CRT) monitors were the big bulky ones that looked like old TV sets that accepted analog output from computers. Flat panel monitors accept digital signals. Figure 2.4 shows an older CRT compared to a flat panel monitor.



FIGURE 2.4 CRT monitor and flat-panel monitor

Video Graphics Array (VGA)

The video graphics array (**VGA**) port was designed for analog output to a CRT monitor. VGA ports are easy to identify because they have three rows of holes. The female port is sometimes advertised as an **HD-15** or **DE-15** port. The VGA cable has a **DB-15** male end that attaches to the DE-15 port.

Digital Visual Interface (DVI)

A newer port is a Digital Visual Interface (**DVI**) port, and it has three rows of square holes. DVI ports are used to connect flat panel digital displays. Some flat panel monitors can also use the older VGA port. Some video adapters also enable you to connect a video device (such as a television) that has an **S-Video** port. Figure 2.5 shows a video adapter with all three ports. The left port is the DVI connector, the center port is for S-Video, and the right port is a VGA port.

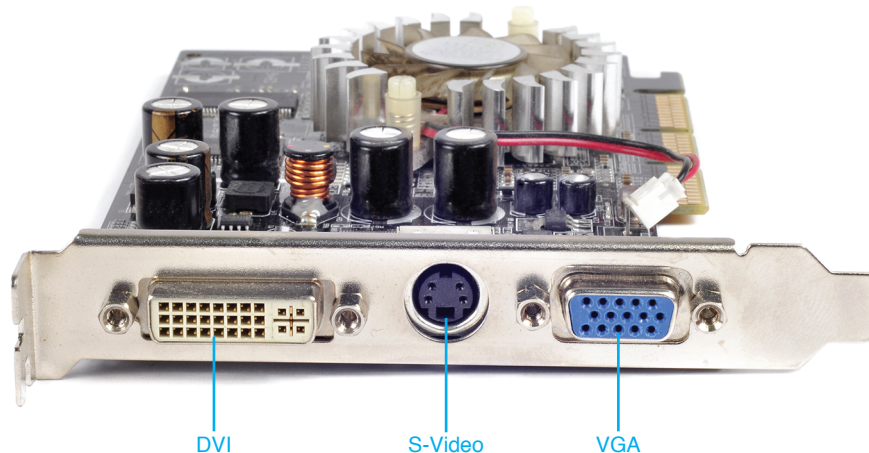


FIGURE 2.5 DVI, S-Video, and VGA ports

There are several types of DVI connectors. The one used depends on the type of monitor attached. Two terms used with these DVI connectors are single link and dual link. A **single link** connection allows video resolutions up to 1920×1080. With a **dual link** connection, more pins are available to send more signals, thus allowing higher resolutions. The two major types of connectors are DVI-D and DVI-I. **DVI-D** is used for digital video connectivity only. **DVI-I** can be used for both digital and analog monitors, and it is the most common. A less common type is **DVI-A**, which is used for analog connectivity and not shown in Figure 2.6 with the other DVI connector types.

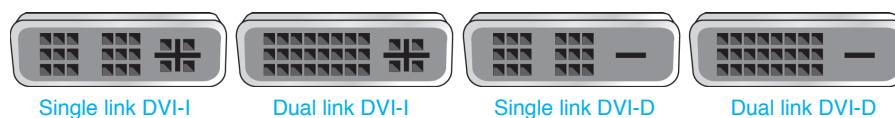


FIGURE 2.6 DVI connectors

TECH TIP

Match a monitor to the DVI port type

Be careful when installing a monitor. Ensure that the video port matches the DVI connection type for the monitor. Converters can be purchased to adapt to a monitor with a VGA port.

DisplayPort

The **DisplayPort** developed by VESA (Video Electronics Standards Association) can send and receive video, audio, or both types of signals simultaneously. The port is designed to primarily output to display devices, such as computer monitors, televisions, and home theaters. A passive converter can be used to convert to a single-link DVI or HDMI port (covered next). You use an active converter to convert to a dual-link DVI.

To understand why an active converter is needed, you must understand the difference between active and passive cables. A **passive cable** is one that does not contain a chip like active cables. **Active cables** have a chip that boosts the signals, thus allowing cables to be thinner and to support sending signals further and faster than passive cables. Active and passive cables are found in computer networks and video systems.

A mini DisplayPort is also available on mobile devices. Figure 2.7 shows the DisplayPort and a cable that would connect to this port.



FIGURE 2.7 DisplayPort

Thunderbolt

An updated port that uses some of the DisplayPort technology is the **Thunderbolt port**. The Thunderbolt interface was developed by Intel with support from Apple. The Thunderbolt port used on Apple computers is the same connector as the mini DisplayPort. Thunderbolt 3 will use the USB Type-C connector shown in the USB section that follows. In addition to carrying video signals, a Thunderbolt cable can also be used to carry audio signals and data to external storage devices. Figure 2.8 shows the current Thunderbolt port and cable.



FIGURE 2.8 Thunderbolt cable and port

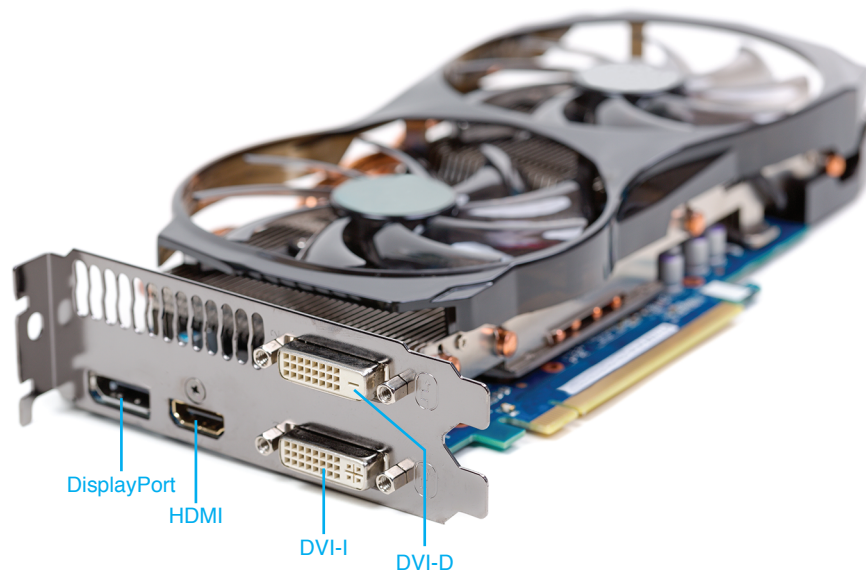
High-Definition Multimedia Interface (HDMI)

Another upgrade to DVI is High-Definition Multimedia Interface (**HDMI**), such as a digital interface that can carry audio and video over the same cable. HDMI is found on cable TV boxes, televisions, video adapters, laptops, desktops, and tablets. **MiniHDMI**, or microHDMI connectors, are used with devices such as cameras, tablets, and smartphones. Table 2.1 describes the different HDMI ports.

TABLE 2.1 HDMI ports

HDMI connector type	Description
A	19-pin port found on a TV or PC that can have a Category 1 (standard) or Category 2 (high-speed) cable attached
B	29-pin port used with very high-resolution displays
C	19-pin mini port (2.42mm × 10.42mm) found on mobile devices
D	19-pin micro port (2.8mm × 6.4mm) found on mobile devices

Figure 2.9 shows a video card that would be used in a gaming computer (one the user plays video games on). On top is a dual-link DVI-D port. On the bottom from left to right are a DisplayPort, HDMI port, and a dual-link DVI-I port. Table 2.2 summarizes important PC video ports for the 901 certification exam.

**FIGURE 2.9** Video ports, including a DisplayPort, HDMI port, and two DVI ports**TABLE 2.2** Video port summary

Port type	Analog (A), Digital (D), or both (B)	Transfer speeds	Carries audio	Max cable lengths
VGA	A	N/A	N	Depends on resolution
DVI	B	Dual-link 7.92Gb/s	N	Up to 15' for display resolutions up to 1280 × 1024
HDMI	D	18Gb/s	Y	Up to 16' for standard cable Up to 49' for high speed with quality cable and connectors
DisplayPort	D	25.92Gb/s	Y	9.8' (passive) 108' (active)
Thunderbolt 20Gb/s (v2) 30Gb/s (v3)	D	10Gb/s 200' optical	Y	9.8' copper (passive)

High-Bandwidth Digital Content (HDCP)

In an effort to prevent piracy, some vendors implement the high-bandwidth digital content protection (**HDCP**) feature on the DVI, DisplayPort, or HDMI port. HDCP is part of Intel's digital rights management (**DRM**) specification, which is designed to protect copyrighted material. What this means is if you are on an Apple MacBook that has this feature, you cannot externally display a legally purchased movie unless the external display is HDCP-capable.

Bayonet Neill-Concelman (BNC)

The last type of connector you might see associated with video, but more likely with cable TV, is a Bayonet Neill-Concelman (BNC) connector. A **BNC connector** is used with **coaxial** cable that is found in video networks such as a school where multiple TVs connect to the same distribution center or in a home that obtains TV channels through a cable provider. A BNC connector has a center conductor that pushes onto the receptacle. Then the metal outside is twisted to snap the connector into place. Figure 2.10 shows a BNC connector.

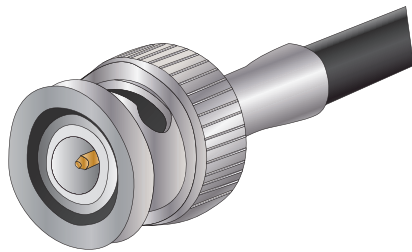


FIGURE 2.10 BNC connector

Video Adapters and Converters

Converters can be purchased for video ports. For example, a **DVI-to-HDMI converter** is shown in Figure 2.11. The figure shows both ends of the same converter. Figure 2.12 shows a VGA-to-DVI converter. Figure 2.13 shows the opposite, the ends of a **DVI-to-VGA converter**. An **HDMI-to-VGA converter** would look like a combination of the left port in Figure 2.11 and the right port in 2.13. Figure 2.14 shows a **Thunderbolt-to-DVI converter**. Finally, Figure 2.15 shows a Thunderbolt-to-VGA converter.



FIGURE 2.11 DVI-to-HDMI converter

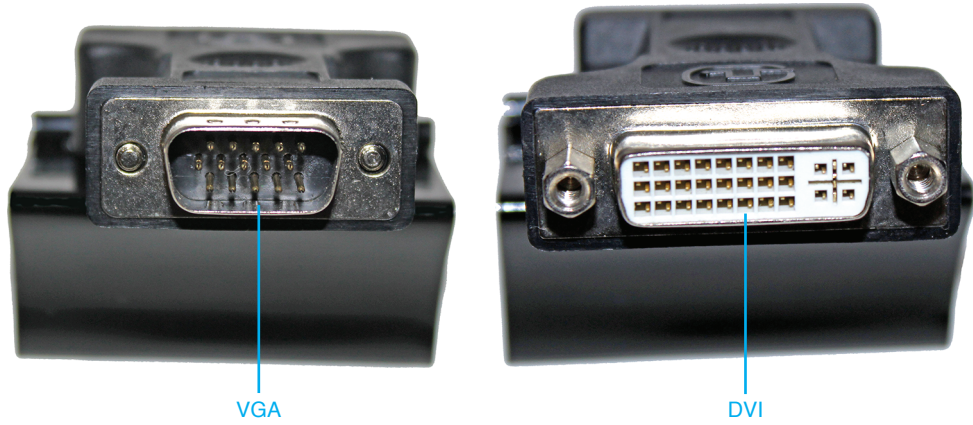


FIGURE 2.12 VGA-to-DVI converter

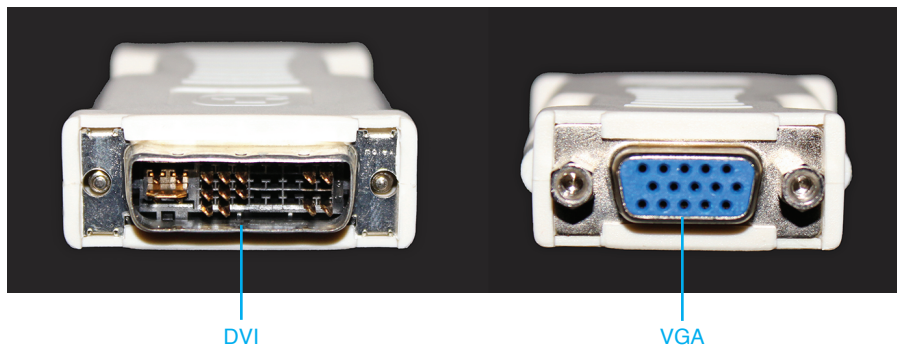


FIGURE 2.13 DVI-to-VGA converter



FIGURE 2.14 Thunderbolt-to-DVI converter

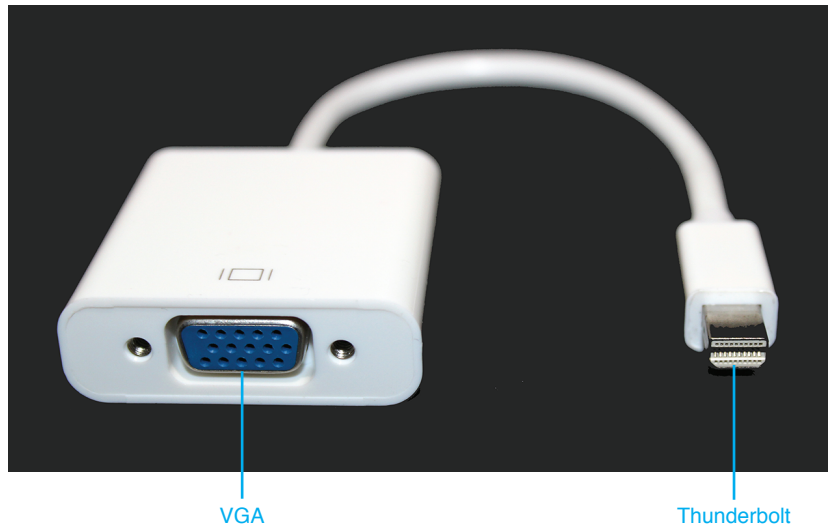


FIGURE 2.15 Thunderbolt-to-VGA converter

An exercise at the end of the chapter provides an opportunity to practice port identification.

USB Ports

USB stands for Universal Serial Bus. A **USB port** allows up to 127 connected devices to transmit at speeds up to 10Gb/s (10 billion bits per second). Devices that can connect to a USB port include printers, scanners, mice, keyboards, joysticks, optical drives, tape drives, game pads, cameras, modems, speakers, telephones, video phones, data gloves, and digitizers. Additional ports can sometimes be found on the front of a PC case or on the side of a mobile device. Figure 2.16 shows some USB ports.

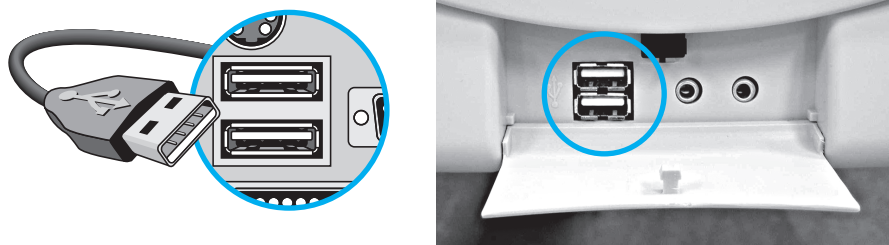


FIGURE 2.16 USB ports

USB Versions

USB ports and devices come in three versions: 1.0/1.1, 2.0 (Hi-Speed), and 3.0 (SuperSpeed). USB 1.0 operates at speeds of 1.5Mb/s and 12Mb/s; version 2.0 operates at speeds up to 480Mb/s. Version 3.0 transmits data up to 5Gb/s. The 3.0 USB port, which still accepts older devices and cables, is colored blue. Version 3.1 increases the speed to 10Gb/s, is backward compatible with prior versions, can deliver more power, and ports are colored teal.

To achieve USB 3.0/1 speeds, however, a 3.0/1 device, 3.0/1 port, and 3.0/1 cable must be used. The version 1 and 2 cables used 4 wires. Version 3 cables use 9 wires. Figure 2.17 shows the different version and speed symbols. Note that the port is not required to be labeled, and sometimes looking at the technical specifications for the computer or motherboard is the only way to determine port speed.

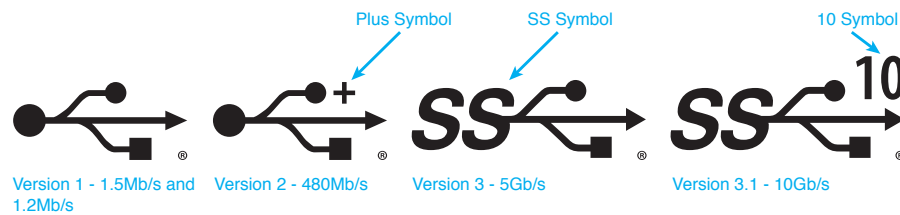


FIGURE 2.17 USB versions, speeds, and symbols

USB Cables

Each USB standard has a maximum cable length:

- > Version 1.0/1.1: 9.8 feet, or 3 meters
- > Version 2.0: 16.4 feet, or 5 meters
- > Version 3.x: 9.8 feet, or 3 meters

USB cables can be longer than these specifications, but the standards are provided to ensure that devices function properly. Sometimes a USB extender cable is needed. Figure 2.18 shows a cable used to extend the length of a standard USB cable.



FIGURE 2.18 USB extension cable

USB Connectors

USB ports are known as upstream ports and downstream ports. An **upstream port** is used to connect to a computer or another hub. A USB device connects to a **downstream port**. Downstream ports are commonly known as **USB Type-A** and **USB Type-B**. A standard USB cable has a Type-A male connector on one end and a Type-B male connector on the other end. The port on the computer is a Type-A port. The Type-A connector inserts into the Type-A port. The Type-B connector attaches to the Type-B port on the USB device. Figure 2.19 shows Type-A and Type-B connectors.

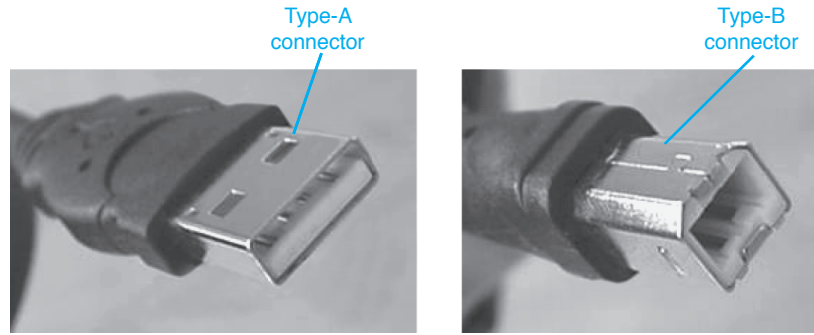


FIGURE 2.19 USB Type-A and Type-B connectors

The USB Type-C connector is the latest connector that will eventually replace the Type-A and Type-B connectors. Older devices use an adapter and the older cables in order to attach to a Type-C connector. Many USB 3.x ports are Type-C connectors, but they do not have to be. Figure 2.20 shows the USB Type-C connector and cable.

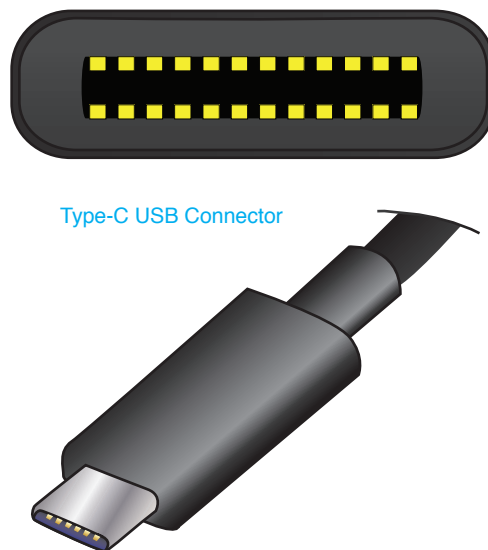


FIGURE 2.20 USB Type-C connector and cable

USB Hubs

A USB port can have more than one device attached to the port through the use of a USB hub. Many hubs can operate in two power modes—self-powered and bus-powered—and a hub may have a switch control that must be set to the appropriate mode. A **self-powered hub** has an external power supply attached. A **bus-powered hub** has no external power supply connected to it. Once USB devices attached to a hub are tested, the hub's power supply can be removed and the devices can be retested. If all attached devices work properly, the hub power supply can be left disconnected. Figure 2.21 shows USB hub connectivity, and Figure 2.22 shows USB cabling rules.

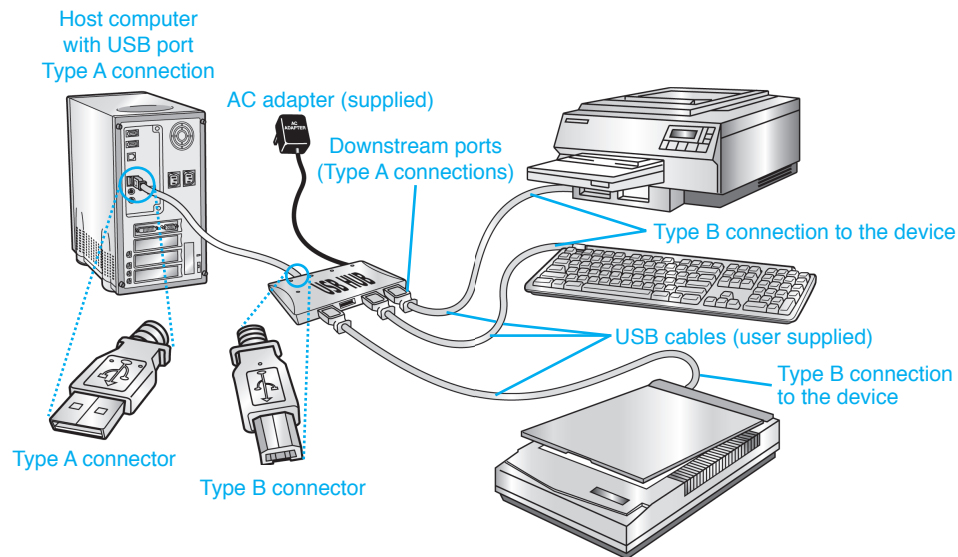


FIGURE 2.21 USB hub connectivity

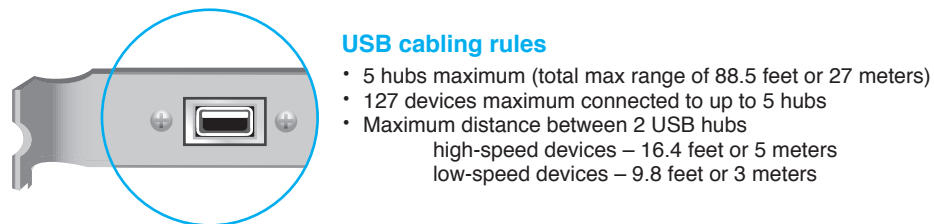


FIGURE 2.22 USB cabling rules

USB ports have always been able to provide power to unpowered devices, such as flash drives. A **charging USB port** is a port designed to be able to provide power- and charge-attached devices. Note that not all USB devices can be powered on while charging. A **sleep-and-charge USB port** is one in which the port still provides power to the device (power to charge the device), even when the computer is powered off. See the computing device's specifications to see if a USB port supports this feature. Table 2.3 summarizes USB speeds, port colors, and alternate names.

TECH TIP

Safely remove USB devices

To remove a USB device, do not simply unplug it from the port. Instead, click on the *Safely Remove Hardware* icon from the notification area and select the USB device to remove. The operating system prompts when it is safe to unplug the device.

TABLE 2.3 USB port summary

Port type	Speed	Port color	Alternate name
USB 1.x	1.5 and 12Mb/s	Usually white	Low speed and full speed
USB 2.0	480Mb/s	Black	High speed
USB 3.0	5Gb/s	Blue	SuperSpeed
USB 3.1 Gen 1	5Gb/s	Blue	SuperSpeed
USB 3.1 Gen 2	10Gb/s	Teal	SuperSpeed+
USB sleep-and-charge	N/A	Yellow, orange, or red	N/A

USB Converters

Converters are available to convert a USB port to a different type of connector (or vice versa), such as PS/2 mouse/keyboard, or mini-DIN. Figure 2.23 shows a **PS/2-to-USB converter** that inserts into a PS/2 mini-DIN connector and allows a USB mouse or keyboard to be connected if the device supports USB. Figure 2.24 shows a USB-to-PS/2 mouse and keyboard connector. Figure 2.25 shows a **USB-to-Ethernet converter** used to connect a device, such as a tablet that has a USB port to a wired network.



FIGURE 2.23 Mini-DIN-to-USB converter

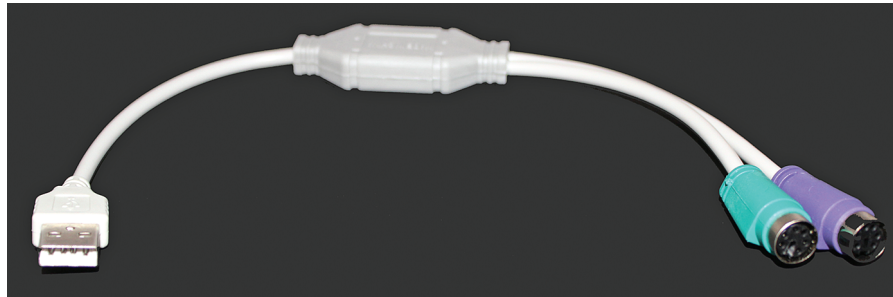


FIGURE 2.24 USB-to-PS/2 mouse and keyboard converter

A smaller USB port used on small devices such as USB hubs, digital cameras, and phones is known as a mini-USB port. There are several types of smaller USB ports: mini-A, mini-AB, micro-B, and micro-AB. The mini-/micro-AB ports accept either a mini-/micro-A or a mini-/micro-B cable end. Figure 2.26 shows the standard Type-A USB port found on a PC compared to the mini-B and micro-B ports found on mobile devices. The micro-USB ports are now a standard interface for smartphones. Figure 2.27 shows a USB 3.0 micro-B connector and port. Figure 2.28 shows a set of USB connectors that can be purchased as a set including a **USB A-to-USB B converter**.



FIGURE 2.25 USB-to-Ethernet converter

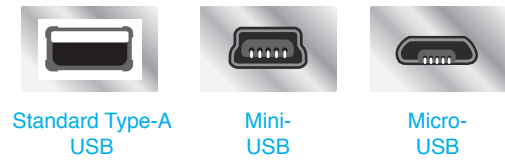


FIGURE 2.26 USB Type-A, mini, and micro ports



FIGURE 2.27 USB micro-B 3.0 port and cable

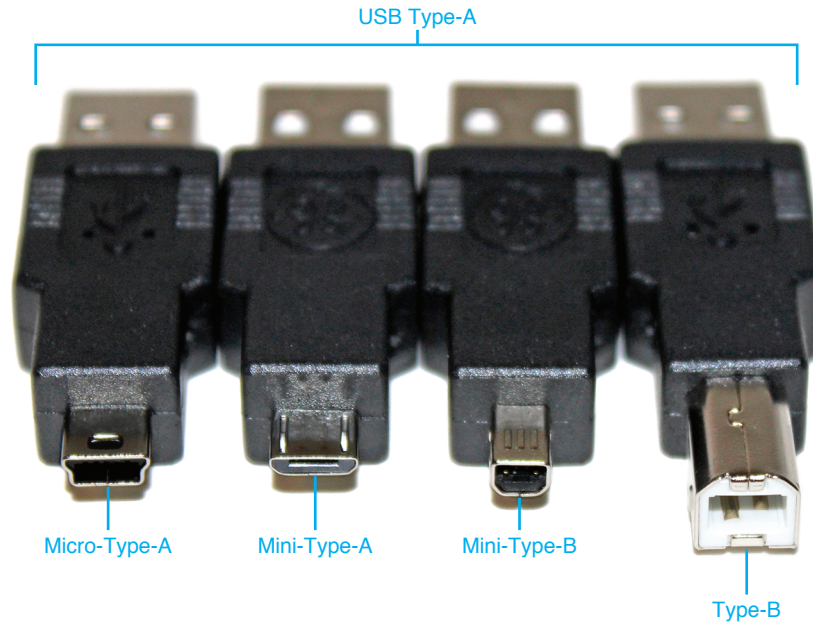


FIGURE 2.28 USB converter kit

Other USB Types

USB has expanded into other fields. **USB OTG** (on-the-go) is a supplement to the USB 2.0 specification and is included in the specification for USB 3.0. Normally with USB, a device that does not have too much intelligence built into it attaches to a host—specifically, a PC. USB OTG allows a USB device, such as an audio player or a mobile phone, to act as the host device. This allows two USB devices to communicate without the use of a PC or a hub. The supplement still allows the USB OTG device to attach to a PC because USB OTG is backward compatible with the USB 2.0 standard.

Certified W-USB (wireless USB) supports high-speed, secure wireless connectivity between a USB device and a PC, at speeds comparable to Hi-Speed USB. Certified Wireless USB is not a networking technology; it is just another way that you can connect your favorite USB devices to a host. You just don't have to plug a cable into a USB port. Wireless USB supports speeds of 480Mb/s at a range up to 3 meters (~10 feet) or 110Mb/s up to 10 meters (~30 feet). Wireless USB uses ultra-wideband low-power radio over a range of 3.1 to 10.5GHz. Figure 2.29 shows the various USB logos that might be found on devices.

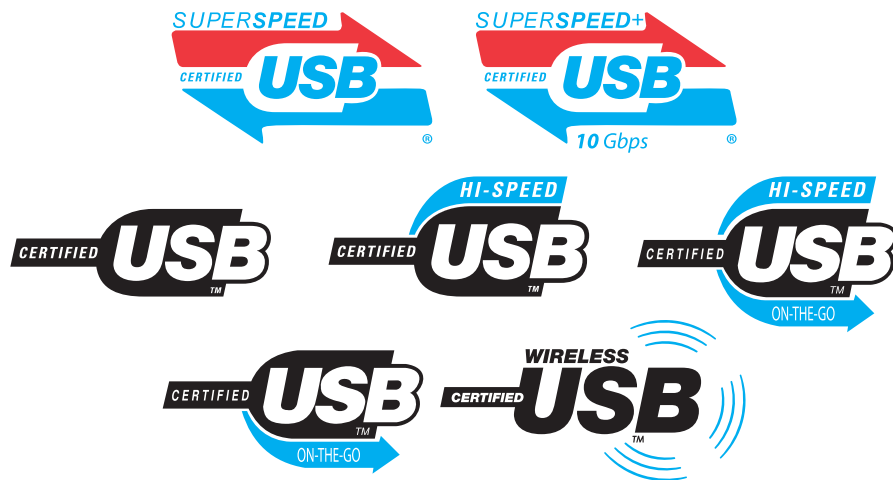


FIGURE 2.29 USB logos

Installing Extra USB Ports

Sometimes people want more USB ports and do not want to add another hub or a hub with more ports. Many motherboards support adding two or more USB ports by using a cable that attaches to motherboard pins, which is also known as a USB header. The ports mount in an expansion slot space, but they do not take an expansion slot. Even if the motherboard has such pins, the ports and cable assembly might have to be purchased separately. Figure 2.30 shows sample USB ports that attach to a motherboard.

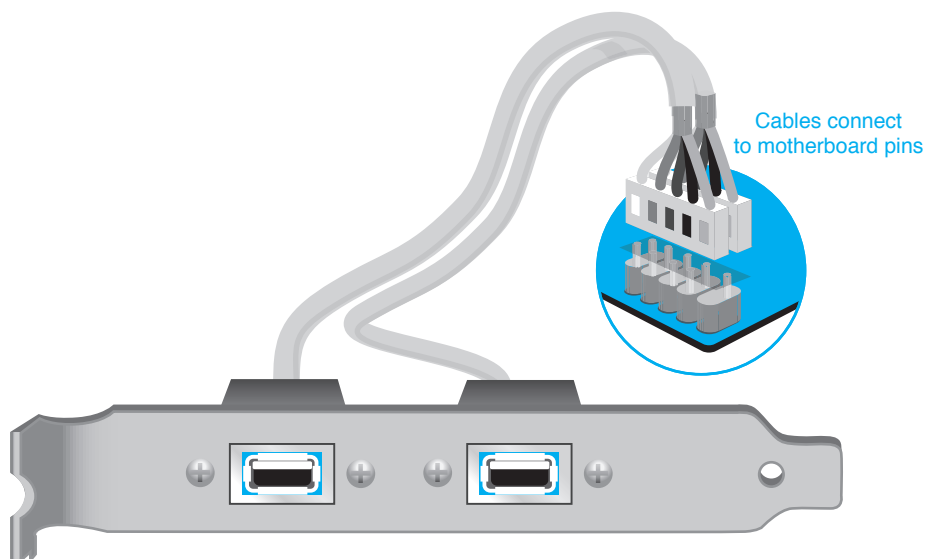


FIGURE 2.30 Installing extra USB ports

Audio Ports

A **sound card** converts digital computer signals to sound and sound to digital computer signals. A sound card is sometimes called an audio card. Sound ports are commonly integrated into the motherboard, but some people want better sound and so they add a card. The most common sound

ports include a port for a microphone, MP3 player, or other audio device and one or more ports for speakers. The ports can accept analog or digital signals. Refer back to Figure 2.3 to see the difference.

The traditional analog sound ports are 3.5mm such as those shown in Figure 2.31. The newer **Sony/Phillips Digital interface (S/PDIF)** in/out ports are on the left in Figure 2.31 and are used to connect to various devices, such as digital audio tape players/recorders, DVD players/recorders, and external disc players/recorders. There are two main types of S/PDIF connectors: an **RCA** jack (last port on the left) used to connect a coaxial cable and a fiber-optic port for a **TOSLINK** cable connection (two optical ports beside the RCA jack in the Figure 2.31). Sound cards are popular because people want better sound quality than what is available integrated into a motherboard.

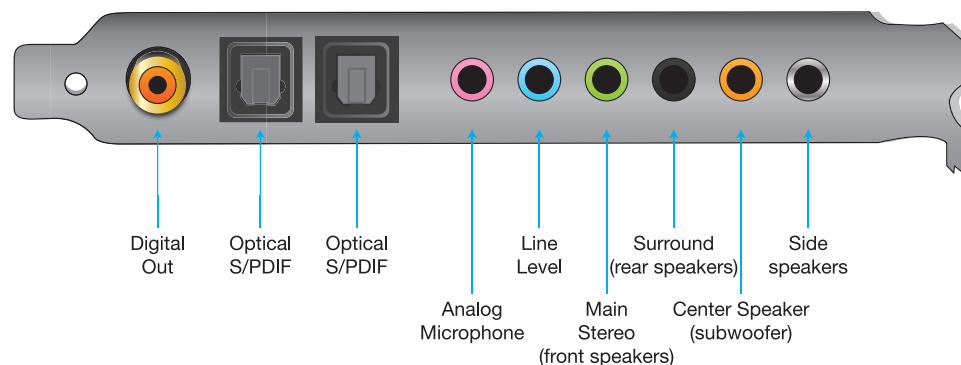


FIGURE 2.31 Sound card ports

IEEE 1394 (FireWire) Ports

The **IEEE 1394** standard is a serial technology developed by Apple Inc. Sometimes it is known as **FireWire** (Apple), **i.Link** (Sony), or **Lynx** (Texas Instruments). **IEEE 1394 ports** have been more predominant on Apple computers, but they are also seen on some PCs. Windows and Apple operating systems support the IEEE 1394 standard. Many digital products have an integrated IEEE 1394 port for connecting to a computer. IEEE 1394 devices include camcorders, cameras, printers, storage devices, video conferencing cameras, optical players and drives, tape drives, film readers, speakers, and scanners.

IEEE 1394 has two data transfer modes: asynchronous and isochronous. The asynchronous mode focuses on ensuring that data is delivered reliably. Isochronous transfers allow guaranteed bandwidth (which is needed for audio/video transfers) but do not provide for error correction or retransmission.

Speeds supported are 100, 200, 400, 800, 1200, 1600, and 3200Mb/s. IEEE 1394 devices commonly include the speed as part of their descriptions or names; for example, a **FireWire 400** device transfers at speeds up to 400Mb/s and a **FireWire 800** device up to 800Mb/s. With FireWire, as many as 63 devices (using cable lengths up to 14 feet) can be connected (daisy-chained). The IEEE 1394 standard supports hot swapping, plug-and-play, and powering of low-power devices.

An IEEE 1394 cable has 4, 6, or 9 pins. A 4-pin cable/connector does not provide power, so the device must have its own power source. The 6- and 9-pin connectors do provide power. A 6-pin connector is used on desktop computers and can provide power to the attached IEEE 1394 device. A 9-pin connector is used to connect to 800Mb/s devices that are also known as IEEE 1394b devices. Figure 2.32 shows an IEEE 1394 port found on PCs, a mini port found on mobile devices, and a 9-pin port found on 800Mb/s IEEE 1394 devices. Figure 2.33 shows three IEEE 1394 ports on an adapter.

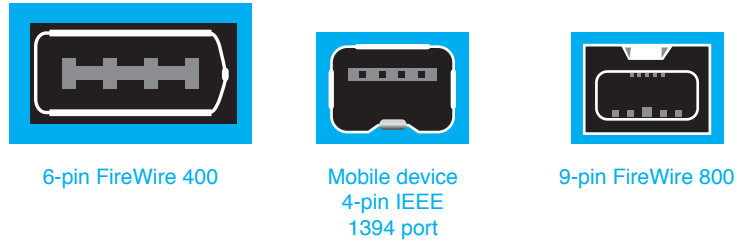


FIGURE 2.32 FireWire ports

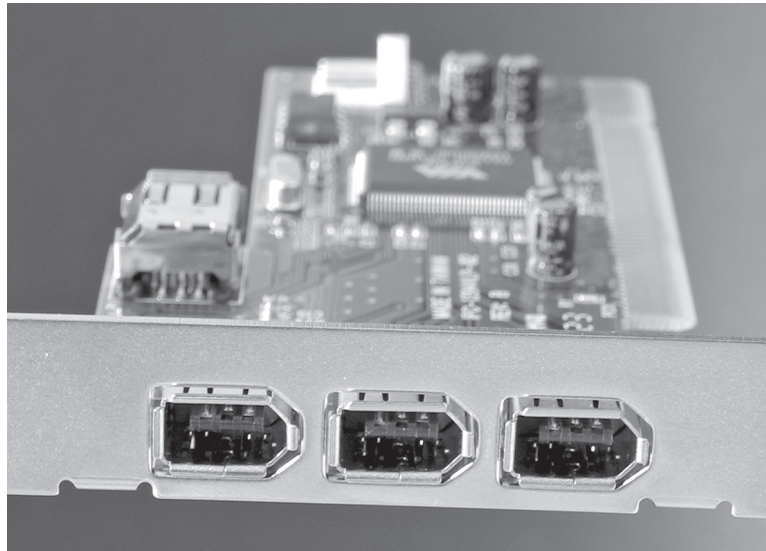


FIGURE 2.33 IEEE 1394 ports on an adapter

An IEEE 1394 device can connect to a port built into the motherboard, an IEEE 1394 port on an adapter, another IEEE 1394 device, or a hub. A motherboard might have pins to connect additional IEEE 1394 ports. IEEE 1394 does not require a PC to operate; two IEEE 1394 devices can communicate via a cable. The IEEE 1394 bus is actually a peer-to-peer standard, meaning that a computer is not needed. Two IEEE 1394-compliant devices can be connected (for example, a hard drive and a digital camera), and data transfer can occur across the bus.

IEEE 1394c devices transmit at 800Mb/s, but instead of using a 9-pin connector, they have an RJ-45 connector, such as an Ethernet port (shown later in this chapter, in the “Network Ports” section). The IEEE 1394d standard uses a fiber connection. Table 2.4 provides a summary of the different IEEE 1394 standards.

TABLE 2.4 IEEE 1394 standards

Standard	Other names	Description	Cable
IEEE 1394	S100, S200, S400, and FireWire 400	Speeds of 100, 200, or 400Mb/s half-duplex (one transmission direction at a time); 6-pin connector (later named the Alpha connector)*	~15 feet (4.5 meters) on a single cable; up to 60 feet (18 meters) with extra cables and a repeater
IEEE 1394a	S100, S200, S400, and FireWire 400	Added a 4-pin nonpowered connector	See IEEE 1394

Standard	Other names	Description	Cable
IEEE 1394b	S800, S1600, S3200, and FireWire 800	Speeds up to 3200Mb/s; added a 9-pin (Beta) connector and CAT5e or better UTP (unshielded twisted pair) cable*	~15 feet (4.5 meters) on a single cable; 330 feet (100 meters) with CAT5e or better or optical cable
IEEE 1394c	S800T	Up to 800Mb/s over CAT5e or better UTP cable*	See IEEE 1394b
IEEE 1394d	N/A	Added support for single-mode fiber	N/A

*See Chapter 18 for more information on half-duplex and CAT UTP cabling.

Figure 2.34 shows a USB and two IEEE 1394 connectors. The leftmost connector is the Type-A USB connector. The center connector is the 9-pin FireWire 800 connector. The right connector is a 6-pin FireWire 400 cable.

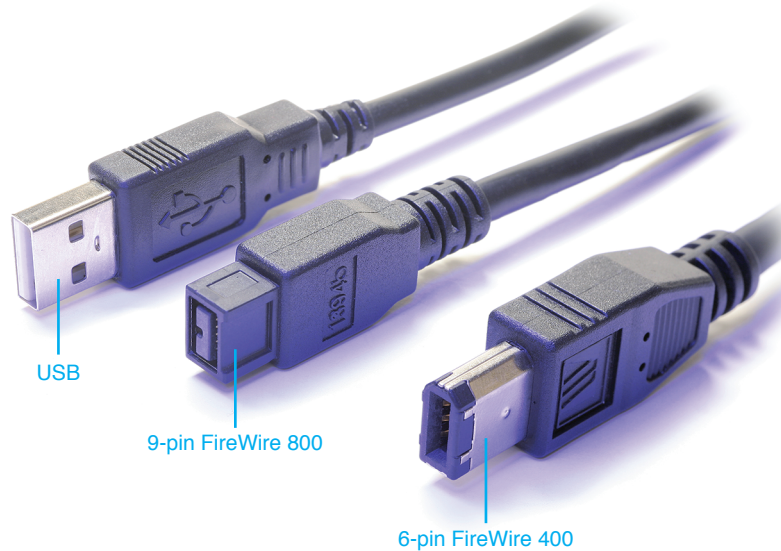


FIGURE 2.34 USB and IEEE 1394 cables

TECH TIP

What if I don't have the right IEEE 1394 cable?

FireWire devices can have three types of connectors—4-, 6-, and 9-pin connectors. A 4-pin cable does not provide for voltage over the IEEE 1394 bus. Placing a 6-pin connection on a FireWire 800 cable reduces connection speeds to a maximum of 400Mb/s. Converters can be purchased to convert 4- to 6-pin or 6- to 9-pin connectors.

eSATA Ports

SATA (serial AT attachment) is used for connecting storage devices such as hard drives or optical drives. eSATA can transfer data at 600MB/s. A 7-pin nonpowered external SATA (**eSATA**) port is used to connect external storage devices to computers at a maximum of approximately 6.6 feet or 2 meters. An eSATA port is commonly found on laptops to provide additional storage. If the

internal hard drive has crashed, an external drive connected to an eSATA or USB port could be used to boot and troubleshoot the system.

A variation of the eSATA port is the **eSATAp port**, which is also known as eSATA/USB or power over eSATA. This variation can accept eSATA or USB cables and provides power when necessary. Figure 2.35 shows a standard eSATA port and an eSATAp (eSATA/USB combination) port.



FIGURE 2.35 eSATA and eSATAp ports

Network Ports

Network ports are used to connect a computer to other computers, including a network server. The most common type of network port is an **Ethernet port**. A network cable inserts into the Ethernet port to connect the computing device to the wired network. A network port or an adapter that has a network port is commonly called a **NIC** (network interface card/controller).

Ethernet adapters commonly contain an **RJ-45** port that looks like an **RJ-11** phone jack, as shown in the next section, but the RJ-45 connector has 8 conductors instead of 4. UTP (unshielded twisted pair) cable connects to the RJ-45 port so the computing device can be connected to a wired network. An RJ-45 Ethernet port can also be found on external storage devices. A storage device could be cabled to the wired network in the same fashion as the PC. Figure 2.36 shows an Ethernet NIC with an RJ-45 port.

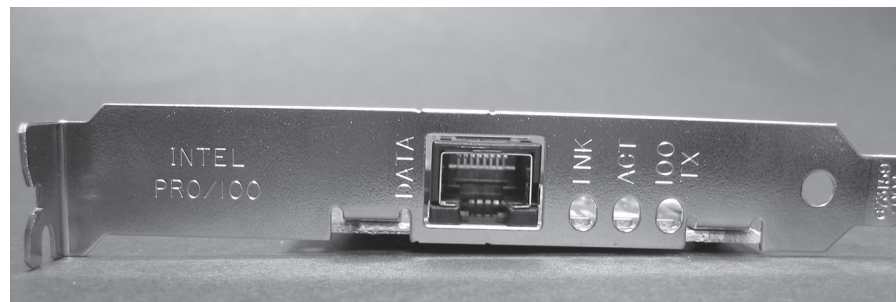


FIGURE 2.36 An RJ-45 Ethernet port

TECH TIP

Ethernet port symbols

Ethernet ports may not have any symbol above the port or one of the following:



Modem Ports

A **modem** connects a computer to a phone line. A modem can be internal or external. An internal modem is an adapter that has one or two **RJ-11** phone jack connectors. An external modem is a

separate device that sits outside the computer and connects to a 9-pin serial port or a USB port. The external modem can also have one or two RJ-11 connectors. The RJ-11 connectors look like typical phone jacks. With two RJ-11 connectors, one can be used for a telephone and the other has a cable that connects to the wall jack. The RJ-11 connector labeled *Line* is for the connection to the wall jack. The RJ-11 connector labeled *Phone* is for the connection to the phone. An internal modem with only one RJ-11 connector connects to the wall jack. Figure 2.37 shows an internal modem with two ports.

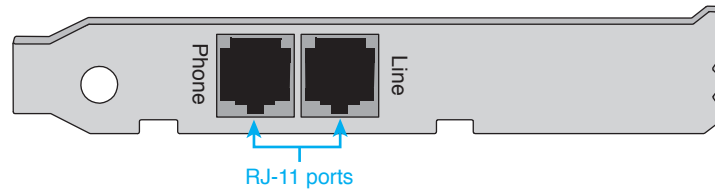


FIGURE 2.37 An internal modem with two RJ-11 ports

Integrated Motherboard Ports

An integrated motherboard provides expandability because ports are built in and do not require separate adapters. If a motherboard includes the USB, network, sound, keyboard, mouse, and video ports, there is more space available for other adapters. The number of available expansion slots in a system depends on the motherboard manufacturer. Figure 2.38 shows integrated motherboard ports.

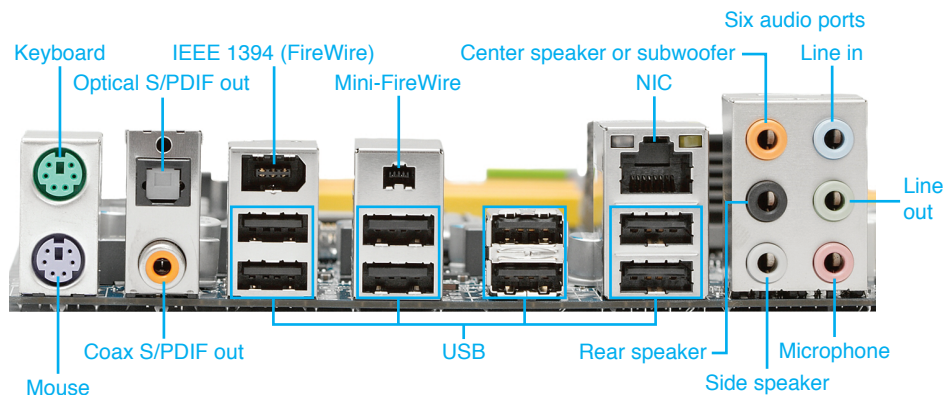


FIGURE 2.38 Integrated motherboard ports

Ports built into a motherboard are faster than those on an expansion board. All adapters in expansion slots run slower than the motherboard components. Computers with integrated motherboards are easier to set up because you do not have to install an adapter or configure the ports. Normally, systems with integrated motherboards are easier to troubleshoot because the components are on one board. The drawback is that when one port goes bad, you have to add an adapter that has the same type of port as the one that went bad. Furthermore, ports found on an adapter might be of higher quality or have more capabilities than an integrated port. See Figure 2.39.

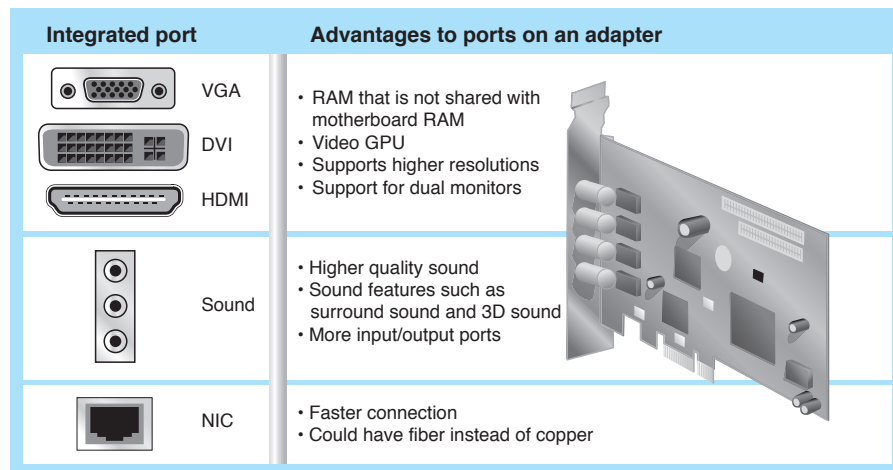


FIGURE 2.39 Advantages of adapters

Getting to Know Ports

Being able to identify ports quickly and accurately is a critical skill in computer repair. Table 2.5 lists the most common computer ports.

TABLE 2.5 Common ports

Port	Usage	Port color code	Common connector
PS/2 mouse	Mouse	Green	6-pin mini-DIN
PS/2 keyboard	Keyboard	Purple	6-pin mini-DIN
IEEE 1394	Camcorder, video recorder, camera, printer, optical drive, scanner, speaker, hard drive	Gray	4-, 6-, or 9-pin IEEE 1394
USB	Printer, mouse, keyboard, camera, scanner, digitizer, external hard drive, optical drive	Black or blue	USB Type-A, Type-B, Type-C, mini-USB, micro-USB
Video	Analog monitor (VGA or higher)	Blue	3-row 15-pin female D-shell or mini-VGA port
Video	DVI digital or analog monitor	White	3-row 18- or 24-pin female DVI, mini-DVI, or micro-DVI
Video	HDMI digital audio and video monitor	N/A	19- or 29-pin HDMI, mini-HDMI, or micro-HDMI
Video	DisplayPort digital audio and video monitor	N/A	20-pin DisplayPort or mini-DisplayPort
Video	Thunderbolt	N/A	20-pin DisplayPort or mini-DisplayPort
Audio	Analog audio input	Light pink	1/8-inch (3.5mm) jack
Audio	Analog line level audio input	Light blue	1/8-inch (3.5mm) jack
Audio	Analog line level audio output from main stereo signal	Lime green	1/8-inch (3.5mm) jack
Audio	Analog line level audio for right-to-left speaker	Brown	1/8-inch (3.5mm) jack

Port	Usage	Port color code	Common connector
S/PDIF	Audio input/output	Orange	RCA jack (coax) or TOSLINK (fiber)
Ethernet	UTP network	N/A	8-conductor RJ-45
Modem	Internal modem or phone	N/A	4-conductor RJ-11
eSATA	External storage devices	N/A	7-pin eSATA port
eSATAp	External devices	N/A	Combination eSATA/USB port

Table 2.6 has older computer ports that you might still see, but they are not on the A+ certification any more.

TABLE 2.6 Older ports

Port	Usage	Port color code	Common connector
Parallel	Printer, tape backup	Burgundy (dark pink)	25-pin female D-shell
Serial	External modem, digitizer	Teal or turquoise	9-pin male D-shell
S-Video	Composite video device	Yellow	7-pin mini-DIN
Game port/MIDI	Joystick or MIDI device	Gold	15-pin female D-shell

Wireless Connectivity for Input Devices

Many input devices, such as keyboards, mice, game pads, touch pads, and headphones, have wireless connectivity. Technologies used to connect without a cord include infrared, radio, Bluetooth, and near field communication (NFC). Many computing devices, especially smartphones and other mobile devices, have cordless connectivity integrated into the device; otherwise, a transceiver is connected to a USB port to allow connectivity to the computing device. Figure 2.40 shows a wireless presenter used with a computing device and a projector.



FIGURE 2.40 Wireless presenter

Table 2.7 summarizes the various wireless technologies used with **input and output** devices.

TABLE 2.7 Wireless input/output technologies

Technology	Description
Infrared (IR)	Used for very short distances. Cheaper than other technologies.
Radio	Works in the 27 or 900MHz, or 2.4, 5, or 60GHz radio frequency range. Longer distances are supported than with infrared.
Bluetooth	Includes 128-bit security and works in the 2.4GHz range. There are three classes of devices, with ranges up to 19.6 feet (6 meters), 72.1 feet (22 meters), and 328 feet (100 meters). Up to eight devices can be connected in a master-slave relationship, with only one device being the master.
Near Field Communication (NFC)	Used to print from a phone or a camera or to transfer data between two smartphones that are positioned very close to one another (less than 6 inches). Works in the 13.56MHz range at transfer speeds up to 424kb/s.

SOFT SKILLS—USE APPROPRIATE TITLES

The Internet and mobile devices have brought us new methods of communication. In today's social media world, communication tends to be more casual with people using colloquialisms, slang, and other language habits that aren't necessarily professional. In addition, acronyms, such as HAGD, LOL, BTW, NRN, TYVM, and YMMD are examples of what some people use regularly to communicate, and it bleeds over into emails, notes, text messages, and memos.

Many places of business are returning to the basics when it comes to customer service, and these businesses expect you as an IT professional to use professional communication methods. People expect the IT department to up its game by using more professional communication skills. This has translated into improved soft skills that are emphasized during the hiring process. For example, the expectation is that IT personnel use appropriate titles such as Dr., Mr., Professor, and Ms. when talking to non-IT personnel, including external vendors. In the work environment, you should use a person's title, sir, or ma'am until the person you are addressing tells you otherwise. Figure 2.41 shows a couple of examples.

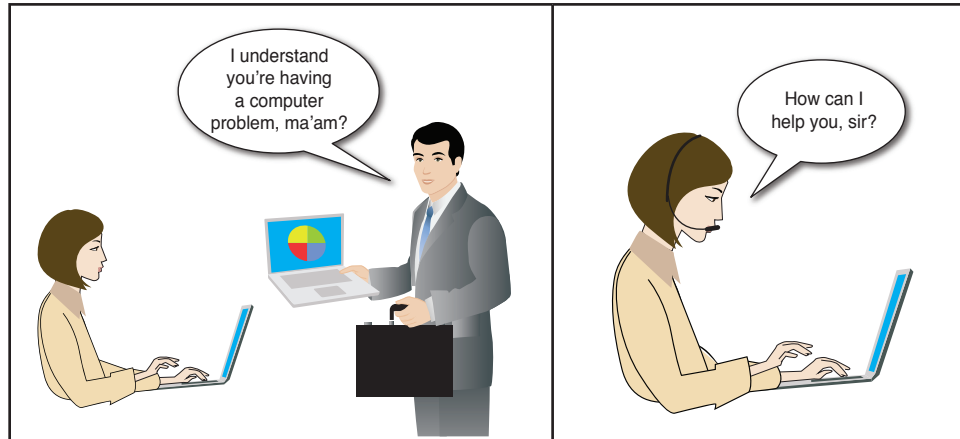


FIGURE 2.41 At work, use appropriate salutations

Chapter Summary

- > Easily identify various ports to determine which device attaches to them: VGA, DVI, HDMI, DisplayPort, Thunderbolt, USB, IEEE 1394, 3.5mm sound jack, TOSLINK, RCA jack, PS/2, RJ-45, eSATA, and RJ-11.
- > The most popular method for adding devices to desktops, laptops, and tablets is to use a USB port.
- > USB 3.0/3.1 will accept 3.0/3.1 and older devices and provide more power. You can add additional ports by connecting a USB hub.
- > Up to five USB hubs can be daisy-chained to one port. Upstream ports connect to the computer or another USB port. Devices connect to downstream ports.
- > USB hubs can be self-powered or bus powered.
- > IEEE 1394 devices do not have to have a computer port and can be cabled to each other; otherwise, an IEEE 1394 device can be cabled to a port or a hub.
- > Converters are available for display ports, such as DVI to VGA.
- > Converters are available for USB ports, such as USB Type A to mini-Type-A.

- > Audio ports can be analog or digital. S/PDIF ports are digital. There are two types of S/PDIF ports: TOSLINK and fiber.
- > Input devices can connect to the computer using four wireless technologies: IR, radio, Bluetooth, or NFC.
- > When speaking with others, use appropriate professional titles when appropriate.
- > Some vendors implement the **HDCP** feature on the video port. HDCP protects copyrighted material.

A+
CERTIFICATION
EXAM TIPS

- ✓ Know what port(s) a device can use. Particular ports to know include HDMI, VGA, DVI, DisplayPort, Thunderbolt, USB, IEEE 1394, eSATA, eSATAp, PS/2, RJ-45, RJ-11, and Ethernet. (On 3x5 cards, write the names of ports you have a hard time remembering. Put a picture of the port on one side and the term on the other. Take the cards with you wherever you go the week before the exam and practice with them.)
- ✓ The following communication and professionalism skills are part of the 220-902 exam: Be culturally sensitive and use appropriate professional titles when applicable.

Key Terms

active cable.....x	eSATAp port.....x	PS/2-to-USB converter.....x
analog signalx	Ethernet port.....x	radiox
Bluetooth.....x	FireWirex	RCAx
BNC connector.....x	FireWire 400x	RJ-11x
bus-powered hubx	FireWire 800x	RJ-45x
Certified W-USBx	HD-15x	self-powered hub.....x
charging USB portx	HDCP.....x	single link.....x
coaxialx	HDMI.....x	sleep-and-charge USB port... x
D-shell connectorx	HDMI-to-VGA converter....x	sound cardx
DB-15.....x	IEEE 1394.....x	S/PDIF.....x
DE-15.....x	IR.....x	Thunderbolt portx
digital signal.....x	keyboard portx	Thunderbolt-to-DVI
DisplayPortx	keyedx	converter.....x
downstream port.....x	mini-DIN-6 connector.....x	TOSLINK.....x
DRMx	miniHDMI.....x	upstream portx
dual linkx	modem.....x	USB OTG.....x
DVI portx	mouse port.....x	USB portx
DVI-to-HDMI converterx	network port.....x	USB-to-Ethernet converter...x
DVI-to-VGA converterx	NFC.....x	USB A-to-USB B converter.. x
DVI-Ax	NIC.....x	USB Type-Ax
DVI-Dx	passive cablex	USB Type-Bx
DVI-I.....x	portx	USB Type-Cx
eSATAx	PS/2 port.....x	VGA portx

Review Questions

1. Match the port to the description.

___ DVI	a. Ethernet
___ VGA	b. TOSLINK
___ PS/2	c. up to 127 devices
___ USB	d. mouse/keyboard
___ NIC	e. CRT
___ S/PDIF	f. flat panel monitor
2. What is one visual indication that a USB port can be used to charge a mobile device?

3. What is a visual indication that a port is USB version 3.0?

4. What is another name for IEEE 1394?

5. How is an eSATAp port different from an eSATA port?

6. When considering VGA, HDMI, DVI, DisplayPort, and Thunderbolt, which video port can output both digital audio and video signals and is the most technologically advanced?

7. What is the most common DVI port?

8. Which has the faster transfer time when connected externally to a computer, USB 3.0, or FireWire 800?

9. What are the two ports most commonly used to attach a keyboard?

10. Describe the physical difference between an analog sound port and a digital one.

11. List two titles that might be used in the workplace that are not sir or ma'am.

12. You see a port on a computer that you have never seen before. There are no markings. How will you determine the purpose of the port?

13. What type of port uses an RJ-45 connector? [Ethernet | modem | display | keyboard]

14. List one reason why using professional titles is important to an IT person.

15. Which adapter would be used to convert from an analog signal to a digital one? [VGA to DVI-D | DVI-I to HDMI | Thunderbolt-to-DVI-I | S-Video to VGA]?

16. Which USB port type is commonly found on a PC?

17. In addition to carrying video signals, which cable can also carry audio and be used to connect external storage devices? [HDMI | DVI-I | Thunderbolt | DIN]

18. In which of the following situations would Bluetooth most likely be used?
 - a. To connect to a corporate wireless network
 - b. To attach a keyboard to a PC
 - c. To connect a PC to a phone line
 - d. To connect a flash drive to a camera
19. List one advantage of having an adapter rather than an integrated motherboard port. Answers will vary, but normally it is because the user wants better quality than offered by the port integrated into the motherboard. Common ports added are sound, video, and network card.
20. Draw one symbol you might see above an Ethernet port.

Exercises

Exercise 2.1 Computer Port Identification

Objective: To identify various computer ports correctly

Procedure: Identify each computer port in Figure 2.42.

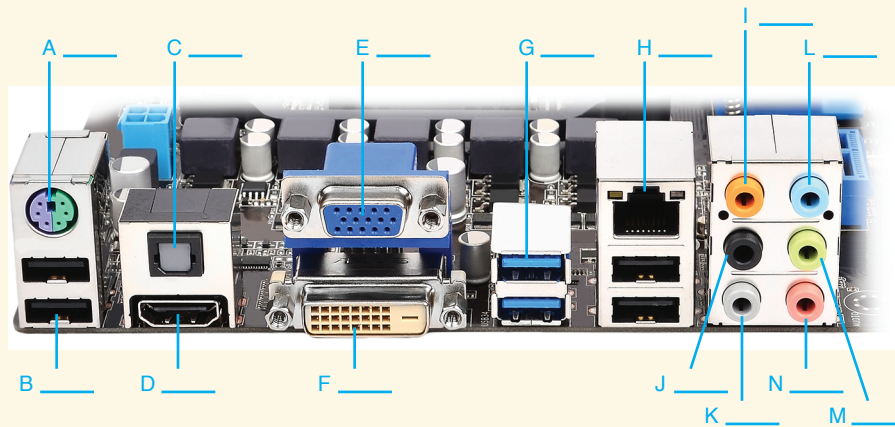


FIGURE 2.42 Identify Motherboard Ports

- | | |
|----------|----------|
| A. _____ | H. _____ |
| B. _____ | I. _____ |
| C. _____ | J. _____ |
| D. _____ | K. _____ |
| E. _____ | L. _____ |
| F. _____ | M. _____ |
| G. _____ | N. _____ |

Exercise 2.2 More Computer Port Identification

Objective: To identify various computer port using graphics

Procedure: Identify each computer port in Figure 2.43.

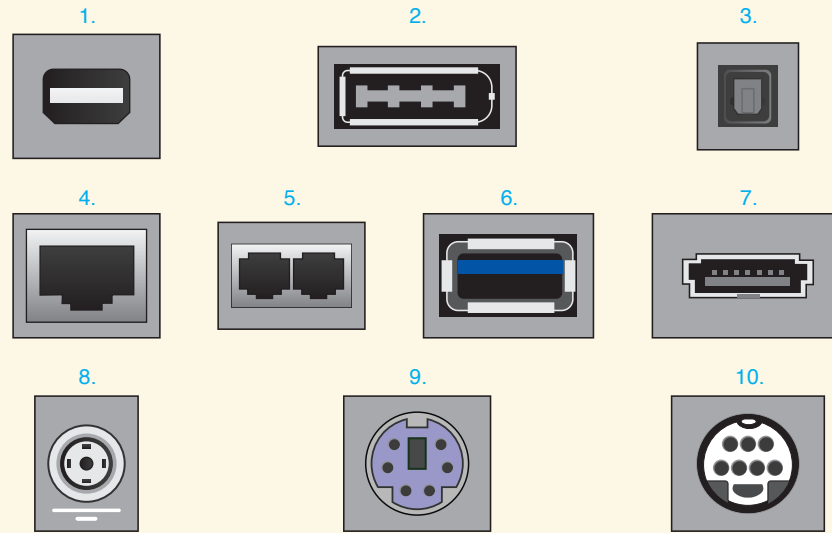


FIGURE 2.43 Identify computer port graphics

- | | |
|----------|-----------|
| 1. _____ | 6. _____ |
| 2. _____ | 7. _____ |
| 3. _____ | 8. _____ |
| 4. _____ | 9. _____ |
| 5. _____ | 10. _____ |

Exercise 2.3 Display Port Identification

Objective: To identify various display ports correctly

Procedure: Identify each display port in Figure 2.44.

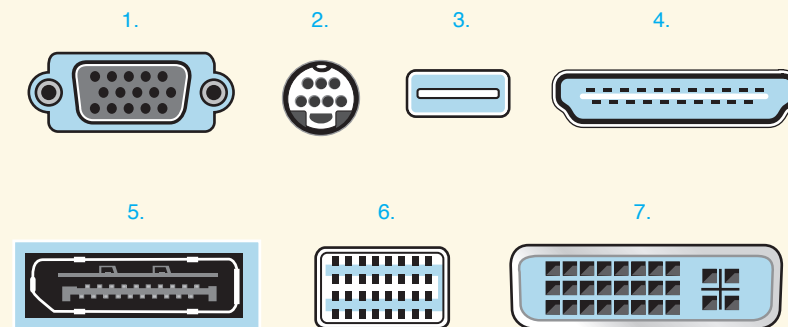


FIGURE 2.44 Identify video port graphics

- | |
|----------|
| 1. _____ |
| 2. _____ |
| 3. _____ |
| 4. _____ |
| 5. _____ |
| 6. _____ |
| 7. _____ |

Activities



Internet Discovery

- Objective:** To obtain specific information from the Internet regarding a computer or its associated parts
- Parts:** Computer with Internet access
- Procedure:** Complete the following procedure and answer the accompanying questions.
- Questions:** For Questions 1–4: Obtain technical information about a particular computer (maybe your own model or a model number given by the instructor). Answer the following questions based on the information. You may need to obtain more documents or you may need to select a different computer model to answer questions. Please use only one computer model.

1. Which ports are available on the front of the computer?

2. Which ports are available on the back of the computer?

3. How many drive bays are available to install devices such as hard drives, optical drives, tape drives, and so on?

4. Were the photos in the documentation clear enough to differentiate between the different ports? If not, explain what is wrong.

5. List ten Internet acronyms and what they stand for that would be appropriate in a text message to a family member, but inappropriate to use when communicating (even texting) with an employee from a non-IT department that is not a close friend but a professional acquaintance. Also, provide the URL(s) where this information is found.

6. Using the Internet, list one fact about NFC that was not in the chapter and the URL where you found this information.



Soft Skills

Objective: To enhance and fine-tune a future technician’s ability to listen, communicate in both written and oral forms, and support people who use computers in a professional manner

Procedure:

1. In teams of two, one student writes a professional note that contains Internet acronyms that are commonly used for texting. The other student tries to then guess what the acronyms mean. Together, re-write the note so it is more professional.
2. Draft an email to a pretend computer customer that you just met yesterday for the first time. You did not have the part needed to repair the computer, but now the part has come in. Be sure you use professionalism in your email.



Critical Thinking Skills

Objective: To analyze and evaluate information as well as apply learned information to new or different situations

Procedure:

1. Find an advertisement for a computer in a local computer flyer, in a newspaper, in a magazine, in a book, or on the Internet. List which ports you know in one column and the ports you do not know in the other column. Select one port you do not know and research that component. Write the new information and share with at least one other person.

2. Work in groups of three. As a group, do you think future computers will only have wireless connections or continue to have both wired and wireless connectivity? Why or why not? What might be some hindrances that would prevent this from happening?

3. Provide five tips that might help someone identify the different computer ports. If possible, each person in the class should state a tip without duplicating someone else’s tip.

Labs

Lab 2.1 Port Identification

Objective: To identify various computer ports correctly

Parts: Computer ports, either built into a specific computer or as separate adapters

Procedure:

1. Contact your instructor for a computer on which to work or to obtain adapters.
2. Identify the computer port(s) given to you by the instructor. In Table 2.8, fill in the connector type, number of pins, and port type. Note you may have to refer to information in the book or on the Internet.

TABLE 2.8 Connector identification

Connector type (D-shell, DIN, etc.)	Number of pins	Port purpose (video, USB, NIC, etc.)
1. _____	_____	_____
2. _____	_____	_____
3. _____	_____	_____
4. _____	_____	_____
5. _____	_____	_____
6. _____	_____	_____
7. _____	_____	_____
8. _____	_____	_____
9. _____	_____	_____
10. _____	_____	_____

Lab 2.2 Device/Port Identification

Objective: To identify various computer ports correctly based on the type of connected device

Parts: Computer that has devices connected

Procedure:

1. Contact your instructor for a computer on which to work.
2. Ensure the computer is powered off.
3. Each device connected to the computer will go through the same three (3) step process: (1) Identify one item attached to the computer. Trace its cable to a port. In Table 2.9, write the name of the device in the first line. (2) On the same line in the second column, identify all ports that the device could possibly use to attach to the computer. (3) Disconnect the device from the port. On the same line in the third column, identify the port to which the device actually attaches. Do the same for all devices connected to the computer.

Note: You may have to refer to information in the book or on the Internet.

TABLE 2.9 Port Identification

Device attached	Ports that possibly could have this device attached	Remove device and identify the port the device actually connects to. Reattach device when finished.
1. _____	_____	_____
2. _____	_____	_____
3. _____	_____	_____
4. _____	_____	_____