CHAPTER 6

Exploring Video and Display Devices

In this chapter, you'll learn about different types of display devices used to provide video for monitors. Most monitors are flat-panel displays, but there are other types you should know about. There are several different interfaces used by monitors, and these interfaces have different connectors that you should be able to recognize. If you come across any of the older monitors, you need to understand some important safety concerns. Last, this chapter includes many of the common symptoms of problems with video and how you can resolve them.

Exam 220-801 objectives in this chapter:

- 1.4 Install and configure expansion cards.
  - Video cards
- 1.7 Compare and contrast various connection interfaces and explain their purpose.
  - Physical connections
    - Other connector types: VGA, HDMI, DVI
    - Analog vs. digital transmission : VGA vs. HDMI
- 1.10 Given a scenario, evaluate types and features of display devices.
  - Types
    - CRT
    - LCD
    - LED
    - Plasma
    - Projector
    - OLED
  - Refresh rates
  - Resolution
  - Native resolution

        - Brightness/lumens
        - Analog vs. digital
        - Privacy/antiglare filters
        - Multiple displays
    - 1.11 Identify connector types and associated cables.
        - Display connector types
            - DVI-D
            - DVI-I
            - DVI-A
            - Displayport
            - RCA
            - miniHDMI
        - Display cable types
            - HDMI
            - DVI
            - VGA
            - Component
            - Composite
            - S-video
            - RGB
    - 1.12 Install and configure various peripheral devices.
        - Input devices
            - Touch screen
        - Output devices
            - Display devices
    - 5.1 Given a scenario, use appropriate safety procedures.
        - Personal safety
            - CRT safety – proper disposal

Exam 220-802 objectives in this chapter:

- 1.5 Given a scenario, use Control Panel utilities (the items are organized by "classic view/large icons" in Windows).
    - Common to all Microsoft Operating Systems
        - Display: Resolution

- 4.4 Given a scenario, troubleshoot common video and display issues.
  - Common symptoms
    - VGA mode
    - No image on screen
    - Overheat shutdown
    - Dead pixels
    - Artifacts
    - Color patterns incorrect
    - Dim image
    - Flickering image
    - Distorted image
    - Discoloration (degaussing)
    - BSOD

Display Devices

One of the most important output devices of a computer is the display device or monitor. As an A+ technician, you need to be aware of some common terms related to display devices and the different types commonly in use today.

Common Terms

The following are some common terms used when describing display devices:

- **Pixels.** On monitors, a pixel (short for *pixel element*) includes three colored dots (red, green, and blue). A pixel can be any color, illuminating the dots with varying intensity.
- **Resolution.** The resolution of a monitor describes the width and height of a display in pixels. For example, the resolution of VGA is 640 × 480, meaning that it can display 640 pixels across the screen (width) on 480 separate lines (height). A higher number of pixels results in a higher resolution and an overall better display.
- **Native resolution.** Most new monitors are designed to use a specific resolution, referred to as the native resolution. If a different resolution is used, it distorts the display.
- **Refresh rates.** This is the frequency with which the screen is redrawn. For example, a refresh rate of 60 Hz indicates that the screen is redrawn 60 times per second.
- **Brightness/lumens.** Monitors have controls that allow you to control the brightness of the display. On some displays, the intensity of the light is measured in lumens.

CRT

CRT (cathode ray tube) monitors are the oldest type of analog monitor. They are heavy, take up a lot of desk space, and consume a significant amount of power compared with modern displays. You probably won't see anyone purchase a new CRT monitor, but some older ones are still in use.

> ***NOTE*** **CRTS REPLACED TO SAVE MONEY**
>
> **Most organizations recognize the amount of power that CRTs draw and have replaced them with new flat-panel displays. The flat-panel displays consume very little power in comparison, and companies save a noticeable amount of money on their power bills.**

Besides drawing a significant amount of power, the refresh rate can also be a problem on these monitors. If the refresh rate is less than 72 Hz, many people notice a flicker that causes eyestrain and headaches.

These monitors include a large vacuum tube and an electron gun that shoots electrons from the back onto a fluorescent screen. Compared to a typical flat-screen monitor, the CRT monitor is massive, as you can see in Figure 6-1. CRT monitors often extend a foot or more behind the front of the viewable screen.

FIGURE 6-1 Flat panel display and CRT monitor.

LCD

LCD (liquid crystal display) monitors are flat-panel displays that have largely replaced CRT monitors. They are thinner and lighter, and they consume significantly less power than CRTs.

LCD Backlights

A *backlight* is used to shine light through liquid crystals in an LCD monitor to create the display. By changing the way the crystals are oriented, they refract the light differently and display different colors.

This is similar to how you can see different colors by turning a prism. Light is refracted through the prism, and as you turn it, you see different colors. However, if you took a prism into a dark closet and turned it in your hand, you wouldn't see anything because a prism doesn't produce light.

Similarly, liquid crystals don't produce light. Instead, LCD displays depend on light shining through the crystals. Most LCD monitors include a *cold cathode fluorescent lamp (CCFL)* that shines from the back through the liquid crystals. If the CCFL fails, you probably won't see any display at all. In some cases, the display picks up some ambient light and you can see a very dim display, but most often, you won't see anything at all.

EXAM TIP

If an LCD monitor doesn't have any display, ensure that it is plugged in and turned on. If it is connected and turned on but you still have no display, the problem is likely the backlight.

CCFLs on most LCD monitors shine from the back to the front, and these monitors are called backlit-LCD monitors. Some use a refractor and can have the light shining from an edge.

LCD Refresh Rate and Native Resolution

Another benefit of LCD monitors over CRT monitors is that they don't flicker at all. The refresh rate for LCD monitors is normally set at 60 Hz.

LCD monitors are designed to use a *native resolution*. If you change the resolution to something different, it distorts the display. Many video cards can automatically sense the native resolution of a monitor and will show this as the recommended resolution.

LED

A LED (light emitting diode) monitor is an LCD monitor that uses LEDs for the backlight instead of a CCFL. This provides several benefits, including a brighter display, better contrast, and lower power consumption. The difference in the display is often dramatic. I recently bought a new LED monitor and hooked it up next to a CCFL backlight display, and I was quite surprised at the differences.

NOTE **LEDS USED ONLY AS THE BACKLIGHT**

An LED monitor uses the same type of liquid crystals used by an LCD monitor. The LEDs are used only as a backlight.

Quick Check

1. **What type of monitor consumes the most power?**
2. **What provides illumination in an LCD monitor?**

Quick Check Answers

1. **CRT.**
2. **Backlight.**

Plasma

A plasma display device is another type of flat-panel display. They can produce some vivid colors but are more susceptible to screen burn-in. Additionally, they draw more electricity than LCD monitors.

NOTE **SCREEN BURN-IN**

If the same image is displayed on a display screen for an extended period, the image can be burned into the display. This image is viewable even if the power is turned off. Plasma displays are susceptible to burn-in, but LCD displays are immune to this phenomenon.

Plasma displays use a concept similar to fluorescent lights. A fluorescent light is a gas-filled tube, and when electricity is applied to the gas, it emits a light. A plasma display includes millions of small cells filled with a gas, and when voltage is applied to these cells, they can emit different-colored lights.

Projector

People often use projectors for giving presentations. This includes trainers or instructors teaching different topics, and also people giving presentations in a variety of different business situations. The projector is often mounted to the ceiling and projected onto a blank screen or sometimes a blank wall. Sometimes presenters carry a portable projector with them.

Two primary characteristics to look for with projectors are lumens and throw ratio.

- **Lumens.** This identifies the brightness of the display. In classroom or small business settings, a 2,000 lumen projector provides adequate brightness even when competing with other lights within a room. Projects used in large conference hall settings can have as many as 15,000 lumens.

- **Throw ratio.** The size of the display from the projector is affected by where the projector is positioned. For example, if you want the display to be six feet wide and the throw ratio is 2:1, the projector is mounted 12 feet from the screen.

OLED

An *organic light-emitting diode (OLED)* is a newer type of display device that is used in some smaller mobile devices. Unlike an LCD device, it can emit light without a backlight. OLED devices are thinner and lighter, and they provide better pictures and wider viewing angles than LCD devices.

With all these benefits, you can expect to see more of them, but maybe not for a few years. I recently checked prices, and a 17" OLED monitor from Sony was available for $4,100 and a 25" model was available for $6,100. I didn't buy one.

Using Multiple Displays

Many people use more than one display device when working on computers. For example, I've occasionally created training videos for the web with Camtasia. Having two monitors has made the process of editing the video much easier.

Windows will normally recognize the second display as soon as you plug it in. However, you need to know how to configure it. On Windows 7, you can right-click the desktop and select Screen Resolution. You'll see a display similar to Figure 6-2.

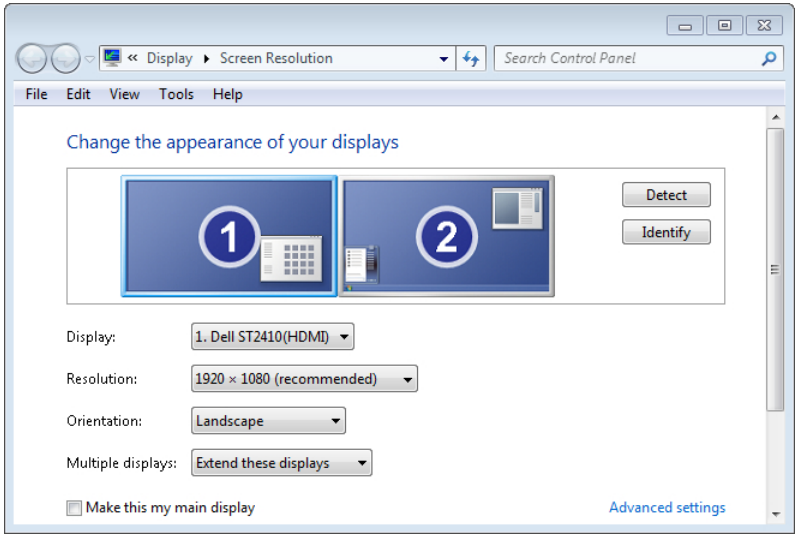


FIGURE 6-2 Configuring multiple displays.

If the monitor isn't recognized, ensure that it is connected and turned on and then click the Detect button. In Figure 6-2, the two monitors are labeled as 1 and 2. If you click Identify,

it will display a large number on each of the monitors corresponding to the number shown on the Screen Resolution page.

In the figure, the number 1 monitor is selected and the number 2 monitor is the main display. Items like the Windows Start menu and taskbar appear on the main display.

The Multiple Displays drop-down box gives you two primary choices:

- **Duplicate These Displays.** The same information is displayed on both. This is useful when giving presentations. The presenter can manipulate the monitor in front of them, and the same thing is shown to anyone watching the presentation.
- **Extend These Displays.** This allows you to drag windows between the displays. For example, you can have Internet Explorer open in one display while you're taking A+ notes in Microsoft Word in the other display.

A key requirement for using multiple displays is that your computer must support more than one display. That is, your computer needs to have active interface connections for more than one monitor. Video cards commonly have more than one active connection.

EXAM TIP

Dual monitors are used by many people doing any type of editing. This includes audio and video editing and even editing of books or articles.

Common Resolutions

There are more than 20 different resolutions used by different monitors. You don't need to memorize them all, but you should be aware of common resolutions. Table 6-1 lists the resolutions that CompTIA included in their acronym list.

TABLE 6-1 Display Resolutions

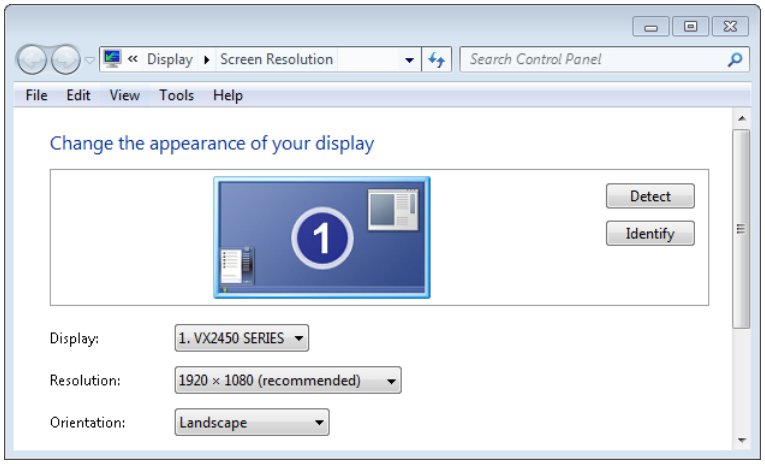
Name	Resolution
VGA (Video Graphics Array)	640 × 480
SVGA (Super VGA)	800 × 600
XGA (Extended GA)	1024 × 768
EVGA (Extended VGA)	1024 × 768
SXGA (Super XGA)	1280 × 1024
UXGA (Ultra XGA)	1600 × 1200
WUXGA (Wide UXGA)	1920 × 1200
HDMI (High-Definition Multimedia Interface) 1080	1920 × 1080
HDMI 780	1280 × 720

Configuring the Resolution

As an A+ technician, you need to be able to adjust the resolution for a computer. The following steps show you how to adjust it on computers running Windows 7, Windows Vista, and Windows XP.

Windows 7:

1. Click Start and select Control Panel.
2. Select Large Icons in the View By selection.
3. Double-click Display.
4. Select Adjust Resolution from the menu on the left.
5. Select the resolution from the Resolution drop-down box. If a native resolution is needed, it will often be listed as "Recommended," as shown in the following graphic.



EXAM TIP

There are other ways of getting to the Screen Resolution page. For example, on Windows 7, you can right-click the desktop and select Screen Resolution. However, the exam objectives specifically identify the Control Panel by using the Classic View/large icons. On the job, use whatever method you desire. For the exam, know these steps.

Windows Vista:

1. Click Start and select Control Panel.
2. Select Classic View.
3. Double-click Personalization.

4. Select Display Settings.
5. Use the slider to adjust the screen resolution as desired.

Windows XP:

1. Click Start and select Control Panel.
2. Select Classic View from the menu on the left.
3. Double-click Display.
4. Click the Settings tab.
5. Use the slider to adjust the screen resolution as desired.

Touch Screens

Touch screens are becoming more and more common. Instead of using a mouse to point and click, you can use different touch gestures with your fingers to manipulate the computer.

> ***MORE INFO*** **CHAPTER 9, "UNDERSTANDING MOBILE DEVICES"**
>
> **Chapter 9 covers many of the common touch gestures used with touch screens on mobile devices. These same gestures are used with touch screens for desktop computers.**

Touch screens are widely available on tablet devices, such as Apple's iPad, and on smartphones. They've also been available with regular monitors for a long time and are most commonly used in kiosks. For example, many airlines have these available for customers to check in and print their tickets.

Windows 7 supports touch screens, and you're likely to run across Windows 8 notebooks with touch screens instead of traditional display devices.

Privacy and Anti-Glare Filters

Some monitors have a glare that bothers people and causes eye strain. Filters are available that act like sunglasses, but instead of the user wearing them, they fit over the screen. Many filters are designed with plastic tabs that lay on top of the monitor with the filter covering the screen. Others use Velcro attached to the monitor. Either way, the filter covers the screen to remove the glare.

In addition to stopping glare, filters are also available to limit the viewing angle of the display. "Shoulder surfers" sometimes try to look at displays to get some private information. With a filter over the monitor, the only person who can see the contents of the monitor is the person sitting right in front of it.

Quick Check

1. What resolution should be used for an LCD monitor?
2. What is the resolution of HDMI 1080?

Quick Check Answers

1. Native resolution.
2. 1920 × 1080.

Interfaces, Connections, and Cables

As a PC technician, you need to be able to identify the different types of connections used for video displays and know which interface is being used. Because monitors can use different types of interfaces, video card manufacturers commonly include more than one port on the video cards. For example, Figure 6-3 shows a circuit card with three different ports. These ports are described in the following sections.

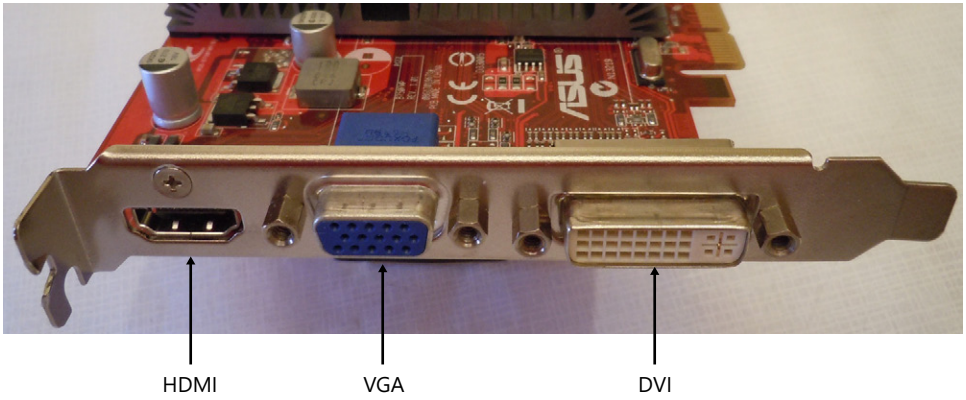


FIGURE 6-3 Common ports on a video card.

Analog vs. Digital

Video displays have evolved quite a bit over time, and one of the primary changes is related to analog and digital data. Computers work with *digital* data sent as 1s and 0s. However, older monitors such as CRTs can display data only when it is sent as *analog* data. Analog data is created as modulation on an alternating current sine wave.

For example, Figure 6-4 shows how data is sent to an analog monitor. The PC creates digital data, sends it to the video card, which formats it as analog data, and then sends it to the monitor.

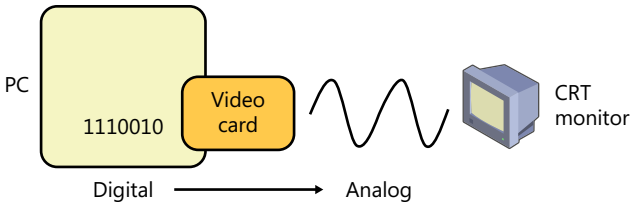


FIGURE 6-4 Sending analog data to an analog monitor.

This works fine for analog monitors. However, many newer display devices, such as LCD monitors, use digital data. When they receive the analog data, they need to convert it back to digital data, as shown in Figure 6-5. Because of this, many LCD monitors have extra electronics to do this conversion.

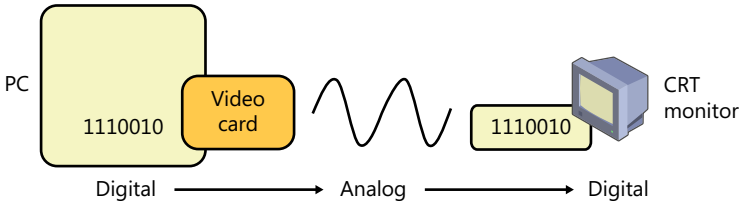


FIGURE 6-5 Converting analog data back to digital data for a digital monitor.

Do you see a problem here?

If the computer creates digital data and the monitor needs digital data, why not just send digital data to the monitor instead of using time and resources to convert it twice? Actually, that's exactly what is occurring with many interfaces today, as shown in Figure 6-6.

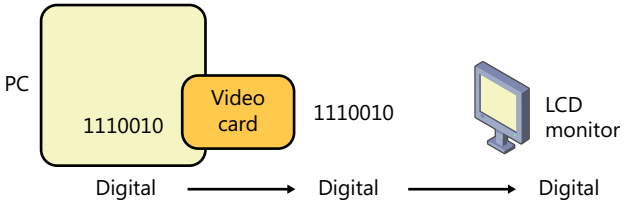


FIGURE 6-6 Sending digital data to a digital monitor.

Ten years from now, this will be ancient history for IT technicians, but right now there is still a mixture of analog and digital devices in use. Therefore, you need to be aware of the differences and know which devices and interfaces are analog and which are digital.

EXAM TIP

When studying the devices and interfaces, pay attention to which ones are analog and which ones are digital. In some cases, you can use a simple adapter to match dissimilar connections. However, simple adapters cannot change the signal from analog to digital or from digital to analog.

VGA

Video Graphics Array (VGA) has been the standard analog video interface used for many years. New display devices use improved interfaces, but it's still common to see VGA connectors. Figure 6-7 shows a connector on a standard VGA cable. It is a DB-15 connector with three rows of pins.

FIGURE 6-7 VGA cable.

VGA also indicates a very basic resolution of 640 × 480. However, the VGA interface can transmit data using higher resolutions.

DVI

The *Digital Visual Interface (DVI)* connector is rectangle-shaped and is commonly found on many PCs and monitors today. It was primarily created to provide a digital interface but also supports analog. The three primary versions are as follows:

- DVI-A connectors supply only analog data.
- DVI-D connectors supply only digital data.
- DVI-I connectors are integrated and supply both analog and digital data.

Additionally, DVI comes in both single-link and dual-link versions. Single-link DVI supports resolutions up to 1920 × 1200. Dual-link DVI uses more pins and wires and is used for higher resolutions up to 2560 × 1600.

> ***NOTE*** **SINGLE-LINK DVI MORE COMMON**
>
> **The single-link DVI cables are cheaper than dual-link cables and are more readily available. You can plug a single-link DVI cable into dual-link ports without any problem as long as the resolution isn't higher than 1920 × 1200.**

Figure 6-8 shows the different types of connections you'll see with DVI. The DVI-A connector includes pins that can transmit the same data as a standard VGA cable. The DVI-D connector includes pins that are required to transmit the video signal digitally. The DVI-I connector includes the pins needed for both.

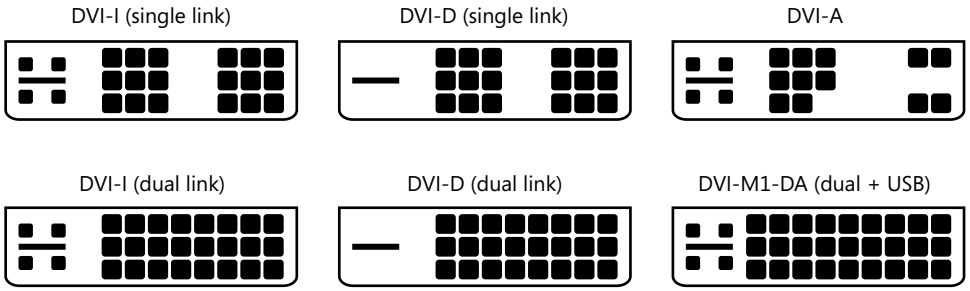


FIGURE 6-8 DVI connector versions.

The dual-link connectors include six extra pins in the middle, which are used to carry additional signals for higher bandwidths. The DVI-M1-DA connector adds three extra pins for a USB connection. Monitors supporting this will also have USB ports that connect with a USB controller in the computer via the DVI connection.

NOTE **USB PORTS ON MONITORS**

Many monitors include a built-in USB hub. You can connect the monitor to the PC with a USB cable and then use the USB ports on the monitor. If the monitor and video interface support the DVI-M1-DA connection, the USB cable isn't needed.

HDMI

High-Definition Multimedia Interface (HDMI) uses a single cable that can transfer both audio and video in a digital format. The audio signal supports eight channels used by 7.1 sound systems. It's used on many flat-panel displays and also on a wide variety of high-definition televisions and DVD/Blu-Ray players.

HDMI is backward-compatible with DVI-D and DVI-I and is believed by many to be the successor to DVI. There are some other digital video standards, but, currently, HDMI is more popular.

Figure 6-9 shows the end of a typical Type A HDMI cable used with display devices. Most cables have Type A connections on both ends.

FIGURE 6-9 Type A HDMI cable.

EXAM TIP

HDMI includes digital video and 8-channel digital audio. It is backward-compatible with DVI-D and DVI-I but not with VGA or DVI-A. It is definitely a requirement for anyone who is building a home theater PC.

The Type A connector is the most common, but you might also run across the Type C (or mini-HDMI) connector. The Type A connector is 13.9 mm × 4.45 mm, and the Type C connector is 10.42 mm × 2.42 mm.

You might remember from Chapter 5, "Exploring Peripherals and Expansion Cards," that some USB cables have a Standard Type A connector on one end to connect with the computer and a mini or micro connector on the other end to connect with smaller devices such as cameras. Similarly, HDMI cables are available with the Type A connector on one end for the computer and a mini-HDMI connector on the other end.

HTMI resolutions are commonly identified as 1080 and 720.

- HDMI 1080 uses a resolution of 1920 × 1080.
- HDMI 720 uses a resolution of 1280 × 720.

Comparing VGA and HDMI

The previous sections show the progression of video interfaces from VGA to DVI and then to HDMI. In brief, the key differences between VGA and HDMI include the following:

- VGA provides analog video.
- HDMI provides digital video plus 8-channel digital audio.

Adapters

Passive adapters are available that allow you to plug a cable of one type into a different type of port. These reroute the connections from one connector to the specific pins on the other connector. For example, DVI and HDMI both use the same type of signals, and adapters are available to convert one connector to another.

Imagine that you have an HDMI cable coming from a display but have only a DVI-D port on the computer. You can use an HDMI-to-DVI adapter like the one shown in Figure 6-10. The HDMI cable plugs into the adapter, and the DVI-D side plugs into the DVI port on the computer. DVI-A-to-VGA adapters are also available.

FIGURE 6-10 HDMI-to-DVI adapter.

EXAM TIP

You cannot use a passive converter to convert a digital HDMI signal to an analog VGA signal—it just won't work. You might be able to find an active converter to convert the signals, but they are expensive. A better choice is to get a new monitor or a new video card.

Quick Check

1. **What types of signals are supported by DVI?**
2. **What are the primary differences between VGA and HDMI?**

Quick Check Answers

1. **Analog and digital.**
2. **VGA is analog video only, and HDMI is digital video and audio.**

Other Connections

While the primary connections used for display devices are VGA, DVI, and HDMI, you might come across other connections. This section covers the other connections mentioned in the CompTIA objectives.

DisplayPort

DisplayPort is an interface developed by the Video Electronics Standards Association (VESA), an organization that has developed many standards used for displays and video peripherals. It can transmit video, audio, and USB signals for monitors that have USB connectors.

Figure 6-11 shows the outline of the DisplayPort next to an HDMI connection. The shape is distinctive when you're looking at the line drawing, but when you're looking at the back of a computer without adequate light, it's easy to confuse the two. (Figure 6-15 includes a picture with both connectors.) The DisplayPort port is recessed in the case, so the shape isn't as clear.

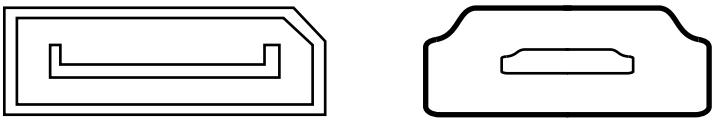


FIGURE 6-11 DisplayPort and HDMI port.

Composite and RCA

Composite cables use an RCA jack and carry only video. They are most commonly used with TVs and are combined with two additional jacks that carry stereo audio. *RCA* is a type of connector created by the Radio Corporation of America in the 1940s. RCA isn't an acronym, but the cables are commonly known as RCA connectors.

Figure 6-12 shows both ends of a combined composite and audio cable. The jacks are color-coded, with the yellow connector used for the composite video and the white and red connectors used for audio.

FIGURE 6-12 RCA jacks used for composite video and audio.

RGB

Red Green Blue (RGB) cables also use three RCA jacks: one for red, one for green, and one for blue analog signals. The cable includes three connectors, with each connector carrying one of the primary colors as an analog signal. These are more commonly used with televisions and disc players, but they have been used with some monitors. Using three cables instead of the single cable used with a composite signal provides a higher-quality display. RGB cables are commonly color-coded with red, green, and blue.

> ***NOTE*** **VGA COMMONLY CALLED RGB**
>
> **VGA uses a 3-row, 15-pin DB connector, and it is often referred to as RGB because it transmits the red, green, and blue video signals.**

Component

Component video is similar to RGB in that it uses a cable with three jacks and provides an analog signal. It is often referenced as $YP_BP_{R,}$ and these three signals are derived from an RGB signal.

Cables and connections are commonly color-coded. Green is used for Y, blue is used for P_B, and red is used for P_R. However, the signals aren't the same as RGB. That is, the red cable carrying the P_R signal is not the same signal as Red in an RGB cable.

S-Video

A *Separate Video (S-Video)* connector is a 4-pin DIN used for analog video. It transmits the video over two channels and provides a higher-quality display than a single-channel composite video signal, but not as good as 3-channel RGB and component video.

Figure 6-13 shows two ends of an S-Video cable. It has been used on some monitors but has been more common on TVs and DVD players.

FIGURE 6-13 S-Video cable.

Video Interface Summary

Table 6-2 provides a summary of the key video interfaces.

TABLE 6-2 Video Interface Summary

Interface	Analog/Digital	Comments
HDMI	Digital	Includes video and 8-channel audio. Compatible with DVI-D and DVI-I.
DVI-D	Digital	Compatible with HDMI but doesn't include audio.
DVI-A	Analog	Compatible with VGA.
DVI-I	Analog and Digital	Compatible with VGA and HDMI. Doesn't include audio.
VGA	Analog	This commonly refers to the 15-pin, 3-row DB-15 connector.
Composite	Analog	Uses a single RCA jack. Often used with two RCA jacks for audio.
Component and RGB	Analog	Use three RCA jacks each carrying a separate analog signal.
DisplayPort	Digital	Not compatible with DVI or HDMI. Includes audio, video, and USB.
S-Video	Analog	Uses round 4-pin DIN connection

Quick Check

1. What type of connection includes USB?
2. What type of connector does S-Video use?

Quick Check Answers

1. DisplayPort.
2. A 4-pin DIN.

Video Cards and Drivers

The chipset on most motherboards includes video capabilities, and different chipsets provide different types of video. There might be times when the video provided by the chipset doesn't meet the user's needs and doesn't provide the quality of graphics expected. Users can purchase an additional video card, also called a graphics device interface (GDI), and use the video from the GDI instead.

Figure 6-14 shows two different video cards. Both have *graphics processing units (GPUs)* and onboard RAM. The GPUs can generate a lot of heat, just like a central processing unit (CPU), so it's common to see heat sinks (highlighted by the white boxes), as shown in Figure 6-14.

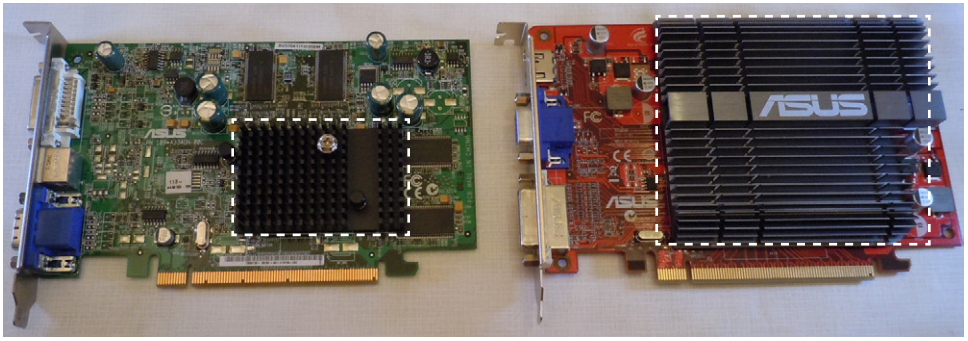


FIGURE 6-14 Video cards with GPUs.

EXAM TIP

If a video card is added to a system, the video provided by the onboard features of the chipset should be disabled in the BIOS. This prevents any conflicts between the two.

Some manufacturers have used two or more video cards that work together to provide a faster high-quality single output. For example, NVIDIA created Scalable Link Interface (SLI) to link multiple GPUs on separate video cards.

Video Memory

Video cards include onboard RAM, which provides two important benefits. Without onboard RAM, the video card shares the system memory. For example, imagine your display needs 500 MB of RAM and your system has 3 GB of usable RAM. The display reserves the 500 MB of RAM, leaving your system with only 2.5 GB of usable RAM. The second benefit is that the RAM is closer to the GPU, making it quicker.

The type of RAM used in video cards is often different than RAM used in the computer. Past graphics cards have used video RAM (VRAM) and synchronous graphics RAM (SGRAM), which were quicker than the RAM used in the systems at the time.

Many current video cards use Graphics Double Data Rate version 5 (GDDR5), which is similar to the Double Data Rate version 3 (DDR3) memory described in Chapter 3, "Understanding RAM and CPUs." GDDR5 uses additional buffers that aren't included with DDR3.

Drivers

Just as with other hardware devices, the operating system needs a device driver to use a video card. One big difference with graphics cards is that these drivers tend to be updated more often.

The video graphics card market is very competitive. Gamers spend a lot of money on games and want quality graphics that often just aren't available from a motherboard's chipset. They're willing to pay more for the cards and are more vocal when things aren't perfect.

Manufacturers release the driver with the video card, typically on a CD, and then provide updates through their site. For example, AMD provides drivers from Support.amd.com. You just need to select your video card and identify your operating system.

> ***NOTE*** **VIDEO CARD APPLICATIONS**
>
> **Many video card manufacturers also provide applications you can use to view and manipulate the properties of the display. For example, AMD includes the Catalyst Control Center, which includes tools to adjust the color, rotate displays, view properties, and even configure settings to overclock the video card.**

Video Card Ports

When installed, the video card will have ports available at the back of the computer. A typical video card will include multiple ports designed to support various interfaces.

For example, Figure 6-15 shows the video card outputs available on the back of a computer. These are provided by a single video card installed in the system, and this video card supports multiple monitors using any or all of these ports. For example, it's possible to hook up two monitors using DVI, or one DVI and one HDMI, or even four monitors using all the ports.

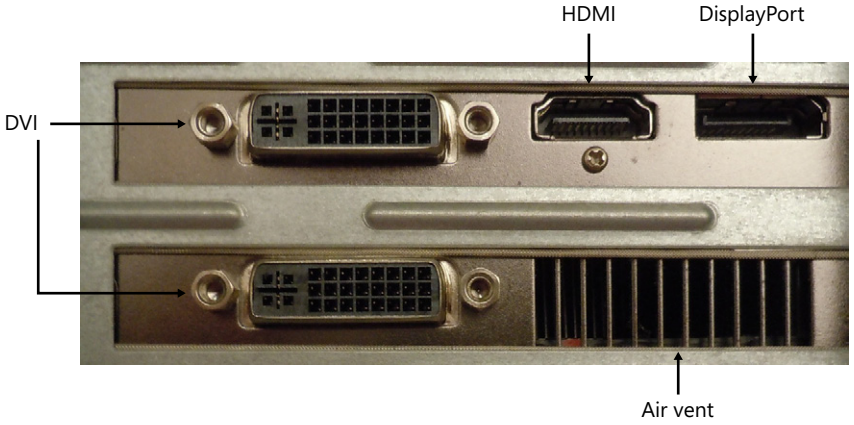


FIGURE 6-15 Multiple ports on back of computer.

NOTE **GRAPHICS CARDS AND HEAT**

Figure 6-15 shows the output ports of a single graphics card. This card includes a temperature-controlled fan installed on the card and a special vent to help air flow over the graphics card and keep it cool.

Safety Concerns

When working with monitors, there are some specific safety concerns technicians need to know about. When working with CRTs, the primary concerns are your safety and the environment. With flat-panel displays, you want to use the proper cleaning materials.

Working with CRTs

CRT monitors require very high voltages to power the vacuum tube and the electron gun. If the monitor is opened and you touch the wrong component, these voltages can very easily kill you. Even after you turn the CRT monitor off, these components retain the voltage. Most organizations have safety policies in place directing technicians not to open a CRT monitor. If the monitor fails, replace it.

IMPORTANT **ELECTROCUTION DANGER**

Deadly voltages are contained within a CRT monitor even after it has been turned off. You should not open a CRT monitor unless you have been specially trained to do so.

Disposal of CRTs

CRTs contain a significant amount of toxic substances, including cadmium and lead. Therefore, they should be treated as hazardous waste. They should not be discarded in the trash, taken to landfills, or incinerated.

In the United States, the Environmental Protection Agency (EPA) has created specific rules for the disposal of CRTs. A company can be fined for discarding CRTs in landfills instead of taking them to recycling centers. In Europe, disposal is governed by the Waste Electrical and Electronic Equipment (WEEE) Directive.

Cleaning Supplies

If you ever saw *My Big Fat Greek Wedding*, you might remember the father's response to most problems was to use Windex. No matter what the problem was, the solution was, "Put some Windex on it." They were memorable lines, but Windex is not a good solution for many computer components, especially LCD and plasma screens.

The ammonia and alcohol contained within many common household cleaners can easily scratch, smudge, or cloud the display. The recommended method for cleaning these displays is to wipe them down with a dry lint-free cloth and then use a cleaner specially designed for the screen. You should not spray the screen directly. Instead, put the cleaner on the cloth, and clean the screen with the cloth.

CRT monitors are an exception. These monitors have glass screens, and it is OK to use glass cleaners such as Windex on them.

Troubleshooting Video and Display Issues

If you understand the basics about how displays operate and how they're connected, you'll be able to resolve most of the problems without any difficulty. The following section describes a Windows Diagnostic tool and some common display problems you might see.

Dxdiag

Windows-based systems use a suite of multimedia technologies for video and audio known as DirectX. Windows also includes the *DirectX Diagnostic Tool (dxdiag),* which you can use to run a quick check on DirectX. You can start this on Windows 7 by clicking Start, typing **dxdiag** in the Search Programs And Files text box, and selecting dxdiag. If you are prompted to check whether your drivers are digitally signed, select Yes. You'll see a display similar to Figure 6-16.

You can either click Next Page to view the output in order, or you can select any of the tabs. In addition to giving you information about your system and the current version of DirectX, it also provides information about the display and sound drivers. For example, if you suspect your driver isn't up to date, you can use DirectX to identify your version and compare it to available versions.

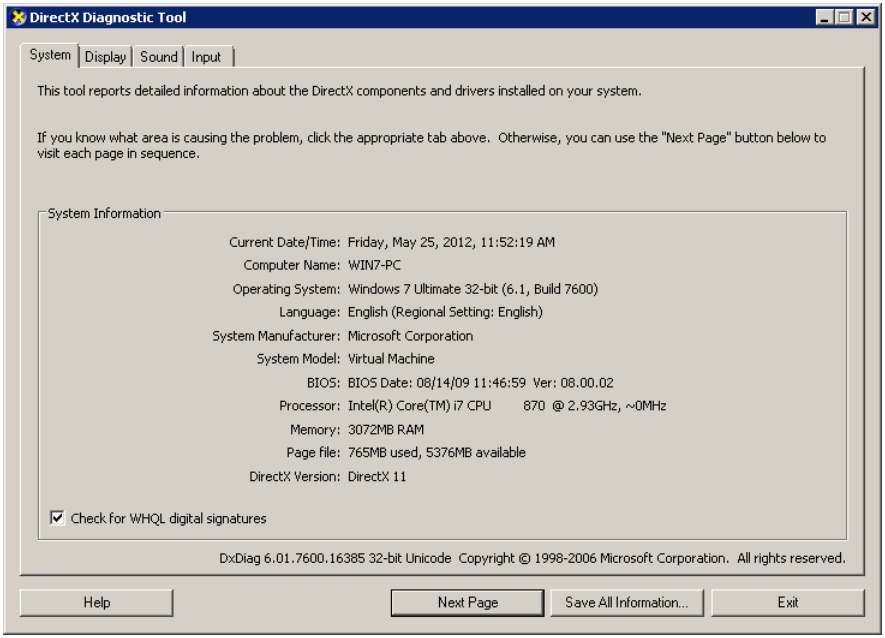


FIGURE 6-16 Dxdiag.

VGA Mode

In some cases, your display can default to VGA mode with a basic resolution of 640 × 480. You'll normally be using a much higher resolution, but with VGA mode, you'll see fewer items and items on the screen will be larger. It will be apparent that something is wrong.

The most common reason that a system defaults to VGA mode is due to a faulty or incorrect driver used with the video card. The solution is to get the correct video driver.

> ***MORE INFO*** **CHAPTER 15, "CONFIGURING WINDOWS OPERATING SYSTEMS"**
>
> **Chapter 15 covers device drivers in more depth, including how to use the Device Manager to update and modify drivers.**

No Image on Screen

If a display has no image at all, check the basics first. Ensure that it is plugged in and turned on. Any monitor should have some indication that it has power, such as a power LED. If the display is working, it will either display normal video from the computer or display a message indicating that it's not connected.

The most common reason for no image on LCD-based monitors is a failed backlight. The liquid crystals do not emit light, and without the backlight, the screen is dark. In many cases,

the cost to replace the backlight is high. Therefore, instead of trying to replace it, most organizations replace the monitor.

> ***NOTE*** **BACKLIGHTS AND LAPTOPS**
>
> **An exception is when a backlight fails on a laptop. Instead of replacing the entire laptop, many organizations choose to replace the backlight.**

A common problem that many people make when plugging in a new monitor is using the wrong port. For example, Figure 6-17 shows the back of a PC with two standard ports provided from the motherboard and three additional ports provided from a video card.

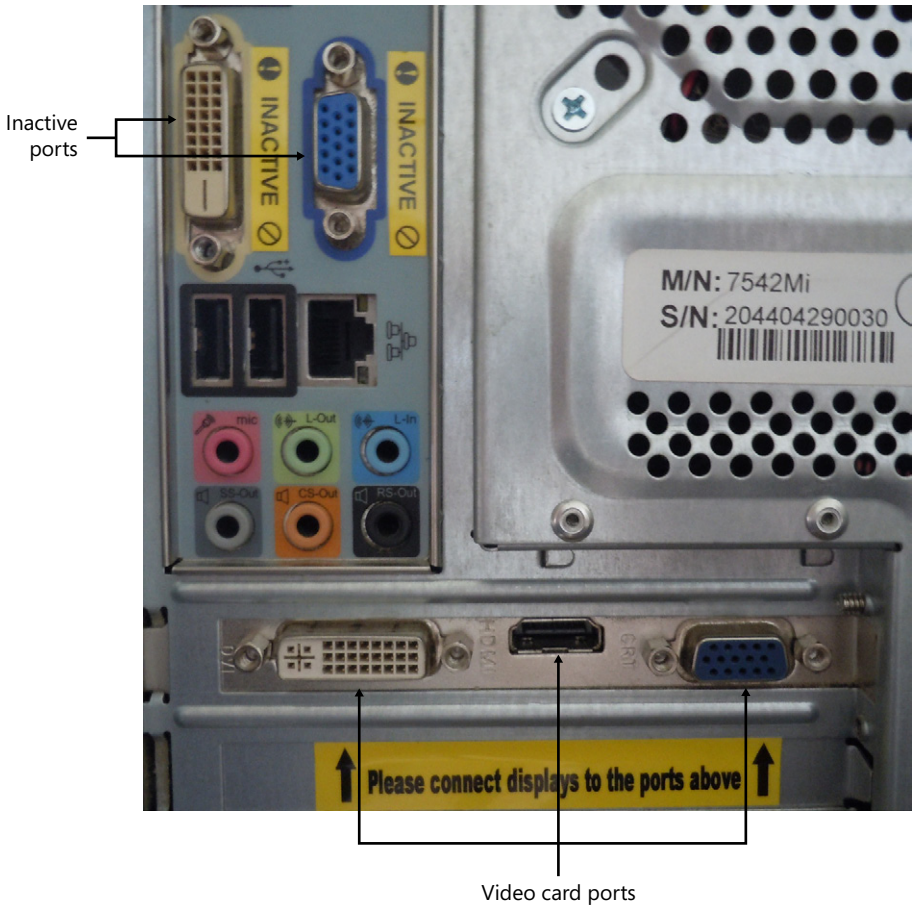


FIGURE 6-17 Inactive and active ports on PC.

The two top ports are labeled "Inactive" with yellow stickers and have been disabled in BIOS. Additionally, there's a note in bright yellow below the video card ports saying, "Please connect displays to the ports above." If either of the top ports is used, you will typically see

a default message indicating that the monitor isn't connected. Some monitors won't display anything.

REAL WORLD **WATCH OUT FOR INACTIVE PORTS**

Not too long ago, I was working in a classroom when a technician came in to replace a monitor. The old monitor had long since been removed. He reached around with the cable, plugged it into the back of the computer, and turned it on. Unfortunately, the monitor simply gave a default message indicating that it wasn't connected.

He thought that the cable might have been bad, so he went and retrieved another cable but still had the same problem. He wasn't giving up but was momentarily stumped and asked for some advice.

I remembered how easy it is to use the inactive ports and wondered aloud if the PC had inactive video ports. His eyes lit up, and he said, "Yes!" He had seen this before. This time, he got down on his hands and knees to look at the ports and realized that was exactly the problem. He swapped the cable, and the monitor worked perfectly.

It's very easy to plug a monitor into the inactive ports, and even seasoned technicians can sometimes be confused by this. If you don't have a display when plugging in a new monitor, double-check the ports you're using.

Dim Image

If the image is dim, first check the brightness controls on the monitor. In some cases, you can simply turn up the brightness to get the image back.

A dim image is often the result of a failed backlight on LCD-based monitors. Some monitors can pick up some light from the room or possibly from the sun if they are by a window. In this case, you'll see a dim image, but it will be barely perceptible.

CRT monitors gradually dim as they age. There's no solution other than sending them to the recycling center and getting an LCD monitor that will be gentler on your power bill. Similarly, some bulbs with projectors will dim with age. The solution is to replace the bulb.

Flickering Image

Flickering images are common with CRT monitors when the resolution is set too low. It's irritating and often causes eye strain. In general, you can eliminate the flicker by setting the resolution to 72 Hz or higher. This isn't a problem for LCD-based monitors.

Discoloration (Degaussing)

Discoloration of the image is most commonly seen on CRT monitors. One of the causes is placing magnetic materials too close to the monitor. Moving external hard drives and any other electronic devices away from the monitor often solves the problem.

In some cases, the monitor has electromagnetic buildup that needs to be removed. Most CRT monitors have a button labeled Degauss that sends a magnetic pulse through the monitor to release this buildup. When you press the button, you'll often hear a loud "thunk" that sounds a little ominous the first time you hear it, but it is normal. This often clears up the display.

Overheat Shutdown

Video cards generate a lot of heat, and by now you probably realize that heat is a computer's enemy. Video cards commonly have heat sinks on the GPU to keep them cool, and many also have thermal-controlled fans. These fans automatically speed up as the temperature rises.

If the video card overheats, it can cause the system to shut down. In some cases, sensors recognize that it is getting too hot and they shut down the system. In other cases, the heat causes a hardware failure, shutting down the system. If you suspect a heat problem related to the video card, check all the cooling methods.

Dead Pixels

A dead pixel is an area on the screen that is always black on an LCD monitor. These are relatively common on LCD monitors, but you usually won't see many. If a new monitor has too many dead pixels or too many in a certain area of the screen, the warranty might allow you to replace it. However, different manufacturers have different policies about how many pixels can fail before the warranty covers it.

> ***NOTE*** **DEAD PIXELS AND WARRANTIES**
>
> **Manufacturers do not always guarantee that 100 percent of the pixels are operational. That is, a monitor with some dead pixels is still considered a good monitor. You won't be able to return it for warranty repair just because of a few dead pixels. About the best you can do is what one of my students did: he had a T-shirt made that said, "I see dead pixels."**

A stuck pixel is stuck in a specific color such as white or red. Some people have had success with videos from YouTube or software developers to unstick them. These tools quickly flash the screen with different colors and, in some cases, can unstick the pixels.

Artifacts and Distorted Images

Visual artifacts are simply drawing errors where the screen is displaying something that it shouldn't. Some examples include the following:

- Horizontal or vertical lines through the display. These can be thin black lines or wide bars with distorted colors.
- A repeating pattern of small bars or rectangles over the entire screen.

- Wobbly vertical lines equally spaced across the screen.
- A small number of random dots in one area, or a huge number of random dots distorting the entire image.

The most likely cause of artifacts is an overheating video card. Check to ensure that all the cooling components within the system are working correctly.

Wobbly vertical lines are specifically related to the DVI interface. Ensure that the cable is seated firmly on the interface and the monitor. If you have two DVI connectors, try the other one. The problem might affect only one DVI port.

In some cases, these problems can be due to an incorrect video card driver. Update the driver, or if these symptoms appeared after updating the driver, roll it back to the previous version.

Color Patterns Incorrect

In some cases, the colors displayed on the monitor are not completely accurate. This isn't noticeable to many people. However, it is noticeable and important to some people. For example, graphics artists often manipulate photos and other graphics that they'll print. They want to ensure that what they see on the screen is what they'll see when it is printed. Calibration is the answer.

For very basic calibration, you can display a test image on your screen and adjust the contrast, brightness, tone, and hue. However, this is very difficult and tedious to do manually. A more efficient method is using a calibration tool that plugs into the USB port. It includes optical sensors that can "view" the colors displayed on the monitor and modify the display electronically.

BSOD

In some cases, a faulty driver can result in a serious stop error in Windows—also known as the Blue Screen of Death (BSOD). That sounds much more ominous than it really is; you simply need to replace the driver. You first restart your machine and go into safe mode, and then use Device Manager to install the correct driver.

> ***MORE INFO*** **CHAPTER 17, "TROUBLESHOOTING WINDOWS OPERATING SYSTEMS"**
>
> **Chapter 17 covers different methods used to troubleshoot Windows, including how to start safe mode. As mentioned previously, Chapter 15 covers Device Manager.**

Chapter Summary

- CRT monitors are heavy, large, power-hungry, analog-based monitors. They are frequently replaced with flat-panel displays to save money on power.
- LCD monitors are light, thin, digital-based monitors that consume significantly less power than CRTs.
- Backlights illuminate crystals in LCD monitors. If the backlight fails, the LCD will be dim or completely dark. LED monitors are LCD monitors that use LEDs for backlights.
- Plasma monitors are flat-panel displays. They include gas-filled cells that emit colors but are susceptible to screen burn-in. LCD monitors aren't susceptible to burn-in.
- VGA mode uses a resolution of 640 × 480. Resolutions have been regularly improved, and WUXGA uses 1920 × 1200.
- Operating systems allow you to modify the resolution of monitors, but you should always use the native resolution required by LCD monitors.
- Multiple displays allow you to display the same information on multiple monitors or to extend the display.
- The primary interfaces used by video devices are VGA, DVI, and HDMI. VGA is analog, DVI supports both analog and digital, and HDMI is digital. HDMI also supports audio.
- Adapters are available to convert VGA to DVI-A, DVI-D to HDMI, and DVI-I to HDMI. However, you cannot convert analog VGA data to digital HDMI data with an adapter.
- Video cards include a GPU and additional RAM. It's important to update drivers when installing new cards.
- CRT monitors include deadly voltages and should not be opened. They should be disposed of as hazardous waste.
- Dxdiag provides information on a system, DirectX, the display, and sound capabilities. It can be used to diagnose some problems related to the display.
- Many display problems can be attributed to the incorrect driver, an overheated video card, or the connection. Ensure that the driver is up to date, the cooling system is working, and that cables are plugged into the correct ports.

Chapter Review

Use the following questions to test your knowledge of the information in this chapter. The answers to these questions, and the explanations of why each answer choice is correct or incorrect, are located in the "Answers" section at the end of this chapter.

1. Of the following display interfaces, what uses an analog signal? (Choose all that apply.)
   - **A.** HDMI
   - **B.** DVI-D

C. DVI-A

D. VGA

2. Which of the following display interfaces include both audio and video signals?

   A. HDMI

   B. DVI-D

   C. DVI-A

   D. VGA

3. You have a computer with a DVI port and an HDMI port. One monitor is connected to the DVI port, and you want to add a second monitor. The second monitor has a single VGA port. How can you accomplish this?

   A. Plug the VGA cable into the HDMI port.

   B. Use a passive VGA-to-HDMI adapter.

   C. Plug the VGA cable into the DVI port, and plug the DVI cable into the HDMI port.

   D. None of the above.

4. Your company is replacing all the CRT monitors with flat panel displays. What should be done with the old monitors?

   A. Take them directly to a landfill.

   B. Throw them in the dumpster.

   C. Take them to an incinerator.

   D. Dispose of them as hazardous waste in compliance with local regulations.

5. You have recently installed a new video card with a DVI interface. The display always defaults to VGA mode and can't be changed. What is the most likely problem?

   A. Nothing; this is normal for DVI.

   B. Incorrect driver.

   C. Faulty monitor.

   D. Faulty video card.

6. You are troubleshooting a problem with a blank LCD display. You have verified that it is connected to the computer and has power. What's the most likely problem?

   A. Incorrect driver

   B. Faulty CRT tube

   C. Failed backlight

   D. Dead pixels

Answers

1. **Correct Answers:** C, D
   - **A. Incorrect:** High-Definition Multimedia Interface (HDMI) uses digital transmissions.
   - **B. Incorrect:** Digital Visual Interface—Digital (DVI-D) uses digital transmissions.
   - **C. Correct:** Digital Visual Interface—Analog (DVI-A) uses analog transmissions.
   - **D. Correct:** Video Graphics Array (VGA) uses analog transmissions.
2. **Correct Answer:** A
   - **A. Correct:** High-Definition Multimedia Interface (HDMI) includes both 8-channel audio and video.
   - **B. Incorrect:** Digital Visual Interface—Digital (DVI-D) includes video in only a digital format.
   - **C. Incorrect:** Digital Visual Interface—Analog (DVI-A) includes video in only an analog format.
   - **D. Incorrect:** Video Graphics Array (VGA) uses only analog video.
3. **Correct Answer:** D
   - **A. Incorrect:** A VGA cable with a DB-15 connector will not plug into an HDMI port.
   - **B. Incorrect:** A passive adapter cannot convert analog VGA signals to digital HDMI signals.
   - **C. Incorrect:** The VGA cable cannot plug into a DVI port, and the DVI cable can't plug into the HDMI port.
   - **D. Correct:** HDMI is digital, and VGA is analog, and none of these solutions can convert the signals.
4. **Correct Answer:** D
   - **A. Incorrect:** Monitors should not be taken to a landfill.
   - **B. Incorrect:** Monitors thrown in the dumpster go to a landfill.
   - **C. Incorrect:** Monitors should not be incinerated.
   - **D. Correct:** CRT monitors include toxic substances and should be disposed of as hazardous waste.

5. **Correct Answer:** B

   A. **Incorrect:** VGA mode (640 × 480) is not common for DVI.

   B. **Correct:** The most common reason for a new video card defaulting to VGA mode is an incorrect driver.

   C. **Incorrect:** Problems with the monitor can affect the display quality but wouldn't change the resolution.

   D. **Incorrect:** A faulty video card can default to VGA mode, but it is much more likely that the driver isn't installed for the new video card.

6. **Correct Answer:** C

   A. **Incorrect:** An incorrect driver would give some other symptoms.

   B. **Incorrect:** An LCD monitor does not have a CRT tube.

   C. **Correct:** LCD crystals do not emit light, so the most likely problem is that the backlight failed.

   D. **Incorrect:** LCDs might have a few dead pixels, but if the screen is completely blank, all the pixels would be dead.