LESSON

13 Multimedia: Sound and Video

Multimedia devices are an often overlooked feature of PC hardware in the business world, but multimedia plays a larger role in business with each passing year. In fact, some segments, such as the entertainment industry, rely on multimedia capabilities to perform daily tasks. However, even for seemingly unrelated segments, the reliance on multimedia features in presentations and company videos makes multimedia an important aspect of certain systems.

As a professional hardware technician, you need to know how to properly install, configure, and troubleshoot various multimedia devices, such as sound cards and video cards. You also need to be able to choose the correct peripheral device for a system based on the client's needs. To properly choose and support these peripherals, you need a solid understanding of multimedia features and benefits, as well as how to troubleshoot and resolve common error conditions.

Goals

In this lesson, you will learn how to install, configure, and support video cards, sound cards, and digital cameras. Additionally, you will learn how each device is used, and how to specify the correct device for a potential client.

Lesson 13 Multimedia: Sound and Video

Skill	A+ Hardware Objective
1. Understanding Sound Cards	1.1 Identify the names, purpose, and characteristics of system modules. Recognize these modules by sight or definition. 1.9 Identify procedures to optimize PC operations in specific situations. Predict the effects of specific procedures under given scenarios.
2. Installing Sound Cards	1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.
3. Troubleshooting Sound Cards	2.1 Recognize common problems associated with each module and their symptoms, and identify steps to isolate and troubleshoot the problems. Given a problem situation, interpret the symptoms and infer the most likely cause.
4. Understanding Video Cards	1.1 Identify the names, purpose, and characteristics of system modules. Recognize these modules by sight or definition. 1.9 Identify procedures to optimize PC operations in specific situations. Predict the effects of specific procedures under given scenarios.
5. Installing a Video Card	1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.
6. Working with Digital Cameras	1.8 Identify proper procedures for installing and configuring common peripheral devices. Choose the appropriate installation or configuration sequences in given scenarios.

Requirements

To complete this lesson, you will need a computer running Windows XP, a sound card and video card to install on the computer, as well as a technician's toolkit.

skill 1 Understanding Sound Cards

A+ Hardware Objective

1.1 Identify the names, purpose, and characteristics of system modules. Recognize these modules by sight or definition.

1.9 Identify procedures to optimize PC operations in specific situations. Predict the effects of specific procedures under given scenarios.

overview

A **sound card** is an expansion card that gives your PC the ability to produce, record, and manipulate sound (**Figure 13-1**). To produce sound, a number of different methods can be used. Primarily, sound cards use one or more of the following three methods to produce sound: digital audio playback, synthesis, and input playback.

Digital audio playback occurs whenever the sound card plays a sound stored in a digital audio file, such as a wave file (.wav extension) or MPEG Layer 3 file (.mp3 extension). Digital audio playback, at its most basic level, is performed by converting the digitally encoded representation of the sound in the file and converting it to analog sound. However, in nearly all cases, the sound card is responsible only for taking a raw bit stream and converting those pulses into an analog sound. The sound card itself does not understand how to decode these file formats. The task of decoding the file formats is left to the operating system, and is described by a codec (short for coder/decoder). Because each file format has a different method of encoding, a new codec is required for each new file type. Luckily, this is not an issue because most audio applications include the relevant codecs. In fact, some, such as the newer versions of Windows Media Player, even attempt to automatically download and install newer codecs for unrecognized file types.

Once a file is decoded, the bit stream is passed to the sound card, which then reproduces the sound. The quality of the final sound output is determined by several factors:

- The **bit depth** of the original recording.
- The **sampling rate** of the original recording.
- The quality of the original recording.
- The **signal to noise ratio (SNR)** of the sound card.
- The quality of the sound card’s output path.

As you can see, the first three determinants all relate to the original recording. This is a key point to realize when dealing with sound: You can never reproduce a sound at a higher quality than that at which it was originally recorded. In fact, the resulting playback is always at a lower quality than the original recording, due to noise introduced during playback. The ultimate goal for high-end sound cards is to reduce the noise introduced into the playback as much as possible.

To understand how the original bit depth and sampling rate affect the recording, you need to understand the process of sampling. Sampling is a process whereby analog to digital converters turn an analog waveform into a digital representation. This is done by taking samples of the amplitude of the waveform many times per second and applying a digital value to each sample. For instance, imagine we want to convert the simple wave shown in **Figure 13-2** into a digital sound. For this, we need to take snapshots, or samples, of the sound at set intervals. We also need to apply a value to the “height” of each sample. For instance, suppose that the given waveform is 1 second long, and that we chose to sample this waveform at a rate of 10 Hz, or 10 times per second. For each sample, we need to describe the amplitude or “height” of that sample. If we chose a bit depth of 2, this gives us four possible values for each sample, 0 - 3. This is because two binary digits allow only for four possible values: 00, 01, 10, 11. So, In this case, with a 10 Hz sampling using a bit depth of 4, the resulting digital representation of the waveform would be similar to **Figure 13-3**.

Obviously, the result from our digitization of the previous waveform is not similar to the original. However, if we double the bit depth and double the samples per second, we get a

Figure 13-1 Sound card

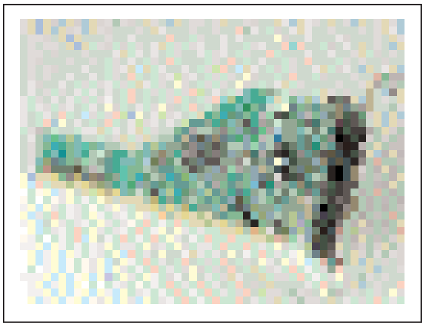


Figure 13-2 A simple waveform

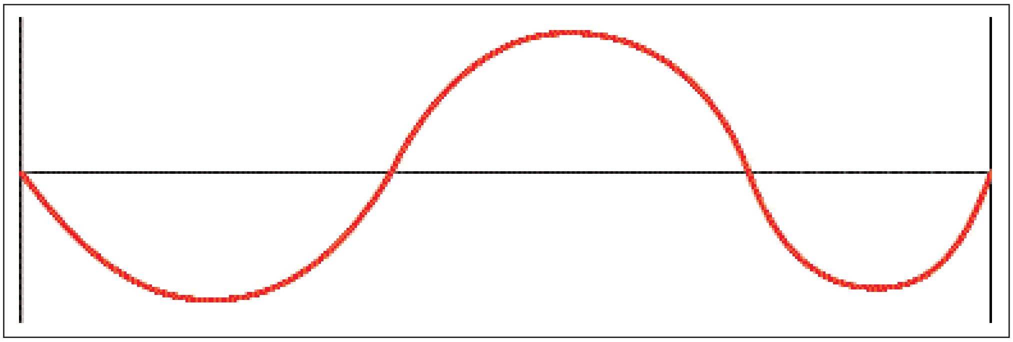
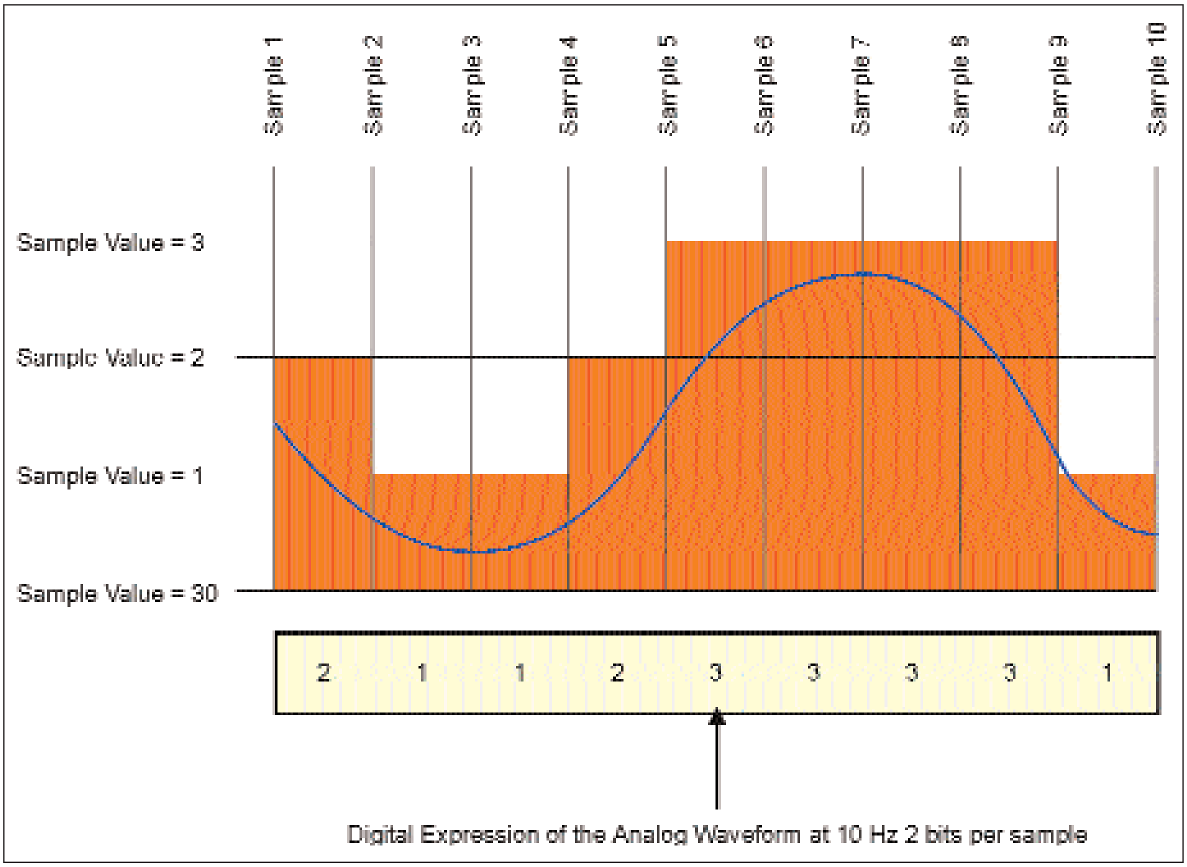


Figure 13-3 A simple digitization of the previous waveform



skill 1

Understanding Sound Cards (cont'd)

A+ Hardware Objective

1.1 Identify the names, purpose, and characteristics of system modules. Recognize these modules by sight or definition.

1.9 Identify procedures to optimize PC operations in specific situations. Predict the effects of specific procedures under given scenarios.

overview

more accurate representation **(Figure 13-4)**. Still, this representation would sound very poor when converted back to analog, as the sampling rate is still very, very low. In general, the higher the sampling rate and bit depth, the more accurate the recording. To effectively digitize an analog sound, you must sample the sound at double the effective frequency of the sound. For example, if you wanted to sample a sound at the frequency of 256 Hz (approximately equivalent to middle C on a piano), you would need to sample the sound at greater than 512 Hz to record it. However, the farther above this threshold you sample, the more information you record, and the better the resulting sound. This is because sound is almost never made up of a single frequency. Harmonic overtones may be heard in some instruments at more than double the base frequency, which is part of what gives each instrument its own unique sound. As a general rule, a 44 KHz sampling rate at 16 bits per sample is considered CD-quality audio. This rate is based on the assumption that the human ear cannot perceive any frequency greater than 22 KHz. However, the accuracy of this assumption is in question. Many people claim to be able to tell a distinct difference between a sound recorded at 96 KHz and one recorded at 44 KHz. It is theorized that this is due to ultrasonic interactions between the different instruments producing audible secondary frequencies. Although the validity of this theory is simply speculation at this point, it is important to note that many audio professionals use sample rates that are considerably higher than 44.1 KHz to record.

Next, the quality of the original recording greatly affects the resulting sound. Each device along the path during the recording affects the overall quality of the recorded sound, primarily by introducing noise, or "color," into the sound. The amount of noise a device introduces into a given signal path is represented by the device's SNR. The SNR expresses how much signal is present for each decibel (dB) of noise introduced into the sound. For instance, a SNR of 86 dB would mean that 86 dB of sound are present for each 1 dB of noise introduced. Because decibels are logarithmic, which means that the scale is not linear, this means that the effective difference between 86 dB and 1 dB is around 200,000,000. In other words, this means that the base sound is around 200,000,000 times louder than the noise, in this test. However, in practice, noise can be perceived in devices with high SNRs. This is partially because the noise is captured as a modification of the sound, rather than a separate sound **(Figure 13-5)**. Additionally, every device in the recording path introduces some noise into the sound **(Figure 13-6)**. Finally, outside factors such as 60 cycle hum from computer power supplies can influence the effective SNR of the sound card in real-world applications. In general, however, the higher the SNR of the device, the higher the effective quality of the recording.

In addition to affecting the recording, SNR is also important for playback. If a recording was done with a low final noise ratio, but is played back through a device with a high SNR, the final sound produced is obviously very noisy.

The final factor affecting the quality of digital audio playback is the quality of the sound card's output path. In general, sound cards can output the sound in one of three methods:

- **High-level analog**: Amplified signal, delivered with enough power to drive a set of small speakers.
- **Low-level analog**: Non-amplified signal, delivered with enough power to serve as an input to an amplifier or amplified speakers.
- **Digital**: Digital signal, send via special connectors to digital equipment, which can then convert the signal into analog.

Figure 13-4 A more complex digitization of the simple waveform

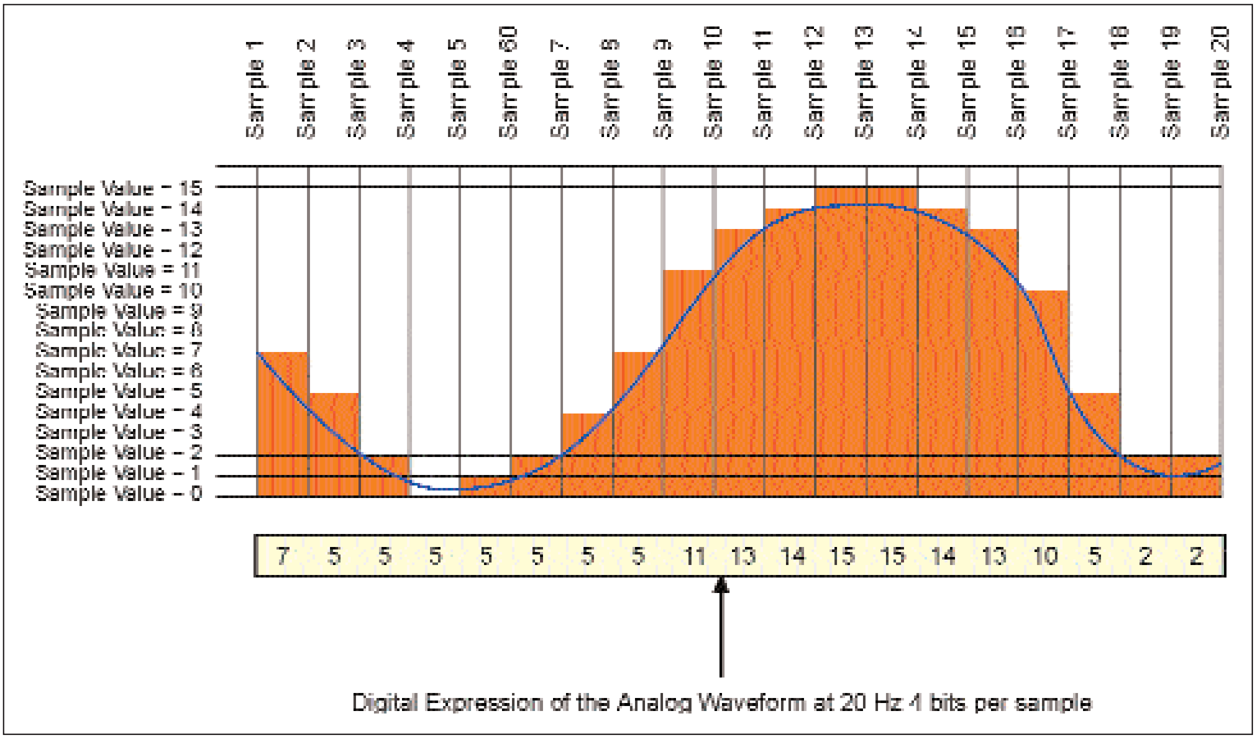


Figure 13-5 How noise affects the output sound

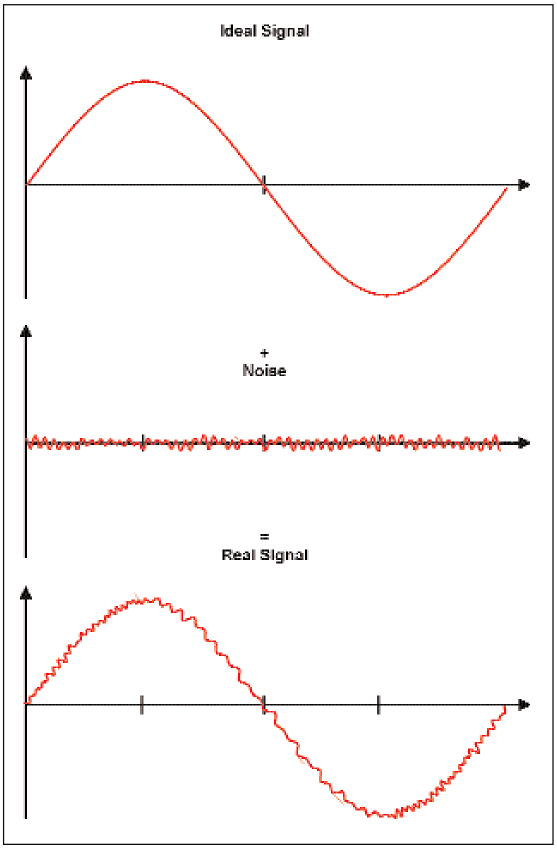
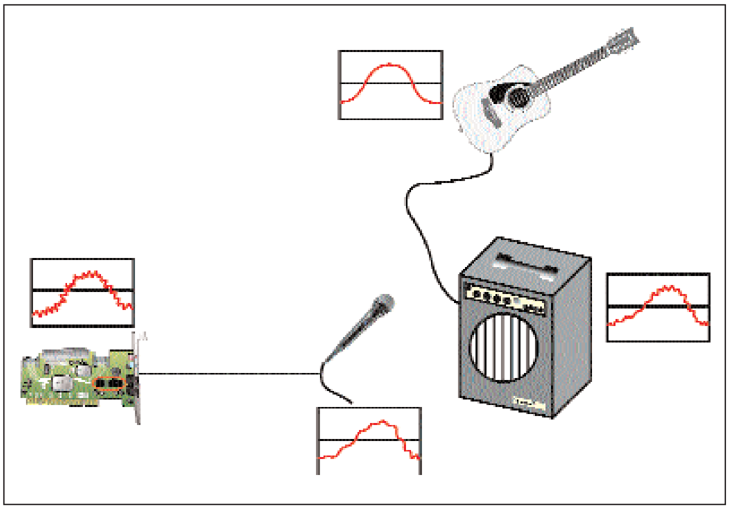


Figure 13-6 Each device in the path adds noise to the final sound



skill 1

Understanding Sound Cards (cont'd)

A+ Hardware Objective

1.1 Identify the names, purpose, and characteristics of system modules. Recognize these modules by sight or definition.

1.9 Identify procedures to optimize PC operations in specific situations. Predict the effects of specific procedures under given scenarios.

overview

Of these three, digital signals introduce the least amount of noise and high-level analog signals introduce the most. Digital is the clearest because when the signal is sent digitally, the sound cards own **digital to analog converters (DACs)** are not responsible for the conversion. Rather, the device that is receiving the signal (which could be anything from a set of digital speakers to a pro-audio mixing board) converts the signal as necessary. Because, with the possible exception of very expensive pro-audio sound cards, sound cards have generally low quality DACs, this can remove much of the noise that the sound card might otherwise introduce into the path. High-level analog, on the other hand, is generally very noisy, because the signal travels through the sound card's own DACs and is amplified by the sound card's internal amplifier, which is typically horrendously noisy.

Realize also that the effective quality of digital audio for a sound card also affects the quality of all sounds the sound card is capable of producing. In other words, synthesis and input playback are both affected by the quality of the sound cards output path in the same manner as digital audio playback is affected.

Synthesis is another method of producing sound. Synthesis is the act of using one or more synthesizer chips to create sounds from note inputs. Put simply, you can think of synthesis as allowing your sound card to become a musical instrument of its own. Synthesis was, at one time, used quite extensively in gaming and other multimedia applications. However, because the quality of the synthesis varies greatly depending on the sound card, most modern applications use digital audio instead of synthesis. Still, synthesis has its uses, most notably in digital audio workstations (DAWs) for musicians. Synthesizers on sound cards come in three basic varieties: analog, wave table, and physical modeling **(Table 13-1)**.

Analog synthesis is the oldest type of synthesis, and is still popular among some musicians. Analog synthesizers create new sounds by combining (known as additive synthesis) or subtracting (known as subtractive synthesis) simple waveforms to a base waveform. For instance, a sine wave might be added to a square wave to make a new waveform **(Figure 13-7)**. Analog synthesis results in sounds that are typically "alien," and don't closely resemble any natural sounds, but are quite popular in certain musical genres (such as techno).

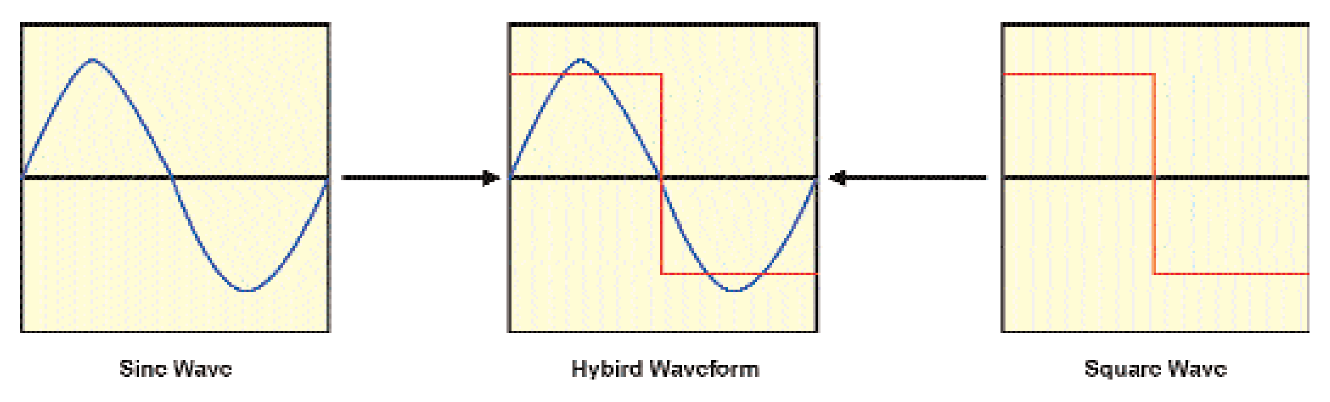
A sound card's synthesizer is commonly accessed using **Musical Instrument Digital Interface (MIDI)**. MIDI is a format that allows the synthesizer to accept needed musical data, such as tempo, pitch, and velocity. The most common method of inputting notes into the synthesizer is through the playback of MIDI files (.mid extension), though you can also send MIDI data by inputting notes directly using a MIDI controller (such as a MIDI compatible keyboard) connected to the sound card's MIDI port. On most sound cards, the MIDI port is shared with the joystick port, and requires an adapter to connect to a MIDI controller. Note, however, that some sound cards do not have a MIDI port, which requires you to use a separate hardware device to connect the MIDI controller.

Wavetable synthesis is perhaps the most popular form of synthesis. Wavetable synthesizers do not technically create sounds. Rather, they play back prerecorded sounds at different speeds to alter their pitch. These prerecorded sounds are known as samples. The quality of wavetable synthesis is largely determined by the size and quality of the sample set used. A large sample set recorded at high quality can produce sounds that are very similar to the instruments they are attempting to emulate. In fact, some wavetable synthesizers are so realistic that they can fool the average listener into thinking they are hearing an actual live instrument. In most

Table 13-1 Sound card synthesis methods

Synthesis Method	Description		
Analog	Oldest type of synthesis Combines and subtracts simple wave forms	Produces "techno" or "synthesizer" sounds popular in some musican genres such as "techno"	Found on older sound cards
Wavetable	Play back samples (pre-recorded sounds) at different speeds to alter their pitch	High-quality wavetable soundcards can produce sounds very similar to types of instruments they are emulating	Found on most commercial sound cards
Physical modeling	Use mathematical models to recreate the timbre of live instruments	Produces most realistic sounds	Found on professional (non-commercial) sound cards

Figure 13-7 Additive synthesis



skill 1

Understanding Sound Cards (cont'd)

A+ Hardware Objective

1.1 Identify the names, purpose, and characteristics of system modules. Recognize these modules by sight or definition.

1.9 Identify procedures to optimize PC operations in specific situations. Predict the effects of specific procedures under given scenarios.

overview

sound cards, however, wavetable synthesis is mediocre at best. High quality sample-sets are typically included only in very expensive and specialized sound cards.

Whereas most wavetable sound cards come with an uneditable sample set contained in on-board ROM, some wavetable synthesizers allow you to load your own samples into sample RAM, which allows you to create your own instruments. This is fairly common in high-end sound cards, but is also available on some consumer models, such as the SoundBlaster Audigy series.

The final type of synthesis is physical modeling, which can produce extremely realistic sounds when done well. Physical modeling synthesizers attempt to recreate the timbre of live instruments by physically modeling the instrument using mathematical formulas. For instance, a physical model of an acoustic guitar would attempt to determine the vibration produced by the string when struck, and then factor in the resonance of the guitar body, the effect of the plectra (pick) on the string, the effect of one string's vibration on other strings, and so on, to create a mathematical model of the final sound. If this sounds complicated, that's because it is. Physical modeling is the most resource-intensive of all of the synthesis methods, but it is capable of producing very expressive and realistic sounds. Very few sound cards are capable of producing physically modeled sounds, and many that do, such as the Korg Oasys, are very expensive and have not achieved commercial success.

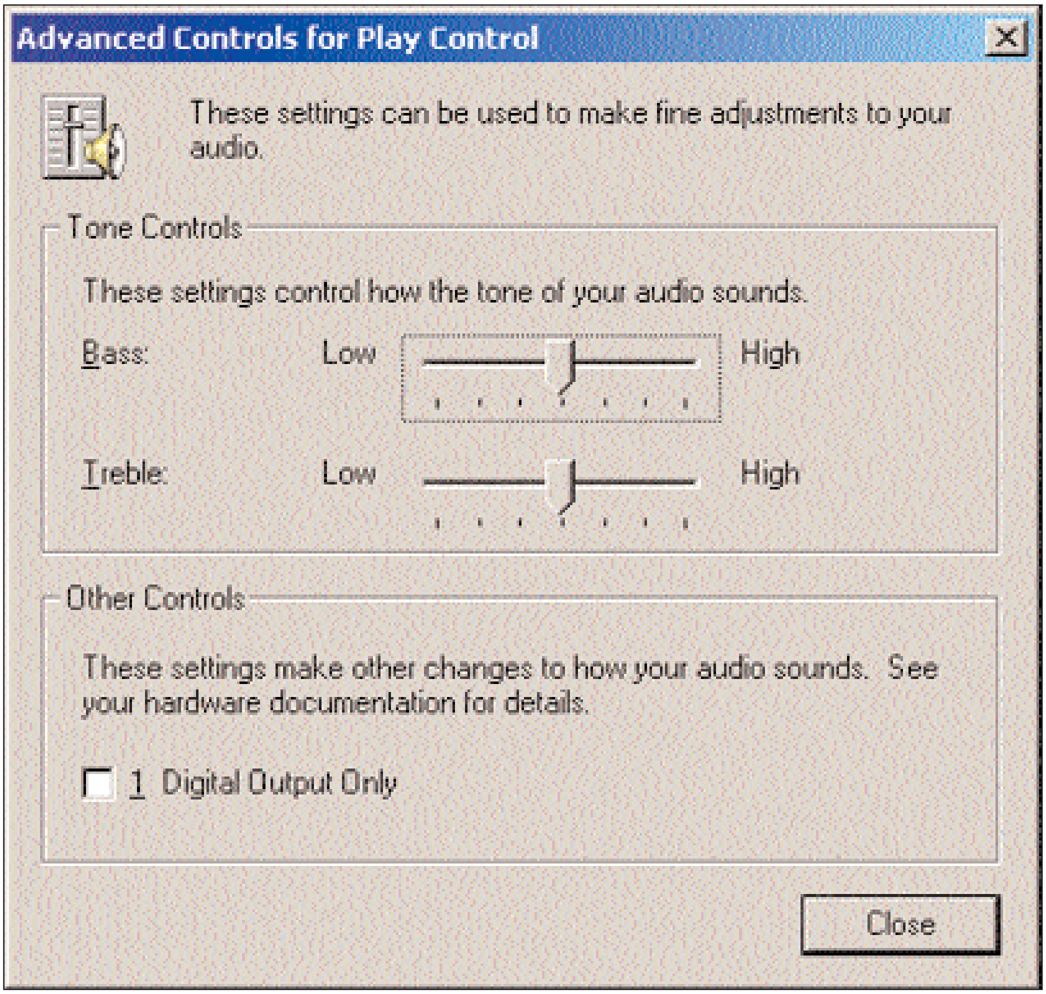
The final type of sound production method is input playback. Input playback involves playing a signal from one input back out another. A simple example of the use of input playback is the playback of a CD through your sound card. The digital audio is sent from the CD player to the sound card through a CD audio cable, and the sound card plays the resulting sound out of one or more outputs. Input playback is limited in quality by the same factors that influence digital audio playback.

Now that we have examined the different methods of producing sound, let's examine the different ways a sound card can manipulate sound. The methods used to manipulate sound are endless, and some sound cards have plethora of options in this regard. One of the simplest methods of sound manipulation, and one available in nearly all sound cards, is equalization. An equalizer modifies the amplitude of a sound at specific frequencies, making some frequencies more (or less) prominent than others. The simplest form of an equalizer is the tone controls for bass and treble **(Figure 13-8)**. However, there are many more complicated methods of sound manipulation, ranging from reverberation to pitch shifting and beyond.

In most sound cards, sound manipulation is performed by specialized chips known as **Digital Signal Processors (DSPs)**. You can think of a DSP as an on-board processor specifically for sound manipulation. DSPs allow you to perform sound manipulation needed for certain applications without taxing the system processor. For instance, DSPs can be used to create the illusion of surround sound using just two speakers without forcing the processor to perform additional calculations. DSPs, like most hardware components, come in many forms and vary in quality and capabilities. In most consumer sound cards, the DSP's quality and capabilities is limited at best. However, some high-end and very expensive sound cards, such as the Yamaha DS2416 DSP Factory, are capable of a wide range of high-quality effects.

Finally, sound cards are capable of recording sounds. Recording follows many of the same principles as playback in regards to quality. Like playback, sound cards can typically record using three types of inputs: high-level analog, low-level analog, and digital. Again, high-level analog inputs are typically the noisiest, whereas digital inputs are the quietest.

Figure 13-8 Tone controls in Windows



skill 2 Installing a Sound Card

A+ Hardware Objective

1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.

overview

For the most part, installing a sound card is really no different than installing any other expansion card. The only difference comes in the fact that the sound card has a lot of connectors both internal and external. **Table 13-2** explains what each of these connectors are and what they do. You can see what the various connectors look like in **Figure 13-9**.

It's important to remember that the connectors listed in Table 13-5 are only the most common types of sound connectors. Higher end sound cards often have many more connectors. For example, the Creative Labs SoundBlaster Live series of sound cards make use of something called a Live Drive. A Live Drive, shown in **Figure 13-10**, is simply a series of connectors that are mounted into a 5.25" drive bay. These connectors provide connections for fiber optic sound cables, and various MIDI and SPDIF (Sony/Philips Digital Interface) jacks. The SB Live Drive also features a sensor for an infrared remote that comes with the sound card, volume controls, and connectors for headphones and additional inputs.

The process for installing the sound card's driver varies depending on the brand of the sound card and on the PC's operating system. Creative Labs sound cards usually ship with an installation CD. Insert the CD and an auto run application installs the necessary drivers along with a plethora of audio applications. However, not all manufacturers make installing the drivers quite this easy. It is therefore necessary to know how to manually install a sound card driver.

Table 13-2 Connectors on a sound card

Connector	Location	Purpose
TV/IDE connector	Internal	Attaches to the audio outputs from a DVD decoder card, TV tuner card, or IDE CD-ROM drive.
CD audio connector	Internal	Connects to a CD-ROM drive by using a CD audio cable.
TAD (telephone answering device) /modem connector	Internal	Connects to internal audio sources, such as an internal modem.
Speaker out jack	External	Attaches the sound card to external speakers. This is a high-level analog output on most sound cards.
Microphone in jack	External	Allows you to plug in a microphone for recording sound. This is a high-level analog input on most sound cards.
Line out jack	External	This jack is used to attach speakers, but can also be used to output sound to other recording or amplification hardware. This is a low-level analog output.
Auxiliary in	External	This jack is used to record audio from sources other than a microphone. This is a low-level analog input.

Figure 13-9 Sound card connectors

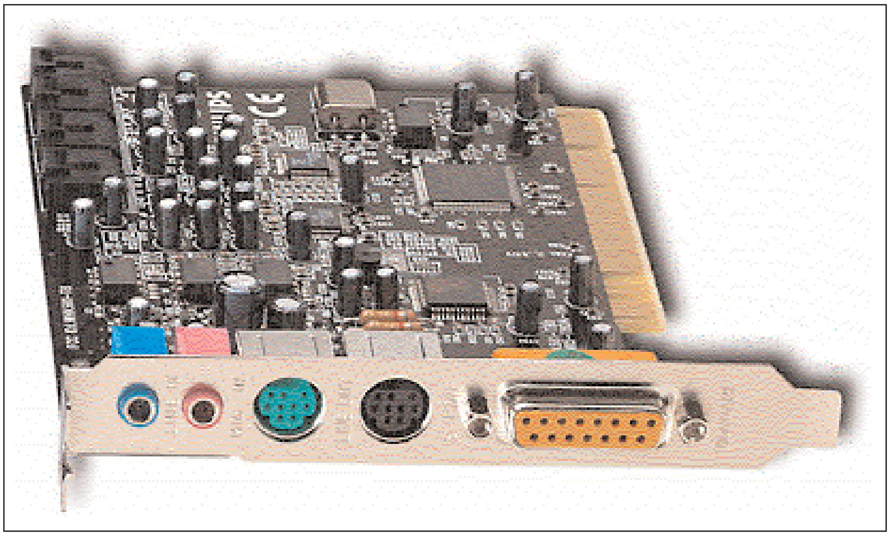
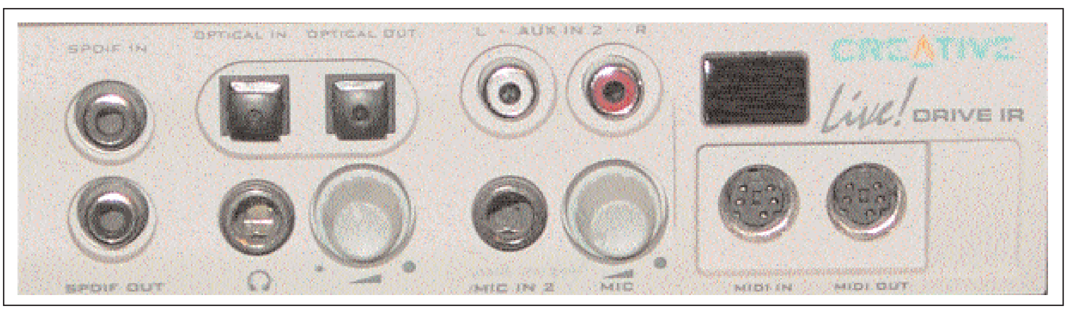


Figure 13-10 The Creative Live Drive



skill 2

Installing a Sound Card (cont'd)

A+ Hardware Objective

1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.

how to

To install a sound card, follow these steps.

1. Turn off and unplug the PC.
2. Remove the PC's cover and locate an empty expansion slot, preferably near the CD-ROM drive.
3. Remove the cover from the expansion slot opening in the back of the PC's case.
4. Install the sound card into the expansion slot and screw the card to the case.
5. Connect the sound card to the CD-ROM drive by using an audio cable.
6. Connect the DVD decoder to the sound card's TV/IDE decoder connector if appropriate.
7. Put the PC's cover back on and plug the computer back in.
8. Connect the external speakers and microphone to the appropriate ports.

Install the driver for the sound card in Windows XP.

1. Open the **Control Panel** and click the **Performance and Maintenance** link, followed by the **System** link. When you do, you will see the System Properties sheet.
2. Select the **Hardware** tab and then click Add Hardware Wizard, as shown in **Figure 13-11**.
3. When the wizard starts, click Next > to bypass the wizard's Welcome screen. The wizard attempts to automatically detect your new sound card. If the sound card is automatically detected, then follow the prompts to complete the installation.
4. If the new sound card isn't automatically detected, Windows asks you whether you have installed the new hardware yet. Click **Yes**, followed by Next >, and you will see a list of all of the hardware in your system, as shown in **Figure 13-12**.
5. Select the **Add a new hardware device** option and click Next >. Windows now asks you if you want it to search for the new hardware again or if you would prefer to install the hardware manually.
6. Select the **Manual installation** option and click Next >. You now see a list of various categories of hardware that may be installed, as shown in **Figure 13-13**.
7. Select the **Sound, Video, and Game Controller** option and click Next >. You now see a list of various sound card manufacturers and some of the models of sound cards that each manufacturer produces, as shown in **Figure 13-14**. Windows XP is notorious for supplying drivers that don't work. Therefore, even if your sound card is listed, you are better off clicking Have Disk... and supplying the driver disk provided with the sound card. If you don't have such a disk, you can always download the latest drivers from the sound card manufacturer's Web site.

tip

Most of the time, installing the sound card's driver is enough to make the sound card functional. Even so, most sound cards have some configurable options.

Figure 13-11 The Add Hardware Wizard button

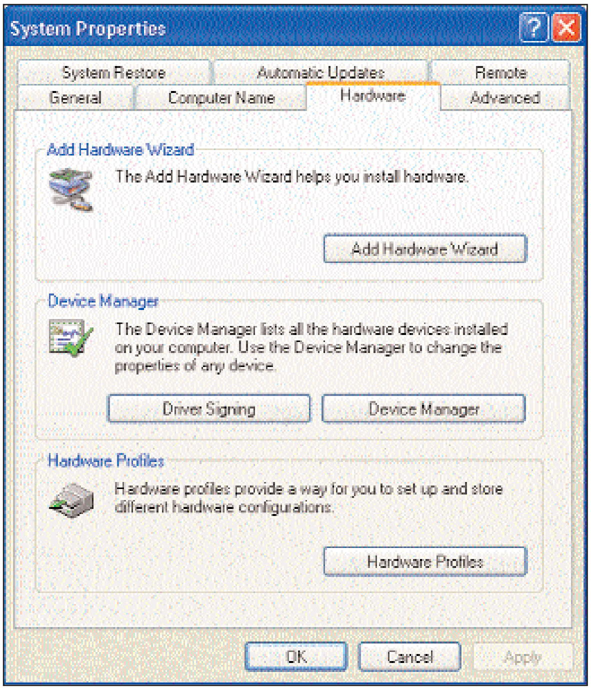


Figure 13-12 Listing installed hardware

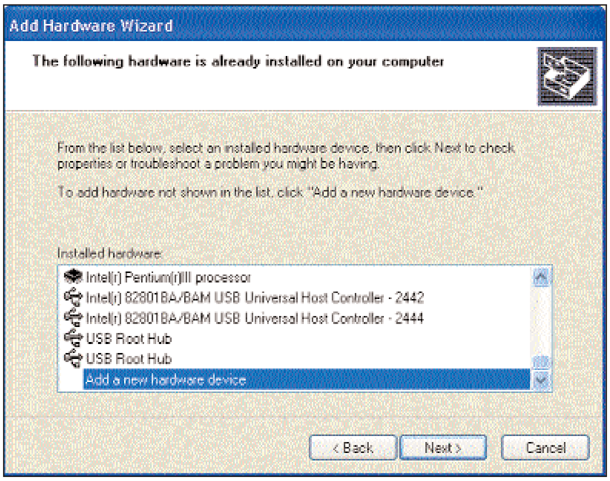


Figure 13-13 Hardware categories

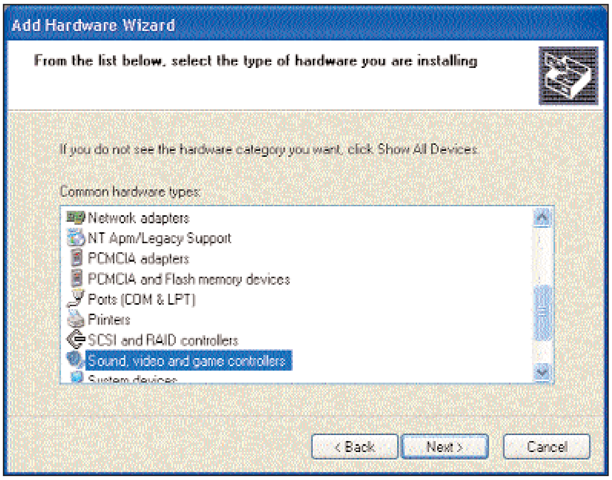
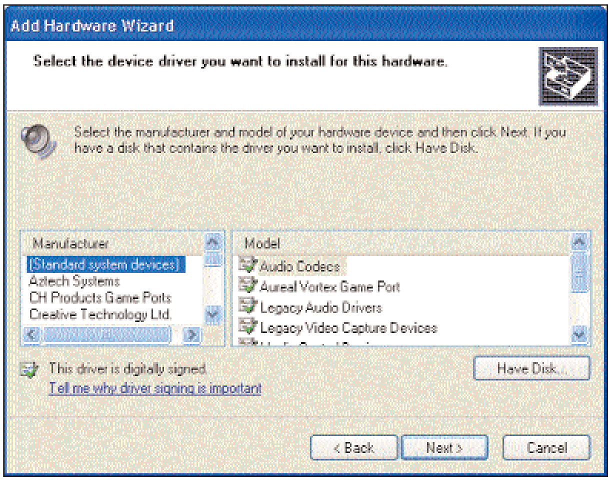


Figure 13-14 Examining different sound card models



skill 2

Installing a Sound Card (cont'd)

A+ Hardware Objective

1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.

how to

Configure the sound card.

1. Open the **Control Panel** and click the **Sounds, Speech, and Audio Devices** applet, followed by the **Sounds and Audio Devices** link. When you do, you will see the Sounds and Audio Devices **Properties** sheet, shown in **Figure 13-15**.
2. By default, the **Volume** tab is selected. This tab allows you to adjust the sound card's volume.
3. If you have good quality speakers, or anything beyond generic speakers, select the **Volume** tab, then click the **Advanced** button. This is very important if you have anything beyond just a generic pair of speakers. As you can see in **Figure 13-16**, you can configure your PC to produce sound for anything from a pair of speakers to a full-blown 7.1 channel surround sound configuration.
4. Click the **Audio** tab. This tab is important is because many system boards contain integrated, low-end sound cards. If you were to install a high-end sound card into a system with integrated sound, then it is sometimes be necessary to tell Windows which sound card to use. The Audio tab, shown in **Figure 13-17**, allows you to select which sound device will be used for various functions.

tip

Speaker selection options depend upon sound card support.

Figure 13-15 Sounds and Audio Devices Properties

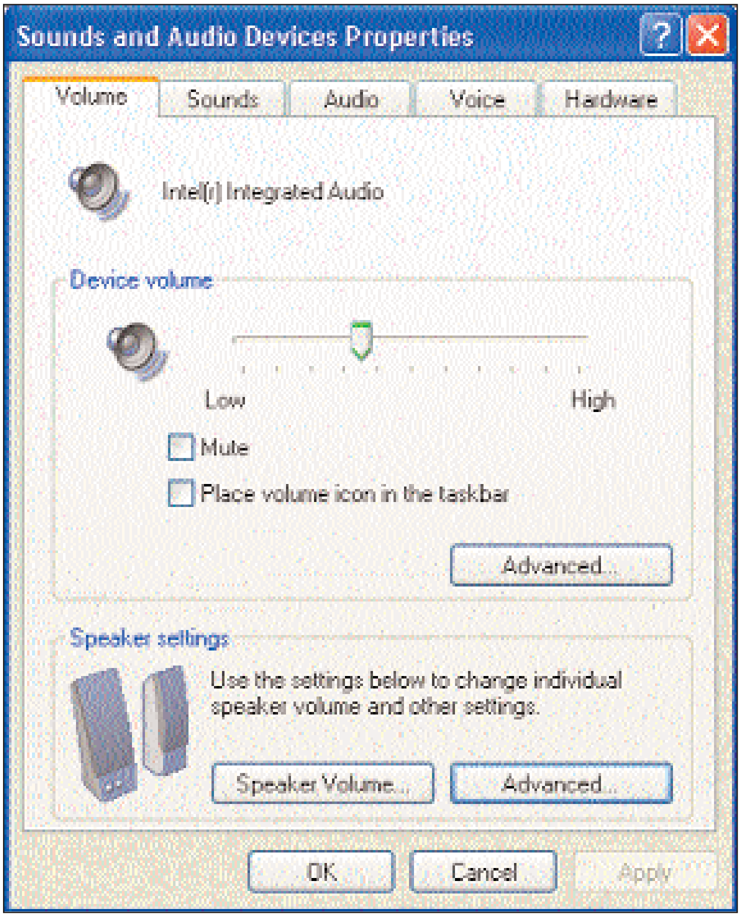


Figure 13-16 The Advanced Audio Properties dialog box

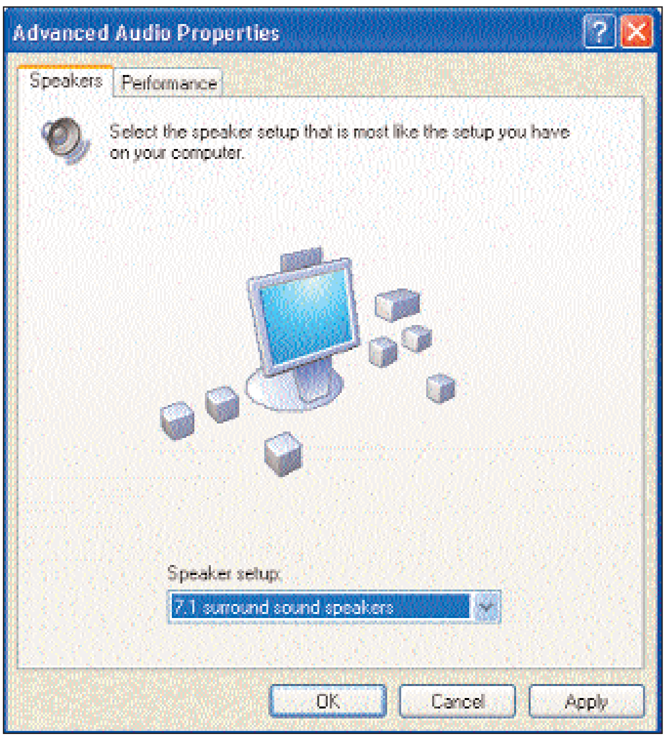
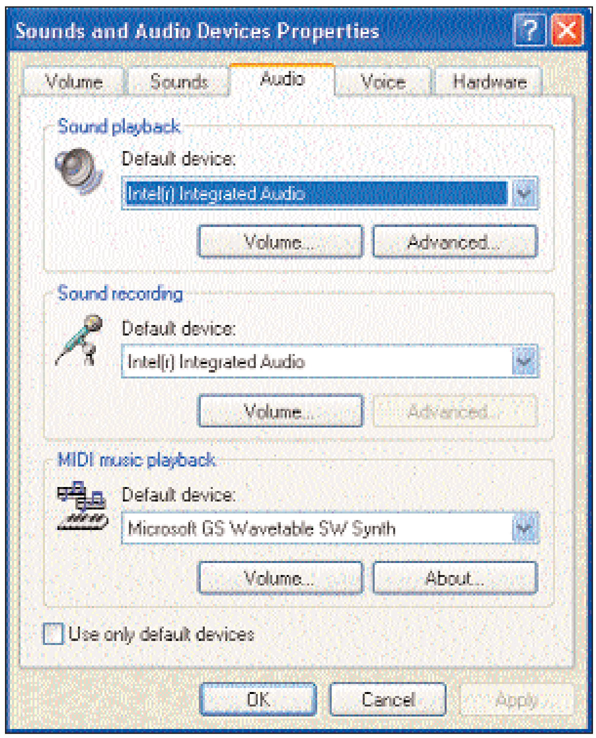


Figure 13-17 The Audio tab



skill 3 Troubleshooting Sound Cards

A+ Hardware Objective

2.1 Recognize common problems associated with each module and their symptoms, and identify steps to isolate and troubleshoot the problems. Given a problem situation, interpret the symptoms and infer the most likely cause.

overview

For the A+ exam, it is important to be able to troubleshoot various types of sound problems. The first step in troubleshooting a sound card problem is to try playing various types of sound files. For example, you might try playing a .wav file, a .mid file, and some CD audio. If none of the types of sound play, then it's likely that you have a driver problem or a hardware installation problem. If one or more types of sound play, then your hardware is installed correctly, and you might just need to make a minor adjustment. For example, if CD audio won't play but .wav files and .mid files do play, then it's likely that the sound card is installed properly, but either the CD audio is muted or the CD audio cable is not connected. Below are some other general troubleshooting techniques.

how to

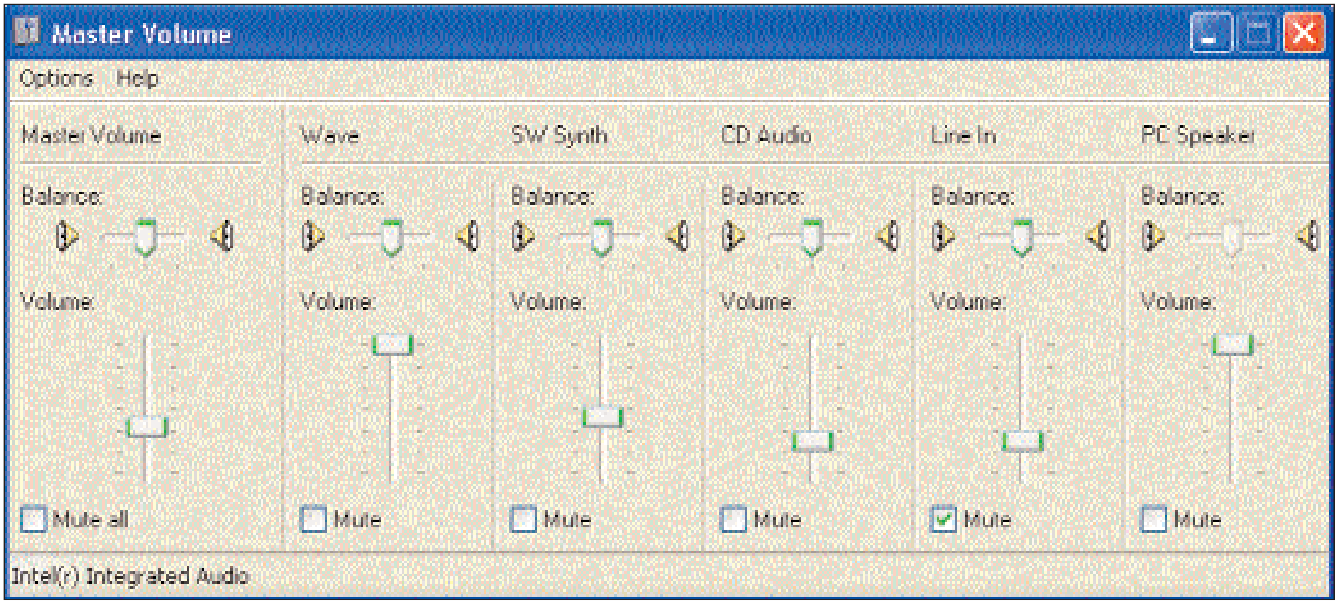
Troubleshoot a sound card.

1. Make sure that the speaker connector is plugged into the correct port on the sound card and the volume is turned up.
2. If the speakers are powered speakers, then make sure that the speakers are receiving power.
3. Try playing a long .wav or .mp3 file as you plug the speakers into various ports in an effort to see if any of them produce sound. There have been cases in which sound card ports have been mislabeled.
4. Check the volume controls on the Sounds and Audio Devices Properties. Open the **Control Panel** and click the **Sounds, Speech, and Audio Devices** link, followed by the **Sounds and Audio Devices** link. Keep in mind that the Volume tab displays only the master volume. It is possible to adjust the volume for different types of audio independently.
5. Click the **Advanced** button to reveal the **Master Volume** dialog box shown in **Figure 13-18**. As you can see, the volume can be adjusted and muted independently for a variety of sound types. Make sure that all levels are adequate.

more

Some other techniques that you might try are replacing the sound card with a known good one or checking the Device Manager for reported errors with the sound card. Some sound cards even come with their own special diagnostic programs.

Figure 13-18 The Master Volume dialog box



skill 4 Understanding Video Cards

A+ Hardware Objective

1.1 Identify the names, purpose, and characteristics of system modules. Recognize these modules by sight or definition.

1.9 Identify procedures to optimize PC operations in specific situations. Predict the effects of specific procedures under given scenarios.

overview

A **video card** is an expansion card that provides display capabilities to your PC. A video card is a required component of most PCs, and modern video cards do much more than basic system display functions.

In general, modern video cards have two major functions:

- **2-D graphics capability**: This is the capability of displaying any form of two-dimensional graphics, including monochrome and text-only displays. All video cards include this capability.
- **3-D graphics processing**: This is the ability to use onboard video processors to speed up or otherwise enhance three-dimensional applications, including many games, 3-D rendering software, and some Computer Aided Design (CAD) applications. Most modern video cards also include this capability.

2-D graphics capability is present at some level on all video cards. Even very old video cards, such as Hercules monochromatic cards, still support simple text and ASCII-based two-dimensional graphics.

Two-dimensional graphics are defined by the resolution and color depth they support. Many standards for these have been defined, but other modes are available. The standardized display modes are listed in **Table 13-3**.

Resolution and bit depth are intertwined, and your video card's support for a given resolution and color depth is primarily defined by its available video RAM. As you can see in Table 13-3, supporting higher resolutions and more colors requires more video RAM. This is because each refresh of the display requires a particular amount of RAM to hold the contents of the screen. For example, imagine you want to run 800 x 600 resolution at 8-bit color depth, which is 800 horizontal pixels by 600 vertical pixels, with 8-bits per pixel being used to represent the color of that pixel. To support this resolution, you require at least 480 KB of video RAM. This figure comes from multiplying the number of bits per pixel times the total number of pixels on the screen. The total number of pixels on the screen is 480,000 in this case, as 800 x 600 = 480,000. Because each pixel requires 8 bits to store, the total RAM required is 8 x 480,000, which is 3,840,000. Because a byte is roughly equivalent to 8 bits, we divide 3,840,000 by 8 to arrive at a final amount required of 480,000 bytes.

If you perform the math given in this example, you can see why XGA, at 1024 x 768 with a 16-bit color depth, requires a minimum of 2 MB of video RAM.

In addition to the amount of RAM an adapter contains, the type of RAM is also important. Video cards come with various types of video RAM designed for screen refreshes at an increased rate. The different types of video RAM, listed from fastest to slowest, are shown in **Table 13-4**.

Today, nearly all modern video cards are equipped with RAM of sufficient speed to support their maximum resolution and bit depth at an acceptable refresh rate, so you should not have to worry about the type of RAM used very much. It is important that you understand the speed differences between the types of RAM.

tip

Some servers can operate without a display adapter, keyboard, or mouse by redirecting all of these functions out of another port, such as a serial port. You then control the server using a terminal. These servers are typically called headless servers.

Table 13-3 Standardized display modes

Mode	Resolution	Bits per pixel	Colors	Video RAM required*
Color/Graphics Adapter (CGA)	160 x 200	4	16	16 KB
Enhanced Graphics Adapter (EGA)	640 x 350	4	16	128 KB
Video Graphics Array (VGA)	640 x 480	4	16	256 KB
Extended Graphics Array (XGA)	1024 x 768	16	16.7 million	2 MB
Super XGA (SXGA)	1280 x 1024	16	16.7 million	4 MB
Ultra XGA (UXGA)	1600 x 1200	16	16.7 million	4 MB
Wide XGA (WXGA)	1366 x 768	16	16.7 million	2 MB

*Video RAM required is rounded to the nearest power of 2.

Table 13-4 Different video RAM types

RAM Type	Description
Dynamic RAM (DRAM)	Similar to standard PC DRAM, but with slightly faster access times.
Synchronous Graphic RAM (SGRAM)	Similar to DRAM, but uses enhanced access techniques to improve performance.
Video RAM (VRAM)	Dual ported RAM, for double the speed of DRAM.
Windows RAM (WRAM)	Similar to VRAM, but with enhanced access patterns optimized for Windows systems.
3-Dimensional RAM (3-D RAM)	A technique for encasing the processor in RAM, allowing for additional access paths and higher throughput.

skill 4 Understanding Video Cards (cont'd)

A+ Hardware Objective

1.1 Identify the names, purpose, and characteristics of system modules. Recognize these modules by sight or definition.

1.9 Identify procedures to optimize PC operations in specific situations. Predict the effects of specific procedures under given scenarios.

overview

Next, most modern video cards can accelerate three-dimensional graphics rendering. 3-D graphics have extended requirements above and beyond 2-D graphics because they are processor intensive, involving a significant amount of number crunching, because the system must calculate luminosity, shadows, complex polygons, and more, and render these into an image displayed in real time. This is in contrast to 2-D graphics, where the images are largely predrawn, and the system must combine the individual elements, or sprites, to form a complete image. The additional processing required by 3-D applications can significantly impact an application's performance, because the processor must perform all of these calculations in addition to the standard calculations necessary to operate the application. To help relieve the processing requirements 3-D graphics can impose, manufacturers include 3-D processors on video cards. These processors offload many of the CPU-intensive rendering chores from the processor and allow the processor to handle application functions instead.

Many different types of 3-D acceleration chips exist, and 3-D acceleration is perhaps the fastest changing aspect of computer hardware. A new generation of 3-D accelerators typically ships yearly, which makes keeping up with the cutting edge video cards very difficult. Furthermore, it is rare to see a single accelerator dominate all performance tests. More commonly, each chip excels with applications written to take advantage of their unique features, and perform at a lower level with other software.

In addition to providing these features, all video cards have one or more video outputs (**Figure 13-19**), and some video cards also include video inputs, allowing you to capture video from another source such as a camcorder and store it on your hard disk. The different types of outputs available include:

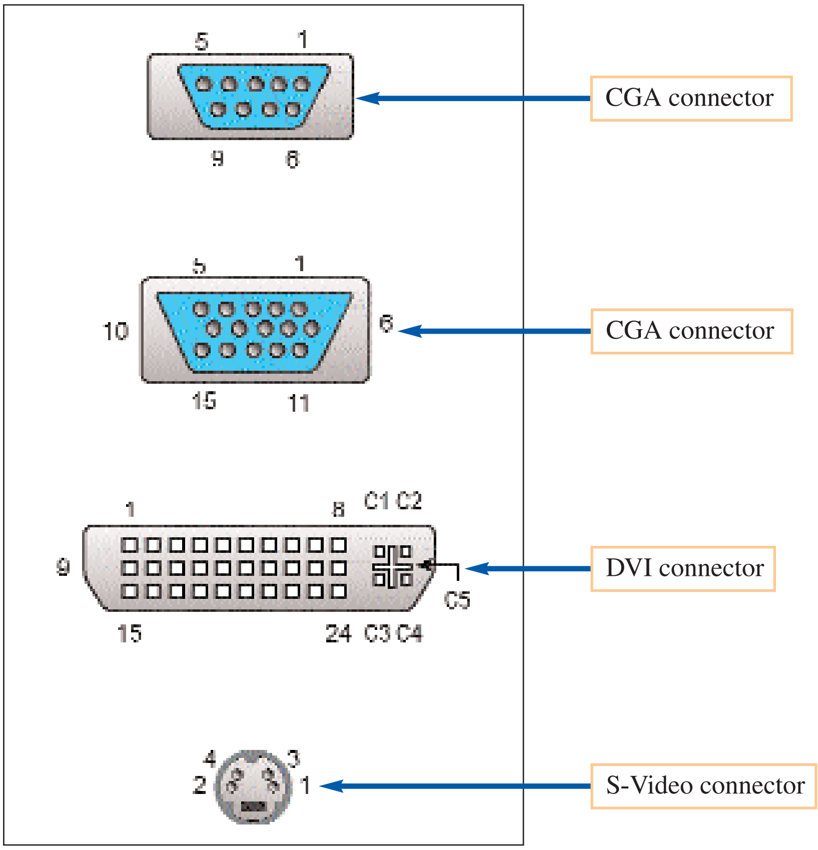
- **Color/Graphics Adapter (CGA)**: An obsolete standard, CGA ports utilize a 9-pin D-shell connector.
- **Video Graphics Array (VGA)**: The most commonly used connection for modern CRT monitors. Uses a 15-pin micro-D connector.
- **Digital Visual Interface (DVI)**: Used for connections to digital monitors, such as flat panel displays. Utilizes a custom D-shell connector.
- **Super-Video (S-Video)**: Used to send video different types of video equipment, including TVs and VCRs. Uses a four-pin round connector that resembles a PS-2 port (**Figure 13-22**).
- **Composite video**: Used to send video to TVs. Uses two RCA connectors. This method generally produces lower quality video than S-video.

In addition, some video cards provide multiple outputs, and support multi-monitor connections. These video cards are sometimes referred to as **multi-headed**. With a multi-headed video card, you can connect more than one monitor to the video card and, using either Windows 2000 or Windows XP, extend your desktop and applications across multiple monitors to provide a panoramic view.

tip

In most cases, the most taxing application a standard PC is likely to ever see is a 3-D graphics game. Most business applications (with a few exceptions) do not require extensive video processing capabilities. Games, however, usually tax even the most powerful system.

Figure 13-19 Video output connectors



skill 5

Installing a Video Card

A+ Hardware Objective

1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.

overview

Installing a video card generally follows the same steps required for any other expansion card. However, you must be careful to install the video card properly, because most systems will not boot if the video is not functional. This means that if you fail to seat the card properly, for instance, you will generally receive a BIOS beep code as your only troubleshooting tool (generally one long beep followed by three short beeps). Also, if your system is equipped with onboard video, you may need to disable the onboard adapter before you can install a new video adapter.

The process for installing the video card's driver varies depending on the brand of the video card and on the PC's operating system. Most video cards are detected as a new device immediately upon booting into Windows, but sometimes Windows may install the wrong driver or request a driver CD. In these cases, you must manually install the correct video card driver. In a Windows XP environment, this is accomplished through the following steps.

tip

ATI video cards require you to cancel out of the Windows detection and use the supplied ATI CD-ROM to install the video card instead.

how to

Install a video card.

1. Turn off and unplug the PC.
2. Remove the PC's cover and locate an empty expansion slot of the type you require. For instance, if you are installing an AGP video card, you need to locate your AGP slot. If you are upgrading an existing video adapter, remove the old adapter from the slot at this time.
3. If necessary, remove the cover from the expansion slot opening in the back of the PC's case.
4. Install the video card into the expansion slot and screw the card to the case. Ensure the card is seated properly. Improper card seating is a common problem, especially with AGP cards.
5. Connect the video card to the monitor.
6. Put the PC's cover back on and plug the computer back in.
7. Power on the monitor, then power on the PC.

Install the video card's driver.

1. Open the **Control Panel** and click the **Performance and Maintenance** link, followed by the **System** link. When you do, you will see the **System Properties** sheet.
2. Select the **Hardware** tab and then click [Add Hardware Wizard] **(Figure 13-20)**.
3. When the wizard starts, click [Next >] to bypass the wizard's Welcome screen. The wizard attempts to automatically detect your new video card. If the video card is automatically detected, then just follow the prompts to complete the installation.
4. If the new video card isn't automatically detected, Windows asks you whether or not you have installed the new hardware yet. Click **Yes**, followed by [Next >], and you will see a list of all of the hardware in your system **(Figure 13-21)**.
5. Select the **Add a new hardware device** option and click [Next >]. Windows now asks you if you want it to search for the new hardware again or if you would prefer to install the hardware manually.
6. Select the **Manual installation** option and click [Next >]. You now see a list of various categories of hardware that may be installed **(Figure 13-22)**.
7. Select the **Display Adapter** option and click [Next >]. You now see a list of various video card manufacturers and some of the models of video cards that each manufacturer produces. Windows XP is notorious for supplying drivers that don't work. Therefore, even if your video card is listed, you are better off clicking [Have Disk...] and supplying the disk provided with the video card. If you don't have such a disk you can always download the latest drivers from the video manufacturer's Web site.

Figure 13-20 The Add Hardware Wizard button

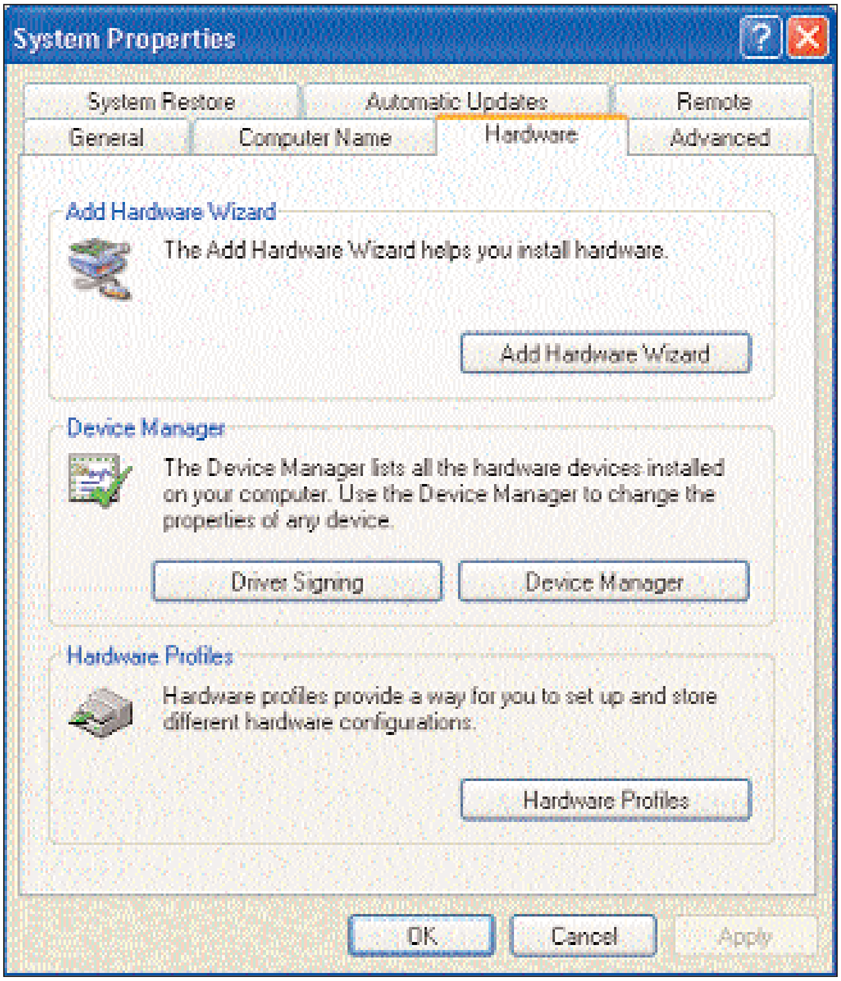


Figure 13-21 Listing installed hardware

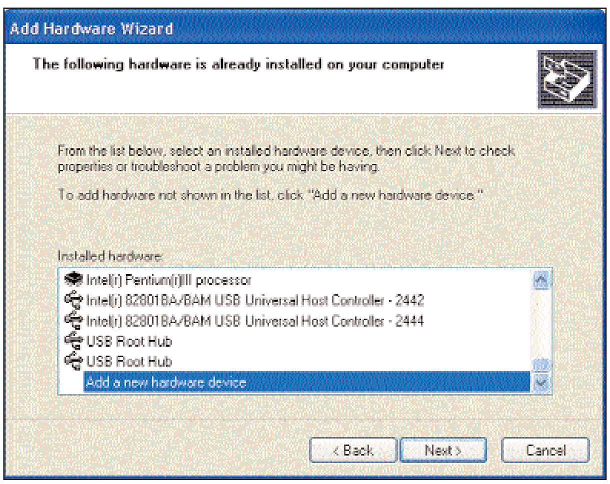
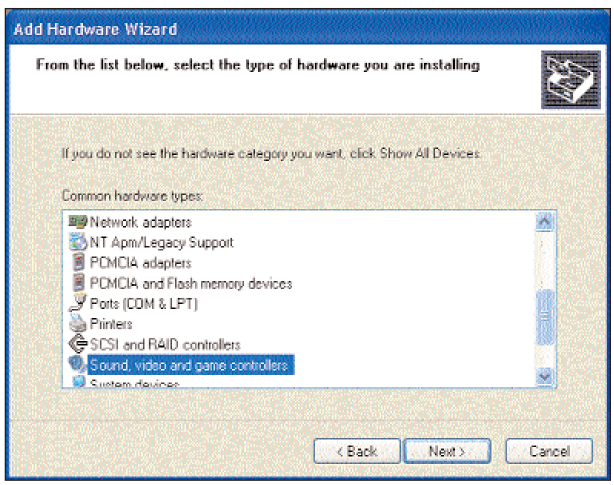


Figure 13-22 Hardware categories



skill 6

Working with Digital Cameras

A+ Hardware Objective

1.8 Identify proper procedures for installing and configuring common peripheral devices. Choose the appropriate installation or configuration sequences in given scenarios.

overview

Digital cameras **(Figure 13-23)** are another aspect of multimedia that you may need to support. Digital cameras come in a variety of styles and configurations and may include a large number of features. It is important to understand digital camera features to recommend and support these products.

Perhaps the most important aspect of a digital camera is the maximum resolution. Most modern digital cameras resolution is referenced in **megapixels**. A megapixel is one million pixels, which sounds like a large number. However, one million pixels is only roughly equivalent to a 1280 x 768 image, as 1280 x 768 = 983,040 pixels. This resolution is more than adequate for some tasks, but if you want to take pictures larger than 3" x 5", you need a much higher resolution, such as 3, 4, or 5 megapixels.

Next, and almost equally important, is the storage capacity and expandability of the camera. All digital cameras need some method for storing the images you take **(Table 13-5)**. All of these storage options use **flash memory** technology to retain data in the absence of power, with the exception of the IBM Microdrive devices, which use magnetic media (similar to a small hard disk). The type of storage available on the card should not be the major factor in your purchase, because all of these storage options are readily available. However, be careful to select a camera that supports a large enough amount of storage to support your needs. For instance, if you plan to take digital video, you need a large amount of RAM as your storage media.

Another factor to consider is the method used by the camera to retrieve images. Most digital cameras support some type of data transfer connection, with Universal Serial Bus (USB) being the most common. With most digital cameras, you can simply plug the camera's storage media into a USB port and the images appear as a new removable disk in Windows Explorer. Then you copy the images from the media using standard techniques such as drag and drop. You can also transfer images by inserting your storage device into a special card reader on your PC. Readers are available for all storage types, except, of course, internal storage. To retrieve images stored on a camera's internal memory, you need to use a USB or FireWire (IEEE 1394) connection to the camera.

Figure 13-23 Digital camera

Table 13-5 Digital camera storage technology

Storage technique	Description
Internal Memory	Uses flash memory
Compact Flash Memory	Uses flash memory
Secure Digital Memory	Uses flash memory
Microdrive Storage	Uses magnetic media (similar to a small hard disk
Sony Memory Sticks	Uses flash memory

Summary

- Digital audio playback occurs whenever the sound card plays a sound stored in a digital audio file.
- The task of decoding the file formats is left to the operating system, and is described by a codec (short for coder/decoder).
- You can never reproduce a sound at a higher quality than at which it was originally recorded.
- To effectively digitize an analog sound, you must sample the sound at double the effective frequency of the sound.
- A 44 KHz sampling rate at 16 bits per sample is considered "CD-quality" audio.
- Each device along the path during the recording affects the overall quality of the recorded sound, primarily by introducing noise, or "color," into the sound.
- Digital signals introduce the least amount of noise and high-level analog signals introduce the most.
- The effective quality of digital audio for a sound card also affects the quality of all sounds the sound card is capable of producing.
- Most modern applications use digital audio instead of synthesis.
- MIDI is a format that allows the synthesizer to accept needed musical data, such as tempo, pitch, and velocity.
- The quality of wavetable synthesis is largely determined by the size and quality of the sample set used.
- An equalizer modifies the amplitude of a sound at specific frequencies, making some frequencies more (or less) prominent than others.
- DSPs allow you to perform sound manipulation needed for certain applications without taxing the system processor.
- The process for installing the sound card's driver varies depending on the brand of the sound card and on the PC's operating system.
- When troubleshooting sound problems, first make sure that the speakers are plugged into the correct port and the volume is turned up.
- Your video card's support for a given resolution and color depth is primarily defined by its available video RAM.
- The additional processing required by 3-D applications can significantly impact an application's performance, because the system processor must perform all of these calculations in addition to the standard calculations necessary to operate the application.
- Some video cards provide multiple outputs, and support multi-monitor connections.

Key Terms

Bit depth
Color/Graphics Adapter (CGA)
Composite video
Digital Signal Processors (DSPs)
Digital to analog converters (DACs)
Digital Visual Interface (DVI)
Flash memory
Megapixel
Multi-headed
Musical Instrument Digital Interface (MIDI)
Sampling rate
Signal to Noise Ratio (SNR)
Sound card
Super-Video (S-Video)
Video card
Video Graphics Array (VGA)

Test Yourself

1. You have been asked to give advice on a sound card purchase for a medium-sized church. The church will use the sound card to record sermons and music for final distribution as recordings of the service. Which of the following aspects of the sound card should you be most concerned about? (Choose all that apply.)
   a. The internal synthesizer chips
   b. The on-board CD connections
   c. The number and type of available inputs
   d. The SNR of the sound card
   e. The DSP capabilities of the sound card

2. You are asked to record a concert for a local band using the band's digital audio workstation. This concert will eventually be copied to CD and distributed as a demo. What settings should you use for the recording?
   a. 22 KHz at 16 bits per sample
   b. 44 KHz at 8 bits per sample
   c. 11 KHz at 16 bits per sample
   d. 44 KHz at 16 bits per sample

3. You need to configure a laptop to host a presentation for your company's annual board meeting. The laptop is a top of the line audio/video model, and includes DVI, S-Video, and composite outputs. You want to connect this laptop to your company's presentation system, which uses a wide-screen plasma display and has S-Video and composite inputs. Which input should you utilize to provide the highest quality video?

a. DVI
b. S-Video
c. Composite
d. VGA

4. You have a client that wants to use a screen resolution of 1600 x 1200 on his new computer system. He requires a minimum of 16.7 million colors. What is the minimum amount of video RAM he can use to support this resolution and color depth?
a. 8 MB
b. 2 MB
c. 4 MB
d. 16 MB

5. Place the following types of video RAM in order, beginning with the fastest and ending with the slowest. (Use all choices.)
a. VRAM
b. 3DRAM
c. WRAM
d. SGRAM

6. Your CEO wants you to specify a new video card for his system. He wants to run high resolutions with high amounts of color to view large, colorful presentations. In same cases, he may want to display these presentations across multiple displays. The only applications that are installed on his system are Microsoft Office applications. Which of the following features are not required for the new video card? (Choose all that apply.)
a. Large amounts of Video RAM
b. Multi-headed display capability
c. Video input
d. 3-D processing

7. You are recommending a new sound card to a friend who is a musician. Your friend will use the sound card to record and produce music with a MIDI keyboard. Your friend wants to emulate actual analog instruments, such as the guitar, as much as possible. Which of the following features should you look for in your recommendation? (Choose all that apply.)
a. Wave table synthesis
b. Analog synthesis
c. High SNR
d. Low SNR
e. MIDI inputs

Projects: On Your Own

1. Make an assessment of the capabilities for professional audio recording for a popular soundcard
a. Open a browser window and navigate to the Web page http://www.digit-life.com/articles2/creative-audigy2-zs/index.html
b. Examine the article regarding the Creative Labs Audigy 2 ZS soundcard, paying close attention to signal to noise testing and manufacturer claims
c. How do the SNR tests compare with manufacturer claims?
d. Use an Internet search engine to search for additional reviews of this soundcard.
e. Based on the information you have researched, make an assessment of the suitability of this soundcard for professional audio recording.

2. Examine benchmarks and reviews for several popular video cards and determine which components are most important for high-speed 3D graphics processing
a. Open a browser window and navigate to the Web page http://graphics.tomshardware.com
b. Click on the graphics cards link under the guides section in the left hand menu to open the list of graphics cards reviews.
c. Choose three cards from the list of graphics cards and examine the reviews and tests of each card. Compare the differences of each card.
d. Which of your choices is the better performing card in most tests? Which components of the card (such as RAM, graphics processor, and slot type) do you feel make this card superior and why?

Problem Solving Scenarios

1. You have been tasked with the job of determining which soundcard is best suited for use as a primary recording device and MIDI synthesizer for a home musician. You have been given a $500 budget. Research the available options and determine the best possible choice. Ensure that you give reasons for your choices.

2. You are building a high-end gaming workstation for a friend of your family. You want the workstation to be capable of running the latest 3D action games for the next few years, preferably at high resolutions. You have chosen the best possible processor for the system. You now need to determine which graphics card to use with the system. Rank at least three graphics cards that you would suggest, and provide pros and cons for each choice.