DigiPoints

The Digital Knowledge Handbook

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Acknowledgement

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DVD, Part Two

The last issue of *DigiPoints* discussed how DVD has created a new paradigm for storing and viewing digital video information. The method of storing digital information as multiple tracks on optically read discs was presented, as well as the various DVD output formats. Also covered were the various ways to adapt one format to another before storage on the disc, as well as during the playback process.

Perhaps most important to cable personnel, however, is the fact that several features of a DVD system are similar to, but not the same as, those provided by a cable telecommunications system. For example, DVDs provide menus, interactivity, and parental control. Helping the customer understand which features are associated with each system, and how they differ between systems, will become a necessary part of both installation and customer service personnel.

This issue examines how a DVD system is connected to the rest of a home entertainment system. Cable personnel will need to understand these connections because it may be necessary to rewire the customer's system to accommodate a cable operator's equipment interfaces.

Integrating a DVD Player into an Entertainment System

DVD interacts with a home entertainment system in two ways: via the customer interface (the remote control), and via the wired connections between the DVD player and the entertainment system.

Remote Control Basics

Standard features of DVD remote controls provide playback control such as pause, play, fast forward, and chapter skip; navigation through on-screen menus; and access to special features such as audio tracks and subtitles. The directional arrows move the highlight to different portions of an onscreen menu. The Enter key selects the highlighted choice. The Menu key returns to the menu of choices for the current program, while the Title key returns to the menu for the entire disc. At least that's the way it's supposed to work—many movies do not use the Title key at all.

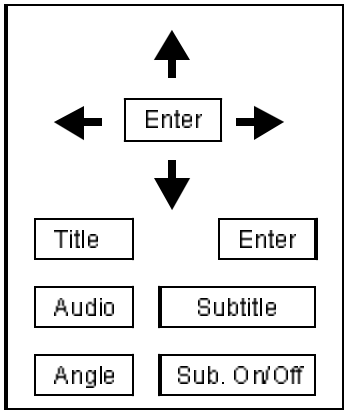

Figure 1: Remote Control Basics

It is very likely that the customer with a multi-component home entertainment system will have a universal remote control of the type described in *DigiPoints*, Volume III, Issue 4. In this case, non-assigned or unused keys on that remote may have been programmed for the special DVD functions. Cable telecommunications personnel must be aware of the potential for the customer to inadvertently reassign a set-top box control key to a DVD or other function, making it unusable for its original purpose.

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DVD Outputs

Most DVD players produce the following output signals:

- Analog stereo audio. The standard two-channel audio signal, which can include Dolby Surround encoding.
- Digital audio. Raw digital signal for connecting to an external digital-to-analog converter or digital audio decoder. Digital audio includes PCM audio, multichannel Dolby Digital (AC-3) encoded audio, multichannel MPEG-2 encoded audio, and additional optional digital audio data.[1]
- Composite baseband video. The standard video signal for connecting to a TV with direct video inputs or an A/V receiver.
- Y/C (S-video). A higher-quality video signal in which the luminance and chrominance portions travel on separate wires.

Some players may produce additional signals:

- Six-channel analog surround. Six audio signals from the internal audio decoder, for connecting to a multichannel amplifier or a Dolby-Digital-ready (AC-3-ready) receiver.
- AC-3 RF audio. The Dolby Digital frequency-modulated (FM) audio signal from a laserdisc, for connecting to an audio processor or receiver with an AC-3 demodulator and decoder.
- RF audio/video. Old-style combined audio and video signals modulated onto a VHF radio-frequency carrier for connection to the antenna leads of a TV tuner.
- Component analog video (interlaced scan). Three video signals (RGB or YUV) for connecting to a high-end television monitor or video projector.
- Component analog video (progressive scan). Three video signals (RGB or YUV) for connecting to a progressive-scan monitor or projector.

Connectors

The different output signals may be presented on the following types of connectors shown in Figure 2.

- **RCA phono.** This is the most common connector, used for analog audio, digital audio, composite video, and component video.
- **BNC.** This connector carries the same signals as RCA phono connectors, but is more popular on high-end equipment.

1 Multichannel audio includes Dolby Digital (AC-3) audio, MPEG-2 audio, and DTS audio. Dolby Surround audio is a two channel system. PCM is a simpler version of a digital signal, which is the result of the analog-to-digital conversion process without further compression or packetizing.

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- **Phone or miniphone.** This connector carries stereo analog audio signals and may be used by portable DVD players. It may also appear on the front of a DVD player for use with headphones.
- **S-video DIN-4.** This connector, also called Y/C, carries separated video signals on a special four-conductor cable.
- **Toslink fiber optic.** This connector, developed by Toshiba, uses a fiber-optic cable to carry digital audio. One advantage of the fiber-optic interface is that it's not affected by external interference and magnetic fields. The cable should not be more than 50 feet (15 meters) long.
- **DB-25.** This 25-pin connector, adapted from the computer industry, is used by some audio systems for multichannel audio input. Note that although this connector looks like an RS-232 connector, it does not have the same electrical connections.
- **SCART.** This 20-pin multipurpose connector, used primarily in Europe, carries many audio and video signals on a single cable: analog audio, composite RGB video, component video, and RF.
- **Type-F.** This connector typically carries a combined audio and video RF signal over a 75-ohm cable. A 75-ohm to 300-ohm converter may be required. Very few DVD players have an RF output.

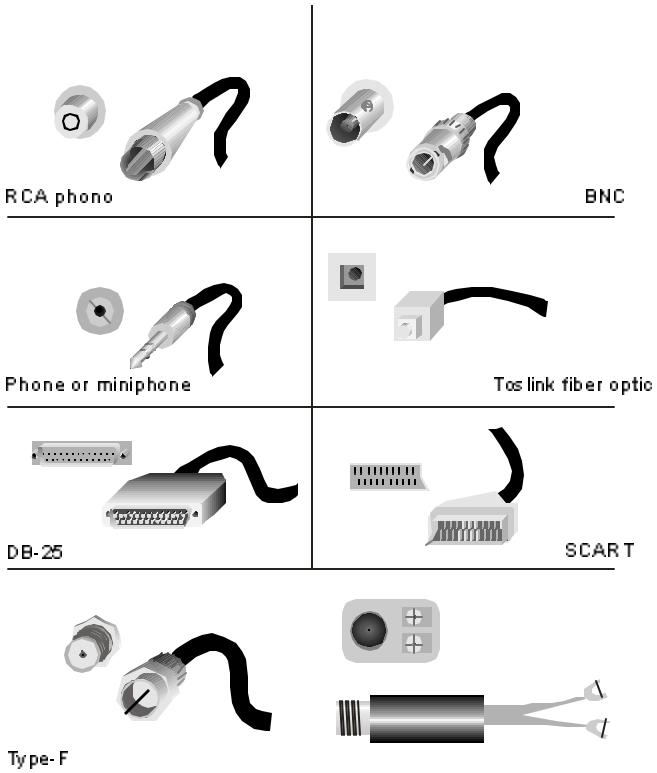

Figure 2: Common Connectors

Interconnecting Equipment

DVD uses some of the latest advances in digital audio and video, yet the players are also designed to work with TVs and video systems of all varieties. Therefore, the back of a DVD player can have a confusing diversity of connectors producing a potpourri of signals. Even though the options are many, customers will usually have a specific set of equipment which needs to be matched to the DVD player. Given the number of options, it's helpful to narrow down the possibilities by separately analyzing audio and video connections.

Audio connection

Just like a VCR, a DVD player must be connected to an audio system: a receiver, a control amplifier or preamplifier, a digital-to-analog converter, an audio processor, a TV, a "boom box," or other equipment designed to process or reproduce audio. There are four major categories of audio outputs which correlate with the major types of audio system inputs.

- Digital audio
- Component audio
- Stereo/surround audio
- AC-3 RF audio

Most DVD players provide two or three of the four audio hookup options.

Digital audio connection

The digital audio outputs provide the highest quality audio signal. All DVD players have digital audio outputs for PCM audio and multichannel audio. These outputs carry either the raw digital audio signal directly from the digital audio track or the two-channel down-mixed PCM signal from the internal Dolby Digital multichannel decoder. The digital audio output must be connected to a system designed to accept PCM digital audio, Dolby Digital (AC-3), or both. For multichannel audio output, the encoded digital signal bypasses the player's internal decoder. The appropriate decoder is therefore required in the receiver or as a separate audio processor.

For PCM audio output, the PCM signal from an audio track is sent directly to the digital audio output. Alternately, the multichannel decoder in the player produces a PCM signal. In either case, a receiver with built-in digital-to-analog converter (DAC) or an outboard digital-to-analog converter is required.

Some players provide separate outputs for multichannel audio and for PCM audio. Other players have either a switch on the back or a section in the on-screen setup menu where you can choose between multichannel or PCM output. The multichannel output menu option is usually labeled AC-3 or Dolby Digital.

The digital audio output is also used for PCM audio when playing a CD. Players that can play video CDs may also produce PCM audio output converted from the MPEG-1 audio signal.

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Combination laserdisc/DVD players also use this output for the laserdisc's PCM audio track (but not the AC-3 track, as explained shortly).

The direct output from PCM tracks on a DVD is at a 48- or 96-KHz sampling rate with 16, 20, or 24 bits, with higher sampling rates possible on DVD-Audio. The DVD license restricts PC output from copy-protected content to 48/24. Some players can output 96/24 PCM audio using a non-standard variation of IEC-958 running at 6.2 MHz (6.144 Mbps) instead of the normal limit of 3.1 MHz. The converted PCM output from multichannel audio tracks is at 48 KHz and up to 24 bits. The PCM output from a CD or laserdisc is at 44.1 KHz and 16 bits. Not all audio systems that can be connected to a DVD player are able to handle all these variations, but the more the better.

DTS soundtracks are available on a limited selection of DVD discs. Only DVD players with the DTS Digital Out logo can recognize DTS soundtracks. Most DTS-capable players don't have an internal DTS decoder, so they must be connected to a DTS-capable receiver or external DTS decoder.

There are two different standards for the digital audio connection interface: coaxial and optical. There are many arguments about which one is better, but since they are both digital signal transports, good-quality cables and connectors will deliver exactly the same data. Some players have only one type of connector, though many have both.

Coaxial digital audio connections use the IEC-958 II standard, also known as S/P DIF (Sony/Philips Digital Interface Format). Most players use RCA phono connectors, but some use BNC connectors. A 75-ohm cable should be used to connect the player to the audio system. Multichannel connectors are usually labeled Dolby Digital or AC-3. PCM audio connectors are usually labeled PCM, digital audio, digital coax, optical digital, or the like. Dual-purpose connectors may be labeled PCM/AC-3, PCM/Dolby Digital, or something similar. To prevent signal degradation, a video-quality cable should be used; a cheap cable may degrade the digital signal to the point where it does not work.

Optical digital audio connections use the EIAJ CP-340 standard, also known as Toslink. A fiber optic cable connects the player to the audio receiver or audio processor. The connectors are labeled Toslink, PCM/AC-3, optical, digital, digital audio, or the like.

If the digital connection (either coaxial or optical) is made to a multichannel audio system, select Dolby Digital/AC-3 audio output from the player's setup menu or via the switch on the back of the player. If the connection is to a standard digital audio system (including one with a Dolby Pro Logic processor), select PCM audio output instead.

In cases where the player has an optical (Toslink) connection but the audio system has a coaxial (S/P DIF) connection, or vice versa, a converter can be used to match the connectors.

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Component audio connection

A component multichannel audio connection can be as good as a digital audio connection. An amplifier with multichannel inputs or a Dolby-Digital-ready receiver accepts component audio connections. However, these outputs use the digital-to-analog converters that are built into the player, and they may not be of the best quality, especially on a low-cost player. All DVD players include a built-in two-channel Dolby Digital audio decoder. Not all players include the six-channel features, digital-to-analog converters, and external connectors necessary to make all channels of the decoded audio available. DVD-Audio players, which provide six channels of PCM audio, require a decoder with 6-channel input.

A player with component audio output will typically have six RCA or BNC jacks, one for each channel. A receiver/amplifier with six audio inputs—or more than one amplifier—is required. Six audio cables are hooked to the connectors on the player and to the matching connectors on the audio system. The connectors are typically labeled for each speaker position: L, LT, or Left; R, RT, or Right; C or Center; LR, Left Rear, LS, or Left Surround; RR, Right Rear, RS, or Right Surround; and Subwoofer or LFE. Some receivers use a single DB-25 connector instead of separate connectors. An adapter cable is required to convert from DB-25 on one end to six RCA connectors on the other.

Stereo/surround audio connection

A two-channel audio connection is the most widely used option, but it does not have the quality and discrete channel separation of a digital or multichannel audio connection. All DVD players include at least one pair of RCA (or sometimes BNC) connectors for stereo output. Any disc with multichannel audio will automatically be downmixed by the player to Dolby Surround output for connection to a regular stereo system or a Dolby Surround/Pro Logic system.

Two audio cables with RCA or BNC connectors are used for the connection between the player and the sound system. Connectors may be labeled audio, left, or right. The connector for the left channel is usually white, and the connector for the right channel is usually red.

In some cases, the audio input on the stereo system will be a phone or miniphone jack instead of two RCA jacks. An adapter cable is needed. If the player is a portable player with a miniphone connector, a phone to RCA adapter cable is usually required to connect the player to the audio system. If the player includes a phone or miniphone connector for headphones, it’s generally not recommended that the headphone output be used to connect the player to a stereo system since the line levels are not appropriate.

AC-3 RF digital audio connection

This digital audio output is provided only by combination laserdisc/DVD players. Laserdisc AC-3 audio does not appear at the standard PCM/AC-3 output (although the stereo PCM audio output does). Audio from a DVD does not come out of the AC-3 RF output. In other words, this is a special output designed solely for the AC-3 signal from a laserdisc, which is in a different format from DVD’s AC-3 signal.

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Hook a coaxial cable from the AC-3 RF output of the player to the AC-3 RF input of the receiver or AC-3 processor. Make sure the receiving end is set to RF mode or can automatically adapt to an RF signal. In order to receive all audio signals from a combination laserdisc/DVD player, three separate audio hookups are required: a PCM/AC-3 connection (for DVD digital audio and laserdisc PCM digital audio), an AC-3 RF connection (for laserdisc AC-3 audio), and an analog stereo connection (for the laserdisc analog channels, which often contain supplemental audio).

Video connection

A DVD player must be connected to a video system: a television, video projector, flat-panel display, video processor, A/V receiver or video switcher, VCR, or other equipment capable of displaying or processing a video signal. There are five major categories of video outputs:

- Component video
- S-video
- Composite video
- RF audio/video
- Digital video

Most DVD players provide two or three video connection options.

Component video connection

Until digital connections are available, this is the preferred method of connecting a DVD player to a video system. Component video output provides three separate video signals in RGB or YUV (Y, B-Y, R-Y) format. These are two different formats that are not directly interchangeable. Most of the DVD players with component video outputs use YUV. YUV to RGB transcoders are available, sometimes for as low as $200, but more typically for $700 and up. There is also a progressive-scan variation of component video output that requires a progressive-scan display.

Unlike composite or S-video connections, component signals do not interfere with each other and are thus not subject to the slight picture degradation caused by crosstalk. Since the video is stored in three component parts on the disc, this provides the cleanest path from disc to display. However, not all DVD players provide component video output, there are very few televisions with component video connections, and there are very few receivers or A/V controllers that can switch component video inputs.

Most U.S. DVD players with component video output have three RCA or BNC connectors. The connectors may be labeled Y, U, and V; or Y, Pb, and Pr; or Y, B-Y, and R-Y. The connectors may be colored green, blue, and red, respectively. Some European DVD players have RGB component video output via a 20-pin SCART connector or via three RCA or BNC connectors. The connection for component video is simple: hook three video cables from the three video outputs of the player to the three video inputs of the video system.

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S-video connection

Almost all players have an S-video (Y/C) output, which generally gives a better picture than a composite video output unless the S-video cable is very long. The advantage of S-video is that the luma (Y) and chroma (C) signals are carried separately. They are stored independently on the disc, so it's best when they are not combined by the player only to be re-separated by a comb (or similar) filter in the TV. S-video may be erroneously referred to as S-VHS, since it was popularized by S-VHS VCRs.

An S-video cable is used to connect from the player to the video system. The round, 4-pin connectors may be labeled Y/C, S-video, or S-VHS.

Composite video connection

This is the most common, but lowest-quality connection. All DVD players have standard baseband video connectors. This is the same type of video output provided by most VCRs, camcorders, and video game consoles.

A standard video cable is used to connect the player to the video system. The connectors are usually yellow and may be labeled video, CVBS, composite, baseband, and so on.

RF audio/video connection

This is the least desirable way to connect a DVD player to a television and is only provided by a few players for compatibility with older televisions which have only an antenna connection. The RF signal carries both audio and video modulated onto a VHF carrier frequency. This type of output is provided by many VCRs and set-top boxes.

A coaxial cable with F connectors is used to connect from the player to the antenna input of the TV. The connectors may be labeled RF, TV, VHF, antenna, or Ch. 3/4. Set the switch near the connector on the back of the player to either channel 3 or 4, whichever is not used for broadcast in your area. Tune the TV to the same channel.

Digital connection

When DVD players were introduced, none included digital video connections or digital bitstream connections. This is partly because the copyright protection and encryption systems for digital video had not yet been established and partly because almost no other consumer equipment provided digital connections at that time. There is also no standard format for streaming compressed audio/video over digital connections. Standards are being finalized to deal with all of these issues, so a new generation of DVD player with digital outputs will probably appear in 2000. Eventually, most consumer electronics equipment will be interconnected via IEEE 1394/FireWire or a similar format.

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Potential Challenges

Even when the installation is technically correct, there are some conditions inherent to DVD that may make it appear to the customer that something went wrong — especially if the customer is not familiar with DVD. The properties of regional disks and copy protection, for example, may explain why the customer can't do certain things with the disks that he or she may have thought possible.

Regional Disks

Motion picture studios want to control the home release of movies in different countries because theater releases aren't simultaneous. A movie may come out on video in the United States when it's just hitting screens in Europe. Therefore, each DVD contains a set of regional flags to prevent playback of certain discs in certain geographical regions. If a flag is cleared, the disc is allowed to be played in the corresponding region; if the flag is set, the disc is not allowed to be played. Players are branded with the code of the region in which they are sold. The player will put up a message and refuse to play a disc which is locked out of the region. This means that discs bought in one country may not play on players bought in another country.

The use of regional codes is entirely optional. Discs with no region flags set will play on any player in any country. The codes are not an encryption system: there is just one bit of information on the disc that the player checks. In many cases, discs will be released without any region locks, but in other cases regional control is very important to the business model of movie distribution. Many studios sell exclusive foreign release rights to other distributors. If the foreign distributor can be assured that discs from other distributors won't be competing in its region, the movie studios can sell the rights for a better price. The foreign distributors are free to focus on their region of expertise where they may better understand the culture and commercial environment.

The DVD standard specifies six regions, also called locales. Players and discs are identified by the region number that is usually superimposed on a world globe icon. If a disc plays in more than one region, it will have more than one number on the globe. The regions are broken out as follows:

1. North America (Red)
2. Japan and Europe (Yellow)
3. Southeast Asia (Purple)
4. Australia, New Zealand, and Central/South America (Blue)
5. Northwest Asia and most of Africa (Green)
6. China (Brown)
7. Unassigned
8. Special non-theatrical venues (airplanes, cruise ships, hotels)

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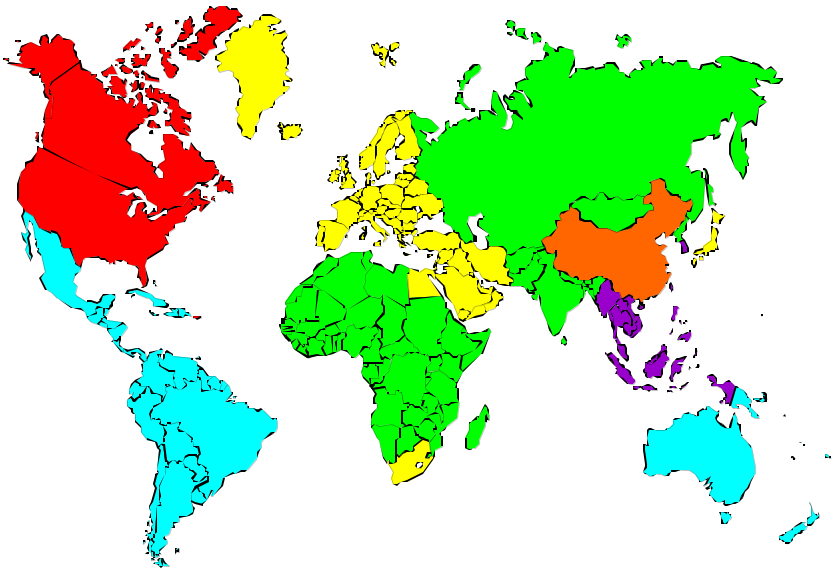

Figure 3: DVD Region Icon

A way around all artificially imposed deterrents is inevitably found. Not surprisingly, shortly after DVD players were released, numerous ways were found to defeat the regional coding. Some early players could be set to region 0 with a switch on the circuit board or sequence of keys on the remote control. Movie studios quickly complained, and manufacturers made user modification of player regions more difficult. Nevertheless, “code-free” players can be purchased, even from legitimate manufacturer outlets outside of the U.S. After-market “region mod” chips are also available for many players.

Regional codes apply to DVD-ROM systems when playing DVD-Video discs. Each DVD-ROM drive either comes with a set region code, or allows the user to set the region code up to five times.

The average customer in the United States and Canada will never need to worry about regions. All the region 1 discs they buy from North American producers will play fine in their region 1 players. Only those who buy discs from other regions will potentially run into problems.

Copy Protection

DVD provides three forms of copy protection: antitaping protection, copyright information, and content scrambling. All three forms of copy protection are optional for the producer of a DVD-Video disc and must be deliberately enabled by information contained on the disc. In addition, new DVD players with digital connections will support digital transmission protection which does not require that any new information be stored on the disc. Most customers will only be noticeably affected by the antitaping protection.

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Analog protection system

Copying from DVD to VHS and other analog recording systems is prevented with a Macrovision or similar circuit in the player. The general term is APS (analog protection system). Computer video cards with composite or S-video output may also use APS.

The Macrovision 7.0 process provides two separate copy protection methods: Automatic Gain Control (AGC) and Colorstripe. Macrovision AGC technology has been in use since 1985 to protect prerecorded videotapes. It works by adding pulses to the vertical blanking sync signal in order to confuse the automatic-recording-level circuitry of a VCR, causing it to record a noisy, unstable picture. The Colorstripe technology was developed in 1994 for digital set-top boxes and digital video networks (it can't be applied to prerecorded tapes). The Colorstripe process produces a rapidly modulated colorburst signal that confuses the chroma processing circuitry in VCRs, resulting in horizontal stripes when the recording is played back.

AGC works on approximately 85 percent of consumer VCRs, and Colorstripe works on approximately 95 percent. The system is intended to affect only VCRs, but unfortunately may degrade the picture, especially with old or nonstandard television equipment. Macrovision creates severe problems for some line doublers. Effects of Macrovision may appear as stripes of color, repeated darkening and brightening, rolling or tearing, and black-and-white picture.

Just as with videotapes, some DVDs are Macrovision-protected and some are not. The discs themselves tell the player whether to enable Macrovision AGC or Colorstripe or both. The producer of the disc decides what amount of copy protection to enable and pays Macrovision royalties accordingly. Macrovision AGC and Colorstripe protection are provided on the composite and S-video output of all commercial DVD players. AGC protection is provided for component video outputs, which have no colorburst signal.

Macrovision protection can be defeated with inexpensive video processing boxes that clean up the video signal. The Macrovision Corporation has been very aggressive in buying the patents for these technologies in order to take them off the market.

Copy generation management

Digital video copying—and some analog video copying—is controlled by information on each disc specifying whether the data can be copied. This serial copy generation management system (CGMS) is designed to prevent copies or to prevent copies of copies. The information is included in the analog and digital video signals. The analog (CGMS/A) information is encoded into line 21 of the NTSC television signal so that digital recorders with analog inputs can recognize it.

The CGMS information indicates whether no copies, one copy, or unlimited copies can be made. If no copies are allowed, the recording device will not make a copy. If one copy is allowed, the recording device will make one copy and change the CGMS information to indicate that no copies can be made from the copy. As with APS information, CGMS flags are present for each sector on the disc.

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Content scrambling

Because of the potential for perfect digital copies, worried movie studios required that a deeper copy protection feature be added to DVD-Video. Content scrambling system (CSS) is a form of data encryption that prevents reading files directly from the disc. Selected sectors are scrambled in such a way that the data can't be used to re-create a valid signal. The key required to descramble the data is hidden in an area of the disc that is not directly accessible from a DVD-ROM drive or other DVD reader.

All standard DVD players have a descrambling circuit that decrypts the data before displaying it. The process is similar to scrambled cable channels, except that the average consumer will never see the scrambled video and will have no idea that it has gone through a scrambling/descrambling process. The process does not degrade the data; it merely shifts it around and alters it so that the original values are unrecognizable and difficult to decipher. The descrambling process completely restores the data. The only case in which someone is likely to see a scrambled video signal is if they attempt to play it on a player or computer which does not support CSS, or if they attempt to play a copy of the data or the disc. Since the copy does not include the key, the video signal cannot be descrambled and appears garbled or blank.

Digital transmission protection

To make the most of a digital medium such as DVD, it should be connected digitally to other devices such as a digital television or a digital video recorder. To keep the transmission of copy protected information secure, a method of encryption and authentication between devices is needed. A number of proposals have been developed, but the leader is DTCP (digital transmission content protection), which focuses on IEEE 1394/FireWire, but can be applied to other protocols. The draft proposal (called 5C, for the five companies that developed it) was made by Intel, Sony, Hitachi, Matsushita, and Toshiba in February 1998. DTCP chips from Sony and others began appearing in late 1999. Under DTCP, devices that are digitally connected, such as a DVD player and a digital TV or a digital VCR, exchange keys and authentication certificates to establish a secure channel. The DVD player encrypts the encoded audio/video signal as it sends it to the receiving device, which must decrypt it. This keeps other connected, but unauthorized devices from stealing the signal. No encryption is needed for content that is not copy protected.

Digital CPS is designed for the next generation of digital TVs, digital receivers, and digital video recorders. It will require new DVD players with digital connectors (such as those on DV equipment). These first of these new products won't appear until 2000.

Other Considerations

Some players include a dynamic range compression setting (also called *midnight mode*) that boosts soft audio. This setting should be turned off for best effect with a home theater system, but it should be turned on for environments where the dialogue can't be clearly heard, such as when everyone else in the house has gone to bed and the volume is down low.

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Summary

Audio and video connections between a DVD system and the rest of the customer's home entertainment system can be completed in a variety of ways. Alternate output signal formats are available for the same data, but each format has distinct characteristics and some are better than others. An output or input jack may have multiple appearances on a consumer terminal device, permitting new devices to be easily added to an entertainment center. However, this is often not the situation.

When cable personnel need to add a set-top terminal to the entertainment center, it may be necessary to change some existing connections. When this is done, the installer will need to explain to the customer how system performance will be affected, and if any features or quality will be lost. The information in this issue should help the installer choose the optimum configuration for a DVD system, and explain why the choice was the best possible alternative.

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Learning Just Enough to be Dangerous: Glossary

2-2 pulldown – The process of transferring 24-frames-per-second film to video by repeating each film frame as two video fields. When 24-fps film is transferred via 2-2 pulldown to 25-fps 625/50 (PAL) video, the film runs 4 percent faster than normal.

2-3 pulldown – The process of transferring 24-frames-per-second film to video by repeating one film frame as three fields, then the next film frame as two fields.

3-2 pulldown – An uncommon variation of 2-3 pulldown where the first film frame is repeated for three fields instead of two. Most people mean 2-3 pulldown when they say 3-2 pulldown.

525/60 – The scanning system of 525 lines per frame and 60 interlaced fields (30 frames) per second. Used by the NTSC television standard.

625/50 – The scanning system of 625 lines per frame and 50 interlaced fields (25 frames) per second. Used by PAL and SECAM television standards.

AC-3 – The former name of the Dolby Digital audio-coding system that is still technically referred to as AC-3 in standards documents.

Artifact – An unnatural effect not present in the original video or audio, produced by an external agent or action. Artifacts can be caused by many factors, including digital compression, film-to-video transfer, transmission errors, data readout errors, electrical interference, analog signal noise, and analog signal crosstalk. Most artifacts attributed to the digital compression of DVD are in fact from other sources. Digital compression artifacts will always occur in the same place and in the same way. Possible MPEG artifacts are mosquitoes, blocking, and video noise.

Aspect ratio – The width-to-height ratio of an image. A 4:3 aspect ratio means the horizontal size is a third again wider than the vertical size. The standard NTSC television ratio is 4:3 (or 1.33:1). The widescreen DVD and HTDV aspect ratio is 16:9 (or 1.78:1). Common film aspect ratios are 1.85:1 and 2.35:1.

CGMS – Copy Guard Management System. A method of preventing copies or controlling the number of sequential copies allowed. CGMS/A is added to an analog signal (such as line 21 of NTSC). CGMS/D is added to a digital signal, such as IEEE 1394.

Chapter – In DVD-V, a division of a title. Technically called a part of title (PTT).

Chroma/chrominance (C) –The color component (hue and saturation) of light, independent of luminance. Technically, chroma refers to the common nonlinear signal, while chrominance refers to a linear signal.

Closed captions – Text captions for video that are not normally visible, as opposed to open captions, which are a permanent part of the picture. In the United States, the official NTSC

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Closed Caption standard requires that all TVs larger than 13 inches include circuitry to decode and display caption information stored on line 21 of the video signal. DVD-V can provide closed caption data, but the subpicture format is preferred for its versatility.

Component video – A video system containing three separate color component signals, either red/green/blue (RGB) or chroma/color difference (YC_bC_r, YP_bP_r, YUV), in analog or digital form. The MPEG-2 encoding system used by DVD is based on color-difference component digital video. Very few televisions have component video inputs.

Composite video – An analog video signal in which the luma and chroma components are combined (by frequency multiplexing), along with sync and burst. Also called CVBS. Most televisions and VCRs have composite video connectors that are usually colored yellow.

Compression – The process of removing redundancies in digital data to reduce the amount that must be stored or transmitted. Lossless compression removes only enough redundancy so that the original data can be recreated exactly as it was. Lossy compression sacrifices additional data to achieve greater compression.

CVBS – Composite video baseband signal. Standard composite video signal.

Decoder – 1) A circuit that decodes compressed audio or video, taking an encoded input stream and producing output such as audio or video. DVD players use the decoders to recreate information that was compressed by systems such as MPEG-2 and Dolby Digital; 2) a circuit that converts composite video to component video or matrixed audio to multiple channels.

Discrete surround sound – Audio in which each channel is stored and transmitted separate from and independent of other channels. Multiple independent channels directed to loudspeakers in front of and behind the listener allow precise control of the soundfield in order to generate localized sounds and simulate moving sound sources.

Dolby Digital – A perceptual coding system for audio, developed by Dolby Laboratories and accepted as an international standard. Dolby Digital is the most common means of encoding audio for DVD-V.

Dolby Pro Logic – The technique (or the circuit that applies the technique) of extracting surround audio channels from a matrix-encoded audio signal. Dolby Pro Logic is a decoding technique only, but is often mistakenly used to refer to Dolby Surround audio encoding.

Dolby Surround – The standard for matrix encoding surround-sound channels in a stereo signal by applying a set of defined mathematical functions when combining center and surround channels with left and right channels. The center and surround channels can then be extracted by a decoder such as a Dolby Pro Logic circuit that applies the inverse of the mathematical functions. A Dolby Surround decoder extracts surround channels, while a Dolby Pro Logic decoder uses additional processing to create a center channel. The process is essentially independent of the recording or transmission format.

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Downmix – To convert a multichannel audio track into a two-channel stereo track by combining the channels with the Dolby Surround process. All DVD players are required to provide downmixed audio output from Dolby Digital audio tracks.

DTS – Digital Theater Sound. A perceptual audio-coding system developed for theaters. A competitor to Dolby Digital and an optional audio track format for DVD-V and DVD-A.

DTV – Digital television. In general, any system that encodes video and audio in digital form. In specific, the Digital Television System proposed by ATSC or the digital TV standard proposed by the Digital TV Team founded by Microsoft, Intel, and Compaq.

DVD-Audio (DVD-A) – The audio-only format of DVD. Just becoming available in late 1999.

DVD-ROM – The base format of DVD. ROM stands for read-only memory, referring to the fact that standard DVD-ROM and DVD-V discs can't be recorded on by the end user. A DVD-ROM can store essentially any form of digital data.

DVD-Video (DVD-V) – A standard for storing and reproducing audio and video on DVD-ROM discs based on MPEG video, Dolby Digital and MPEG audio, and other proprietary data formats.

Dynamic range – The difference between the loudest and softest sound in an audio signal. The dynamic range of digital audio is determined by the sample size. Increasing the sample size does not allow louder sounds; it increases the resolution of the signal, thus allowing softer sounds to be separated from the noise floor (and allowing more amplification with less distortion).

Dynamic range compression (DRC)– A technique of reducing the range between loud and soft sounds in order to make dialogue more audible. Used in the downmix process of multichannel DVD sound tracks.

Error-correction code (ECC) – Additional information added to data to allow errors to be detected and possibly corrected.

Field – A set of alternating scan lines in an interlaced video picture. A frame is made of a top (odd) field and a bottom (even) field.

Frame – The piece of a video signal containing the spatial detail of one complete image; the entire set of scan lines. In an interlaced system, a frame contains two fields.

Frame doubler – A video processor that increases the frame rate (display rate) in order to create a smoother-looking video display. Compare to line doubler.

IEEE 1394 (FireWire) – A standard for transmission of digital data between external peripherals, including consumer audio and video devices. Based on the original FireWire design by Apple Computer.

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Interlaced scanning – A video scanning system in which alternating lines are transmitted, so that half a picture is displayed each time the scanning beam moves down the screen. An interlaced frame is made of two fields.

i.Link – Trademarked Sony name for IEEE 1394.

Letterbox – The process or form of video where black horizontal mattes are added to the top and bottom of the display area in order to create a frame in which to display video using an aspect ratio different than that of the display. The letterbox method preserves the entire video picture, as opposed to pan & scan. DVD-V players can automatically letterbox a widescreen picture for display on a standard 4:3 TV.

Line doubler – A video processor that doubles the number of lines in the scanning system in order to create a display with scan lines that are less visible. Some line doublers convert from interlaced to progressive scan.

Lines of horizontal resolution – A common but subjective measurement of the resolution of an analog video system, measured in half-cycles per picture height. Each cycle is a pair of lines, one black and one white. Sometimes abbreviated as TVL. The measurement is usually made by viewing a test pattern to determine where the black and white lines blur into gray. The resolution of VHS video is commonly gauged at 240 lines of horizontal resolution, broadcast video at 330, laserdisc at 425, and DVD at 500 to 540. Because the measurement is relative to picture height, the aspect ratio must be taken into account when determining the number of vertical units (roughly equivalent to pixels) that can be displayed across the width of the display. For example, an aspect ratio of 1.33 multiplied by 540 gives 720 pixels.

Lossless compression – Compression techniques that allow the original data to be recreated without loss. DVD-A uses MLP.

Lossy compression – Compression techniques that achieve very high compression ratios by permanently removing data while preserving as much significant information as possible. Lossy compression includes perceptual coding techniques that attempt to limit the data loss to that which is least likely to be noticed by human perception.

Luma/luminance (Y) – The brightness component of a color video image (also called the grayscale, monochrome, or black-and-white component). Technically, luma refers to the common nonlinear signal, while luminance refers to a linear signal.

Macrovision – An antitaping process that modifies a signal so that it appears unchanged on most televisions but is distorted and unwatchable when played back from a videotape recording. Macrovision takes advantage of characteristics of AGC circuits and burst decoder circuits in VCRs to interfere with the recording process.

MLP (Meridian Lossless Packing) – A lossless compression technique (used by DVD-A) that removes redundancy from PCM audio signals to achieve a compression ratio of about 2:1 while allowing the signal to be perfectly recreated by the MLP decoder.

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Motion vector – A two-dimensional spatial vector used for MPEG motion compensation to provide an offset from the encoded position of a block in a reference (I or P) picture to the predicted position (in a P or B picture).

MPEG – Moving Pictures Expert Group. An international committee that developed the MPEG family of audio and video compression systems.

MPEG audio – Audio compressed according to the MPEG perceptual encoding system. MPEG-1 audio provides two channels, which can be in Dolby Surround format. MPEG-2 audio adds data to provide discrete multichannel audio. Stereo MPEG audio is the mandatory audio compression system for 625/50 (PAL/SECAM) DVD-V.

MPEG video – Video compressed according to the MPEG encoding system. MPEG-1 is typically used for low data rate video such as on a Video CD. MPEG-2 is used for higher-quality video, especially interlaced video, such as on DVD or HDTV.

Multiangle – A DVD-V program containing multiple angles allowing different views of a scene to be selected during playback.

Multichannel – Multiple channels of audio, usually containing different signals for different speakers in order to create a surround-sound effect.

Multilanguage – A DVD-V program containing sound tracks and subtitle tracks for more than one language.

NTSC – National Television Systems Committee. A committee organized by the Electronic Industries Association (EIA) that developed commercial television broadcast standards for the United States. NTSC refers to the composite color-encoding system. The 525/59.94 scanning system (with a 3.58-MHz color subcarrier) is identified by the letter *M*, and is often incorrectly referred to as NTSC.

NTSC-4.43 – A variation of NTSC where a 525/59.94 signal is encoded using the PAL subcarrier frequency and chroma modulation. Also called 60-Hz PAL.

PAL – Phase Alternate Line. A video standard used in Europe and other parts of the world for composite color encoding. Various versions of PAL use different scanning systems and color subcarrier frequencies (identified with letters B, D, G, H, I, M, and N), the most common being 625 lines at 50 fields per second, with a color subcarrier of 4.43 MHz.

Pan & scan – The technique of reframing a picture to conform to a different aspect ratio by cropping parts of the picture. DVD-V players can automatically create a 1.33 pan & scan version from widescreen video by using a horizontal offset encoded with the video.

Parental management – An optional feature of DVD-V that prohibits programs from being viewed or substitutes different scenes within a program depending on the parental level set in the

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player. Parental control requires that parental levels and additional material (if necessary) be encoded on the disc.

PCM – An uncompressed, digitally coded representation of an analog signal. The waveform is sampled at regular intervals and a series of pulses in coded form (usually quantized) are generated to represent the amplitude.

Perceptual coding – Lossy compression techniques based on the study of human perception. Perceptual coding systems identify and remove information that is least likely to be missed by the average human observer.

Progressive scanning – A video scanning system that displays all lines of a frame in one pass. Contrast with interlaced scan.

Regional code – A code identifying one of the world regions for restricting DVD-V playback.

Regional management – A mandatory feature of DVD-V to restrict the playback of a disc to a specific geographical region. Each player and DVD-ROM drive includes a single regional code, and each disc side can specify in which regions it is allowed to be played. Regional coding is optional—a disc without regional codes will play in all players in all regions.

Resolution – 1) A measurement of relative detail of a digital display, typically given in pixels of width and height; 2) the ability of an imaging system to make clearly distinguishable or resolvable the details of an image. This includes spatial resolution (the clarity of a single image), temporal resolution (the clarity of a moving image or moving object), and perceived resolution (the apparent resolution of a display from the observer's point of view). Analog video is often measured as a number of lines of horizontal resolution over the number of scan lines. Digital video is typically measured as a number of horizontal pixels by vertical pixels. Film is typically measured as a number of line pairs per millimeter; 3) the relative detail of any signal, such as an audio or video signal.

RSDL – Reverse-spiral dual-layer. A dual-layer disc layout where readout begins at the center of the disc on the first layer, travels to the outer edge of the disc, then switches to the second layer and travels back toward the center. Designed for long, continuous-play programs.

Scan line – A single horizontal line traced out by the scanning system of a video display unit. 525/60 (NTSC) video has 525 scan lines, about 480 of which contain the actual picture. 625/50 (PAL/SECAM) video has 625 scan lines, about 576 of which contain the actual picture.

SECAM – *Séquential couleur avec mémoire*/sequential color with memory. A composite color standard similar to PAL, but currently used only as a transmission standard in France and a few other countries. Video is produced using the 625/50 PAL standard and is then transcoded to SECAM by the player or transmitter.

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S/P DIF – Sony/Philips digital interface. A consumer version of the AES/EBU digital audio transmission standard. Most DVD players include S/P DIF coaxial digital audio connectors providing PCM and encoded digital audio output.

Subpicture – Graphic bitmap overlays used in DVD-V to create subtitles, captions, karaoke lyrics, menu highlighting effects, and so on.

Subtitle – A textual representation of the spoken audio in a video program. Subtitles are often used with foreign languages and do not serve the same purpose as captions for the hearing impaired. See subpicture.

Surround sound – A multichannel audio system with speakers in front of and behind the listener to create a surrounding envelope of sound and to simulate directional audio sources.

S-video – A video interface standard that carries separate luma and chroma signals, usually on a four-pin mini-DIN connector. Also called Y/C. The quality of S-video is significantly better than composite video since it does not require a comb filter to separate the signals, but it is not quite as good as component video.

Widescreen – A video image wider than the standard 1.33 (4:3) aspect ratio. When referring to DVD or HDTV, widescreen usually indicates a 1.78 (16:9) aspect ratio.

YUV – In the general sense, any form of color-difference video signal containing one luma and two chroma components.

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Testing Your Knowledge

1. A customer has a TV with only an antenna (RF) connection. You cleverly route the DVD player (which has no RF output) through the customer's VCR (which does have RF output), but the picture darkens and lightens when playing DVDs. What is the problem and how can you fix it?

2. What connection will provide the customer with the best picture?

3. What connection will provide the customer with the best audio?

4. You have connected the customer's DVD player with a digital audio cable to their Dolby Digital receiver, but the display on the receiver indicates that only 2-channel stereo or 4-channel Dolby Surround is being received. You have checked that a 5.1-channel track is being played on the player? What happened to the 5.1-channel Dolby Digital, and how do you fix it?

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Answers to Questions in Volume III, Issue 8

1. Someone complains that their DVD player won't play their homemade compilation CDs even though they were told it would play CDs. They also wonder about the Video CD they picked up in Chinatown. What do you tell them?

   All DVD players can play standard audio CDs. Only some DVD players can play CD-Rs and CD-RWs. If CD-R/RW playback is important, look for indications such as "MultiRead" or "Dual Laser." Some DVD players can play Video CDs. Check the player specs for details.

2. Is video on DVD stored in progressive format or interlaced format?

   Ok, this is a bit of a trick question. Technically, all video on DVD is encoded for interlaced display. But video from a progressive source such as film usually maintains its progressive character. Video from an interlaced source such as a TV camera is fully interlaced on the disc.

3. Will a disc imported from the UK play on a U.S. Player?

   Not on an unmodified player. In addition to possible region restrictions (a region-2-only disc won't play on a region-1 player) the video is encoded for PAL TV playback not NTSC playback.

4. What different formats are available on a digital audio connection?

   PCM stereo, Dolby Digital, and DTS.

5. The video from the DVD player doesn't look as good on a widescreen TV as it should. What is the likely problem, and how do you fix it?

   The DVD player is set for 4:3 letterboxed output, not anamorphic output, so the widescreen TV has to stretch it in the vertical direction to get rid of the letterbox matters. You need to go into the player's setup menu and change the TV type to 16:9 widescreen.

6. A customer only uses their VCR to play tapes and watch TV—they never record. They use the VCR for the PIP feature on their TV. Their VCR has just broken, so they want to know if they can replace it with a DVD player. What do you tell them?

   They won't be able to watch TV from the DVD (or use it for PIP), since DVD players don't have TV tuners. Down the road, when DVD recorders are available, they will likely come with TV tuners.

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