LaserDisc F.A.Q.

Audience: World-Wide NTSC. Of some value to PAL users.

The article that begins on the next page of this .PDF* is a revised version of one that appeared in the **LASER MAGIC™ 1998** edition of **WIDESCREEN REVIEW** magazine, on shelves during late 1998. That article, in turn, was derived from several plaint-text F.A.Q.s that I have made available on NetNews and/or the World-Wide Web since 1988.

Jim Taylor's DVD FAQ is also available on the web, at URL:
http://www.videodiscovery.com/vdyweb/dvd/dvdfaq.html

To my knowledge, none of the other articles in **LASER MAGIC™ 1998** are available on the web. The front cover and table of contents for that issue are shown below. If you can't find a copy at a regional magazine rack, check the publisher's web site:

http://www.WidescreenReview.com/

as they normally offer back-issues for some period of time.

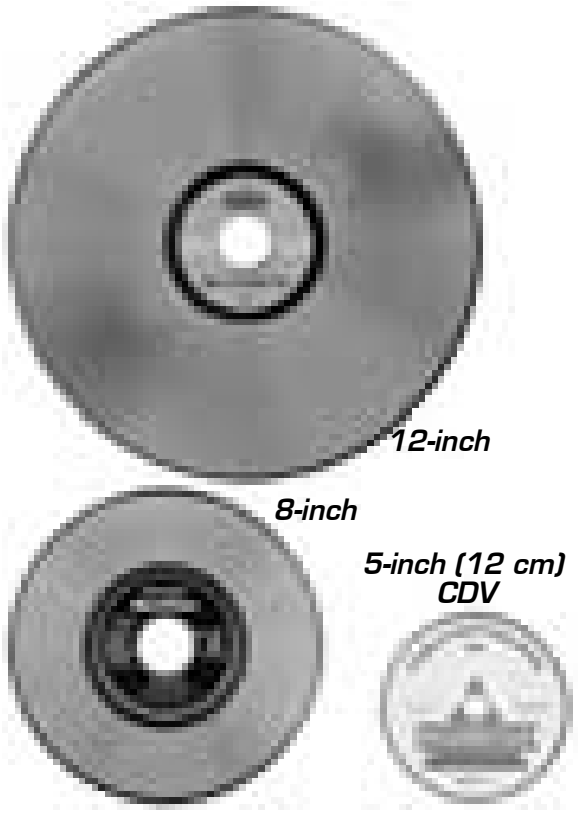
Contents For Laser Magic™ 1998

* Adobe Acrobat Portable Document File. See URL:
http://www.frii.com/~rjn/computer/acrotips.htm
for hints on display and printing of .PDF documents.

LaserDisc F.A.Q.

Approximately What You Wanted to Know

Bob Niland



1. What is this FAQ[1]?

This article is a revised version of one that appeared in the ***LASER MAGIC 1998*** edition of ***Widescreen Review*** magazine (http://www.WidescreenReview.com/). The purpose of this article is to expose LD technology to those unfamiliar with it. This article is focused on home entertainment laser, and not industrial or interactive, although these other uses share much of the technology.

There are several challenges in being an alert consumer of video products. One of them is the lack of solid technical information needed to make informed decisions; hence, this article (older editions of which have been available on the Internet for several years).

Typical LaserDisc Player

1. F.A.Q. Frequently Asked Questions. Internet nomenclature for a document whose actual value is Frequently Supplied Answers.

2. Index

Page

3. What is LD?

LD stands for LaserDisc, now the industry-wide term for consumer 12-inch laser video (Pioneer surrendered their trademark on the term). During its life, the format has also been known as LV (LaserVision) and CDV (Compact Disc Video). The players are also sometimes referred to as VDPs (Video Disc Players) and Sony calls them MDPs.

3.1. How old is LD?

LD technology was first demonstrated by Philips and MCA over a quarter century ago, in 1972. Laser video disc has been in the retail market since 1978, or about as long as VCR and six years longer than CD.

LD should not be confused with the stylus-based Japanese VHD or RCA CED "SelectaVision" videodisc systems. CED was discontinued in the U.S. in 1984, and as a point of interest to WSR readers, never offered any titles in widescreen formats.

3.2 How common is LD?

There are over 2 million players in home use in the U.S. (compared to 100 million VCRs), and over 5 million LD players in Japan (reportedly 10% of households there).

There are about 10,000 LD titles presently "in the catalog" in the U.S., and a comparable number in Japan. In reality, only a fraction of these are actually in stock at any one time.

The U.S. and Japan use the NTSC standard. LD also exists in PAL countries, but the technical feature set is restricted, the PAL catalog is less than 10% of NTSC's, with the result that those markets rely on multi-standard players/TVs and imported NTSC media.

3.3 What is the historical appeal of LD?

Prior to DVD, LD ***was*** home theatre. For in-home media, LD was the closest alternative to owning actual projection prints, which are difficult to obtain, cost several hundred dollars per title, fade and wear out.

Excepting those few consumers who own pro video gear, the only video signal source that was arguably superior to LD was large-dish analog satellite.

We may be in the twilight years of the Golden Age of NTSC LaserDisc, but the format still has a lot to offer, and represents the largest catalog of titles on optical media.

4. What are the LD Advantages?

Pioneer pitches LD as "60% sharper" (than VHS, without explicitly saying so). If your TV or monitor is adequate, and adjusted to reasonable settings (not showroom/factory settings) LD is comparable to 16mm exhibition prints (whereas VHS is comparable to 8mm). LD audio, on the other hand, easily beats 35mm SVA optical sound, and roughly equals the various magnetic and digital theatrical audio formats.

There are no home video formats comparable to 35mm or 70mm film; however, exhibition practices in most 35mm theatres are so poor that I consider the loss of resolution to be an acceptable trade-off compared to the horrible (often mono) sound, misframing, cropping of anamorphic projection and dim substandard projection lamp illumination I find on the majority of the non-THX screens in my area.

The pulse-FM data structure on an LD (unlike ordinary VHS/Beta), is defined to hold all the information present in the composite NTSC or PAL video signal. Depending on source material and the transfer to disc, LD is above live TV broadcast quality: For NTSC, this is can be up to 425 TVL (luminance lines horizontally) and about 482 visible scan lines, compared to 330x482 for broadcast.

Compare this further to 250x482 for typical VHS. Super-VHS and ED-Beta approach LD signal quality, but pre-recorded material is not widely available in these VCR formats. Even using S-VHS/ED-Beta to tape off-air still only reaches the 330x482 inherent in the broadcast signal. However, LD rarely reaches the full "425 TVL" resolution, due in part to video master tapes, in part to pre-mastering practices, and other factors. LD is always superior to VHS.

Compared to LD, all consumer tape formats also fall short in time-base stability, chroma resolution, video noise and audio fidelity. Although the video signal-to-noise ratio (s/n) appears to be about the same for LD and VCR hardware, s/n is inexorably degraded by playing tapes.

LD inherently has terrible time-base stability, particularly in CLV mode. Consequently, all LD players have time-base-correction; mechanical, optical, analog electronic or digital. TBC eliminates the horizontal line jitter and color decoding errors so common on tape. Digital TBC, present on high-end players, appears to convey no significant advantages over the conventional analog schemes. Only a handful of VCRs have TBC of any kind.

4.1 LD advantages vs. VCR

- Widescreen formats more frequently encountered.
- No media wear in careful use.
- Potential for archival media shelf life.
- Higher resolution image.
- Higher signal/noise ratio.
- Smaller time-base errors.
- High quality analog sound, and often full-digital sound.
- Used media of acceptable quality. Lending possible.
- Essentially no bootleg media.
- Random access (and no rewinding!).
- No Macrovision copy protection (and attendant artifacts).
- Still-frame subjects available.
- More extensive liner notes.
- Synchronized audio commentaries.
- Supplements more often supplied, including theatrical trailer, outtakes, pre-production material sometimes included.
- Computer control of Pioneer players via Macintosh or Apple IIgs.
- LD "combi" players (common) can also play your CDs, and now DVDs.

4.2 LD disadvantages vs. VCR

- Does not record.
- Entry-level LD player price ($300) slightly higher than VCRs.
- Fewer rental outlets.
- Title availability lower and more unpredictable than VHS.
- Media may require flipping after 30 or 60 minutes.
- Players can be noisier than VCRs.

4.3 LD vs. DVD

Another article in the ***LASER MAGIC 1998*** issue addressed this in more detail, but in general, DVD is a modest net advance over LD and a major advance over VHS.

4.4 LD advantages vs. DVD

- More titles, for the moment.
- Durability, especially in rental.
- 54,000 full resolution CAV still frames per side.
- Full 60 Hz temporal resolution.
- No digital compression artifacts (a form of noise).
- No Macrovision problems.
- Uncompressed PCM stereo audio.
- No region lock.
- No pay-per-period encryption (DIVX). If all the LD player and media suppliers go out of business, you'll still be able to play all your LDs.
- CAV reverse play.

4.5 LD disadvantages vs. DVD

- NTSC artifacts (e.g. dot crawl)
- Composite video artifacts (e.g. cross-color)
- Static resolution.
- Static signal/noise ratio.
- Physical media size.
- Mechanical noise.
- Two or four times as much side changing.
- LD letterboxing wastes data storage space. DVD lbx does not, and DVD also has a cleaner anamorphic implementation.
- DVD has generally more flexible multi-lingual and play programming features, if producers choose to use them.

5. What are the LD Physical Media Formats?

There are six major types of consumer laser video media:

- 12-inch video discs (LDs),
- 8-inch video discs (LDs), and
- 5-inch "CD-Video" discs (CDV-5).
- 5-inch DVDs
- 5-inch CDi/FMVs
- 5-inch VideoCDs

Only the 12-inch, 8-inch and CDV-5 media, shown in the opening photo, use LV-style analog video. The rest use pure digital encodings and are not the focus of this FAQ.

5.1 Can all players handle all discs?

All LD players can play the video signal on all 12- and 8-inch media. All but one early "combi" player can handle CDV-5. (This article uses the term "CDV-5" because at the time CDV was introduced, there was an effort to rename all LDs with digital sound as "CDV") and many 12-inch LDs bear the CDV logo.

Not all players can necessarily extract all of the audio from all possible LD media. All post-1990 players extract at least some useful audio from all discs, but in degenerate cases (e.g. early LV player, PCM disc with commentary and isolated music), you may be unable to hear the original movie soundtrack.

At least two players are now available that handle LD and DVD. Theoretically, it is simple for a DVD or DVD/LD player to also play CDi or VideoCD, but how common that is unknown to me.

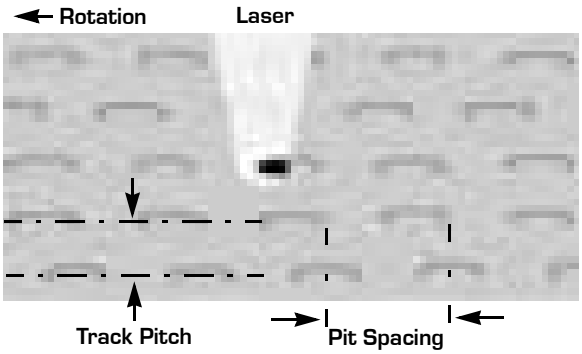
Since the quality and artifacts of the highly compressed CDi and VideoCD formats render them less pleasant to watch than VHS, they aren't candidates for wide-screen home theatre.

Other buzz-words: LD players (whether combi or not) do not generally support CD-ROM. Until recently, only Karaoke LD players supported CD+G subcode text. Pioneer did introduce "LaserActive" players which supported CD+G, LD-G, Sega CD-ROM games, Genesis 16-bit game cartridges, and a new format - "MegaLD" 8- and 12-inch LD-ROM2 discs.

There have been any number of formats launched on the 12-inch acrylic platform. The only ones that have endured are home video titles and industrial training/trade show discs.

6. What is the Physical LD Structure?

At the data layer of the disc, the appearance of the pulse-FM LaserVision signal is common to the two major fabrication techniques. The layer is a thin reflective metal surface (usually aluminum) covered with oval pits, each ¼ wavelength deep. When the focused laser light strikes the "land" between the pits, it is fully reflected to the photo detector. When it straddles a pit, half of the light is reflected back ½ wavelength out of phase, resulting in cancellation of the reflected light at the detector.



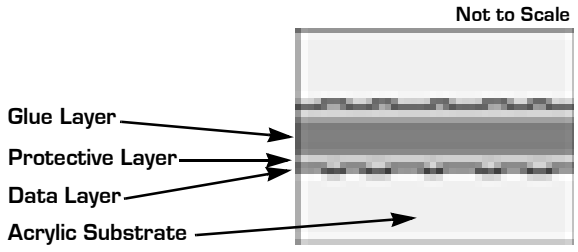
The pits comprising a single spiral "track" from the center of the disc out to the edge. On a CLV discs, there are about 30 billion pits, and the spiral is about 24 miles long. On any type disc, the track-to-track spacing is about 1.6 µm, and the average pit length (or pit-to-pit spacing) is about 1.3 µm. The laser wavelength is 6328Å. To put matters in perspective, the period at the end of this sentence would cover about 20,000 pits.

The two primary fabrication methods use a substrate (external transparent layer) of acrylic plastic (PMMA - Polymethyl Methacrylate, more familiar as Plexiglas®) or polycarbonate (more familiar as Lexan®).

Only acrylic and polycarbonate are encountered in the retail consumer market, but they aren't the only materials that have been used on LDs. Some discs have solid aluminum "dead sides", and there are reports of glass discs. LD player spindle motors can handle anything from fly-weight 3-inch audio CDs to hefty metal arcade discs, an impressive capability.

6.1 How are acrylic LDs constructed?

All consumer 12-inch LDs and most 8-inch LDs are made of acrylic.This cross-section drawing illustrates a typical two-sided disc.



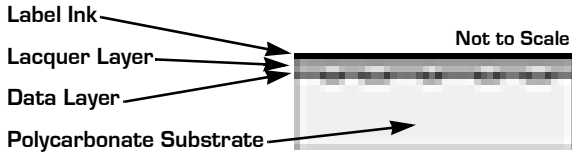
I have never seen the Protective Layer documented. Its composition is probably a well-guarded competitive secret, and its failure modes may be a major factor in "laser rot".

Traditional 12- and 8-inch media are predominantly two-sided, although often only one side contains program material. The 12- and 8-inch LD center hole is larger than a CD's, and there is a small paper label on both sides. The hole and label are about the same size as on a 45 rpm vinyl record. LDs, like CDs are packaged "loose", and not in a carrier like CD-ROM caddies or the old CED discs.

The storage jacket is the same kind of cardboard sleeve used for LPs. From more than a few feet, it is difficult to tell if you are looking at the jacket of the video disc or the soundtrack LP.

6.2 How are polycarbonate CDVs and LDs constructed?

All consumer 5-inch CDVs, Audio CDs, CD-ROMs and a few single-sided 8-inch LDs are made of polycarbonate.This cross-section drawing illustrates a typical disc.



6.3 Which side is which?

The data for side "1" is on the opposite side of the medium from label surface "1". In most players, play begins from the bottom surface. Two-sided LDs are literally two single-sided discs glued together, and the edge of the disc is often sticky for this reason.

Single-side acrylic discs are actually two-sided. The non-program side may be a "turn me over" video signal, a slab of solid plastic (or other material), or an optically obscured side containing completely unrelated video programming. In the early days, wiping the coating off such "dead sides" was a grand adventure, often revealing defective pressing of other titles, experimental CLV pressings or even industrial training content.

All consumer optical media play from the inside out. LD Chapter 1 (or 0), as with CD Track 1, is near the center hole. This allows players to avoid having to determine the disc diameter before figuring out where the lead-in tracks are.

6.4 Is 12-inch the dominant format?

Yes. The acrylic 8-inch format is not substantially less expensive to master and manufacture than 12-inch, and is rarely seen now. Most LD-8s were music-video titles, as were CDV-5s, and neither was a market success in the U.S. Single-sided 12-inch LDs or DVDs make a far more sensible delivery vehicle for music videos.

6.5 What's a CLD?

Some 8- and 12-inch LDs were referred to as CLDs ("Compact Laser Disc"). This means that, like CDV-5 below, only some of the chapters (tracks) have both video and audio. The remaining chapters are audio only. CLDs are almost always music video discs. An example is the rare ***A-Ha / Hunting High and Low*** (Pioneer Artists CLD-86-004), which has 13 music tracks, only 3 of which have motion video (the rest just have title cards).

An unusual single-sided 8-inch format appeared in the early 1990s, the "8-inch LD single". It is LD-8 format at the data layer, but polycarbonate construction (like a CD) and about the same thickness as a CD, requiring a spacer when played in most pre-1989 machines. Image Entertainment released a few LD video catalogs in this format. Some Karaoke LD8's may still be made this way.

6.6 Does CDV-5 still exist?

The 5-inch (CDV-5 or just CDV) media is the most recent, least common, and probably the most familiar appearing of format sizes descended from LV, since it is externally identical to the common audio-only CD.

CDV-5 is single-sided, as CD is. The difference, denoted by the "CD-Video" logo and gold-colored data surface, is that a CDV-5 can contain just under six minutes of CLV full-motion video/audio plus 20 minutes of audio-only, compared to 80 minutes of audio-only on a conventional CD.

As with CD, CDV-5 is polycarbonate on the data side, and lacquer on the label side. Any LD player that can handle CDV-5 can also handle audio-only CD.

There were only a few dozen titles available in the U.S. on CDV-5, and as far as I can tell, none have been released here since 1989. Polygram (the predominant CDV-5 label) announced in 1990 that they would produce no more. The may have lasted a few years longer in Japan, often with only the video track present. Speaking of Japan…

6.7 What is Laser Karaoke?

Karaoke is a Japanese bar/nightclub craze in which inebriated patrons sing the lyrics to instrumental pop tunes. It has gained a foothold in North America. Karaoke players are normal LD players plus five features:

- They have a microphone input so that you can sing along with the on-screen lyrics of laser karaoke discs,
- They often have pitch control,
- They have a vocal-killer circuit that blends the two stereo channels in opposite phase, has a voice-band notch filter, or uses Pro-Logic style DSP to cancel front-center signal, which generally eliminates or dramatically reduces the lead vocal on regular non-karaoke CDs and LDs, and
- They often have reverb and other enhancement processing for the microphone input.
- They may have a CD+G decoder to extract the sing-along lyric text, and mix it with the video signal for on-screen display.

Karaoke players will play normal entertainment LDs, and normal LD players play Karaoke titles, but either mis-match may omit some features of the intended formats for those players.

7. What is the LD Data Format?

Well, that's actually several separate questions:

- Are there LD format differences in addition to size and side counts?
- What video and audio signals are presented at the rear panel of the player.
- What features are made possible by the LD formats?
- How is widescreen delivered on LD?
- What is the physical encoding of the data layer?

7.1 Are there other format differences?

In addition to disc diameter and side count, there are two major video signal formats, two major rotation mode formats and about half a dozen audio variations.

As with VCR, there is no single world-wide video signal standard for LD. Only LDs made for the North American, Japanese and Hong Kong markets have U.S.-standard NTSC (specifically: M/NTSC-3.58) 525 line 59.94 field/sec.

Discs from Europe and other markets are likely to be in European standard PAL {specifically: PAL-4.43} 625 line 50 field/sec format, and will not play on current American machines.

The PAL LD (also called LV or CDV) catalog never exceeded about 1000 titles. However, multi-standard players are available in Europe. These may or may not require a multi-standard TV/monitor.

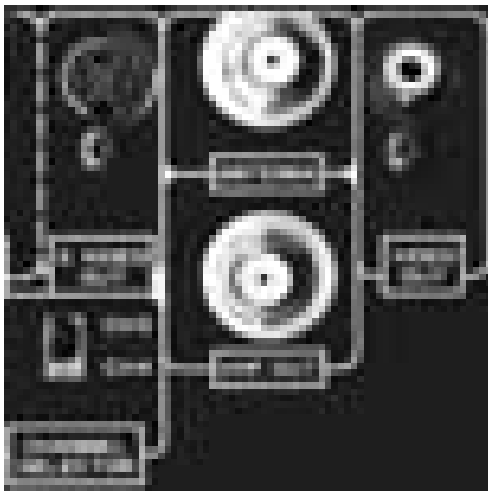
There are reportedly no SECAM discs. SECAM countries use PAL for laserdisc.

As with VCRs, for North American customers, the only significant “grey market” media sources are Japan and Hong Kong. Encoding is really a non-issue for NTSC consumers, and U.S.domestic discs are sometimes not even labelled “NTSC”.

Color: An LD can store a Color or Black & White signal (although colorburst is always present, in case you were wondering). LD can also handle any 3D format compatible with broadcast TV.

Within a single video standard (NTSC or PAL) an LD may use either CAV or CLV rotation on any given side. CAV vs. CLV, and the various LD audio formats are discussed later in this article.

8. What are the Video Outputs?



- Video Out (Composite Video) - All players provide a composite video output, which uses the “video” or “aux” input on the TV/monitor. This signal contains no audio. This is usually a yellow-coded RCA female phono jack.
- VHF Out (RF) - Some consumer players also provide an RF (radio frequency, channel 3/4 emulation) output. The RF video signal quality is often visibly degraded from the composite. Use Video or Y/C rather than RF.
- The RF signal contains mono audio. It could contain MTS stereo, I’m not aware of any players that encode MTS (they will pass through broadcast MTS if they also have Ant/RF input). RF is usually a female, threaded F-connector.
- Note: Some players omit RF output. If your TV doesn’t have a “video” input, you’ll need to either route the LD’s video output through your VCR’s video input, or buy an external RF modulator.
- S-Video (Y/C) - Mid-range and high-end players often provide a Y/C (component or separate luminance/chrominance) output, via a mini-DIN connector. The Y/C signal contains no audio. Players usually do not include a Y/C cable. The value of the Y/C output is debatable.
- YCrCb (Component Color Difference) or RGB (Component) - may be found on some players. YCC has appeared on at least one LD-DVD player, and RGB pins are defined in the SCART connector found on many PAL players. You need downstream components which support the exact standard used, and at NTSC and/or PAL signalling rates.

Ancillary in-video features are also available at any of these outputs. Many discs have Closed-Captioned text encoded in scan line 21 for the hearing-impaired, and this is noted on the jacket.

Copy-protection schemes are possible on LD, but none have appeared, and common vertical interval implementations (like Macrovision) are evidently incompatible with the format. If you have problems with Macrovision-encoded tapes, and have a device to defeat it, don’t run the LD video through it - you don’t need to.

8.1 Should I use the Y/C output?

It depends on your equipment. The native decoded video signal format on LD is composite (essentially a B&W signal with the active line period modulated with a 3.58 NTSC or 4.43 MHZ PAL color subcarrier).

The player’s Y/C output is only worthwhile if the Y/C separator circuit in the player is more sophisticated than that in the TV/monitor, and the TV is accurate enough to tell. Try it both ways on some test patterns. Use whichever is more satisfying.

8.2 Where’s the digital video output?

On a LaserDisc-only or non-DVD combi player, there is never a digital video output, because the LV/LD signal is analog, not digital. LD players sometimes digitize the signal (for time-base-correction and field store), but never deliver it to the rear panel. Even if a manufacturer wanted to include a video ADC, there is as yet no standard for consumer digital video interconnect.

Thus, any “digital” output on the back of the player is for audio only.

9. What Video Features can LD Provide?

LaserDisc has various capabilities that are impossible or rarely seen with tape. DVD offers some (but not all) LD features, and adds a few new ones of its own. Some of these features are encoded in the video signal, some are inherent to the rotation mode (CAV vs. CLV), and some are provided by the player.

9.1. What are CAV and CLV?

Not that big a deal, actually. All consumer players can handle either CAV or CLV media. Some titles are all-CAV, some all-CLV, and some mix the modes from side to side, often with last-side-CAV for special supplements.

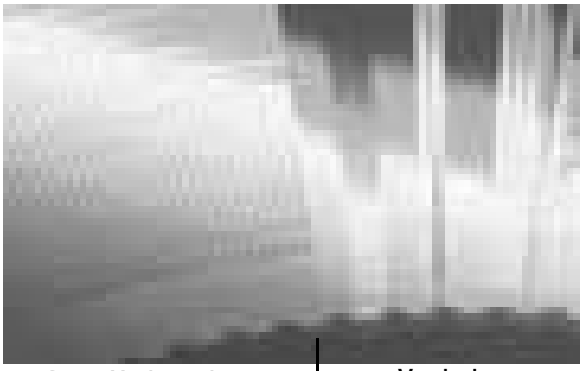
Which edition to buy has far more to do with title/supplement content and video transfer format and quality than with technical details.

9.2 What is CAV?

CAV stands for Constant Angular Velocity. CAV is also known as “standard play” or “full feature play”.

The number of degrees per second, or rpm, is constant. For NTSC, CAV discs spin at 1800 rpm; for PAL, 1500 rpm. For comparison, vinyl records are CAV.

Enlargement of CAV Disc Data



Some Horizontal Scan Lines In a Field (Active Picture Data)

Vertical Blanking Interval

In the CAV photo, the actual pit track spiral is too small to see, but notice the “spokes” radiating across the disc. These are the horizontal retrace (blanking) intervals. They are all aligned, as are all the VBIs. This alignment is key to the full-resolution still/step/reverse play that CAV delivers on any vintage player.

9.3 What is CLV?

CLV stands for Constant Linear Velocity. CLV is also known as “extended play”. CLV implies a constant number of inches per second under the laser (about 423 in./sec.), and thus the disc rpm slows as the laser moves out toward the edge (end).

NTSC CLV discs start at 1800 rpm and slow to about 600 at side end. PAL discs start at 1500 and slow to about 500. For comparison, audio CDs, and indeed all media based on the 12cm CD format, are CLV.

Enlargement of CLV Disc Data

Notice that the lead-in tracks are effectively CAV

In the CLV photo, notice that the disc starts out in CAV mode (so that the player doesn’t need to know before starting). However, after the lead-in area, the alignment of the blanking intervals quickly degenerates. Nonetheless, there is still some apparent structure to the data patterns beyond that.

The name CLV is not entirely accurate for modern media, but is a useful approximation. Almost all “CLV” discs actually use a format called CAA (Constant Angular Acceleration), which is also misleading. “Zoned CAV” would be more accurate. The horizontal blanking intervals are kept in sync for groups of rotations. This minimizes cross-talk (visible leakage of adjacent track data into the track being read).

9.4 What does CAV vs. CLV mean to me?

Only CAV provides all motion control capabilities on all players (at the expense of more platters and shorter 30 minute sides). CAV also provides constantly improving signal-to-noise ratio as the program proceeds toward the outer edge, but this is typically not noticeable on properly manufactured discs.

CLV provides one hour per side playing time resulting in lower prices and less flipping. In return, you give up almost all of the other CAV features, unless you have a high-end 1988 or later vintage player with on-board digital field store, a feature which adds $250 or more to the price of otherwise equivalent machines. (Only one industrial player, the Pioneer LD-V8000, has digital ***frame*** store.)

The majority of disc titles are available only in CLV, with CAV being reserved for special editions and program content that requires CAV.

Here are the details.

CAV vs. CLV

	CAV	CLV, no field store	CLV, field store player
rpm (NTSC) rpm (PAL)	1800 1500	1800…600 1500…500	1800…600 1500…500
Time per side	30 min.	60 min.	60 min.
Simple fast forward & reverse	Yes	Yes	Yes
Variable FF & Reverse	Yes	No	Yes
Variable Slow Fwd & Rev	Yes	No	Yes
Pause (blank)	Yes	Yes	Yes
Freeze image	Frame	No	Field
Still step F/R	Frame	No	Track[a]
Seek Chapter	Yes	Yes	Yes
Seek Time	Rare[b]	Yes	Yes[c]
Seek Frame	Yes	No	No
Auto-still[d]	Yes	No	No
Crosstalk	None	Possible	Possible
SNR @ Edge	+3dB	-	-
Mech. Noise	More	Less	Less
Defects	Still	Scroll	Scroll

a. Only a field (half a frame is displayed, and the field is not the next/previous, but may be an entire rotation or more away (several fields).
b. The data structures used by CLV discs to store the field time-code are used for frame number on CAV. However, if the disc has digital sound, the time is available in the subcodes of the digital audio. Few players can use it for seeking.
c. CLV timecodes can contain a 0…23 or 0…29 frame number sequence within the second, but only industrial players like the LD-V8000 provide true CLV frame seek.The industrial Pioneer LD-V8000 can perform a true CLV still frame, and may be the only LD player that can.

d. If so pre-mastered, a CAV disc can automatically stop and display a given frame. This is often used to display an instructional frame at the end of a brief motion sequence in LD supplements. What this code actually does, by the way, is merely tell the laser head to step back one track replaying the current frame.

The bottom line on CAV vs. CLV is that even on two otherwise identical discs, the quality difference between CAV and CLV is small, and much less dramatic than say, S-VHS vs. VHS… and the CAV and CLV editions are rarely "otherwise identical".

10. What are LD Play Features?

All players can randomly seek to anywhere on the disc in seconds, such as to "chapter marks" (the equivalent of "tracks" on a CD) if the disc has chapter marks on it. Many LDs do not have chapter marks. The lack of them can be a considerable annoyance on music videos. The possible range of chapter numbers is 0 through 79, per side.

Virtually all CLV players can seek-to-time with at least one minute resolution. If the disc is so coded, contemporary players can seek to one second resolution. Unfortunately, the timecode resolution of CLV discs is never noted on the jacket, but fortunately, 1-second is now the most common. Early 1980s discs often have only 1 minute timecodes.

All players and discs can perform a blank-screen pause (indefinitely) and skip fore and aft at high speed. Field-store players can display images during scans, simpler players blank the screen.

CAV discs support seeking to individual frame numbers (if the player or remote has a keyboard), and play forward and reverse at unusual speeds, often in the range ±1/3x to ±3x. Single-frame-step fore and aft is also available. The newer players have a "jog wheel" that allows variable speed slow/fast-mo fore and aft.

The seek-to-frame plus the still-frame capability allows CAV LDs to contain material unthinkable on videotape. A CAV LD can store 54,000 individual still images per side. Discs with all the photos from the Voyager spacecraft mission exist, as well as photos of all the art in Louvre, 250,000 aviation stills from the Smithsonian Air & Space, etc.

Although this is an impressive capability, that entertainment DVDs are unlikely to offer, the relatively low resolution of NTSC and PAL, and the lack of even lossless data compression on LD, suggest that CD-ROM or DVD-ROM are far more appropriate vehicles for purely-still-frame material.

10.1 Are supplements significant?

You expect supplements on VHS special editions and collector editions, but on LD, supplements often turn up on otherwise perfectly ordinary releases, largely due to the fact that the last side can hold 60 or 30 minutes of material even if the final chapters of the film only take 15.

LD can, and often does, provide the same sort of supplements (trailers, making of, out-takes, cut scenes) that have appeared on a few VHS titles. To this, LDs add still-frame capability.

It is also possible to mix motion and stills. Special edition LDs often follow the feature presentation with background material such as: production stills; related text material; outtakes; interviews; set design art, etc. The player automatically pauses on stop-coded still frames, and you are prompted to STEP forward or press PLAY to resume full motion.

The larger container required for a 12-inch disc invites the inclusion of supporting text and illustration. And at least in the case of Criterion Collection editions, you get it. Full credits, dates and details of sourcing (negatives used, whose "cut", etc.).

Sometimes what might otherwise be jacket liners notes are included as still-frame text on the disc itself. For example, the CAV Criterion ***High Noon*** includes, on disc, the complete short story from which the screenplay was ostensibly drawn. The Criterion CAV edition of ***Ghostbusters*** includes a complete shooting screenplay.

10.2 Can I control my player with my PC?

Not easily. Industrial LD players routinely provide a full-duplex RS-232C port for computer control and status read-back. Consumer players have not provided RS-232C since the early 80s. If you need computer control, particularly from a non-Mac PC, consider getting an industrial player.

11. How Does CAV Still Frame Work?

…and how does it fail? Given the age of LD, digital field stores are a recent development, yet LV/LD CAV has always had tack-sharp rock-steady still-frame capability.

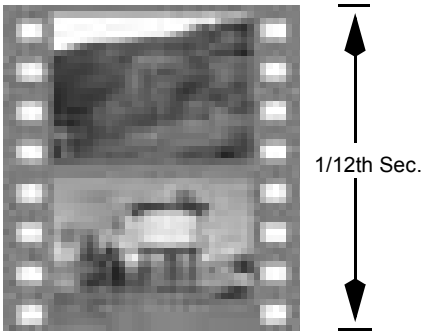
This is accomplished by playing the selected LD frame (two video fields) over and over again. On CAV, the laser merely needs to step back one track spiral at the appropriate moment (during a VBI, actually).

Complicating matters, however, a film frame (usually 24 frames/sec) is not matched to a video frame (either 29.97 or 25 frames/sec.). How is the mapping from film to video handled?

These questions are addressed in the next two topics, 2:3 pull-down and white flags.

11.1 What is 2:3 pull-down?

In standard 35mm exhibition, film is moved at 24 frames per second. In 1/12 of a second, two film frames transpire. In the sample clip, a scene change cut has occurred.



NTSC video is approximately 30 frames/sec or 60 fields/sec. PAL is 25 and 50. Video frames are interlaced, with the odd-numbered scan lines appearing in one field, and the even ones in the other. Interlacing is a primitive form of data compression, and

was about all that was available to the designers of NTSC in the 1940s. In the illustration below, the size of the scan lines is exaggerated.

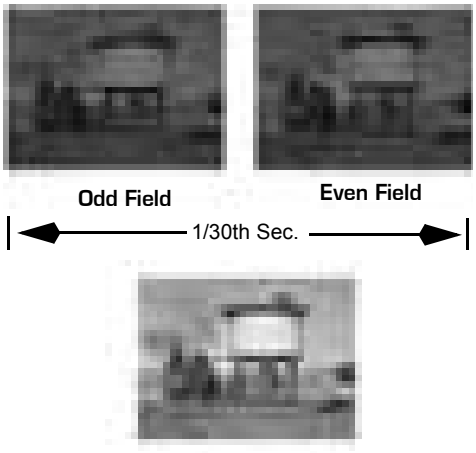
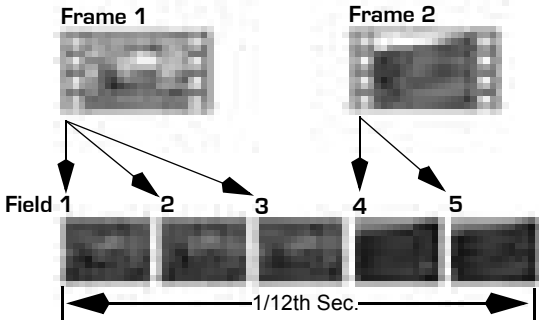


Image Fused in Human Brain

Due to human persistence of vision, we see these fields combined as a single image, although we are sensitive to some interlace artifacts, and CAV "field motion" is one of them.

In "live" video, each field (indeed, each point on each scan line) may represent a different moment in the scene, and field motion is unavoidable. With film, the source "scene" is only changing 24 times per second, and we'd like the video frames to reflect this. We want each video still frame to represent a single complete film frame.

In the same 1/12 second as our pair of film frames, 5 NTSC fields, 2½ video frames transpire.



3:2 Pull-Down Transfer

The common practice on NTSC video transfers is to use a film frame for three video fields, pull-down the next frame and use it for two fields, then repeat - hence the term "3:2 pull-down".

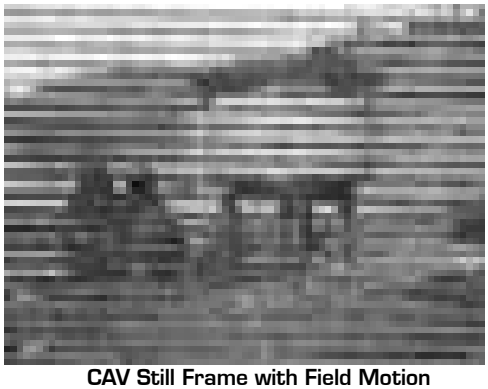
In the early days of NTSC telecine, 3 film frames were mapped to 2 fields each, and the 4th frame repeated for 4 fields. The judder this causes is quite visible, and some 4th-frame-repeat transfer have turned up on early LDs.

With digital video it is now possible to map one film frame to a literal 2.5 video fields, but I haven't seen any such transfers yet.

In PAL, the custom is merely to speed the 24 fps film up to 25 fps during the transfer. And, yes, experienced viewers can detect this 4% speed-up (often accompanied by a 4% audio pitch change).

11.2 What's a white flag?

As you can see in the 5-field sequence above, the NTSC LD player must be careful about which two adjacent fields it thinks comprise a complete video frame. If it still-frames on fields 3+4, the result will be a video frame containing fields from two different film frames, as below (scan lines not to scale).



CAV Still Frame with Field Motion

In the typical case, only a small amount of scene-motion difference exists between the fields, and the repeating "still" frame appears to jump back and forth in time.

The way that LD can avoid this is via the "white flags" that can be encoded in the VBI of LD fields. Correct LD mastering places an "action point" signal called a "white flag" at the start of each sequence of related fields. As it is placed several scan lines prior to the start of a field, it can also be considered to be just after the end of a sequence of related fields, and I believe it is actually used in this latter manner.

In CAV still-frame mode, it tells the laser servo when to perform a one-track (two-field) back-step to re-display the current frame.

The signal is called the "white flag" because it consists of a single horizontal video scan line with the active line period set to maximum white level. It is placed in the vertical interval in either line 11 of an odd field or line 274 of an even field. Lines containing visual picture information start at 21 or 284 (22 or 285 if closed-captioning is present).

White flags are part of the pre-mastering action-point edits that the LD producer must submit to the LD mastering vendor. If they are incorrect, or omitted, the result LD is apt to have field motion often on 2 of every 5 frames. There are unfortunately a percentage of CAV discs with field motion.

Another way that the logical film frame is marked is via the "picture number", a 24-bit bi-phase coded signal present in vertical interval lines 17 & 18 or 280 & 281. A player theoretically also knows where the film frame changes because the frame number changes. The LD spec (IEC-857 for NTSC) suggests that the white flag is used for still framing, but I have seen some indications that some players may be using picture number instead.

The white flag and/or picture number tell the LD player where the start/end of the logical frame is for still-frame purposes only. During normal "PLAY", the LD player will free-run and show all the fields. If the white flags are left out on a CAV disc, most players will never display a still frame at all; they just keep rolling. Consumer LDs with this severe defect are exceedingly rare. There are other "stupid white flag tricks", but they are beyond the scope of this article.

12. How is LD Widescreen Delivered?

Widescreen LD titles are far more common than widescreen VHS. Until DVD arrived, if you wanted access to the same image you saw in the theatre, LD was the only reliable way to get it.

The issues and trade-offs associated with widescreen video have been extensively covered by this magazine, so the following is just an overview from the LD perspective. The sample image is a hypothetical HDTV camera scene, with a superimposed cross-hair cue.

Original 1.77:1 Image

On VHS, of course, the most common format is cropped (as shown below). Many LDs have been made using “full frame” or “pan and scan”, but it is far less common now than in the early days of LD, and tends to be the exception rather than the rule.

Cropped or Pan’n’Scan 1.33:1 Image

On LD, the “letterbox” or “matted” format is used in virtually all cases. A few anamorphic titles have been pressed, but these are essentially experimental.

12.1 What is letterboxing?

During the letterbox video transfer, the desired width of the widescreen theatrical image fills the width of the video image. It does not fill the height of the video image, either because there is no picture to put there, or because what is there on the film was not intended to be seen (microphones, dolly tracks, etc.).

Letterbox Image on Standard TV

When viewed on your display, the unused scan lines are either black, or set to a dark gray value. However, if your TV is over-scanning severely, you may not be able to see the dark bands on letterbox titles with aspect ratios of 1.50:1, 1.66:1, 1.77:1 or even 1.85:1.

The unused scan lines, of course, have to be mastered and recorded on LD, and represent wasted storage. On letterbox DVD, they are stored as data structures that compress to occupy essentially no space on the DVD.

12.2 What is anamorphic LD?

Anamorphic Image as Stored on LD

Anamorphic storage uses all 480 or so scan lines to store picture information. Viewed on a standard 1.33:1 monitor or TV, the stored image appears vertically stretched. On a widescreen monitor or compatible projector in “FULL” mode, the image is stretched horizontally, restoring the correct non-distorted widescreen image, at the maximum resolution possible on LD.

13. What is the Video Encoding at the Data Layer?

The answer to this begins with a revelation that is news to many LD enthusiasts and more than a few home theatre sales people - LD is ***not*** digital video. It is ***analog*** video on the medium. When LD was first demonstrated, there was no digital video.

The video signal on LD is pulse FM. Like CD and DVD, the optical data pits and lands are either there, or nor not (1/0), but their length and spacing are variable (analog).

This single spiral of pits/lands encodes the video signal, LD and video frame control information, two FM subcarriers (for audio or AC3/DD) and a complete RedBook PCM CD audio or DTS digital data structure.

To understand this, it might help to walk through the process of producing a laserdisc. For a simple no-supplement no-commentary movie title, LD pre-mastering shares many steps with tape and DVD mastering up to the point where the video tape is dismounted from the telecine (although there may be some vendor-specific tape format requirements). LD video transfers have been extensively covered by this magazine, and are not addressed in this FAQ.

Once earmarked for LD, the tape must be used to fill out an “action point edit” form that determines, for example, where the chapter numbers index, where the “white flags” must be for proper still-frame, side breaks, etc.

13.1 How is LD video analog?

At the LD manufacturer, the video master, plus any audio streams, is fed into a system that adds the LD control codes to the vertical interval (unseen scan lines), to produce a signal to

feed to the laser recording system. Even if the video master is digital video, the laserdisc is pre-mastered from a composite analog signal.

This baseband composite video signal (about 4.2 MHz wide for NTSC) is pre-emphasized and used to modulate an FM carrier signal with a nominal frequency of 8.5 MHz. The amplitude of the NTSC signal deviates the FM carrier over the range 7.6 MHz (video sync tip) to 9.3 MHz (video white level). The signal is still pure analog at this point.

The two analog audio channels, one of which might be a Dolby DD/AC-3 data stream, each modulate a preemphasized FM audio subcarrier (2.3Mhz for channel 1/Left, 2.8MHz channel 2/Right).

The RedBook PCM or DTS digital audio bits are preemphasized and used directly. They represent a signal envelope with a bandwidth under 1.4 MHz.

The two audio FM streams and the digital audio are summed and attenuated 26dB. This audio stream is summed with the video FM, then clipped.

The resulting clipped signal looks like square waves, and the low level, low frequency components (analog and digital audio) cause a variation in the duty cycle. The signal amplitude may be 1 or 0 (like binary), but where the transitions occur and how long they last is continuously variable (analog).

In over-simple terms, the video signal is represented by the center-to-center pit spacing and the audio is represented in the difference between pit/land length.

This pulse-width modulated signal is then more-or-less directly fed to the writing laser on the LD master table, which usually holds a completely flat solid glass disc that has been coated with a photo-resist or ablative coating that is ¼ wavelength thick. When “on”, the laser chemically enables, prevents or actually burns a pit.

The written glass master, if photo-resist, is chemically etched to remove either the exposed or unexposed regions. An ablative glass master can be used directly. One-off and recordable LDs are produced directly at this step, much like CD-Recordables, using assembled media with an ablative data layer, and reflective flat metal layer beneath.

For mass production, the pitted glass master may be coated with a conductive layer and plated, or simply have a metallization layer sputtered on. The resulting master is used in turn to make additional metal masters, which in turn are used to make stampers for production.

The stamper is used to impress the data pattern on thermally softened acrylic polymer, which is removed and cooled. In an alternative method, the stamper is used as a mold to accept liquid acrylic monomer, which is cured with ultraviolet light.

The cooled/cured transparent disc substrate has a reflective metallization layer applied to the pitted side (by plating, sputtering or other means). The Protective Layer is applied to that. The sandwich is glued to the disc representing the other playing side. The assembly is edge-trimmed, labelled, sleeved and packaged.

14. What is LD Audio?

LDs can deliver mono, dual mono, stereo, matrixed stereo surround (2, 3, 4, 5 or 5.1 channels) and two forms of 5.1 discrete digital surround sound, in various combinations.

Technically NTSC LDs have up to three discrete audio delivery methods, two FM subcarriers and a 1.44 Mbit/sec digital base-band. PAL LDs have one (digital) or two (analog), but not both. What is stored in these delivery area varies.

LD Audio Storage

Area	NTSC	PAL
FM 1/L	Analog Mono, Analog Stereo Left or Analog CX Stereo L	Analog Mono, Analog Left or Analog CX L, but Digital must be vacant for any analog.
FM 2/R	Analog Right, Analog CX Right, or 384 Kbps Dolby DD/AC-3	Analog Right, or Analog CX R, if Digital vacant.
Digital	1.44 Mbps Stereo Left & Right or DTS	Stereo L & R

The average NTSC movie LD is delivered with a matrixed (stereo-based) surround soundtrack that is identical in the digital and FM analog channels.

LD had stereo long before VCRs or broadcast TV did. Movies have had stereo for a surprisingly long time, too. Many early 1950s widescreen epics were released in stereo, some in multichannel.

Stereo content may be simple stereo or matrixed surround. Most “surround” movies made since 1976 employed some form of matrix surround on 35mm stereo tracks. If the movie was released in 35mm surround, the LD stereo is almost always still encoded for surround, even if the LD is a pre-1986 analog title.

It would usually cost more to re-mix for simple stereo, so Hollywood actually helped get the home surround movement started in the early 1980s by the simple expediency of shipping the theatrical mix on home video.

14.1 What are the player audio outputs?

All players have at least one set of 1/L(eft) and 2/R(ight) RCA-style line level audio output jacks with which to feed an external amplifier.

The RF (CH 3/4 VHF) output contains either L+R or the currently selected audio channel. The composite video, Y/C (S-video) and component video outputs contain no audio at all.

If the player supports PCM digital audio, it may also provide an EIJA CP-340 Toslink optical or IEC-958 Type II RCA coaxial digital output jack (usually color coded orange), for use with an external DAC or DTS decoder. Having this port is essential for using the digital audio on DTS discs.

If the player supports DD/AC-3, the signal is presented at an RCA jack (usually color coded black). An external decoder is required.

When players appear that have on-board DTS or DD/AC-3 decoders, expect to see six pairs of RCA jacks for the audio signals, unless the home audio industry can come to some agreement on a 6-channel multi-pin connector standard.

14.2 Do I need a stereo TV?

That depends. All consumer LD players ever made can output stereo.

No LD players, to my knowledge, re-encode the selected LD stereo channels as MTS stereo at the RF output.

Consequently, if you want to listen to LDs in stereo (or surround), or just want to avoid using the RF output, you’ll need to connect the LD’s analog audio outputs, or LD digital audio output, to an external stereo audio system, or to your TV. If you plan to use your TV’s speakers, the TV must have line-level audio input jacks.

However, because built-in TV speakers are generally so low in quality, most LD player owners route the audio to their home audio system, if not to a dedicated home theatre audio system.

The issue of whether or not you need any surround equipment is taken up after the questions on digital audio.

14.3 What are the AFM audio channels for?

The two FM subcarriers were the original LaserVision soundtrack channels, and discs made between 1978 and 1985 typically have only these channels. They are a pair of discrete (not multiplexed) FM audio carriers, each of which can deliver a mono (or half of a stereo) audio signal.

LD analog sound, at a theoretical 75 dB s/n, is comparable to broadcast FM radio and superior to 35mm mag/optical film tracks and VHS HiFi (but with fewer dropouts and no 60Hz helical scan artifacts than HiFi). LD analog sound is far superior to VHS linear analog sound. LD was considered the "high fidelity" video medium even before digital sound.

LD analog stereo is dual-carrier FM, not MTS (multiplexed) stereo. They are both identical on mono programs. Sometimes the analog program is completely different from the digital program (alternate language, related audio content, isolated music/effects, etc.).

Because the FM channels are discrete, and have essentially zero cross-talk (unlike broadcast FM), they can contain completely independent programming, and often do. You will encounter:

- Mono soundtrack with commentary track.
- Mono soundtrack with isolated music and/or effects track.
- Mono soundtrack with DD/AC-3 digital surround soundtrack (see more on this below).

Aside: On some industrial or educational interactive video discs (a variety of LD called "IVD"), analog channel 2/R contains either Sony- or Pioneer-specific binary download programming code to control features of "Level II" industrial LD players.

14.4 What is CX?

CX noise reduction is the rough LD equivalent of Dolby-B on analog cassette or VCR analog audio. CX is only used on the LD analog channels. Over half of the LDs in print are CX encoded. Some antique pre-digital players require external CX decoders.

Don't assume that lack of CX encoding on a new release is evidence of sloppy mastering. There has been debate about whether to CX or not to CX. Because CX decoding uses a pilot signal derived from summing both channels below 500Hz, best practice suggests encoding CX only when:

- the original audio source material has wide dynamic range (i.e. frequently not on early optical soundtracks mastered on film), and
- if the program is not mono, that the left and right channel content is correlated (stereo or matrix surround with minimal inter-channel group delay under 500Hz).

If used on noisy or compressed audio material, audible pumping can occur during decoding. If used on discrete dual-channel material (commentary, isolated music/fx or DD/AC-3) decoder mistracking can have very unpleasant results.

With the advent of digital sound, the CX issue is mostly moot, which is welcome, because CX has other complexities, like lack of auto-tripping on some encoded discs, and the erroneous presence of auto-tripping on unencoded discs.

14.5 What is Dolby DD/AC-3?

DD is one of two "5.1 channel discrete" digital surround encodings that are possible on LD. An external decoder is almost always required for either.

DD is a 384 Kbps Dolby AC-3 digital data stream modulated onto the channel 2/R AFM subcarrier. DD is also used on theatrical 35mm film, where the digital data pattern cleverly occupies the vertical space between the sprocket holes, co-existing with the SVA analog optical tracks.

AC-3 is a form of perceptual coding that compresses audio by discarding portions of the signal that are thought to be "masked" (not heard) due to other portions present that are not discarded. It is a "lossy" or "data reduced" form of compression, having a compression ratio of about 12:1. Debates rage over the merits of AC-3 (~12:1) vs. DTS (~4:1) vs. matrix PCM (1:1, but[1]). With DD/AC-3, unlike DTS, the PCM audio track is still present, so you can choose whichever you prefer (or are equipped for).

When decoded, AC-3 presents a six ("5.1") channel audio signal. The channels are: front left, front center, front right, left surround, right surround, and the ".1" is a 120 Hz low-pass filtered bass channel for subwoofer.

If your player lacks an on-board decoder (and six audio output jacks), then it needs to provide an "AC-3" output, or at least an "EFM" output for an external decoder. It's relatively simple to add an EFM port to players that lack it, and many after-market suppliers can perform the operation.

With a port and decoder, you still need to have a multi-channel audio setup.

14.6 What is the 1.44 Mbps digital storage for?

It was serendipitous that the FM carrier frequencies and the FM video signal envelope left enough bandwidth to insert a RedBook (CD audio) PCM digital data stream on NTSC LVs. LV got digital sound in 1986, about two years after CD was released, and "LV" became "LD" as a result. By 1989, essentially all consumer laser video players had both analog and RedBook digital audio.

The digital data was originally intended to enable NTSC secondary audio programs (on the analog channels) without having to sacrifice a stereo soundtrack, as well as be a generally higher quality stereo signal for LaserVision. It was quickly recognized as providing dramatically superior matrix surround as well. LDs with PCM digital audio are usually labelled ***DIGITAL SOUND***.

Digital sound LDs may also have CD-style "Table Of Contents" (TOC) info in the RedBook P/Q subcodes, but LD players don't seem to be able to do much with TOC beyond displaying the track count and total time.

Since it may not be obvious; if a disc title has only analog sound, the player's digital output will be silent. No players have on-board ADCs for creating a PCM or DTS digital representation of the AFM analog audio.

By the mid-1990s, NTSC LD titles began appearing with the RedBook PCM data structure completely replaced with a DTS digital data structure. There are no PAL DTS titles.

14.7 What is DTS?

DTS (Digital Theatre Systems) is a pair of 1.44 Mbps discrete 5.1-channel surround standards. Theatrically, it is delivered on separate CD-ROMs that accompany the film canisters, and are synchronized to a time code on the film (sandwiched between the SVA optical tracks and the image).

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1. Matrix surround is not lossless. Because the surround, center and subwoofer channels are blended with the normal L/R stereo, it is not possible to extract six (5.1) fully isolated (discrete) audio channels.

On DTS LD or DTS CD, DTS replaces the PCM audio, and almost always requires an external decoder. However, unlike DD/AC-3, DTS often does not require player modification, as the raw digital signal is available at the optical or coaxial digital audio output port.

If you don't have, and don't plan to obtain a DTS decoder, DTS titles are problematic, since you will be forced to fall back on the AFM audio. Fortunately, DTS titles are usually released in dual editions (PCM+AFM and DTS+AFM), but check the jacket.

14.8 What is matrixed surround?

Stereo soundtracks, whether analog or digital, may be encoded for matrix "surround" effects. Simplifying, the rear or surround information is encoded by applying 5 dB of Dolby-B noise reduction, and adding the resulting signal to the front channels, in opposite phases in each channel.

When played in a plain two-channel stereo environment, the signal sounds convincingly like plain stereo, with normal Left Front and Right Front information, and slightly disembodied surround effects. In mono, however, the surround nearly or totally self-cancels and is essentially inaudible.

With a surround decoder, one to four additional channels may be extracted and sent to speakers at locations for Front Center, Surround (single, or left and right), and subwoofer for effects. You need an appropriate processor (external to the LD player), three (or more) amplifier channels and matching number of speakers.

Matrix surround titles are not consistently identified on the disc jacket. The most common format is "Dolby Surround" - the consumer term for theatrical "Dolby Stereo" or Dolby MP matrix (same encoding, too). Discs bearing the double-D [DOLBY SURROUND] logo are so-encoded. Discs bearing the double-D [DOLBY STEREO] may be.

Other terms are "matrix surround", "Ultra Stereo" and "Chace Surround". Films made released since 1976 and simply marked "Stereo" may or may not have surround processing.

14.9 Do I need a surround setup?

No. You can enjoy LD even with mono audio. Surround does enhance the home theatre experience over simple stereo, but is a lower priority than having a display device that does justice to the video signal. If you are running the LD audio through the TV speakers, by all means consider upgrading your audio chain, and look at surround while you are at it.

14.10 What is THX?

THX® is a term applied to LucasFilm® standards for various aspects of film audio creation, film exhibition, LaserDisc, DVD and VHS mastering, Dolby matrix surround decoding and home equipment certification. Theoretically, decoding the matrix surround of a "THX" LD is optimized if you have a THX-certified decoder, but the difference between a quality generic Pro-Logic decoder and a THX-certified Pro-Logic decoder is at best subtle. THX equipment is not required to enjoy THX LDs.

15. How Long do LDs Last?

I own a disc that plays about as well today as it did when it was made in 1978, twenty years ago. The theoretical shelf life of a ***properly manufactured***, and properly stored LD is the same as that of a CD; essentially unknown, and possibly longer than the photographic negatives/prints from which the disc was made (certainly longer than many 1950s- and '60s-vintage dye-coupler tri-pack color negatives and prints). There are no known deterioration modes for properly made and stored discs.

Contrast this with an optimistic shelf-life of 20 years for magnetic tapes of all kinds (less if used often). Tapes have several known deterioration modes: print-through; binder breakdown; base stretch; not to mention physical abrasion wear and signal loss due to external fields (magnetized VCR components, speaker magnets, CRT deflection coils, and degaussers).

Note the emphasis on "properly made" above. At different moments in LD history, all of the LD media manufacturers have "lost the recipe" and made discs that deteriorated on the shelf.

Discs do fail on the shelf, and do experience other manufacturing defects more immediately evident. I've had several discs with "laser rot" (purchased used), and have also purchased new discs with contaminants under the acrylic, and other defects. A detailed list of LD defects is beyond the scope of this article.

Three and five year warranties are common on LD media, and reputable retailers will replace any failed title that is still in stock.The initial defect rate for LDs is lower than for pre-recorded VCR tapes. The rate seems to be slightly higher for LDs (about 2%) than for CDs (which are about 1%).It is difficult to tell because there is significant variance in how various players handle marginal and defective discs.

15.1 How durable are LDs?

As with CD, and unlike CED/VHD videodisc systems and all tape formats, LD is a non-contact medium during play. There should be no wear in normal use, even if you freeze a single frame on screen for hours on end. (Some users are concerned with heat buildup in early gas-tube laser players, but all contemporary players use low-power solid-state lasers, so this should not be an issue for an adequately ventilated player.)

LDs are slightly more susceptible to handling damage than CDs, because, unlike CDs, the video signal and (analog) sound embody no error correction, other than a "dropout compensator", which can replace a single lost scan line with a duplicate of the previous line. A deep concentric scratch is both visible on screen and audible. Radial scratches, light scuff marks and fingerprints tend to be invisible. A regional LD/VCR retailer reports that he has far less damage problems and far longer rental life with LDs than with tapes. The jury is still out on DVD durability.

The modern LD player looks just like an oversize CD player (and indeed, "combi" players handle CDs as well as LDs). All current models are horizontal tray-loading designs, many with the tray concealed behind a swing-down control panel. Earlier models, like the 1981 Pioneer VP1000, are top spindle loading, just like early CD players.

Unfortunately, many tray loaders have felt support pads that touch the LD in the data region during loading and unloading. Further, the trays on some tray-loaders do not expose the entire tray. Some care is required to insert and load a disc without scuffing the plastic enclosing the data surfaces. Generally, LDs are more robust than vinyl LPs, but use the same handling precautions. Another LD FAQ describes LD care.

15.2 What is laser rot?

Laser rot is the appearance of, or an increase in video (and perhaps audio) noise over time, on a disc that did not previously exhibit the problem. The noise is usually snow, and may be color or B&W. Streaking may appear as entire scan lines degenerate. On older media, there may be visible wavy variations in the diffraction patterns of the data layer.

Rot has been postulated to have many causes, the most popular being oxidation of the data layer from within the disc. Although colloquially called "laser rot", the phenomenon has nothing to do with the laser or even how many times the disc has been played. Theoretically, you can minimize your chances of rot by proper storage.

Rot can develop in weeks, months or years, and can affect the media from any manufacturer. Based on my experience to date, you can expect 2% of your newly manufactured discs to turn sour in time. If you buy used discs, the DOA rate from rot can be as high as 30% (but most pre-1987 discs that are going to rot have already done so). It is therefore important that you patronize dealers who offer unlimited warranties, and/or understand your alternatives when such warranties are absent. Another LD FAQ addresses LD defect identification.

15.3 Can LDs be repaired?

The only defects and damage that can be reliably corrected are warps and surface trauma (scratches, nicks, optical blemishes, etc.). Crack repair is risky but possible.

Broken discs (with separate pieces) and laser rot cannot be repaired. The actual procedures for repair are described in another LD FAQ.

16. How are Discs Sold?

The LD media distribution and pricing model differs substantially from VHS, and differs from the emerging DVD model. LDs cost about twice as much to manufacture as tapes, but curiously, LDs often sell for less than tapes.

Video mechandising trivia: VHS tapes are the dominant home video medium. Most people rent tapes rather than buy them. Historically, film studios didn't get a percentage of the rental revenue, although this is now changing. All they got was income from the initial sale of each pre-recorded tape. And the video stores are in hot competition with each other to get new titles fast. It is somewhat a "captive market". Historically, the first tape sales were therefore targeted at, and priced for, video rental stores - not for collectors. More recently, a shift to "sell-through" has been seen in the VHS market.

Consequently, new tape releases were priced very high ($80-90 was common). It was not until the video store demand was satisfied that the studios dropped the prices to levels attractive to individual movie collectors ($30-40). When that market was satisfied, prices might drop further for mass-market customers, $10-20 per tape. LDs, even major titles like ***Top Gun***, are typically introduced at $30-40 (for CLV), and stay there.

16.1 Are LDs rented?

LDs are rented, typically at $2.00 per day, but LD has always been predominantly a "sell-through" market. The major purchasers of new LD releases are individual movie collectors. LD rentals are not a big market.

Unless you live in a major market (L.A., NYC, S.F.Bay, greater Boston, etc.), you may have trouble finding a rental outlet.There are probably less than 5000 LD stores in the U.S., including a few chains.

Due to the longevity of the medium, you can often rent titles that are long out of print. If you are renting for auditioning of the program material, rather than for routine viewing, this is not a big deal. Rent tapes. Buy discs.

Or, simply borrow discs. Establish loaning agreements with your LD acquaintances. Another LD FAQ has a model loaning agreement. If you are interested in renting Criterion titles, be advised that some LD rental stores do not rent them, esp. CAV titles.

16.2 How large is the LD catalog?

The total number of titles that are theoretically orderable in the U.S. is about 10,000, with another 10,000 in Japan. In practice, perhaps 1/3 of these are actually easily found at any moment.

Furthermore, the total number of actual catalog numbers exceeds the total number of ***titles*** by a considerable percentage. This is because there have been so many different editions and re-issues of each title.

Many titles, particularly popular classics (like ***2001: A Space Odyssey***, ***Blade Runner*** or ***Star Wars***), may be available in:

- Widescreen or Pan&Scan,
- Analog or digital PCM or AC-3 re-issue,
- PCM or DTS digital sound
- CAV or CLV,
- Release or Director's Cut,
- 35mm or 70mm transfer,
- Plain or with Supplements,
- Generic or Criterion edition, etc.

Some titles have appeared in nearly a dozen LD versions since 1978, each a completely different disc mastering. You need to do some homework before buying the first package that catches your eye.

In some cases, if a title is not available in domestic release, you may be able to find it as an import. However, unlike Japanese audio CDs, Japanese LDs may have unexpected contents.

Japanese moviegoers are more critical than Americans, and insist on original-language presentation, rather than dubbing. If the film was not made in the U.S. or U.K., there may no English soundtrack at all. Unless the disc is widescreen, there will be Kanji subtitles on-screen and in-picture. An accurate Japanese LD catalog is required to know for sure.

Also, Japanese films and videos censor some types of nudity acceptable in U.S. films.

16.3 What is the price of an LD title?

LDs have list prices ranging from $19.95 to $149.95 (or higher). The average mainstream disc today has an MSRP of about $35.00. Low-volume specialty labels like Criterion Collection command higher prices, and multi-platter CAV sets with extensive features and supplements often run $100 or more.

MSRP however, is not the real bottom line. 10% retail discounts are common for LD, and pre-release pre-order discounts of 15-25% are available.

16.4 What's this about pre-release orders?

Because the LD market is small, over time the producers have discovered that the pre-release stocking orders from the retail dealers are a significant percentage of the expected lifetime volume of the title. The resellers, in turn, have discovered that if they pass on the pre-release information to their customers, they more accurately forecast their own needs, and thus fine-tune the initial stocking orders.

The dealers get a larger discount on large initial stocking orders, and they can pass it on. Pre-announcing also allows you to learn if an existing generic LD from one of the major labels will be soon be joined by CAV and/or CLV editions from Criterion Collection. In general, you can stay about six months ahead of the industry, and plan purchases carefully.

The down-side of this custom is that if the title attracts little or no stocking orders, the producer may cancel it altogether. Further, producers are more frequently manufacturing smaller quantities in excess of initial stocking orders. For non-blockbuster titles, you need to act early to assure that you get a copy.

As in the case of the original ***Wallace & Grommit*** LD, it can take a couple of years before a new production run satisfies a late-blooming demand.

16.5 Are used LDs safe?

Used LDs are like used CDs. Laser rot aside, if they physically look OK, they probably will play like new. The random access capability of LD makes it easy to skip through and QA a used disc in the store.

The prices of used discs are appealing. My average used disc has been $14.00, with a low of $8.00 and a max of $25.00. I obtained some hard-to-get titles that way, and cheaply at that. I refuse to buy full-frame "chopped n' squashed" movies at normal retail prices, but I will take a chance on them at used prices.

If you seek used or "cutout" merchandise, make sure you and the dealer understand each other on the matter of defects, which are more likely on older pressings. Most dealers will accept the return of any disc they sell, regardless of what bin it came from. But in the case of older titles, the dealer may not be able to replace it with the same title. Find out what recourse is available to you in that case.

16.6 What is a cutout?

The LD jacket or box has a hole in one corner or though the UPC code, or a nick in the edge near a corner. This is not a defect, unless the punch or drill damaged the disc(s) within. The liner may have to be replaced in any case.

When a disc title is overstocked at the distributor, or when it is deleted from the catalog with stock remaining, the excess/remaining stock may be defaced in some way and sold to the retailers at a larger than normal wholesale discount. The defacement distinguishes cutouts from ordinary stock. Retailers cannot return cutouts for credit as they can on ordinary slow-moving stock. Cutouts can be returned if defective.

Such warehouse-cleaning usually involves multiple titles, and is often the occasion for special sales at the retail level. I would not expect to pay list price, and would expect to get a greater-than-normal discount on a cutout. Cutouts often provide an opportunity to acquire titles passed up at normal prices.

Sometimes a title will appear as a cutout due to impending re-issue in an improved edition (widescreen, digital sound, restored length, etc.). If you subscribe to any of several LD newsletters, magazines (such as ***WIdescreen Review***) and monthly mail-order catalogs, or just check retailer web sites, you can be aware of impending re-issues.

16.7 No bootlegs. Really?

(Well, vanishingly little.) Have you ever bought or rented a tape that turned out to be a 2nd-generation copy, or worse, a low-quality EP or LP recording (when the box said "SP")? Tape piracy is common, and it is also not unusual for dishonest rental customers to duplicate a rental tape, and swap the labels onto to the dub before returning it.

Because LD is a read-only medium, and because there are only a dozen pressing plants world-wide, and fewer (and thus better known) distribution channels, piracy is virtually unheard of. New discs are almost certain to be authentic. There are rumors of bootlegs in Hong Kong, and bootleg "Jurassic Park" LDs were reported in Canada in early 1994, but I have yet to see a boot' in the U.S.

However, there is one scam to watch out for when buying used discs or when renting re-releases. Crooked customers will sometimes rent a new edition/transfer/pressing, and swap the discs for older platters from their own collection. You may end up with a defective pressing of a cropped transfer of the pre-restoration edition of the film - in analog mono instead of digital surround. Always check disc labels, catalog numbers and side counts against the packaging.

16.8 Who manufactures LDs?

There are less than a dozen plants world-wide that can produce LDs. There are differences in the quality of their product, and who made what is often of some interest to collectors. Some plants have unique capabilities, and others have unique handicaps.

It is possible to identify the manufacturer of an LD with some precision, and that topic is covered in another LD FAQ.

17. Should I Get Into LD?

If you don't yet own LD or DVD, what's your next step? DVD is not as compelling an advance over LD, as CD was over LP, and wasn't intended to be. DVD is really aiming at VHS. Home theatre advocates are having to lobby to get DVD to deliver the aspect ratios and other content they now take for granted on LD.

My recommendation is to buy a stand-alone LD or LD-CD combi player. If you want to try DVD, get a stand-alone DVD player. The existing LD-DVD combi players don't represent a substantial savings over separate players, and any DVD or LD_DVD player you buy today is at high risk of not being able to play available DVD audio or DIVX video media a year from now.

17.1. How do I buy a player?

1. Inventory your system and ensure that your TV, monitor or projector can take advantage of the resolution that LD offers. Decide what to do with the audio signals available.
2. Collect some equipment reviews from magazines that have a credible technical staff (like ***WIdescreen Review***). Some reviews may be available on the web.
3. Use the Internet to chase down user reports on specific player models. Using the "power search" (overriding the start date), at http://www.dejanews.com is very useful for this.
4. Decide what feature set you need:
   LD or LD+DVD
   Two-Sided play
   Digital field store (CLV still)
   Optical or coax PCD/DTS output, AC-3 output
5. Decide if a used LD player will meet your needs. Entry-level new players run $300 and up. You can get a used player from $100 and up.
6. Get a copy of a test laserdisc, such as Reference Recordings ***Video Essentials***. Find someone who can let you play with it for an hour or so to learn which test patterns are the most revealing.
7. Develop an estimate for the physical size of the player you will probably get. Decide where you will put it.
   This last item (#7) is two separate issues:

Space. 12-inch media makes it difficult to make a small player, any many are 18 inches deep. Many entertainment center shelves are not deep enough.

Noise. A 12-inch disc spinning at 1800 rpm can entrain a fair amount of air, and requires a motor much more powerful than that of a CD player or VCR. A slightly unbalanced disc can cause audible vibrations.

Generally, if your low-end LD player is 10 feet or more from your seating position, you won't notice it. High-end players tend to be better sound insulated. My mid-range Pioneer CLD-3070 is about 4 feet away, so I placed Sorbothane pucks under the feet and lined the rack opening with Sonex. End of noise.

17.2 Is two-sided play Important?

It is purely a couch-potato matter. Side change takes about 7 to 15 seconds (by hand or automatically). There are no apparent disadvantages to multi-side players.

How it works by the way, it that the disc is spun down at the end of side A and spun up in the other direction. During this time, the laser head is moved from beneath the platter to on top of it.

17.3 Can I upgrade my old LD player?

It depends on what player you have and what feature you want to add. There are after-market suppliers who can add digital audio, but other desirable capabilities (CD, DVD) are economically impossible.

Upgrade Paths

Feature	Path?	Comment
AC-3/DD	Yes	
CLV Still Field	No	An external frame grabber would work, but independent of LD player controls.
CX Decoder	Yes	Only used equipment is available.
CD Audio	No	Major mechanical changes required.
DTS	Yes	Uses PCM upgrade.
DVD	No	A different laser frequency is just the tip of the iceberg.
NTSC on PAL-only or PAL on NTSC-only player.	Perhaps	Many PAL players are actually dual-standard capable, and can be modified. Few NTSC players are.
PCM Audio	Yes	
Two-Side Play	No	Requires mobile laser head assembly.
Y/C (S-Video)	Sort Of	Any number of external devices can perform Y/C separation on a composite video signal.

17.4 Are there no LD recorders?

Recordable laser video technology does exist. There is a write-once “RLV” system that produces LV-compatible CAV discs (no digital sound) for $300 per side and up, but recording must be done at a certified site, apparently because the hardware is large, expensive, complex and sensitive.

Several vendors offer re-recordable video disc cartridges, but the $300-1200 cartridge media can only be used in the associated $30,000 recorder/player. These technologies are being rapidly replaced by hard-disk based video recorders.

65% of American homes have a VCR. The typical LD owner is likely to have both a VCR and an LD. Lack of recording is really a non-issue as the LD product is currently positioned.

18. What is LD’s Future?

The industry is has placed its bets on DVD, and if the uncertainty surrounding DVD (DIVX, audio formats, etc.) can be resolved, DVD will certainly displace LD over time. LD players and discs will continue to be produced as long as the market remains strong enough.

Taking a longer view, DVD fails to address the next major advance in home theatre - HDTV. Even with modest improvements in laser wavelength, the current 5-inch media cannot store an HD signal without seriously degrading the already marginal temporal resolution (and causing obvious compression artifacts). HD on 5-inch media will require substantial advances in laser wavelengths, track/pit geometries, and would likely require multi-layer dual-sided discs. HD is easily accommodated on 12-inch media, using today’s DVD optics and electronics.

Due to the inconvenience of 12-inch media, this may not happen in the consumer market. Indeed, the viability of “HD” in the form of any consumer product is far from certain.

In 90% of homes today, the quality of video could be doubled or tripled by some simple steps and modest investments. The majority of consumers haven’t taken these steps, and are perfectly happy with VHS, which provides an image well short of what NTSC can deliver.

Can we expect people who won’t spend $300 on an LD player to spend $3,000 on an HDTV? It doesn’t add up. High-end home theatre is apt to remain a niche market.

What might happen, however, is that as video projection technology advances, a single 12-inch digital HD disc could replace the stack of 35mm film canisters that must be shipped to theatres today (and spliced into huge reels, re-spliced when they break, and broken down for re-shipment).

If theatrical film exhibition migrates from film to optical disc (which DTS theatrical sound has already done), the 12-inch LD-type format, probably in polycarbonate, would make a suitable medium. If this happens, high-end home theatre enthusiasts will want access to that technology, and LaserDisc may have another life.

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