# THE OPTICAL DISK FAMILY

*The optical disk is one source of audio and video signals. Solidly represented by the LaserVision Disk and the compact disk, the optical disk family has been expanding recently with the advent of CD-V and the CD single. The following 17 Q&As address various aspects of optical disks in general.*

## *What is a videodisk?*

A videodisk is a substrate on which high quality image and audio signals are recorded. An exclusive player is needed to allow reproduction of the signals on the disk. Both image and sound signals can be played back on the screen and speaker(s) of an ordinary TV. To enjoy the replaying of videodisk images and audio in quality, it is recommended that a high-resolution TV linked to Hi-Fi stereo equipment be used.

## *What kind are available?*

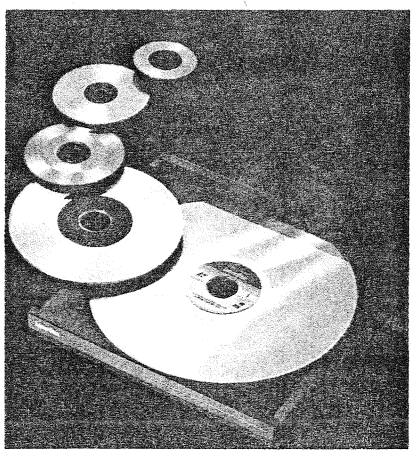
There are two kinds of videodisk systems: The optical system known as, the LaserVision Disk (LVD) uses a laser beam to record signals on a disk and to reproduce them; the electrostatic capacitance system, or the Video High Density System (VHD) is capable of reproducing the signals that have been recorded on a disk with a laser beam, with a stylus. The optical system uses the same recording/reproduction principle as a compact disk, however, the process is generally abbreviated in the CD format. Thus, both the videodisk and the CD belong to the optical disk family.

## *What is an optical disk?*

An optical disk is one on which image or audio signal information is stored using a laser beam. The prerecorded disk, one on which information has been stored, is ready for replay with an optical pickup. According to the user's purpose, there are three variations of disks: The read only memory (ROM) disk intended for replay of prerecorded material; the direct read after write (DRAW) disk that enables the user to write data on the disk only once; and the erasable direct read after draw (E-DRAW) disk that allows repeated recording and erasure of data.

## *Is the optical disk suitable for home use?*

Of the three variations—ROM, DRAW and E-DRAW—of disks, the LVD, most often abbreviated as LD, and the compact CD, two representatives of the ROM disk group, are suited, at present, for home use as audiovideo sources. Replay-only disks other than LD and CD include CD Graphic, CD-ROM and CD-I, but they are destined for professional use. (See Table 1.)



| Variations | Stored information | Major usages |
|---|---|---|
| CD | • Maximum 74-min. digital sound | For music |
| CD graphics | • Maximum 74-min. digital sound and graphic display | For KARAOKE bars |
| CD ROM | • Computer characters, graphic information | • Computer external storage unit<br>• On-line data base (Dictionary, telephone directory, patent information) |
| CD-I | • 2-16 channel digital sound, image/text data | • For educational purpose, presentation through image, music in general, encyclopedia |
| CD V | • 20-min. digital sound, plus, 5-min. digital sound with moving image | • For music, e.g., Video Clip |

Table 1: Available CDs

## What is meant by laserdisk?

The official name for the laserdisk system is LaserVision Videodisk, or LaserVision Disk. Both the system and the disk itself are known as LD. For recording, video and audio signals are frequency modulated to become composite ones. The ready signals activate the laser beam to irradiate the photoresist surface coated on a glass substrate so that pits, exposed portions, are made on it. (Fig. 2) Arrays of pits are recorded on the disk in a spiraling shape, and after the developing process the master disk is ready.

A transparent disk is produced from this master disk through injection molding, while the side with signals or pits is coated with reflective aluminum film and then covered with a plastic film for protection. Then two disks are pasted together with each signal side positioned inside to make one commercial LD. (Fig. 1) An LD thus produced, in which the pit arrays subtlely reflect light, reflects light in spectrum (rainbow) colors. The signals recorded on an LD with a laser beam are read by a laser pickup to be reproduced as images and sound. The player capable of reproducing the signals registered on an LD is called an LD player or LDP.

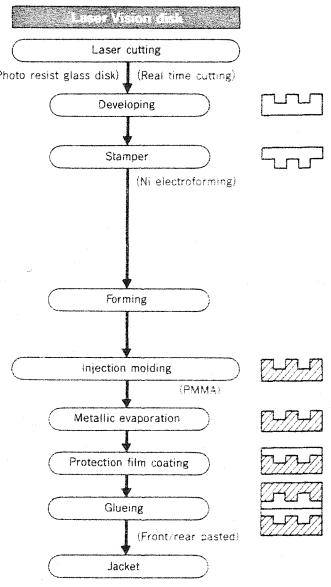



Fig. 1: Manufacturing processes of Laser Vision Disk

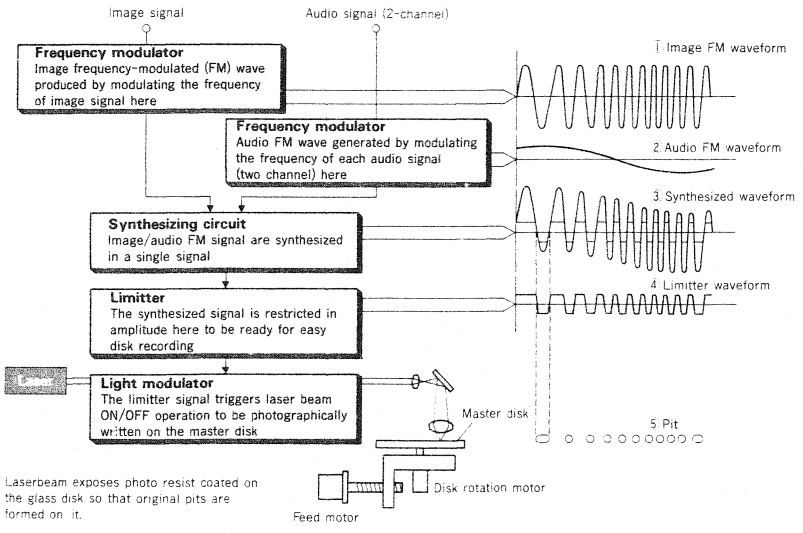



Fig. 2: Laser Vision recording process

## In what frequency are the LD's audio/video signals recorded?

In recording audio/video signals, frequency-modulated NTSC system TV signals are used. The frequency spectrum of the recorded signals is designated as shown in Fig. 3. An LD allows two kinds of audio signal recording: two channel analog and digital. The disk with digitally recorded sound is known as a Laser Digital Disk (LDD).

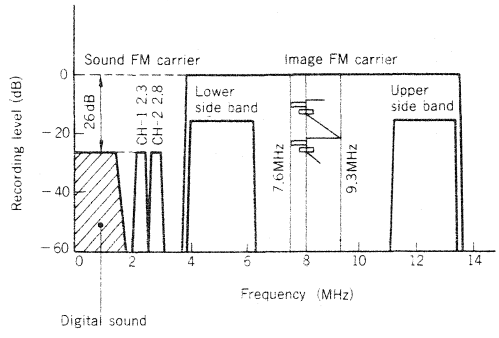



Fig. 3: Recording spectrum of Laser Vision

## What LD variations are available?

There are two LD variations: Constant Angular Velocity (CAV) and Constant Linear Velocity (CLV) disks. The former is a standard disk allowing 30 minutes of recording on one side, or one hour on both sides. The latter is an extended version that allows 60 minutes of recording on one side and two hours on both sides. (Fig. 4)

A CAV disk rotates at a fixed speed of 1,800rpm, and one video-image frame is recorded on one track. Each frame is given a number and there are chapter numbers for easier retrieval. Rotational speed of a CLV disk automatically varies to allow extended recording, two times as much as a CAV disk. In other words, one frame is recorded in one track at 1,800rpm in the innermost portion of the disk, while at the outermost portion, the speed is slower, about 600rpm, which enables storing of three frames per track. Differing from CAV, the CLV disk has no recording frame number index, but chapter and time-passing numbers are recorded

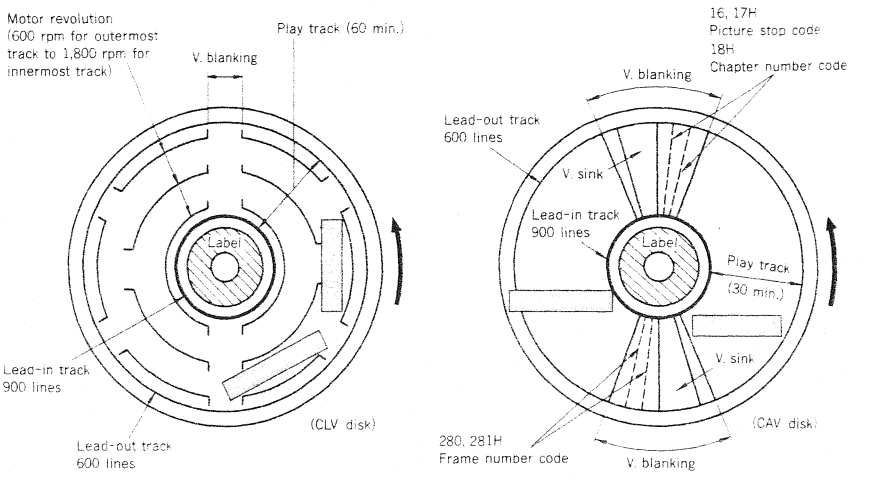



Fig. 4: CAV and CLV disk

in hours, minutes and seconds. Both CAV and CLV disks are available either in 30 or 20cm diameters, and CAV and CLV disks with 20cm diameters respectively offer 13 and 20 minutes of replay per side. The 20cm disk is sometimes referred to as an LD single.

## *What purpose do the LD chapter and frame number codes serve?*

The inscription of these codes allows random access retrieval or a quick search for a picture the user wants to see. One of the most outstanding features of LD is the random access funciton. In case of a CLV disk, where no chapter or frame number codes exist, a picture can be retrieved using the prerecorded time code. Programmed replay is also available by setting the desired order of viewing by employing the various codes.

## *What are the major characteristics of LD?*

Pits on the signal side are protected from dust and scratches with an acrylic film. Further, since the pickup is not in direct contact with the disk surface, the chance of abrasion is eliminated. Thus, it is safe to say that the life of a disk is much longer than other recording media. Disks have semi-permanent lives.

The laser pickup used to read signals has a life span of approximately 7,000 hours. For instance, with daily use of two hours, the pickup will last about 10 years. Unlike a videocassette recorder, compression of brightness signals and coversion of color signals to a lower range are not utilized in LD. But, since NTSC signals are recorded without modification, LD assures better resolution and higher quality image reproduction than VCR format. An LD has the same digital sound quality as a CD. As LDs, CDs and CD-Vs use the identical recording/replay principle, players that replay all three kinds of disks are already on the market. A no-contact, optical pickup system is employed. It guarantees quick random access replay by searching for a required image frame, and such special play as still image, frame-by-frame advance, slow and extended speed replay are available. (Table 3)

## *What is a CD?*

While the videodisk stores both image and sound, the CD only stores sound signals. A maximum digital audio recording of 74 minutes 42 seconds is available on one side of a 12cm-diameter disk. (Fig. 5) As in LD, CD signals are recorded in the form of pits starting from the inner circle and spiraling out in a clockwise direction. Digital sound is recorded

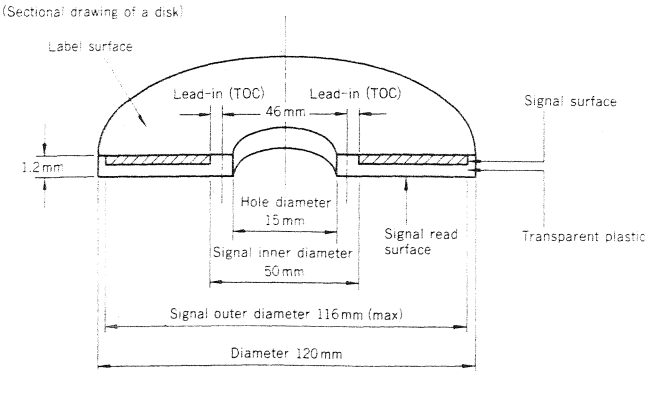



Fig. 5: Sectional drawing of CD

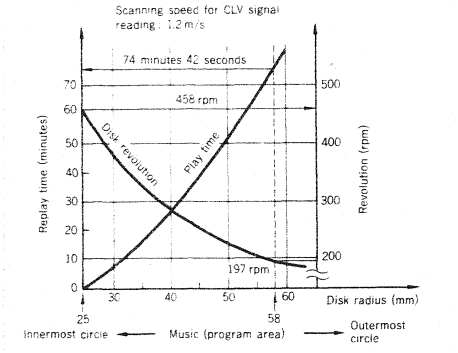



Table 2: Radius of CD, and playtime, revolution

| | Standard disk (CAV) | Extended replay disk (CLV) |
|---|---|---|
| **Playback time** | Single side 30 min. (both 60 min.) | Single side 60 min. (both 120 min.) |
| **Revolution** | 1,800rpm (fixed) | 1,800rpm–600rpm |
| **Basic function** | | |
| **Play** | ○ | ○ |
| **Pause** | ○ | ○ |
| **Fast replay (Advance/reverse)** | ○ | ○ |
| **Sound (1/L · 2/R)** | ○ | ○ |
| **Special effect play** | | |
| **3X extended (Advance/reverse)** | ○ | *** — |
| **Slow (Advance/reverse)** | ○ | *** — |
| **Still (Advance/reverse)** | ○ | *** — |
| **Frame advance (Advance/reverse)** | ○ | *** — |
| **Random access** | | |
| **Frame number search** | ○ | — |
| **** Chapter number search** | ○ | *** ○ |
| **Frame number indication** | ○ | — |
| **Chapter number indication** | ○ | ○ |
| **Time lapse indication** | — | ○ |
| *** Picture stop** | ○ | — |
| **** Chapter stop** | ○ | ○ |
| **Service life of pickup** | Approx. 10,000 hrs. | |
| **Disk** | | |
| **Life** | Semi-permanent | |
| **Handling** | Protective case not required | |
| **Sound** | | |
| **Frequency** | 20Hz–20kHz (analog), 4Hz–20kHz (±0.5dB digital) | |
| **S/N** | 70dB (when analog CX ON), 96dB (digital) | |
| **Image** | | |
| **Horizontal** | 420 line | |
| **S/N** | 48 dB | |

(Notes)
* When using a disk with inscription of picture stop code
** When using a disk containing chapter number
*** Possible with a player incorporating a digital memory. This type of digital memory player also allows such functions as still & sound, strobe motion, noiseless scan, and picture memory search.
(Note) Audio/video technical data complies with the standard specifications of player unit.

Table 3: LaserVision function/performance

in terms of the different pit lengths and intervals. When a CD is placed in a CD player for replay, the pits are read with a laser pickup in codes of 1 and 0, which are converted to reproducible signals. The player adopts a CLV system, that is, the disk rotation speed automatically varies from the inner through the outer circle or track. Similarly, as in LD, the pit engraving (recording) on a CD is made from the inside circle out: the same direction is applied in replay. In a CD, the disk index, called the Table of Contents (TOC), is registered in the lead-in portion of the innermost circle. When the CD player reads and stores this index for programming purpose, it enables immediate replay of the desired portion or display of the total number of tunes included or each recording time. The TOC index includes in it the time code (minutes, seconds and frame number) registered at the beginning of each selection, the total number of selections contained on the CD and the time code to indicate the end of a selection.

## *How are CDs manufactured?*

The CD manufacturing process is very similar to that of the LD, illustrated in a flow chart in Fig. 2, but as recording is available on one side in a CD, the pasting together of two disks is unneccessary.

## *What signals other than audio are recorded on a CD?*

Besides the essential music signals, a CD has room to store the TOC and 8-bit subcode, sometimes called the user's bit—P, Q, R, S, T, U, V and W channels. (Fig. 6) In currently released CDs, the information to discriminate the existence of music, or the pause be-

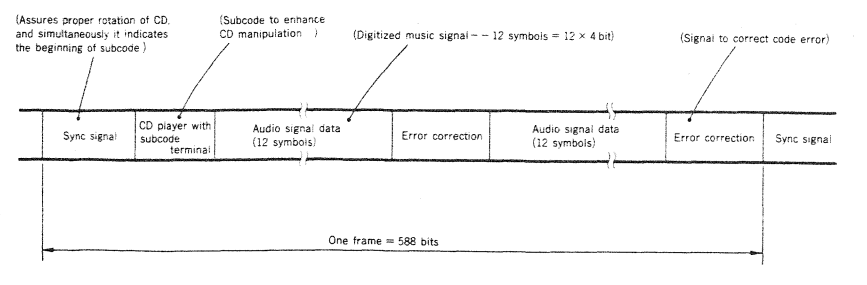
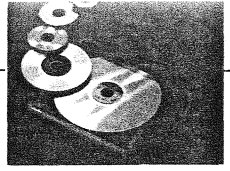



Fig. 6: Fundamental configuration of CD signal



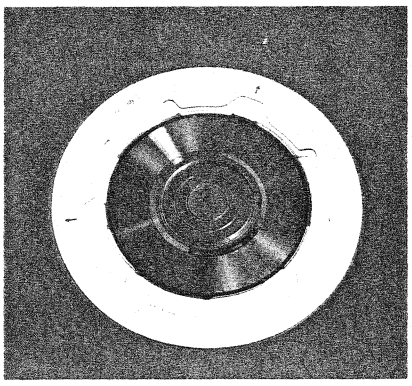
tween two successive selections and in the midst of a selection, and music/track/index numbers are registered in the P channel. These inserted codes enable the random access function. In addition, the Q channel area includes such information as time code, identification codes for mono/stereo and four channels, a signal to discriminate the existence of pre-emphasis and the manufacturing number of the disk. In a CD player, various controls and display of elapsed time, remaining time and selection number are made using the information contained in the Q channel and the TOC.

## *What signifies a CD graphic?*

With a disk in which the signals for graphic control are registered in the R to W channels (6-bit area) of the user's bit, pictures and characters can be displayed on a screen. In graphic rendition, there are two modes—TV graphic and line graphic. The TV graphic allows display of the image(s)/character(s) having 288 × 192 pixels (dot number of one font 6 × 12, number of color sections 48 × 16, and 16 colors freely selectable among available 4,096 colors). Meanwhile, line graphic exhibits character information. One CD can store 2,000 frames of TV graphic color image. One frame can be reproduced as a still image for 2.5 seconds. Possible CD graphic applications will offer display of a word or comment on the selection through characters, such as in karaoke, a sing-along music program system. On-screen indication of musical notes and visual presentation of associated illustrations or landscapes will be included . CD graphic karaoke is commercially available. These disks first display the title and relevant illustrations of a karaoke selection and the printed lyrics change color as the melody moves on. This system cues the singer.

## *Is a CD graphic applicable to any kind of play?*

To replay a CD graphic, it is necessary to prepare a CD player with a subcode terminal for picking up the subcode signal. A CD graphic decoder demodulates the signals received from the subcode terminal of a CD player and outputs them in video signal form. When these signals are input to the relevant terminal of a TV set, characters or still images can be reproduced on the screen. (Fig. 7)



CD Single Adaptor

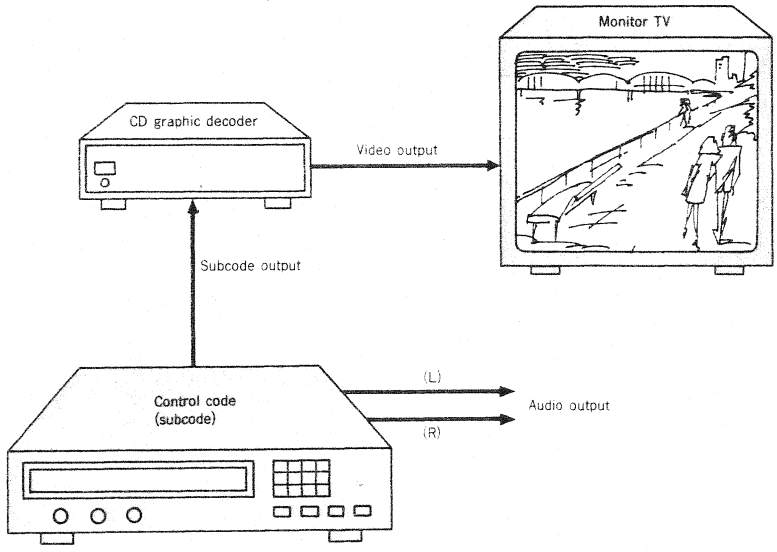



Fig. 7: CD Graphics

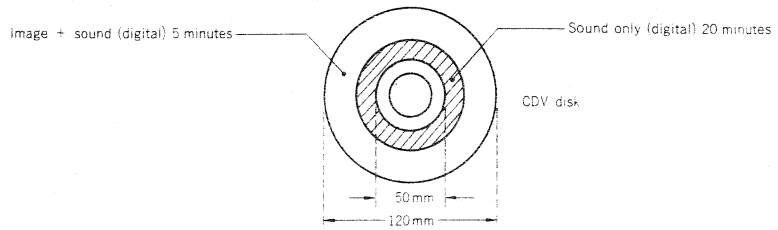
## *What is a CD single?*

A CD single is a smaller version of a CD. It is 8cm in diameter, and its maximum recording time is 10 minutes, about two selections. In Japan, one CD single contains two tunes. There are from 200 to 300 CD singles out at present in Japan. When replaying a CD single with older model CD players, it is necessary to place an adapter on the center spindle as shown in the accompanying photo. Some players, however, are not compatible with CD single reproduction even with an adapter. It depends on the maker and model. Generally speaking, the disk tray of players produced as of this year are designed to accommodate replaying singles.

## *What is CD-V?*

CD-V (compact disk video) is a disk in which the inner portion of a 12cm CD, corresponding to 20 minutes, has digital audio registration and the final outermost five-minute section stores video image information together with digital sound. A CD-V disk is golden while a regular CD is silver. (Fig. 8) The CD-V audio quality is equal to that of a CD. The marketing of CD-Vs is expected to center around music videos, thanks to the disk's capability of displaying five minutes of moving images. In Japan at present, one disk includes four to five selections, one of which accompanies a moving image. Seventy to 80 CD-V titles are out.

They cost ¥2,400 or so per disk. A player equipped with a demodulation function for digital audio and video images is required to allow CD-V reproduction. This necessity can easily be eliminated, however, when employing a CD/CD-V/LD compatible player. A dual-purpose, CD/CD-V player has also been released, although the available number of these units is limited.




| | | LD | | CD-V | CD |
|---|---|---|---|---|---|
| | | CAV (standard disk) | CLV (extended replay disk) | | |
| Disk shape/material | | 30cm or 20cm both-side disk; acryl (PMMA resin) | 30cm or 20cm both-side disk; acryl (PMMA resin) | 12cm single disk; polycarbonate | 12cm single disk; polycarbonate |
| Sound exclusive (maximum) | | None | None | 20 min. (digital) | 74 min. (digital) |
| Image + sound (maximum) | | Single 30 min. (30cm) | Single 60 min. (30cm) | 5 min. | None |
| Sound | Digital | ○ | ○ | ○ | |
| | Analog | ○ | ○ | × | |
| Disk revolution | | 1,800rpm | 1,800 to 600rpm | Sound portion 500 to 330rpm<br>Sound + image 2,700 to 1,800rpm | 500 to 200rpm |
| Linear speed (meter/s) | | Fixed speed rotation | 10.4 to 11.4 | Sound portion 1.2 to 1.4<br>Sound + image 11 to 12 | 1.25 |

Fig. 8: CD/CDV/LV comparison

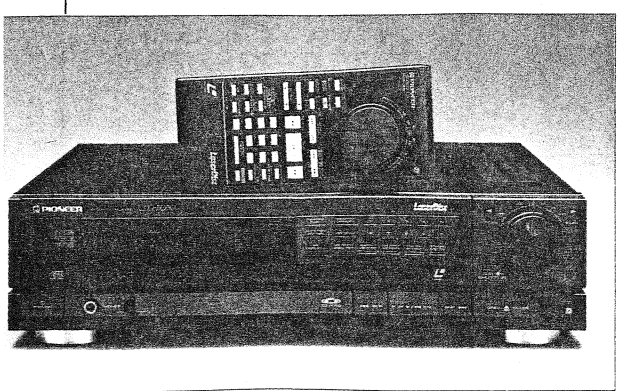
## *What are the major differences among LD, CD and CD-V?*

All three belong to the optical disk family, (Fig. 9), however, LD has two variations according to the difference of the disk diamter: a 30cm disk on which moving pictures and sound (both analog and digital or analog only) are recorded and a 20cm disk popularly called an LD single. Sound and image are replayed with an LD player.

CD is an audio-only disk on which sound is digitally recorded. It also has two variations: a 12cm disk and an 8cm CD single. A CD player enables audio signal reproduction from the disk.

CD-V is a disk that stores 20 minutes of digital sound and combined five minutes of digital sound/moving image signals. For CD-V replay, a dual purpose CD/CD-V or a triple purpose CD/CDV/LD player is needed. There are two kinds of CD VIDEO also available—30 and 20cm diameters—which are LDs with subcode inscriptions. (Fig. 9)

All these disks are members of the optical disk family, so their fundamental principle of recording and reproduction is identical. This is why a single player is able to replay all three disks: CD, CD-V and LD. The logo marks shown in Fig. 9 are attached somewhere on three-in-one players to clearly indicate replay capability.



Pioneer's CLD-3030 CD, CDV, LD player

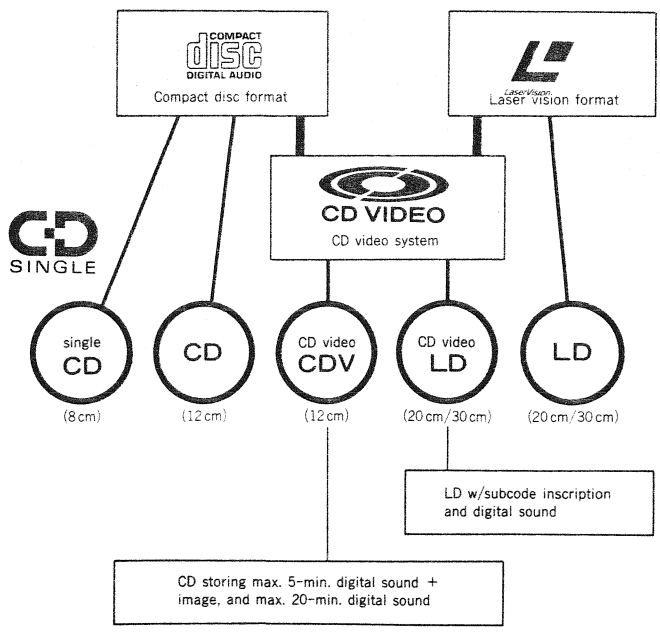



Fig. 9: Optical Disk Family