CHAPTER : 2. CD Player
Marks: 12 Marks.

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2.3 Component used for CD mechanism: CD pickup assembly, gear system, drive motors, CD lens.
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**Introduction:**

The CD player first appeared in the market in 1982. It plays the CD at the correct speed and accurately converts digital data of the CD back into the analogue form by means of a reflected laser beam. The laser beam is used to reproduce the signals recorded on the disk surface. A number of servo systems are used to focus, track, and rotate the disk. The CD player operates in a specific order, with the sequence of operations controlled by a system built around integrated circuits (ICs).

**Construction of a Compact Disc (CD):**

![Figure: Construction of CD](image1)

**Materials used for CD construction:**

![Figure: Construction of CD](image2)

Notes By-- Mr. Tejas Shah
CD consists of four layers:

- A basic layer made of a Polycarbonate plastic.
- A thin layer of Aluminum coating over the plastic layer.
- An Acrylic Sheet to protect the aluminum coating.
- A label to write information of the CD.

Advantages of Compact Disc (CD) over Cassette:

CD makes use of digital storage technique & hence all the advantages of digital storage are applicable to CD.

1. When information is stored in the digital format, the problem of signal loss or disturbance in the signal is completely eliminated.
2. On CD the left & right channel information are stored separately one after another in fixed time interval.
3. Cross talk is eliminated between two channels & provides a real stereo output.
4. The capacity of storage on CD is high.
5. Available in small size.
6. Cost is less.

2.2 Block Diagram of CD player:

CLV: The CD player is also known as CLV or constant linear velocity system. In a CLV device such as the CD player the rotational speed of disc player is adjusted with movement of reading mechanism on the disc surface. This speed is changed to
maintain constant linear velocity i.e. the signal on the disc surface always moves at constant speed of 1.3 m per second under the pick-up head.

**Half-Full Memory:** This half-full memory circuit makes the disc to maintain a constant linear velocity when the reading mechanism moves from outer tracks of disc to inner tracks or from inner tracks to outer tracks on disc surface.

**Decoding CD:** During the decoding, the digital data on the disc surface is read by the decoding circuit and is converted into the analog and that signals are required to drive the speakers and regenerate the stored music.

**Optical pick-up:** the signal stored on the CD surface as pits and flat areas are first picked up by the optical pickup made of lens assembly, prism, photodetectors and laser diodes assembly in the optical pickup unit.

**High frequency amplifier:** The signal is very weak so it is amplified by a high frequency RF amplifier circuit to bring signal to a proper level. This amplified and filtered high-frequency signal contains audio signal as well as synchronization signal in 14-bit EFM (eight to fourteen modulation) format, this signal is sent to an EFM demodulator circuit.
**Figure: Block diagram of CD player**

**EFM Demodulator:** The EFM modulator separates the modulated data and the timing signal from the signal received at its input. It also removes the additional coupling bits and converts the 14-bit EFM symbol to actual 8-bit data. The amplified and filtered EFM signal from high frequency amplifier is also given to clock generation circuit to synchronize detecting and timing circuit. These circuits are used to recover the bit clock and sync pattern data. The timing separated by this system is used to provide timing signal to the system.

**ERCO Circuit:** Demodulated data from EFM demodulator is send to error correction (ERCO) circuit. The demodulated data signals also send to control and display decoding circuit, which recovers the control and display signals which are further multiplexed into signals received from CD. The ERCO circuit mainly used for the error
correction & detection. The ERCO circuit will communicate with servo microprocessor to reduce the error generated during CD scanning.

**Interpolation and muting:** The ERCO circuit is used for error detection and correction purpose. Any error found in the incoming data signal is sent to interpolation and muting section by the ERCO circuit. The interpolation and muting section uses the following methods to correct error found in data stream read from the disc.

- ✔ Muting
- ✔ Last word held
- ✔ Linear Interpolation

1. **Muting:** In muting, when error is detected in the data stream, the player will mute the sound. The sound is not to send speaker. This prevents the undesirable sound to go to the speaker output.

2. **Previous word held:**

   The missing data in a sound stream is filled with the data from the previous word in the stream.

3. **Linear interpolation:** In this technique the value of the word before & after ERROR is taken & average of that value is considered as the value of ERROR bit.

**CLV using the Clock Signal:** The ERCO also responsible for maintaining constant linear velocity of CD rotation motor. For this, the TRCO circuit compare the clock signal derived from the incoming data with reference clock frequency.
De-interleaving: Signals from the ERCO contain audio signal in the interleaved format. Before doing any further operation on this signal, it must be interleaved. The signal is then de-interleaved in the interpolation and muting section to restore the original sequence of information.

Digital Filter and De-multiplexer: The de-interleaved and regenerated is then send to digital filter and de-multiplexer, where it is filtered and separated into left and right channel data. This circuit removes any effect of sampling frequency from the data signal, which would appear as interference in the form of aliasing noise in analog signal.

Oversampling: During digital filtering oversampling method is used to remove both problems of aliasing noise and quantization error.

D/A convertor: The output from digital filter and de-multiplexer circuit is send to D/A convertors. The right and left channels are processed by different D/A convertors. These convertors convert the 16-bit digital signal into the original analog audio signal. Because of the over-sampling, done in the digital filter and de-multiplexer circuit, simple low-pass filter is used. Following the D/A process.

Stereo Amplifier: The analog output from converter is passed through a sample & hold circuit & a LPF circuit to obtain a smooth noise-free output at the speakers. These signals are next fed to a stereo audio amplifier to raise left & right audio channel signal.
2.3 Detection used in CD player:

![Diagram of CD player detection system]

**Laser Diode:** The laser, an acronym for light amplification by stimulated emission of radiation, is a special light source that produces a concentrated light beam. The laser beam is used to reproduce the signals recorded on the disk surface. A laser beam produced by solid state laser of semiconductor aluminum gallium arsenide is made incident on the CD through a half silvered mirror.

**Reflected Beam:** The reflected beam is reflected from the aluminum flat surface represents digit 1. There is only a little reflection from a pit and it represents 0. Thus the returning laser beam is the replica of the original laser beam modulated by binary digit of audio signal.

**Optical mirror and lens system:** The mirror allows beam to pass through itself but does not allow the returning beam to pass. The lens system allows the beam to confine on a proper track for detection purpose. Lenses used are collimated lenses, concave lenses and objective lenses.

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**Photodiode Detector:** The binary digit is represented when this ON-OFF reflected light falls on a photosensitive diode. The diode converts the light into electrical signal which corresponds to digital data.

**Digital audio to DAC circuit:** The digital output of a diode is processed and converted in to original analog signal by using DAC.

**Control:** A clock signal is obtained from the disc itself. It is compared with the crystal oscillator signal any discrepancy results in generation of a correction signal which is applied to a servo system.

**Servo System:** This system issues command such as motor speed correction, track correction and focus correction. In case only error signal received from control block.

**Servo System:**

**The servo system.** The CD player consists of a set of servo systems that make the laser beam accurately focus on the surface of the CD and track across the fine surface of the CD, when the CD is made to rotate at a correct speed. Motors perform simple mechanical operations to drive the CD, optical assembly, and the loading and unloading system. A pair of coils makes the lens within the optical assembly to move vertically and laterally.

Most CD players have four individual servo systems, namely,

- The focus,
- Tracking,
- Carriage, and
- Spindle servos.

CD players with radial optical assembly have only three servo systems, namely,
✓ The focus,
✓ Radial, and
✓ Spindle servos.

**Focus servo.** Focus servo makes the laser beam to focus on the playing surface of the CD by vertical movement of the objective lens. The photodiode array provides the initial focus information along with an amplifier and a control system.

**Tracking servo.** Tracking servo keeps the laser beam to track gradually across the CD playing surface area by sideways movement of the objective lens.

**Carriage servo.** Carriage servo makes the optical assembly to move when the objective lens reaches the surface limits of its operation. This servo works along with the tracking servo.

**Radial servo.** Radial servo with the radial optical assembly does the functions of tracking and carriage servos. In the radial servo assembly the complete optical assembly is moved minutely (in fractions of a micrometer) to keep the objective lens on the proper track.

**Spindle or disk motor servo.** The spindle or disk motor rotates the CD at the correct speed (180-500 rpm). The data reproduced from the CD is compared with an internal reference circuit within the CD player to produce a control voltage. This voltage drives the disk motor accurately. The rotation speed of the CD is around 500 rpm at the center, which slows down to around 180 rpm at the outer edge of the CD.
**Optical Pickup Unit:**

The pick-up assemble consist of –

- ✓ A low power laser diode to illuminate the CD tracks.
- ✓ Lens and prism arrangement to direct the laser beam to the CD surface and to direct the reflected laser beam towards photodiode array.
- ✓ A photodiode array to obtain data, focus and tracking signal from the reflected laser beam.
- ✓ Focus and tracking coils to focus the beam to the CD surface and to move the assembly to proper track across the disc surface.
- ✓ Some optical units do not contain the tracking coil, for example, the single-beam radial tracking assembly, this is explained in latter sections.

![Diagram](image-url)

*Figure: Optical pickup assembly*
Optical arrangement in a single-beam radial tracking pick-up assembly:

- In the optical pickup unit, the laser diode emits laser beam from a small point into an elliptical or conical distribution. This beam is passed through various prism and lens to form a very small diameter light beam on the disc surface at the center of the track.

- The objective lens is controlled by the tracking and focusing coil to keep the beam focused on the CD and to keep the condensed beam at the center of the track.

- This laser beam is reflected back by the flat area and the pits on the disc surface. This reflected beam is applied to a group of photodiodes through objectives lens, collimator lens and some prism arrangement.

- These photodiodes induce voltage according to the reflected beam falling on it. Focus error and tracking error voltage generated by this photodiode array is applied to the tracking and focusing coil to control the objective lens and data signal generated by this photodiode array is sent to an amplifier to amplify the data signals picked-up from the disc. Finally, the output from the amplifier is processed to produce the audio signal stored on the disc surface.

In a CD player the following type of optical assemblies are used:

- Single-beam radial tracking
- Single-beam linear/straight line tracking
- Three-beam linear/straight line tracking.

Lenses used in CD player:

- In case of optical pick up assemble in CD the laser beam is emitted by laser diode for purpose of detection. The lens and prism arrangement is used to direct the laser beam to the CD surface and to direct the reflected laser beam towards photodiode array.
If the lens systems are not used then the laser beam may scatter in other direction and hence proper detection will not take place.

- **Collimation lens**
- **Concave lens**
- **Objective lens**
- **Cylindrical lens**

**Collimation lens:**
- The collimator lens is used to produce completely parallel beams of laser. This lens together with the objective lens is used to focus the laser beam to the disc surface.

**Concave lens:**
- In single-beam linear optical block assembly this concave lens is used to concentrate the laser beam, reflected from the disc surface, onto the photodiode array. This lens is mainly used to improve the sensitivity of the photodiode array.

**Objective lens:**
- Before hitting the disc surface, the laser beam comes out of the pickup assembly through an objective lens. The objective lens is used to focus laser beam onto the CD surface and to receive the reflected laser beam.
- This lens is moved up/down to achieve the focus of the laser beam on the disc face. The objective lens is always kept in focus using a system similar to the voice system used in the audio speakers.
- It is also moved horizontally in the linear pickup assembly to keep the laser in proper track. In players that used the radial tracking method the objective is unit does not move horizontally (laterally).
**Cylindrical lens (in Three-Beam Linear Optical Blocks):**

![Diagram of Cylindrical Lens and Optical Blocks](image)

**Figure: Lens**

- The main action of this lens is to enable the reflected beam from the CD to assist in creating the necessary signal to make sure that focus of the laser beam on the playing surface the disc is maintained.
- As shown in the fig. when the beam is correctly focused a circular beam of light will land on the four photodiode elements. If the beam becomes out of focus the cylindrical lens will distort the beam elliptically.
- As shown in the fig. the distortion depends upon the direction of mis-focus. This distortion is known as astigmatism.

**Motors used in CD player:**

- The drive motors in CD players are used for various purposes such as for loading and unloading CD from tray, for rotating CD, for rotating laser beam etc. The motor circuit consists of transistor or IC components within the drive components are controlled by a PLL and servo processor.

**Different types of motors used in CD players are:**

- Tray loading or carriage motor,
✓ Slide sled feed motor and
✓ Spindle, disc, turn table motor.

- There are three basic motors used in the CD player. CD players with auto CD changer or the table top changer may have up to five different motors or some portable or combination CD and cassette player may have only two motors but three motors used in CD players are most common.
- The **tray or loading motor** moves the CD tray in and out for loading and unloading the CD when the open/close switch is pressed.
- A **disc, spindle or turntable motor** rotates the CD at a variable speed. The disc motor rotates faster at the beginning and slows down as the laser assembly moves toward the outer edge of the CD.
- The **slide, feed or sled motor** moves the optical pickup unit from the center to the outer edge of the disc on sliding rods. Some players have a pick-up motor that travels in a radial or semicircle fashion.

### 2.4 Function of front panel controls:

**Stop / Clear:**

**Program:**

**FF / FR:**

**Repeat:**

**Power:**

**Open / Close:**
2.5 Function of remote control transmitter and receiver unit used in CD player:

Transmitter:

Play:

Reset:

Manual Search Keys:

Automatic Music Search Keys:

Repeat Program Button:

Clear:

Music select:

Random:
Receiver:

Top Load player:

On/ Off:

Play:

Next:

Pause:

Stop:

Repeat:

Rev/ Fwd:

Select:

Store:

Cancel:

Open/ Close:
2.6 Advantageous of Vacuum fluorescent.

1. Emits a very bright light with clear contrast.
2. Easily support display elements of various colors.
3. The light produced by most VFDs contain many colors and can often be filtered to produce a more pure Colour such as deep green or deep blue.
5. Easily configured to display a wide variety of customized messages.
6. Most VFD's continue to function normally in subzero temperatures making them ideal for outdoor devices in cold climates.
7. In addition to ten numerals, the display can be used to show letters including punctuation.
8. It gives hexadecimal encoding for display the digits 0 to F.
9. To remove the ambiguity letter “B” is small “b” and number “8” is in 7 segment display, otherwise both would have looked same.
10. It can give short message giving status information in CD player like “no disc” or “error” etc.
11. The fluorescent numbers and messages can be seen in the dark also.