UNIT I

LOUDSPEAKERS AND MICROPHONES

Loudspeakers and Microphones
Crystal Loudspeaker, Dynamic Loudspeaker, Electrostatic loudspeaker, Permanent Magnet Loudspeaker, Woofers and Tweeters - Microphone Characteristics, Crystal Microphone, Carbon Microphones, Dynamic Microphones and Wireless Microphones.

1.1 LOUDSPEAKERS

- A loudspeaker is a transducer which converts electrical signals of audio frequency into sound waves of the same frequency. It is also called as output transducer or reverse transducer.
- A loud speaker's performance is determined by the following characteristics:

1.2 CHARACTERISTICS

Efficiency:

- It is defined as the ratio of output sound power to the input audio (electrical power).
- Its value depends on proper matching of the mechanical impedance with acoustical impedance of the air volume being disturbed. (Some manufacturers quote the efficiency in terms of sensitivity which is defined to be the input signal required to give a sound pressure level of 0.1 Pa or 1 microbar at a distance of 1 metre from the loudspeaker.)

Noise:

- The unwanted sound, not contained in the input signal but present in the output of a loudspeaker is called noise produced by the loudspeaker (the mechanical parts may vibrate at some resonant frequency, causing noise).
- Signal-to-noise ratio or SNR of the system which is de- fined as ratio of signal output' to the `output of noise in the absence of signal'.

Frequency Response:

- It indicates the loudspeaker's response for the audible frequency range of sound. Ideally, the response of a loudspeaker should be flat within ± 1 dB for the frequency range of 16 Hz to 20 kHz.

- The mass of the diaphragm assembly have high frequencies which are attenuated; and due to series compliance, low frequencies are attenuated. Moreover, the movable system may have some natural resonant frequency within the audible range and the output at that frequency will be emphasized.

Distortion:

- Any change in frequency, phase and amplitude complexion of the output sound as compared to the input audio signal is called distortion.

- Frequency and phase distortions may result due to mass and compliance effect. Amplitude or non-linear distortion will result due to non-uniformity in the magnetic field in which the coil moves.

Directivity:

- It is the ratio of actual sound intensity at a point (in the direction of maximum intensity) to the sound intensity that would have been available there, had the loudspeaker been omnidirectional.

Power :

- It is the maximum audio power (indicated in watts) for which it is designed. Power more than the maximum will damage the speaker.

Impedance :

- The input impedance of the loudspeaker is represented in ohms and is an important parameter, as its matching with the impedance of source amplifier is necessary for the optimum efficiency.

1.3 CRYSTAL LOUDSPEAKER

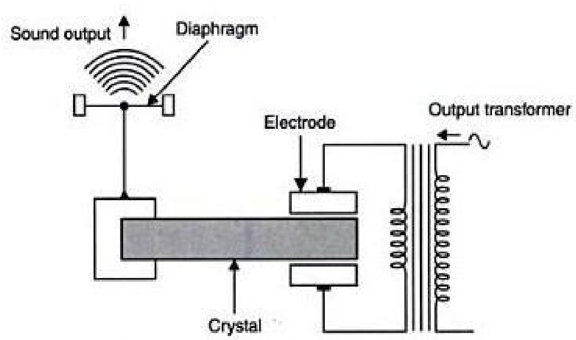


Fig 1.1 Crystal type speakers

- Rochelle-salt crystals have the property of becoming physically distorted when a voltage is applied across two of their surfaces.
- This property is the basis of the crystal type of speaker driver.
- The crystal is clamped between two electrodes across which the audio frequency output voltage is applied.
- The crystal is also mechanically connected to a diaphragm. The deformations of the crystal caused by the audio frequency signal across the electrodes cause the diaphragm to vibrate and thus to produce sound output.
- Crystal speakers have been impractical for reproduction of the full audio-frequency range because the input impedance is almost completely capacitive. Thus it is difficult to couple Power into them.
- At high audio frequencies, the reactance becomes lower and the relative amount of power smaller.
- In the base range, stresses on the crystals are very great, and the crystals have been known to crack under stresses.

1.4 DYNAMIC LOUDSPEAKER

- To provide very strong magnetic field for high wattage speakers, an electromagnet is used instead of a permanent magnet. . Its construction is shown in Fig. 1.2.

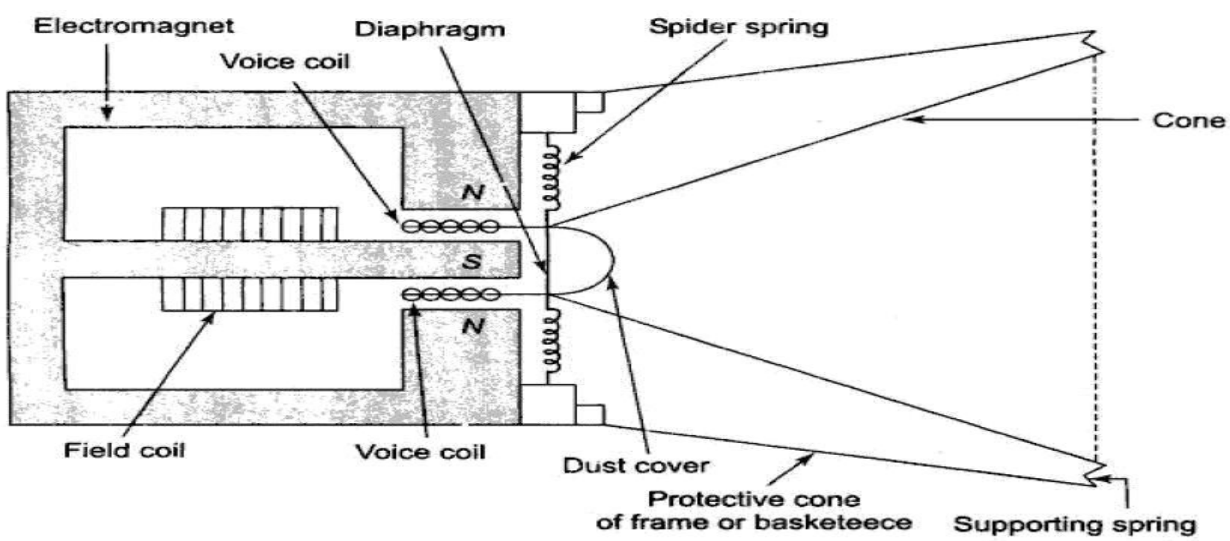


Fig. 1.2 Dynamic Loudspeaker

UNIT-II

TELEVISION STANDARDS AND SYSTEMS

Television Standards and systems: Components of a TV system – interlacing – composite videosignal. Colour TV – Luminance and Chrominancesignal;Monochrome and Colour Picture Tubes – Colour TV systems–NTSC, PAL, SECAM- Components of a Remote Control and TV camera tubes, HDTV, LED and LCD TVs, DTH TV.

2.1 COMPONENTS OF A TV SYSTEM:

- The fundamental aim of a television system is to extend the sense of sight beyond its natural limits, along with the sound associated with the scene being televised.
- Essentially then, a TV system is an extension of the science of radio communication with the additional complexity that besides sound the picture details are also to be transmitted.
- In most television systems, as also in the C.C.I.R. 625 line monochrome system adopted by India, the picture signal is amplitude modulated and sound signal frequency modulated before transmission.
- The carrier frequencies are suitably spaced and the modulated outputs radiated through a common antenna.
- Thus each broadcasting station can have its own carrier frequency and the receiver can then be tuned to select any desired station.
- Fig 2.1 and Fig 2.2 shows a simplified block representation of a TV transmitter and receiver.

2.1.1 PICTURE TRANSMISSION:

- The picture information is optical in character and may be thought of as an assemblage of a large number of bright and dark areas representing picture details.
- These elementary areas into which the picture details may be broken up are known as 'picture elements', which when viewed together, represent the visual information of the scene.
- Thus the problem of picture transmission is fundamentally much more complex, because, at any instant there are almost an infinite number of pieces of information, existing simultaneously, each representing the level of brightness of the scene to the reproduced.

- In other words the information is a function of two variables, time and space. Ideally then, it would need an infinite number of channels to transmit optical information corresponding to all the picture elements simultaneously.
- Presently the practical difficulties of transmitting all the information simultaneously and decoding it at the receiving end seem insurmountable and so a method known as scanning is used instead.
- The conversion of optical information to electrical form and its transmission are carried out element by element, one at a time and in a sequential manner to cover the entire scene which is to be televised.
- Scanning of the elements is done at a very fast rate and this process is repeated a large number of times per second to create an illusion of simultaneous pick-up and transmission of picture details.
- A TV camera, the heart of which is a camera tube, is used to convert the optical information into a corresponding electrical signal, the amplitude of which varies in accordance with the variations of brightness.
- Fig.2.1 shows the elementary details of one type of camera tube to illustrate this principle. An optical image of the scene to be transmitted is focused by a lens assembly on the rectangular glass face-plate of the camera tube.

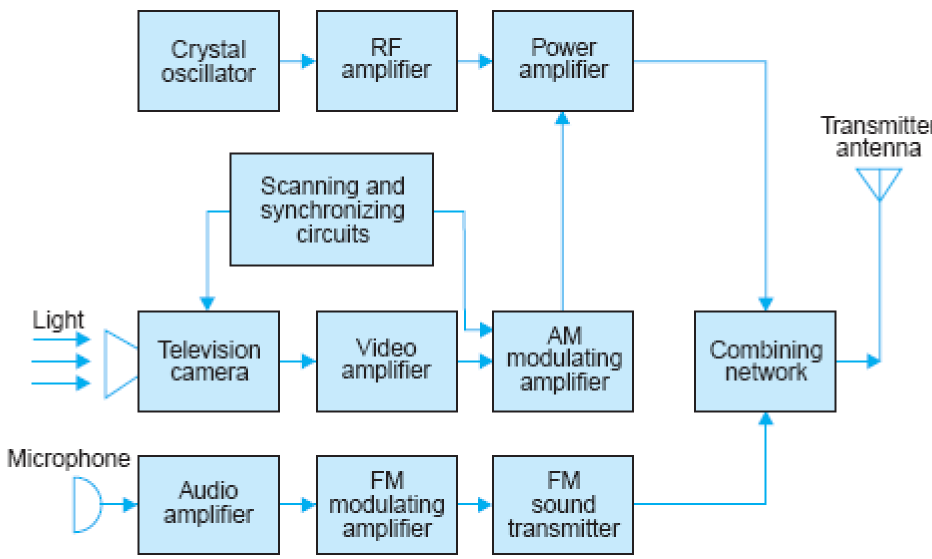


Fig. 2.1 Basic monochrome television transmitter

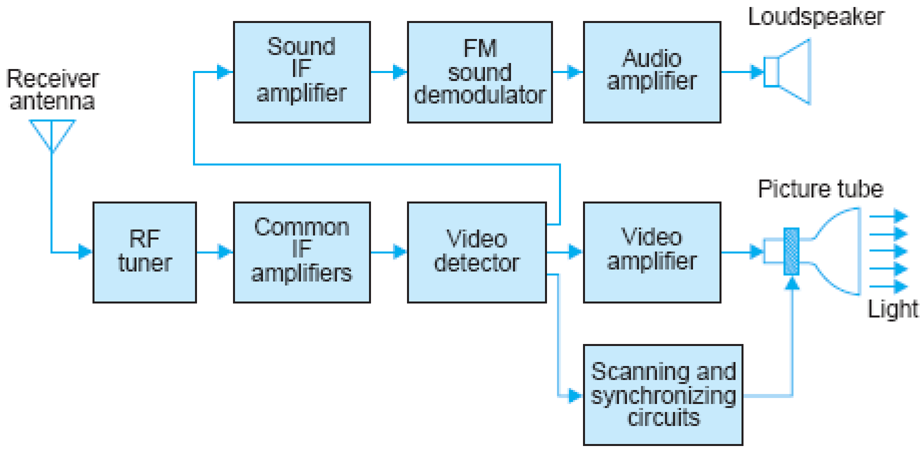


Fig.2.2 Basic monochrome television receiver.

- The inner side of the glass face-plate has a transparent conductive coating on which is laid a very thin layer of photoconductive material.
- The photolayer has a very high resistance when no light falls on it, but decreases depending on the intensity of light falling on it.
- Thus depending on the light intensity variations in the focused optical image, the conductivity of each element of the photolayer changes accordingly.
- An electron beam is used to pick-up the picture information now available on the target plate in terms of varying resistance at each point.
- The beam is formed by an electron gun in the TV camera tube. On its way to the inner side of the glass faceplate it is deflected by a pair of deflecting coils mounted on the glass envelope and kept mutually perpendicular to each other to achieve scanning of the entire target area.
- Scanning is done in the same way as one reads a written page to cover all the words in one line and all the lines on the page.
- To achieve this deflecting coils are fed separately from two sweep oscillators which continuously generate saw-tooth waveforms, each operating at a different desired frequency.
- The magnetic deflection caused by the current in one coil gives horizontal motion to the beam from left to right at a uniform rate and then brings it quickly to the left side to commence the trace of next line.
- The other coil is used to deflect the beam from top to bottom at a uniform rate and for its quick retrace back to the top of the plate to start this process all over again.
- Two simultaneous motions are thus given to the beam, one from left to right across the target plate and the other from top to bottom thereby covering the entire area on which the electrical image of the picture is available.

- As the beam moves from element to element, it encounters a different resistance across the target-plate, depending on the resistance of the photoconductive coating.
- The result is a flow of current which varies in magnitude as the elements are scanned.
- The current passes through a load resistance RL, connected to the conductive coating on one side and to a dc supply source on the other.
- Depending on the magnitude of the current a varying voltage appears across the resistance RL and this corresponds to the optical information of the picture.

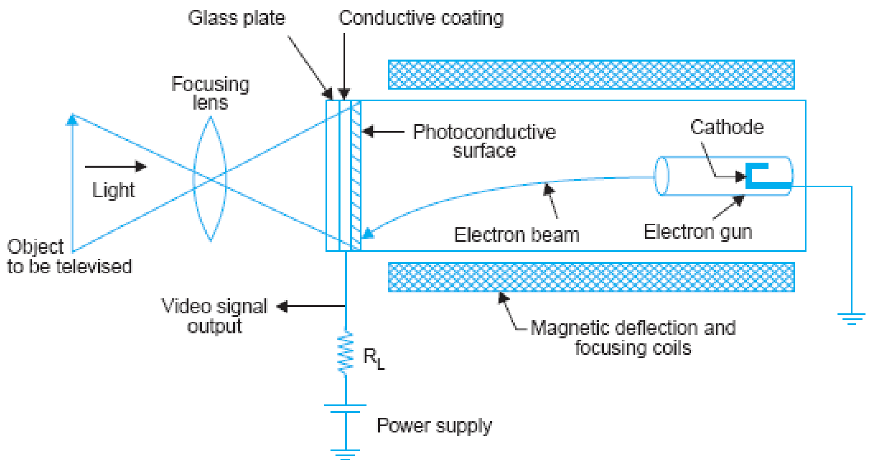


Fig 2.3 Simplified cross-sectional view of a Videocon TV camera Tube

- If the scanning beam moves at such a rate that any portion of the scene content does not have time to move perceptibly in the time required for one complete scan of the image.
- The resultant electrical signal contains the true information existing in the picture during the time of the scan.
- The desired information is now in the form of a signal varying with time and scanning may thus be identified as a particular process which permits the conversion of information existing in space and time coordinates into time variations only.
- The electrical information obtained from the TV camera tube is generally referred to as video signal.
- This signal is amplified and then amplitude modulated with the channel picture carrier frequency. The modulated output is fed to the transmitter antenna for radiation along with the sound signal.

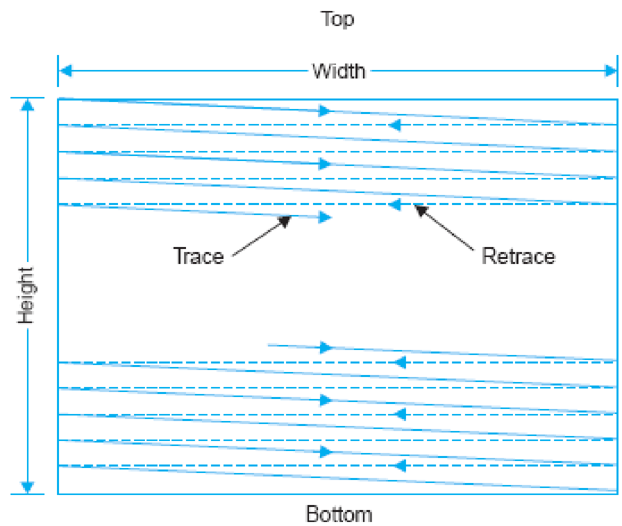


Fig. 2.4 Path of scanning beam in covering picture area

2.1.3 SOUND TRANSMISSION

- The microphone converts the sound associated with the picture being televised into proportionate electrical signal, which is normally a voltage.
- This electrical output, regardless of the complexity of its waveform, is a single valued function of time and so needs a single channel for its transmission.
- The audio signal from the microphone after amplification is frequency modulated, employing the assigned carrier frequency.
- In FM, the amplitude of the carrier signal is held constant, whereas its frequency is varied in accordance with amplitude variations of the modulating signal.
- The output of the sound FM transmitter is finally combined with the AM picture transmitter output, through a combining network, and fed to a common antenna for radiation of energy in the form of electromagnetic waves.

2.1.4 PICTURE RECEPTION

- The receiving antenna intercepts the radiated picture and sound carrier signals and feeds them to the RF tuner.
- The receiver is of the heterodyne type and employs two or three stages of intermediate frequency (IF) amplification.
- The output from the last IF stage is demodulated to recover the video signal. This signal that carries the picture information is amplified and coupled to the picture tube which converts the electrical signal back into picture elements of the same degree of black and white.

- The picture tube shown in Fig is very similar to the cathode-ray tube used in an oscilloscope. The glass envelope contains an electrongun structure that produces a beam of electrons aimed at the fluorescent screen.
- When the electron beam strikes the screen, light is emitted. The beam is deflected by a pair of deflecting coils mounted on the neck of the picture tube in the same way and rate as the beam scans the target in the camera tube.
- The amplitudes of the currents in the horizontal and vertical deflecting coils are so adjusted that the entire screen, called raster, gets illuminated because of the fast rate of scanning.

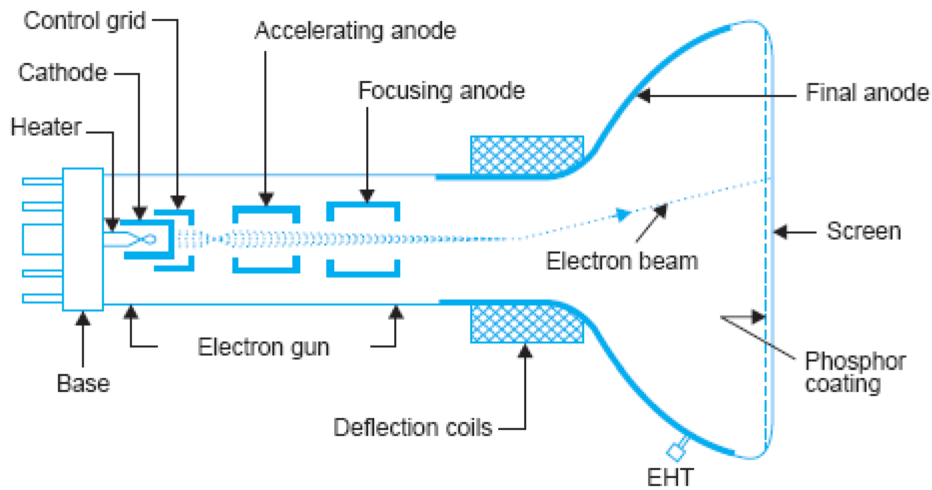


Fig 2.5 Elements of a picture tube.

- The video signal is fed to the grid or cathode of the picture tube. When the varying signal voltage makes the control grid less negative, the beam current is increased, making the spot of light on the screen brighter.
- More negative grid voltage reduces the brightness. If the grid voltages is negative enough to cut-off the electron beam current at the picture tube there will be no light.
- This state corresponds to black. Thus the video signal illuminates the fluorescent screen from white to black through various shades of grey depending on its amplitude at any instant.
- This corresponds to the brightness changes encountered by the electron beam of the camera tube while scanning the picture details element by element.
- The rate at which the spot of light moves is so fast that the eye is unable to follow it and so a complete picture is seen because of the storage capability of the human eye.

2.2 INTERLACING:

1. When referring to a computer monitor or other display, interlace or interlacing is a description of how the picture is created. With interlaced the picture is created by scanning every other line, and on the next scan, scanning every opposite line. This allows for a faster refresh rate by having less information during each scan and often allows the display to be sold at a much lower cost. Unfortunately, this may cause flickering or noticeable line movements in some situations.

2. When referring to an interlaced graphic image, such as an interlaced GIF or progressive JPEG these are images that are displayed by loading every other line of the image and when at the bottom starting over and loading every opposite line. This image is often only noticed by users with slow slow Internet connections, such as users with a modem connection or when downloading a very large image and will often appear to fade in as it's being loaded.

- A common way to compress video is to interlace it. Each frame of an interlaced video signal shows every other horizontal line of the image.
- As the frames are projected on the screen, the video signal alternates between showing even and odd lines. When this is done fast enough, i.e. around 60 frames per second, the video image looks smooth to the human eye.
- Interlacing has been used for decades in analog television broadcasts that are based on the NTSC (U.S.) and PAL (Europe) formats.
- Because only half the image is sent with each frame, interlaced video uses roughly half the bandwidth than it would sending the entire picture.
- The downside of interlaced video is that fast motion may appear slightly blurred. For this reason, the DVD and HDTV standards also support progressive scan signals, which draw each line of the image consecutively.

2.3 COMPOSITE VIDEO SIGNAL:

- Camera signal - corresponding to the desired picture information
- Blanking pulses – to make the retrace invisible
- Synchronizing pulses – to synchronize the transmitter and receiver scanning horizontal sync pulse, vertical sync pulse amplitudes are kept same but their duration are different consecutively and not simultaneously with the picture signal – so sent on a time division basis

2.4 COLOUR TELEVISION

- Colour television is based on the theory of additive colour mixing, where all colours including white can be created by mixing red, green, and blue lights.
- The colour camera provides video signals for the red, green, and blue information. These are combined and transmitted along with the brightness (monochrome) signal.
- Each colour TV system is compatible with the corresponding monochrome system. Compatibility means that colour broadcasts can be received as black and white on monochrome receivers.
- Conversely colour receivers are able to receive black and white TV broadcasts. This is illustrated in Fig 2.6 where the transmission paths from the colour and monochrome cameras are shown to both colour and monochrome receivers.
- At the receiver, the three colour signals are separated and fed to the three electron guns of colour picture tube.
- The screen of the picture tube has red, green, and blue phosphors arranged in alternate dots.
- Each gun produces an electron beam to illuminate the three colour phosphors separately on the fluorescent screen.
- The eye then integrates the red, green and blue colour information and their luminance to perceive the actual colour and brightness of the picture being televised.

2.4.1 COLOUR RECEIVER CONTROLS

- NTSC colour television receivers have two additional controls, known as Colour and Hue controls. These are provided at the front panel along with other controls.
- The colour or saturation control varies the intensity or amount of colour in the reproduced picture. For example, this control determines whether the leaves of a tree in the picture are dark green or light green, and whether the sky in the picture is dark blue or light blue.
- The tint or hue control selects the correct colour to be displayed. This is primarily used to set the correct skin colour, since when flesh tones are correct, all other colours are correctly reproduced.
- It may be noted that PAL colour receivers do not need any tint control while in SECAM colour receivers, both tint and saturation controls are not necessary.
- The reasons for such differences are explained in chapters exclusively devoted to colour television.

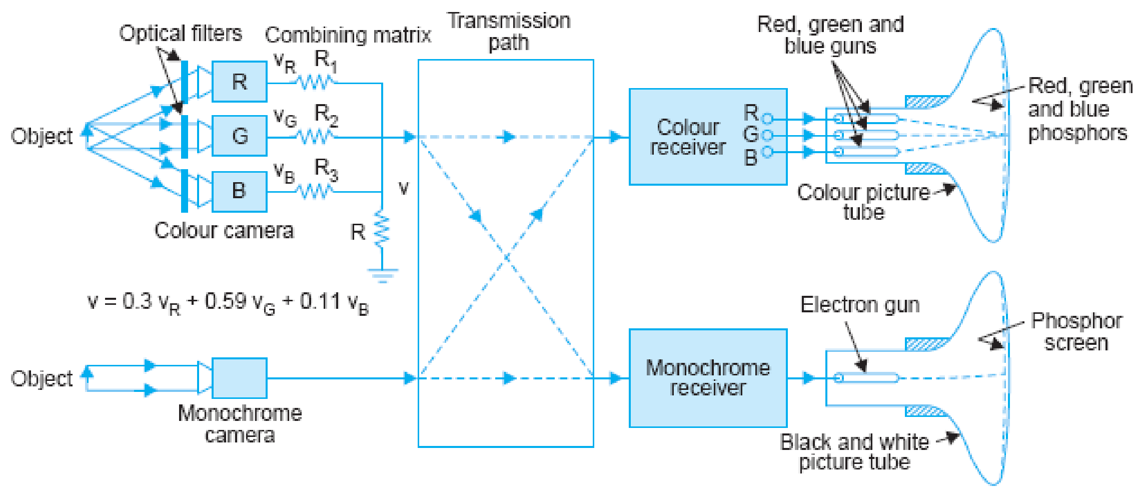


Fig 2.6Signal transmission paths illustrating compatibility between colours and monochrome TV systems.

2.4.2 Color transmission and reception:

- A colour TV transmitter is essentially the same as the monochrome transmitter except for the additional need that colour (chroma) information is also to be transmitted.
- Any colour system is made compatible with the corresponding monochrome system.
- For this, the luminance (brightness) signal is transmitted in a colour system in the same way as in the monochrome system and with the same bandwidth.

2.5 Luminance signal:

- The luminance and chrominance signals take separate paths after the video detector and rejoin later in matrix section.
- The luminance signal processing network recover luminance (Y) signal from composite video signal.

2.6 Chrominance Signal:

- By using chrominance band pass filter selects the chrominance signal (color signal) and rejects other unwanted components of composite signal.

2.7 MONOCHROME PICTURETUBE:

Construction:

1. **Electron gun motion:**

- The electron gun unit has a cathode, control grid and accelerating anode.

The cathode (K) is a small metallic oxide disk placed at the end of a narrow tube that covers the heater. It is heated to produce thermionic emission and thus serves as source of electrons for the beam current.

- The control grid (G1) is used to control the flow of electrons from the cathode (K). The control grid (G1) is maintained at negative potential with

respect to cathode (K).

- The grids that follow the control grid are the accelerating grid (or) screen (G2) and focussing grid (G3).these are maintained at different positive potentials with respect to cathode (K).

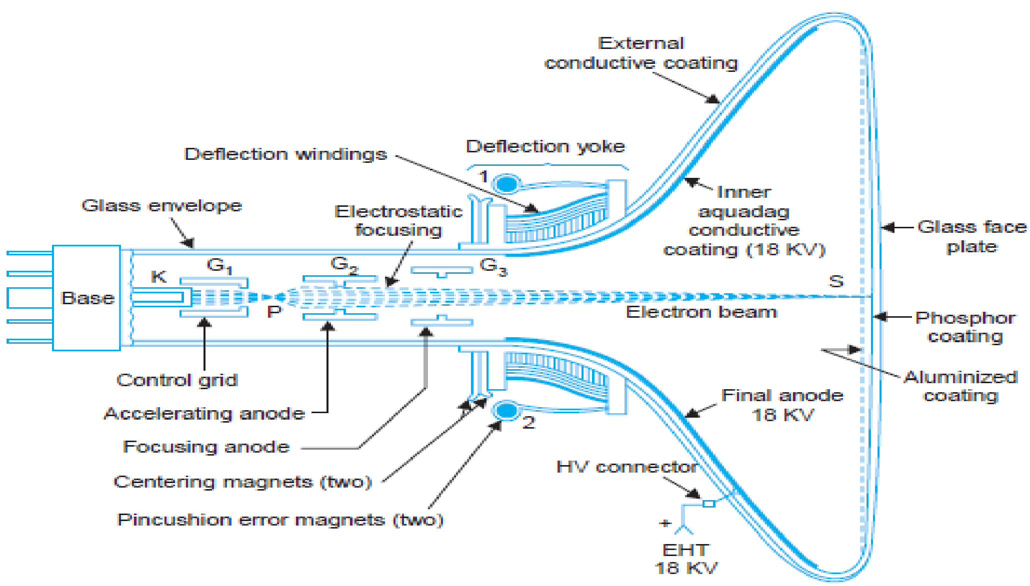


Fig 2.7 Monochrome picture tube

- All the grids, cathode, heater elements of the electron gun are connected

to the base pins. Through this base pins only necessary voltages are applied.

2. **Focussing anode section:**

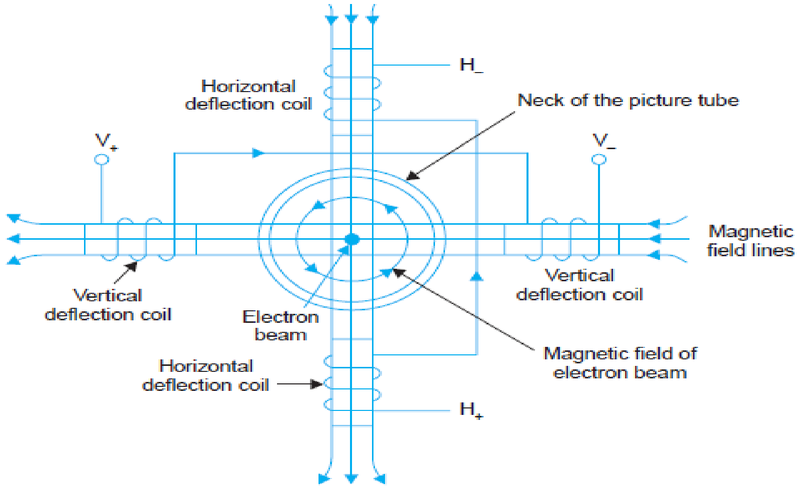
- Electrostatic focussing method is used here, to focus the electron beam.

This section also brings all the electrons in the stream into small spot. It is considered as first electrostatic lens action.

- The second lens system consists of screen grid are so selected that the second convergence point is on the screen of the picture tube.

3. **Deflection coil section:**

- Here we are using electromagnetic system to deflect the electron beam in horizontal and vertical direction.one pair of deflection coils is placed left and right side neck of the picture tube to produce vertical deflection and one pair is placed top and bottom side of the neck to produce horizontal deflection.
- The two pairs of coils are collectively called deflection yoke. The magnetic field in the coil reacts with the electron beam to make the deflection.
- In the deflection yoke centering magnet and pin cushion magnet are also provided for centering the electron beam and adjusting the movement of the electron beam at the corners.



Horizontal and Vertical deflecting coils (pairs) around the neck of the picture tube. Note that the location of the beam on the picture tube screen will depend on the strength and direction of currents in the two pairs of coils. For the directions of current shown the beam will be deflected upwards and to the left.

Fig 2.8 Deflection angle

Deflection angle:

- This is the angle through which the beam can be deflected without striking the side of the picture tube (or) bulb.

4. Final anode section:

- A final anode is included in the tube, to provide sufficient velocity and energy for the electron beam.
- A black graphite material coating called aquadag, it is used as final anode. It is connected through a specially provided pin at the top or side of the glass bell to a very high potential of over 15kv.
- The secondary electrons emitted from the screen are attracted by these aquadag coating.

5. **Phosphor screen:**
    - The phosphor chemicals are generally light materials such as zinc and cadmium in the form of sulphate and phosphate compounds.
    - This material is proceeded to produce very fine particles which are then applied on the inside of the glass plate.
    - The high velocity electrons of the beam on hitting the phosphor excite its atoms with the result that corresponding spot fluoresces and emit light.

6. **External conductive coating:**
    - Aquadag is also coated on the outer surface of the glass bell. A spring clip is used to connect this coating with the chasis ground.
    - This coating is used to filter the AC ripples in high voltage and to provide a perfect higher voltage.

Working:

- An AC supply of 6.3V is given to the heater. This filament heats the cathode (K) and the cathode emits electrons. The control grid (G1) controls the flow of electrons. By varying the control grid voltage, the number of electrons in the beam is also controlled.
- The accelerating anode (G2) increases the velocity of the moving electrons. The focussing anode (G3) merges the electron beam so that they merge at a point and strike the phosphor coating on the screen.

- The aquadag coating inside the tube is given a high voltage in the order of about 10kv to 15kv. This high voltage coating accelerates the electrons and also collects the secondary emissions.

- Using the deflection coils we can deflect the electrons in both vertical and horizontal directions.
- A sawtooth current is used for this, when the electron beam strikes the phosphor coating it emits light.

- Depending on the video signal voltage the emitted light is bright (or) dark.

2.8 Color picture tube – Delta gun picture tube:

- In this color picture tube the three guns are arranged in a rectangular form and hence the name delta gun tube. It was developed by Radio Corporation of America.

Main sections:

1. Electron gun section
2. Screen and shadow mask section

Electron gun section:

- The three guns are spaced equally at 120 degree with one another. They are tilted inward with respect to axis of the tube. The three guns are in the three corners and found delta shape.

- The three independent electron beams for each primary color come out of the three guns.
- Each gun has a heater filament, cathode, control grid and accelerating anode. The accelerating anodes are supplied EHT of about 25 kV.

- While the focussing grids are provided an adjustable potential of about 5 to 75 kV for optimum focus.

- The deflection yoke design is more complex, since, we have to deflect three electron beams at a time.
- The purity magnets are used to adjust the axis of electron beams so that they can strike the correct phosphor dot at the screen.

Screen and shadow mask section:

- In the screen, the three colour phosphor dots are arranged in a group called trials.it forms the delta shape.

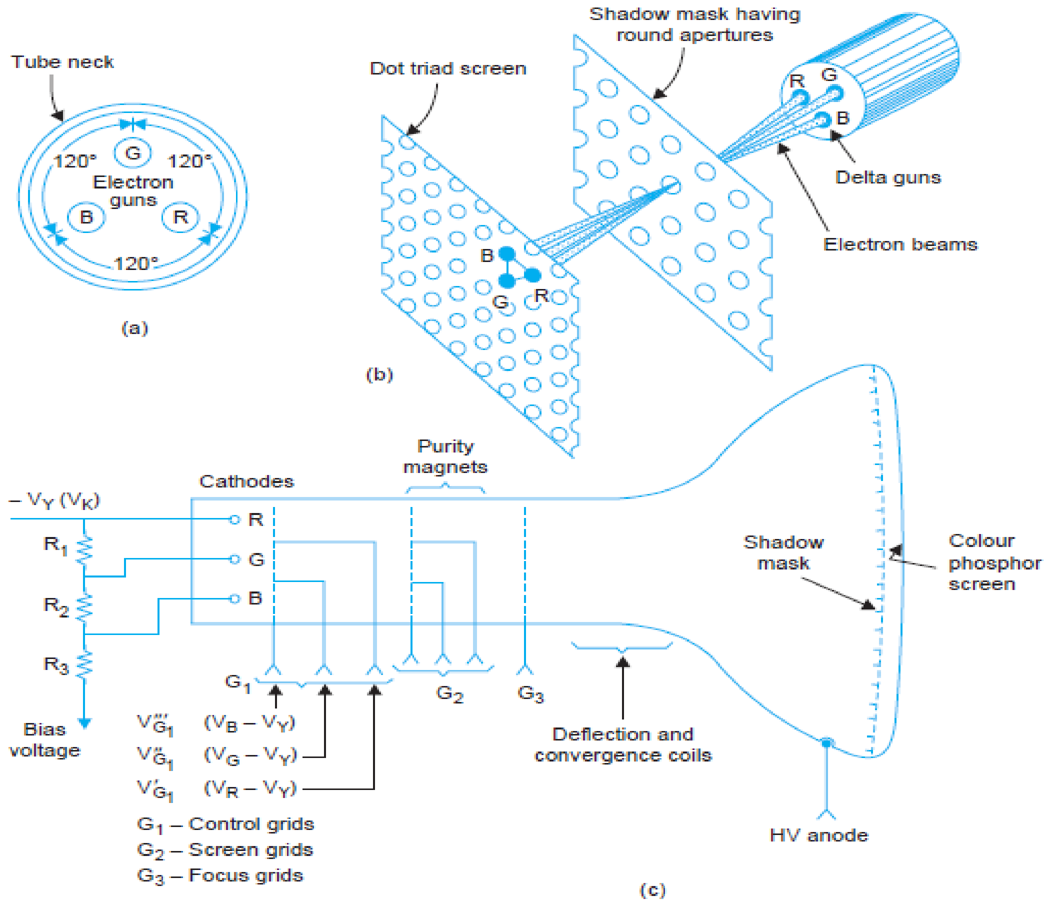


Fig 2.9 a) Gun structure b) Screen and shadow mask c) colour picture tube

- Each dot represents one primary colour. Depending on the screen size nearly 3 lacs to 4 lacs triads are formed over the screen.
- The diameter of the each dot is about 0.42 mm and each spaced some 0.72 mm apart triangularly.
- Shadow mask is a thin perforated metal sheet. It is placed behind the screen. Shadow mask has one hole for each triad on the screen.
- This arrangement moves the electron beam passing through a hole and hit only one triad on the screen.

Working:

- The video signals corresponding to each primary colour are to three electron guns. Necessary acceleration and focussing are done for each electron beam by its accelerating and focussing anodes.

- Here purity magnet adjusts the axis of each electron beam. Convergence coil assembly will converge the electron beams.

- Due to these arrangements the three electrons beams will strike the corresponding colour phosphor dots in each of the triads. The shadow mask arrangement makes only one triad to energise by electron beam at a time.

Advantages:

1. Better focussing, if best possible ratio of gun-to-neck diameter is achieved.

Disadvantages:

1. Shadow mask absorbs 80% of beam current.
2. Beam convergence is a complex process.

2.9 COLOUR TV SYSTEMS:

2.9.1 NTSC (National Television Standards Committee)

- The majority of 60Hz based countries use a technique known as NTSC originally developed in the United States by a focus committee called the National Television Standards Committee.
- NTSC (often funnily referred to as Never Twice the Same Colour) works perfectly in a video or closed circuit environment but can exhibit problems of varying colour when used in a broadcast environment.

2.9.2 PAL (Phase Alternate Lines)

- This huge change problem is caused by shifts in the colour sub-carrier phase of the signal.
- A modified version of NTSC soon appeared which differed mainly in that the sub- carrier phase was reversed on each second line.
- This is known as PAL standing for Phase Alternate Lines (it has a wide range of funny acronyms including Pictures At Last, Pay for Added Luxury etc). PAL has been adopted by a few 60Hz countries, most notably Brazil.

2.9.3 SECAM

- Amongst the countries based on 50Hz systems, PAL has been the most widely adopted.
- PAL is not the only colour system in widespread use with 50Hz; the French designed a system of their own -primarily for political reasons to protect their domestic manufacturing companies .
- Which is known as SECAM, standing for Sequential Couleur Avec Memoire. The most common facetious acronym is System Essentially Contrary to American Method.

SECAM ON PAL

- Some Satellite TV transmissions (usually Russian) that are available over India, are in SECAM Since the field (25 frames /sec) and scan rates are identical, a SECAM signal will replay in B&W on a PAL TV and vice versa.
- The transmission frequencies and encoding differences make equipment incompatible from a broadcast viewpoint. For the same reason, system converters between PAL and SECAM, while often difficult to find, are reasonably cheap.
- In Europe, a few Direct Satellite Broadcasting services used a system called D-MAC. Its use is not wide-spread at present and it is trans-coded to PAL or SECAM to permit video recording of its signals.
- It includes features for 16:9 (widescreen) aspect ratio transmissions and an eventual migration path to Europe's proposed HDTV standard.
- There are other MAC-based standards in use around the world including B-MAC in Australia and B-MAC60 on some private networks in the USA.
- There is also a second European variant called D2-MAC which supports additional audio

channels making transmitted signals incompatible, but not baseband signals.

2.10 COMPONENTS OF REMOTE CONTROL AND TV CAMERA TUBES:

- A remote control is a component of an electronics device, most commonly a television set, used for operating the television device wirelessly from a short line-of-sight distance.

- The remote control is usually contracted to remote. It is known by many other names as well, such as converter, clicker, "The box" didge, flipper, the tuner, the changer, or the button.

- Commonly, remote controls are Consumer IR devices used to issue commands from a distance to televisions or other consumer electronics such as stereo systems, DVD players and dimmers.

- Remote controls for these devices are usually small wireless handheld objects with an array of buttons for adjusting various settings such as television channel, track number, and volume.

- The majority of modern devices with this kind of control, the remote contains all the function controls while the controlled device itself only has a handful of essential primary controls.

- Most of these remotes communicate to their respective devices via infrared (IR) signals and a few via radio signals.

- Earlier remote controls in the 1970s used ultrasonic tones. Television IR signals can be mimicked by a universal remote, which is able to emulate the functionality of most major brand television remote controls.

- The remote allowed audiences, for the first time, to interact with their TV without touching it.

- They no longer watched programs just because they did not want to get up to change the channel. They could also channel surf during commercials, or turn the sound off.

- The invention of the remote control has led to several changes in television programming. One was the creation of split screen credits.

- According to James Gleick, an NBC research team discovered that when the credits started rolling after a program, 25% of its viewers would change the channel before it was over.

- Because of this, the NBC 2000 unit invented the “squeeze and tease” which squeezed the credits onto one third of the screen while the final minutes of the broadcast aired simultaneously.

- The remote control also led to an adjustment in commercial airings. Networks began to feel that they could not afford to have commercials between programs because it would detract viewers from staying tuned in to their channel.

- Programmers decided to place commercials in the middle of programs to make the transition to the next show direct.

- With networks keeping in mind that people were equipped with remotes, 30-second advertisement spots were cut into segments of eight seconds or less.

- MTV was made up of this high-speed and broken cutting style, which aired music videos that were around three-minutes and each shot no more than two or three seconds.

- But MTV felt that even these three-minute segments were too long, so they created an animated series called Beavis and Butthead, to keep their viewer’s attention.

- In the show, they would show segments of music videos and then switch back to the characters and offer dialogue and action while the music video played in the background.

2.10.1 REMOTE CONTROL APPLICATIONS ON MOBILE DEVICES:

In the late 2000s-early 2010s, a number of smart phone and portable media player platforms were provided with installable software applications.

which allow for the remote controlling of media centers and media players on home theater PCs and general-purpose personal computers over Wi-Fi, such as iTunes Remote on iOS.

In comparison to the user interfaces of physically buttoned dedicated remote control devices, the user interfaces of these remote control applications are designed to take advantage of the dynamic graphics offered by usually touch screened handheld devices, making for larger virtual buttons and virtual keyboards.

Most developers of remote control applications for handhelds usually architect the software for usage with specific media player or media center applications (i.e., iTunes Remote for iTunes and iTunes-based software from Apple, Boxee remote for Boxee, DVR Remote for TiVo, VLC Remote for VLC, etc.).

2.11 HDTV:

High-Definition Television, a new type of television that provides much better resolution than current televisions based on the NTSC standard.

Types of HDTV displays include direct-view,plasma, rear screen, and front screen projection.

- HDTV is a digital TV broadcasting format where the broadcast transmits widescreen pictures with more detail and quality than found in a standard analog television, or other digital television formats.

- HDTV requires an HDTV tuner to view and the most detailed HDTV format is1080i.

- DTV (high definition television) is a television display technology that provides picture quality similar to 35 mm.

- HDTV generally uses digital rather than analog signal transmission.

- HDTV provides a higher quality display with a vertical resolution display from 720p to 1080i.

- The *p* stands for *progressive scanning*, which means that each scan includes every line for a complete picture, and

- The *i* stands for *interlaced scanning* which means that each scan includes alternate lines for half a picture.

- These rates translate into a frame rate of up to 60 frames per second, twice that of conventional television.

- HDTV preserves extra clarity.

- All TV programs, DVDs, and DVD players are incompatible with HDTV.

HDTV Minimum Performance Attributes:

Receiver: Receives ATSC terrestrial digital transmissions and decodes all ATSC Table 3 video formats

Display Scanning Format: Has active vertical scanning lines of 720 progressive (720p), 1080 interlaced (1080i), or higher

Aspect Ratio: Capable of displaying a 16:9 image1

Audio: Receives and reproduces, and/or outputs Dolby Digital audio

HDTV tuner:

A device capable of receiving and outputting HDTV signals for display. HDTV tuners can be a stand-alone device or it can integrate in the HDTV display. HDTV has many different consumer names including *HDTV decoder, HDTV receiver, and set-top box.*

Integrated HDTV

A high-definition television or display that has the HDTV tuner built into the set. It does not need a separate set-top box to receive over-the-air HDTV signals.

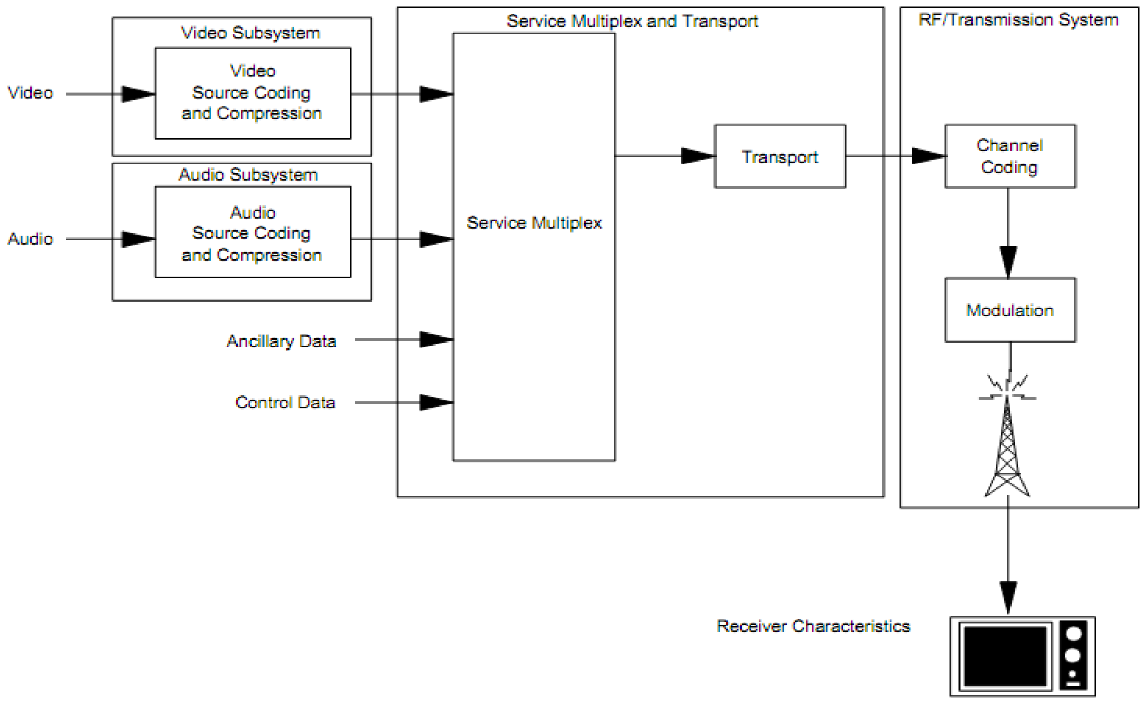


Fig 2.10 HDTV transmitter

2.12 LED TV:

- An LED display is a flat panel display, which uses an array of light-emitting diodes as pixels for a video display.
- Their brightness allows them to be used outdoors in store signs and billboards, and in recent

years they have also become commonly used in destination signs on public transport vehicles.

Fig 2.11 LED TV

- LED displays are capable of providing general illumination in addition to visual display, as when used for stage lighting or other decorative (as opposed to informational) purposes.
- There are two types of LED panels: conventional (using discrete LEDs) and surface-mounted device (SMD) panels.
- Most outdoor screens and some indoor screens are built around discrete LEDs, also known as individually mounted LEDs. A cluster of red, green, and blue diodes is driven together to form a full-color pixel, usually square in shape.

Flat panel LED Television display:

- The first true all-LED flat panel television screen was possibly developed, demonstrated and documented by James P. Mitchell in 1977.
- The modular, scalable display was initially designed with hundreds of MV50 LEDs and a newly available transistor-transistor logic memory addressing circuit from Texas Instruments. The ¼-inch thin flat panel prototype and the scientific paper were displayed at the 29th ISEF expo in Washington D.C. in May 1978.
- It received awards by NASA and General Motors Corporation.
  A liquid crystal display (LCD) matrix design was also cited in the LED paper as an alternative x-scan technology and as a future alternate television display method.
- Additional recognition was provided by Westinghouse Educational Foundation "Honors Group" and the concept prototype was also a selected scientific paper at the Iowa Academy of Science of the University of Northern Iowa.
- The replacement of the 70 year+ high-voltage analog system (cathode-ray tube technology) with a digital x-y scan system has been a significant achievement. Displacement of the electromagnetic scan systems included the removal of inductive deflection, electron beam and color convergence circuits. The digital x-y scan system has helped the modern television to “collapse” into its current thin form factor.

2.13 LCD TV

- Liquid-crystal-display televisions (LCD TV) are television sets that use LCD display technology to produce images.
- LCD televisions are thinner and lighter than cathode ray tube (CRTs) of similar display size, and are available in much larger sizes. When manufacturing costs fell, this combination of features made LCDs practical for television receivers.
- In 2007, LCD televisions surpassed sales of CRT-based televisions worldwide for the first time,[citation needed] and their sales figures relative to other technologies are accelerating.
- LCD TVs are quickly displacing the only major competitors in the large-screen market, the plasma display panel and rear-projection television. LCDs are, by far, the most widely produced and sold television display type.
- LCDs also have a variety of disadvantages. Other technologies address these weaknesses, including organic light-emitting diodes (OLED), FED and SED, but as of 2014 none of these have entered widespread production for TV displays.

- LCD televisions produce a black and colored image by selectively filtering a white light. The light was provided by a series of cold cathode fluorescent lamps (CCFLs) at the back of the screen. Today, most LCD-TV displays use white or colored LEDs as backlighting instead.

- Millions of individual LCD shutters, arranged in a grid, open and close to allow a metered amount of the white light through.
- Each shutter is paired with a colored filter to remove all but the red, green or blue (RGB) portion of the light from the original white source. Each shutter–filter pair forms a single *sub-pixel*.
- The sub-pixels are so small that when the display is viewed from even a short distance, the individual colors blend together to produce a single spot of color, a *pixel*. The shade of color is controlled by changing the relative intensity of the light passing through the sub-pixels.

LCD television at home together with PlayStation 3 and some other equipment

Fig 2.12 LCD TV

- Liquid crystals encompass a wide range of (typically) rod-shaped polymers that naturally form into thin, ordered layers, as opposed to the more random alignment of a normal liquid.
- Some of these, the nematic liquid crystals, also show an alignment effect between the layers. The particular direction of the alignment of a nematic liquid crystal can be set by placing it in contact with an alignment layer or director, which is essentially a material with microscopic grooves in it, on the supporting substrates.
- When placed on a director, the layer in contact will align itself with the grooves, and the layers above will subsequently align themselves with the layers below, the bulk material taking on the director's alignment.
- In the case of a Twisted Nematic (TN) LCD, this effect is utilized by using two directors arranged at right angles and placed close together with the liquid crystal between them.
- This forces the layers to align themselves in two directions, creating a twisted structure with each layer aligned at a slightly different angle to the ones on either side.
- LCD shutters consist of a stack of three primary elements. On the bottom and top of the shutter are polarizer plates set at right angles.
- Normally light cannot travel through a pair of polarizers arranged in this fashion, and the display would be black. The polarizers also carry the directors to create the twisted structure aligned with the polarizers on either side.
- As the light flows out of the rear polarizer, it will naturally follow the liquid crystal's twist, exiting the front of the liquid crystal having been rotated through the correct angle, that allows it to pass through the front polarizer. LCDs are normally transparent in this mode of operation.

- To turn a shutter off, a voltage is applied across it from front to back.
- The rod-shaped molecules align themselves with the electric field instead of the directors, distorting the twisted structure. The light no longer changes polarization as it flows through the liquid crystal, and can no longer pass through the front polarizer.
- By controlling the voltage applied across the liquid crystal, the amount of remaining twist can be selected. This allows the transparency of the shutter to be controlled.
- To improve switching time, the cells are placed under pressure, which increases the force to re-align themselves with the directors when the field is turned off.
- Several other variations and modifications have been used in order to improve performance in certain applications. In-Plane Switching displays (IPS and S-IPS) offer wider viewing angles and better color reproduction, but are more difficult to construct and have slightly slower response times.
- Vertical Alignment (VA, S-PVA and MVA) offer higher contrast ratios and good response times, but suffer from color shifting when viewed from the side. In general, all of these displays work in a similar fashion by controlling the polarization of the light source.

A DTH dish antenna mounted on wall

2.14 DTH TV

Fig 2.13 DTH TV

- **Direct-broadcast satellite** (DBS) is a type of artificial satellite which usually sends satellite television signals for home reception.

- The type of satellite television which uses direct-broadcast satellites is known as direct-broadcast satellite television (DBSTV) or direct-to-home television (DTHTV).
- This has initially distinguished the transmissions directly intended for home viewers from cable television distribution services that are sometimes carried on the same satellite.
- The term DTH predates DBS and is often used in reference to services carried by lower power satellites which required larger dishes (1.7 m diameter or greater) for reception.

- In Europe, prior to the launch of Astra 1A in 1988, the term DBS was commonly used to describe the nationally commissioned satellites planned and launched to provide television broadcasts to the home within several European countries (such as BSB in the United Kingdom and TV-Sat in Germany).
- These services were to use the D-Mac and D2-Mac format and BSS frequencies with circular polarization from orbital positions allocated to each country.
- Before these DBS satellites, home satellite television in Europe was limited to a few channels, really intended for cable distribution, and requiring dishes typically of 1.2m.

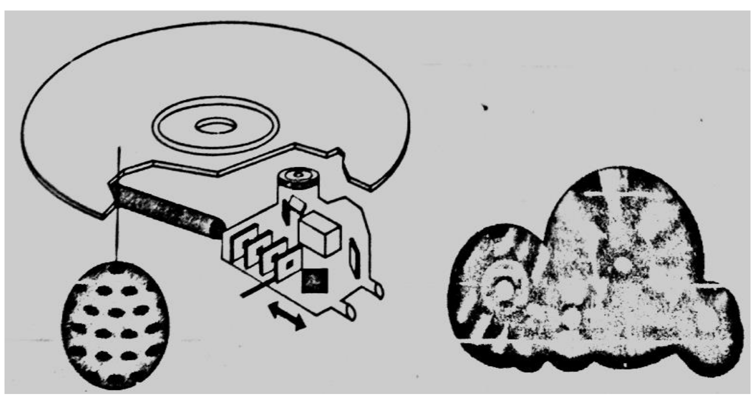
UNIT III

OPTICAL RECORDING AND REPRODUCTION

3.1 DISC

In the *Laser Vision System,* Figure3.1 (a), which records *video* information, the signal is recorded on the disc in the form of a *spiral track* that consists of a succession of *pits.* The intervals between the pits are known as *lands.* The information is present in the track in *analog* form. Each *transition* from land to pit and vice versa marks a zero crossing of the modulated video signal. On th *t compact disc,* Figure.3.1 (b), the signal is recorded in a similar manner, but the information is present in the track in *digital* form. Each pit and each land represents a series of bits called *channel hits.* After each land/pit or pit/land transition there is a 1, and all the channel bits in between are 0, (see Figure.3.2).

The *density of the information* on the compact disc is very high; the smallest unit of audio information (the *audio hit)* covers an area of 1 pm^2 on the disc, and the diameter of the *scanning light spot* is only 1 pm. The *pitch* of the track is 1.6 pm, the *width* 0.6 pm and the *depth* 0.12 pm. The *minimum length* of a pit or the land between two pits is 0.9 pm; the *maximum length* is 3.3 pm. The side of the transparent carrier material



(a) (b)

Figure.3.1 (a) Details of laser vision system showing the optical pickup and the disc microstructure and (b) Compact discs

T in which the pits are impressed, the upper side during playback if the spindle is vertical, is covered with a *reflecting layer R* and a *protective layer* P. *The track is optically scanned from below the disc at a constant velocity of 1.25 m/s.* The *speed of rotation* of the disc therefore varies from about 8 rev/s to about 3.5 revs (or 480 rpm to about 210 rpm).

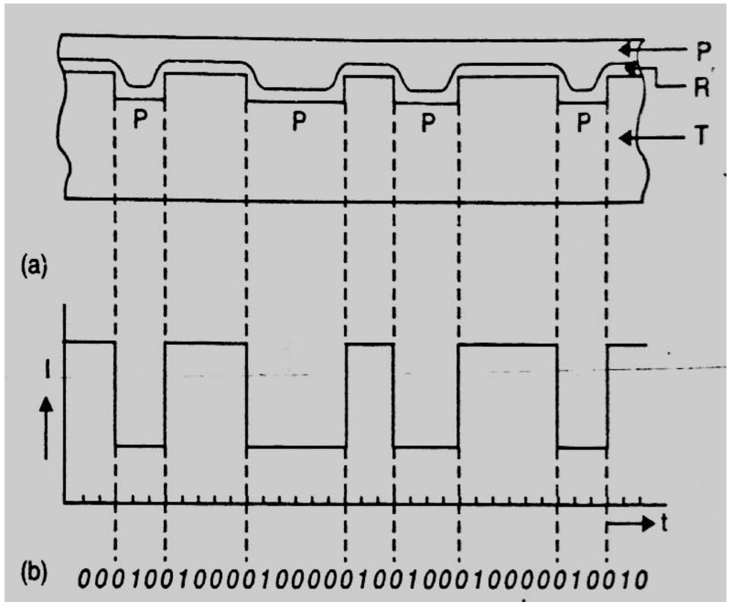


Fig.3.2 (a) Cross section through a compact disc in the direction of the spiral track. T transparent substrate material. ***R*** **reflecting layer,** ***P_r*** **protective layer,** ***P*** **the pits thatform the track, (b) I the intensity of the signal read by the optical pickup plotted as a function of time. The signal, shown in the form of rectangular pulses is in reality rounded and has sloping sides. The digital signal derived from this waveform is indicated as a senes of channel bits Ch**.

3.2 PROCESSING OF THE AUDIO SIGNAL

*F*or converting *the analog signal from the microphone into a digital signal, pulse-code modulation (PCM) is loused. In this system the signal is periodically sampled and* each sample is translated into a binary number. *From Nyquist's sampling theorem* the frequency of the sampling should be at least twice as high as the highest frequency to be accounted for in the analog signal. *The number of bits per sample determines the* signal-to-noise ratio *in the subsequent reproduction.*

In the *compact disc system* the analog system is sampled at a rate of 44.1 kHz, which is sufficient for the reproduction of the maximum frequency of 20 kHz. The signal is quantized by the method of uniform or linear quantization, the sampled amplitude is divided into equal parts. The number of bits per sample (these are called *audio bits*) is 32 i.e. 16 for the *left* and 16 for the *right* audio channel. This corresponds to a *signal-to-noise ratio* of more than 90 dB. The net *bitrate* is thus 44.1 * 10^3 * 32 or 1.41 * 10^6 audio bits per second. The audio bits are grouped into *frames*, eacm containing six of the original samples

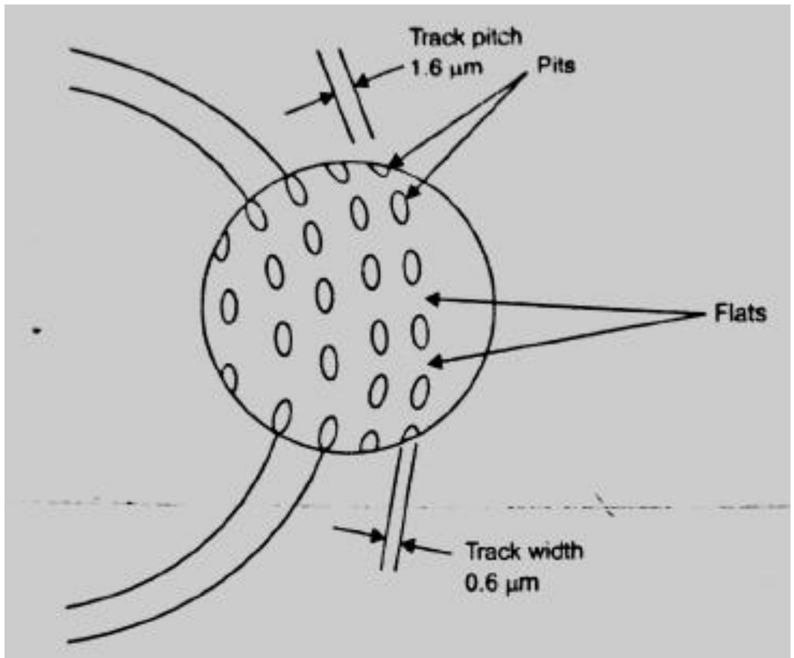


Figure.3.3 The information on the compact disc is recorded in digital form as a spiral track consisting of a succession of pits. The pitch of the track is 1.6µm and the depth of the pit 0.12µm. the length of a pit or the land between two pits has a minimum value of 0.9µm and a maximum value of 3.3m.

Successive blocks of audio bits have blocks of *parity bits* added to them in accordance with *a* coding System called *Cross-Interleaved Reed-Solomon Code* (C IRC). THIS MAkes it possible to correct errors during the reproduction of the signal. The ratio of the number of bits before and after this operation is 3 :4. Each frame then has *Control and Display (C* & D) bits added to it; one of the functions of C & D bits is providing the *information for the listener,* after this operation the bits are called *data bits.*

Next, the bit stream is modulated, that is to say the data bits are translated into channel bits which are suitable for storage on the disc (see Figure.3.2 (*b).* The *Eight-to-Fourteen Modulation (EFM) is used* for this purpose. In EFM code blocks of eight bits are translated into blocks of fourteen bits. The blocks of fourteen bits are linked by these *margin bits.* The ratio of the number of bits before and after modulation is thus 8:17. For the synchronization of the bit stream an *identical synchronization pattern* consisting of 27 channel bits is added to each frame. The *total bit rate* after all these manipulations is $4.32 * 10^6$ channel bits/s.

From the magnitude of the channel bit rate and scanning speed of 1.2 m/s it follows that the *length of a channel bit on the disc is approximately 0.3 µm.*

The signal produced in this way is used by the manufacturer to *switch On and Off the laser beam* that illuminates the light sensitive layer on a rotating glass disc, called the *master.* A pattern of pits is produced on the disc by means of a photographic developing process. After the surface has been coated with a thin silver layer, an electroplating process is applied to produce a nickel impression called the *metal father.* From- this father disc, impressions called *mother discs* are produced in a similar manner. The impressions of mother discs, called *sons or stampers,* are used as tools with which the pits *P* are *impressed* into the thermoplastic transparent carrier material T of the disc.

3.3 READOUT FROM THE DISC

The disc is optically scanned in the player. This is done by *AlGaAs semiconductor laser* Figure.3.4 shows the *optical part of* the pickup. The light from the *laser* La (wavelength 800 nm) is focused through the *lenses L2 and L1onto the reflecting layer of the disc.* The diameter of the light spot S,Figure.3.5, is about 1 *µm.* When the light falls on an *interval* between two pits, the light is almost totally reflected and reaches the four photodiodes D1 to D4 via the half-silvered mirror M. When the spot lands on a *pit*—the depth of a pit is about ¼ of the wavelength in the transparent substrate material—interference causes less light to be reflected and an appreciably smaller amount reaches the photodiodes. When the output signals from the four photodiodes are added together the result is a *fairly rough approximation* to the rectangular pulse pattern present on the disc in the form *of pits and intervals.*

The optical pick-up shown in Fig. 14.4 is very small (about 45 * 12 mm) and is mounted in a *pivoting arm* that enables the pick-up to describe a *radial arc* across the disc, so that it can scan the complete spiral track. Around the pivotal point of arm is mounted a *linear motor* that consists of a combination of a coil and permanent magnet. When the coil is energised the pick-up can be directed to any required part of the track,

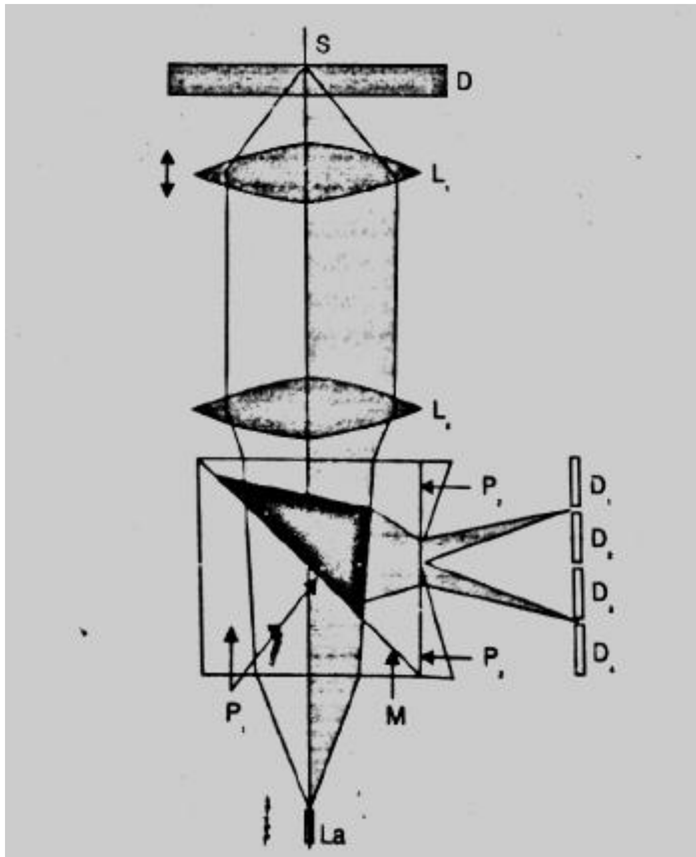


Figure.3.4 Diagram of the optical pick-up

finite *locational information* being provided by the C & D bits added to each frame on the disc. The pick-up is this able to find *independently* any particular passage of music indicated by the listener. When it has been found the pick-up must then *follow the track accurately* to within ±*0.1 µm* without being affected by the next previous track. Since the track on the disc may have some slight *eccentricity,* and since also the suspension of the turntable is not perfect, the track may have a maximum *side-to-side swing* of 300 *µm.* A *tracking servo system* is therefore necessary to ensure that the deviation between pick-up and track is smaller than the permitted value of + *0.1* pm and in addition, to absorb the consequences of small vibrations of the player.

The *tracking-error signal* is delivered by the four photodiodes D. to D_4. When the spot *S*, seen in the radial direction, is situated in the centre of the track, a *symmetrical* beam is reflected. If the spot lies slightly to one side of the track, however, interference effects cause *asymmetry* in the reflected beam. This asymmetry is detected by the prism P_r which *splits* the beam into two components. Beyond the prism, one component has a higher mean intensity than the other. The signal obtained by coupling the photodiodes as (D, + D_2) - (D_3 + D_4) can therefore be used as a tracking error signal.

As a result of the *aging or soiling of the optical system,* the reflected beam may acquire a slowly increasing, more or less constant asymmetry. Owing to a dc component in the tracking error signal, the spot will be *slightly off-centre* of the track. To compensate for this effect a *second tracking error signal* is generated. The coil that controls the pick-up arm is therefore supplied with an alternating voltage at 600 Hz, with amplitude that corresponds to a *radial displacement* of the spot by +0.05 *µm.* The output sum signal from the four photodiodes which is at a *maximum* when the spot is at the centre of the track is thus modulated by an alternating voltage of 600 Hz. *The amplitude* of this 600 Hz signal *increases* as the spot moves off-centre. In addition the *sign* of the 600 Hz error signal *changes* if the spot moves to the other side of the track. This second tracking-error signal is therefore used to correct the error signal mentioned earlier with a direct voltage. The output sum signal from the photodiodes, which is T processed in the player to become the audio signal, is thus returned to its maximum value.

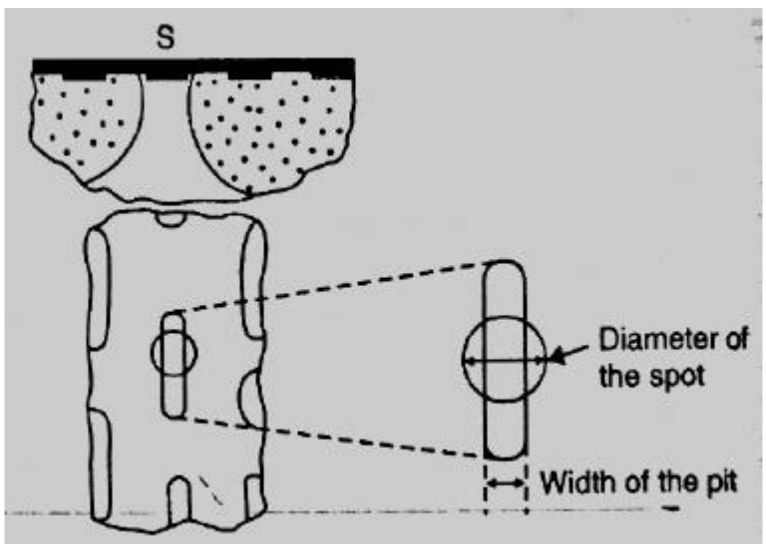


Figure.3.5 A magnified view of the light spot Sand its immediate surroundings, with a plan view.

The *depth of focus* of the optical pick-up at the position S (see Fig. 14.4) is about 4 pm. The *axial deviation* of the disc, owing to various mechanical effects, can be maximum of 1 mm. It is evident that *are servo system* is also necessary to give correct focusing of the pick-up on the reflecting layer. The objective lens L1, can therefore be displaced in the direction of its optical axis by a combination of a coil and a permanent magnet, in the same way as in a loudspeaker. The *focusing-error signal* is also provided by the row of photodiodes D1 to D_4. If the spot is *sharply focused* on the disc, two sharp images are precisely located between D1 and D_2 and between D_3 and D_4. If the spot is *not sharply focused* on the disc, the two images on the photodiodes are not sharp either and have also moved closer together or further apart. The signal obtained by connecting the photodiodes as (D1 +D4) - (D_2 + D_3) can therefore be used for controlling the focusing servo system. The deviation in focusing then remains limited to + 1 *μm.*

3.4 RECONSTITUTION OF THE AUDIO SIGNAL

The signal read from the disc by the optical pick-up has to be reconstituted to form the analog audio signal Figure.3.6 shows the block diagram of the *signal processing* in the player.

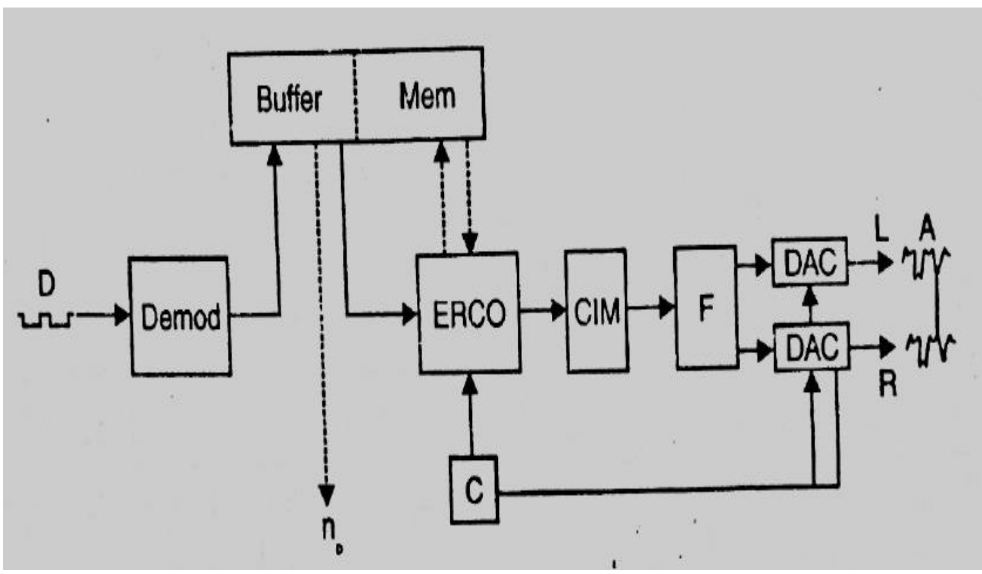


Figure.3.6 Block diagram of the signal processing in the player

In Demod the *demodulation* follows the same rules that were applied to the EFM modulation, but now in the *opposite sense.* The information is then temporarily stored in a *buffer memory* and then reaches the *Error-Detection and Correction Circuit* (ERCO). The parity bits can be used here to correct errors, or just to detect errors if correction is found to be impossible. These *errors* may originate from a defect in manufacturing process, damage during use, or finger marks or dust on the disc. Since the information wife, the CIRC code is *interleaved in time,* errors that occur at the input of ERCO in one frame are spread over a large number of frames during decoding in ERCO. This increases the probability that the maximum number of, correctable errors per frame will not be exceeded. A flaw, such as a scratch, can often produce a train of errors called an *error burst.* The error-correction code used in ERCO can correct a burst of about 4000 data bits, largely because the errors are spread out in this way.

If more errors than the permitted maximum occur, they can only be detected. In the *Concealment, Interpolation and Muting* (CIM) block, the errors detected are then masked. If the value of a sample indicates an error, a new value is found by *linear interpolation* between the preced.ng value and the next one. If two or more successive sample values indicate an error, they are *muted* (made equal to zero). At the same time a gradual transition is created to the values preceding and succeeding it by causing a number of values before the error and after it to decrease to zero in a particular pattern.

In the *digital-to-analog convener* (DAC) the 16 bit samples first pass through *interpolation filters F* and are then translated and recombined to re-create the original analog signal *A* from the two audio channels *L* and *R.* Since samples must be recombined at exactly the same rate as they are taken from the analog audio signal, the DACs and also CIM and ERCO are synchronized by a *clock generator, C,* controlled by a quartz crystal.

Figure.3.6 also illustrates the *control of the disc speed* n_D. The bit stream leaves the buffer memory at a rate synchronised by the clock generator. The bit stream enters the buffer memory, however, at a rate that depends on the speed of revolution of the disc. The extent to which n_D and the sampling rate are matched determines th*e filling degree* of the buffer memory. The control is so arranged as to ensure that the buffer memory is at all times filled to 50% of its capacity. The analog signal from the player is thus completely free from *wow and flutter,* yet with only moderate requirements for the speed control of the disc.

3.5 VIDEO DISC MASTERING AND REPLICATION

The production process of a video disc is more or less comparable with that used for conventional gramophone record. First a master recording is made. It consists of a glass plate with a photosensitive layer deposited on one side. The coded signal of the information to be stored modulates the beam of a 1mm laser which writes the information in the surface of the disc. Cutting is done on real time basis; that it requires only as much as the program lasts and recording takes place at the disc's rotational speed of 30 r.p.s for NTSC and 25 r.p.s respectively for PAL and SECAM. In principle, every normal type of TV signal source can be connected to the cutting devices. In practice however, 50 mm magnetic recording tape is used as a program carrier.

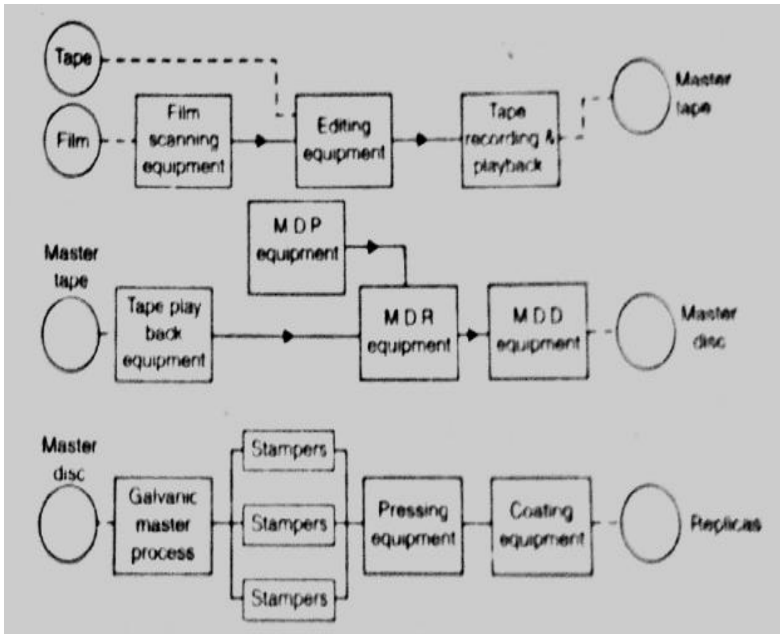


Figure.3.7 Video disc mastering and replication

Exposure to the laser beam is followed by a development process which leaves a pattern of pits on the *master* from which, via a galvanic process; *stampers* are made which are used for disc production in a way *similar* to processing of gramophone records.

After processing, an extremely thin metal coating, not more than 0.04 pm thick is deposited on the information side which is then sealed with a *protective layer*, as shown in Figure.3.8.

3.6 VIDEO DISC FORMATS

The three *non-interchangeable* video disc formats fall into two basic categories optical and *capacitance* The *laser optical system* (also called VLP) which is employed by Philips, uses a laser beam to electronically encoded information stored on the disc. *The capacitance system (also called capacitance electronic disc or CED), employed by both JVC and RCA,*uses a stylus arid tracking arm similar to that of conventional record player to recover the information recorded on the grooves of the *disc*. There are two variations of the laser optical system *reflective* and *transmissive*. There are also two variations of capacitance system, the *video/ audio high density system* (VHD) and the capacitance electronic disc system (CED).

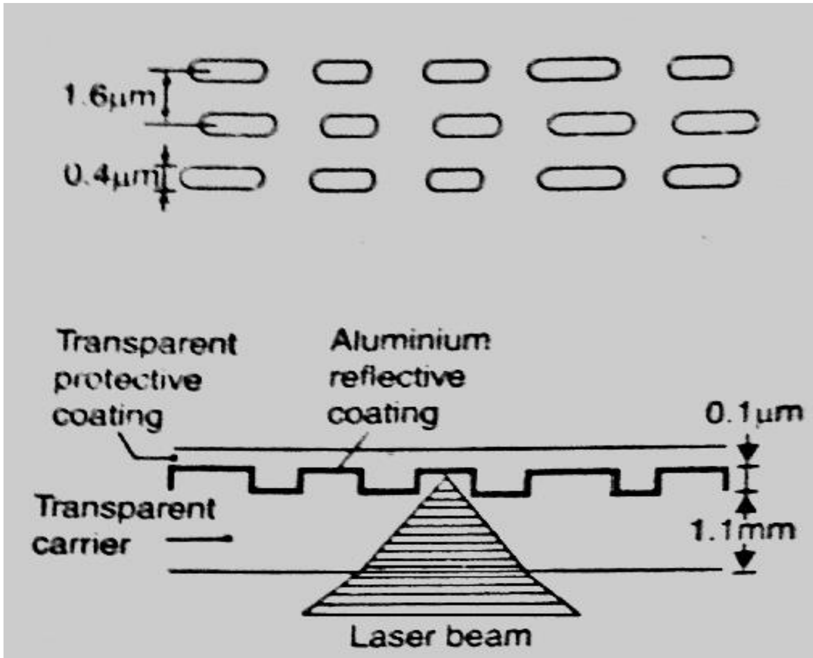


Figure.3.8 the upper half of this diagram shows the tracks of pits, while the lower half shows a cross-section of the disc indicating how the information pits are protected by a transparent protective coating

3.7 LASER VISION

The cores of the Philips laser vision are the *shiny silver video discs* which hold the pre-recorded program - material. These arc *optically read* by a high precision laser, built into the laservision player. *The laservision system features a level of picture and sound without a parallel in video.* Flaw less picture reproduction, full of rich colours, is accompanied by high stereo sound when the player is connected to a stereo TV or hi-fi audio system.

There are two types of Laser vision discs.

Long play discs for straight forward uninterrupted playback of entertainment programs and *active play discs* which involve the viewer in learning a new skill or subject and making full use of the player's many *versatile picture search facilities* that help you to quickly locate any point on the disc and study parts in detail.

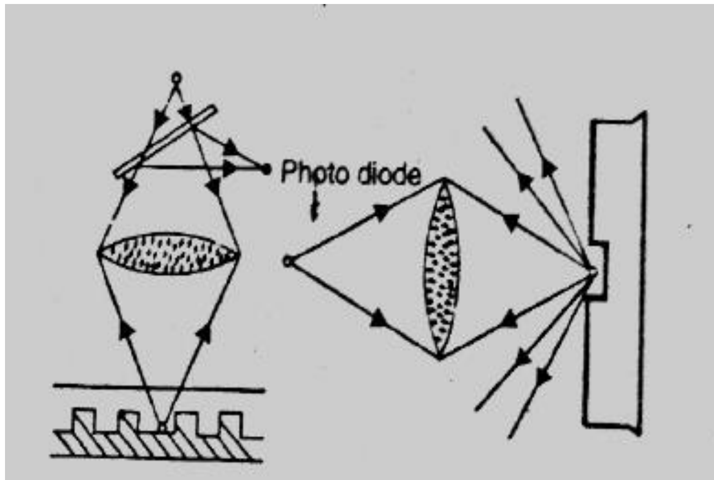


Figure.3.9 When the scaning beam hits a pit in the silvery disc underside the beam is reflected. The beam then passes back to the photodiode which creates the signal output.

The information etched on the *reflective material* of the disc in a *series of pits* is read off with a fine beam created by a helium-neon *laser.* By means of a series of lenses, gratings, prisms and mirrors, the laser beam is directed to the *disc underside* w here it is moved by a scanning lens. When it hits a pit in the silvery surface. Figure.3.9, the beam is reflected. The reflected beam then passes back to the photodiode which creates the signal output.

In a similar system, which is worked in France by Thomson CSF, the laser beam is not reflected from the surface of the disc, but is actually transmitted through it. Variations in the quality of the beam, created by the information etched on the disc, are then used to construct the electrical signals need to create a TV picture.

3.8 SELECTAVISION (RCA)

The *cheapest and the most basic* of the three video disc formats, with the current models offering only mono sound and picture search, selectavision discs, based on the capacitance system, have a maximum *running time* of one hour per side. The RCA stylus recovers information from the disc surface by *direct electrical means.* The selectavision disc is either formed from or coated with electrically conductive material and the stylus serves as a conductive, electrode. Although the groove appears to be smooth, it does have *tiny pits along the bottom* which produce changes in electrical capacitance between the disc surface and the stylus electrode.

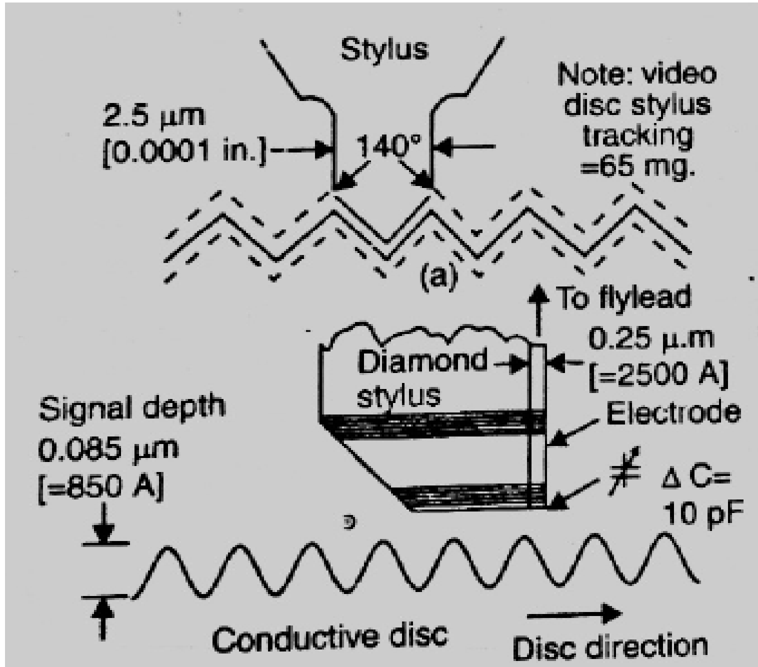


Figure.3.10 The RCA selectavision system employes a capacitance sensing stylus electrode, which is guided along shallow grooves and detects capacitance changes as it passes over shallow pits(a) Front view (b) Side view.

These *changes in capacitance* are sensed by a tuned circuit to produce an output of video signals.

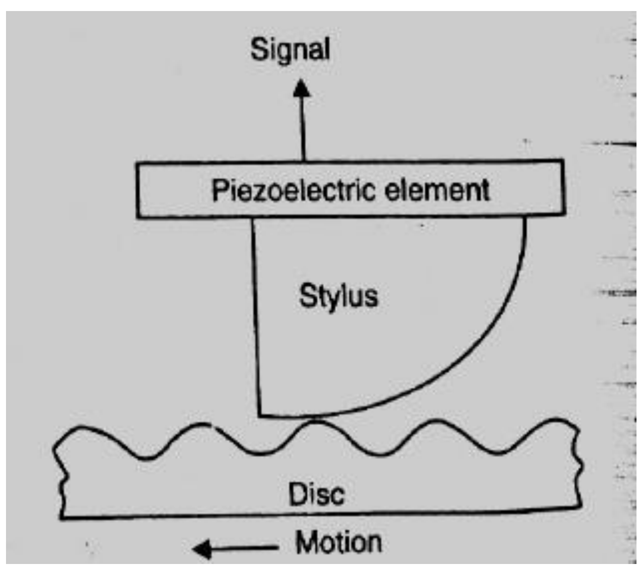


Figure.3.11 The TeD employs a stylus shaped like the prow of a boat which senses mechanically the hill-and –dale modulations that contains the information.

The TeD and RCA systems rely on a stylus following a minute surface groove and *fail to function if the disc surface is damaged.* For this reason, the floppy TeD disc is always stored in a sleeve which is itself loaded into the player for automatic extraction of the vital foil, the sleeve remaining inside the player until the disc has played. RCA discs, which must also be warp free and are rendered useless by finger marks which confuse the capacitance effect, are stored in a *caddy* from which the player automatically extracts the disc for playing.

3.9 VIDEO HGH DENSITY (JVC/THORN-EMJ)

Technically and price wise, VHD falls between laservision and selectavision. The JVC system resembles the RCA approach in it's of capacitance pick up from electrically conductive disc with a spiral of pits on its surface. But the 25cm (10inch) JVC disc has a smooth surface with no groove. The stylus electrode is constrained to follow the spiral pits by a servo system. The spiral of program pits (which the electrode stylus tracks to produce picture on TV screen) is interlaced with a spiral of tracking pits which are sensed to control the servo system to guide the electrode.

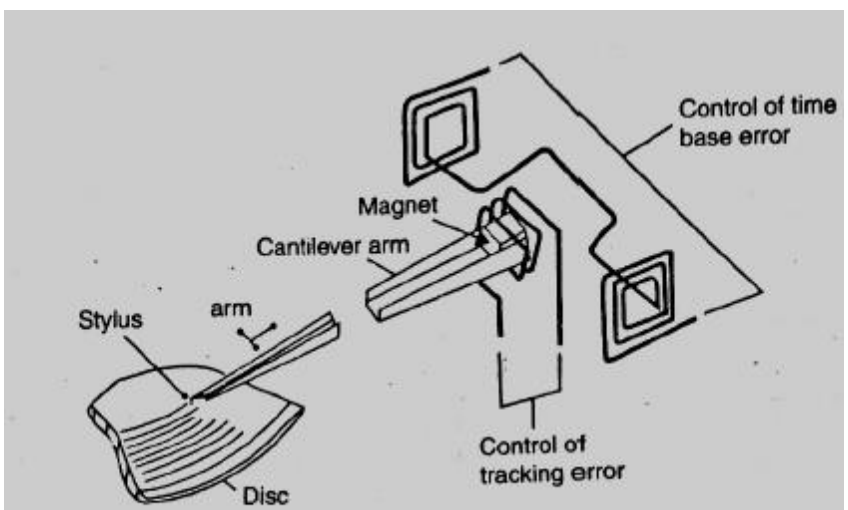


Figure3.12 video signal pick up in VHD system uses a cantilever arm

Figure.3.12 illustrate the method of controlling the stylus. The stylus is mounted at the end of a cantilever pick up arm opposite that end on which a magnet is attached. Fixed coils are positioned near the magnet a single coil is wound around but not in contact with the magnet and a pair of vertical coils are positioned one each on either side of the coil and in phase opposition to each other. Thus the stylus can move transversely and longitudinally in response to the particular current flowing in these coils. The current is varied by a tracking error signal, or by a command to move the stylus to a desired track permitting various functions during playback.

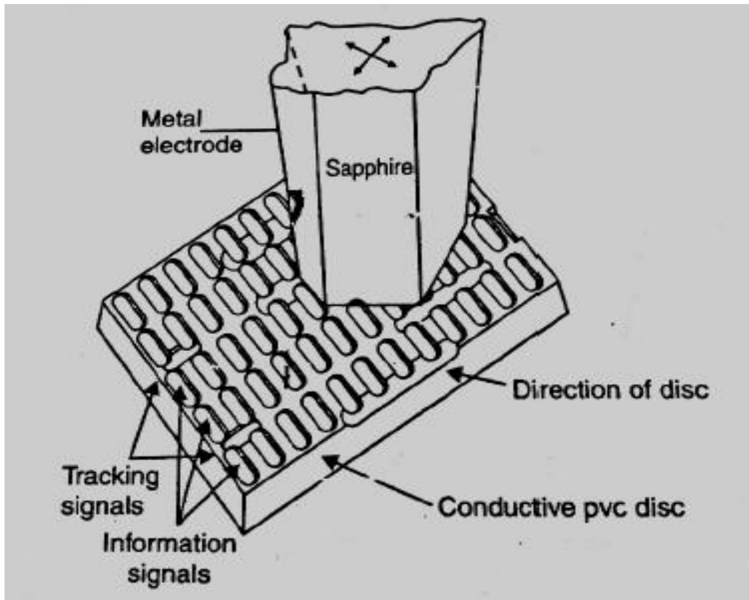


Figure.3.13 the JVC system

The JVC disc rotates at twice the speed of the RCA disc, and gives a playing time of one hour each side. It can also provide *instant replay* of selected short passages. *Freeze frame* is possible but not easy, for examples, it requires a memory to store one of the two frames recorded for each resolution of the disc.

Because there are no *grooves* and *no tracking stylus to follow them* the JVC electrode is required only to slide over a smooth disc surface and will doubtless have a *longer life* than any other system employing a stylus in groove. However, no one yet knows how long a disc wilt last, especially when used to display still frames with any contact system there is inevitably some abrasion.

Although the JVC system is relatively simple to construct, it requires *complex servo control system* which may put the price higher than the mechanically very simple RCA system.

3.10 VIDEO DISC SYSTEMS — A COMPARISON

Common to all video disc systems is the process in which a *program* (originally recorded on magnetic tape) is recorded on to a *master metal disc.* The metal master is then used to mass produce *plastic discs* which are PLAYED on the video dies player (V DP).

Plastic discs for the *laser video (L V) optical pick-up system* are coated with metal on one side (the recorded surface) and then *bonded* with the metal inside for protection. Carbon is added to discs for the two *capacitive pick-up systems.* CED and VHD, to make the disc conductive. A lubricant for smoothing the pick- up and reducing wear is added to the CED discs. This *lubricant* is necessary because the CED system has grooves on the disc for stylus tracking. This makes the CED system simpler (no servo tracking is required) but does produce some wear. However, the wear on a CED disc in no way compares with the wear of a *conventional* audio record. RCA demonstrated this by playing a single groove of a CED disc 9000 times without noticeable deterioration in the video display.

The three video disc systems also have similarities. All three systems use a plastic disc rotating on a turntable. In all the systems, the player picks up in formation represented by changes in the disc surface and converts the information into signals for playback on a television set. All systems use frequency modulation (FM) for both video and audio signals Each disk has a spiral track to carry the information rather than a series of circular tracks.

In spite of all the basic similarities, the systems differ not only in the pick-up technique (optical versus capacitive) but also in the format in which the information is encoded and in the method by which information is tracked Other differences include size, material, rotation speed and signal-protection schemes

3.11 RECORDING SYSTEM

In the optical video disc there is a single information track in which all the information is stored for the reproduction of a colour television program with two sound channels and data signals.

The nonlinearity of the master recording process limits the choice of possible encoding

Technique and a two-level signal recording was found to be the most attractive solution. On this track the information is enclosed in the length and the spacing of the pits or, in other words, for a routing disc in the repitition frequency, determined by the average length of the pits, and a pulse width modulation of the frequency determined by the modulation of the length of the pits. Figure.3.14.

The composite video signal employed in the video disc system is frequency modulated on a carrier at 8MHz which is pulse width modulated by two hi-fi audio channels at 2.3 MHz and 2.8 MHz.

Figure.3.15 shows the block diagram of the signal processing for coding the video and audio system. Before FM modulation of the video signal pre-emphasis time constant of 50µs and 12.5 µs are employed. The audio signal are FM modulated on carrier of 2.3MHz and 2.8 MHz with a frequency deviation of +100KHz and a pre-emphasis of 75 µs. The two audio carriers are summed with the FM carrier and after limiting, the output

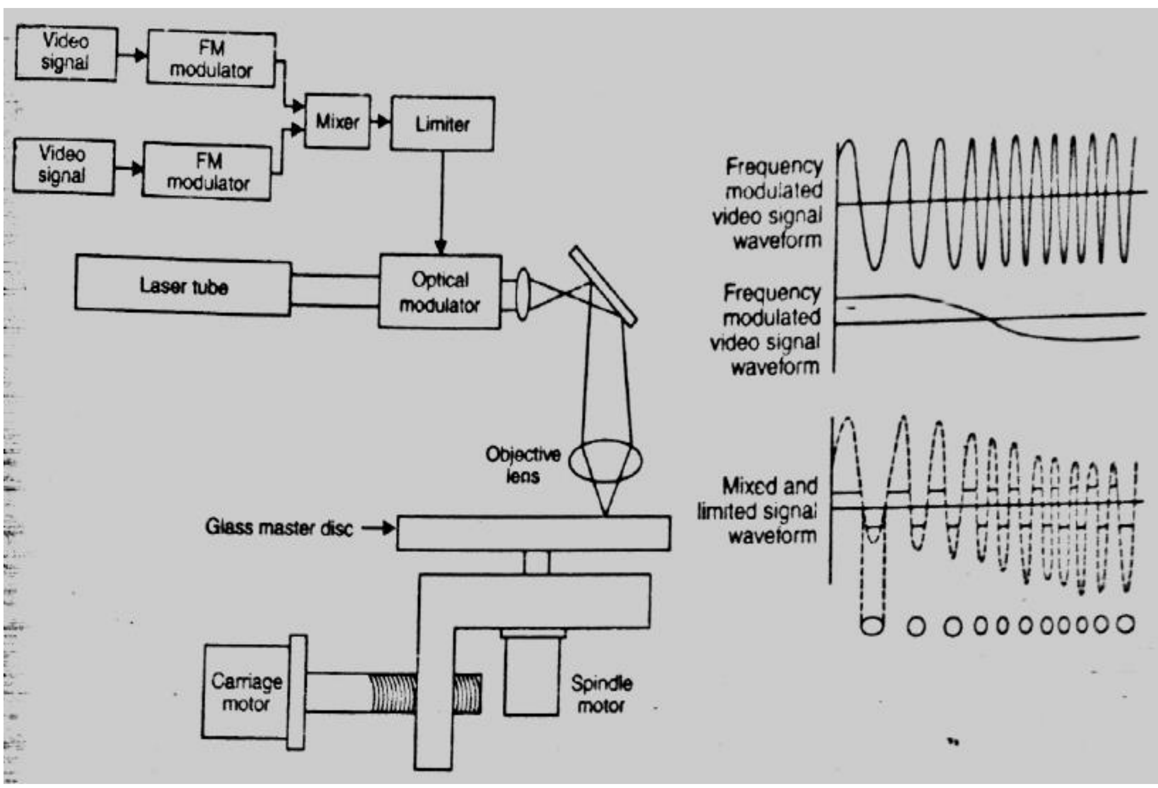


Figure.3.14 Video disc recording system

signal is used to modulate the intensity of a laser beam passing through an electrode optical modulator in the master recording machine.

The spectrum of video and audio signals. The master is used as a starting point for the production of disc.

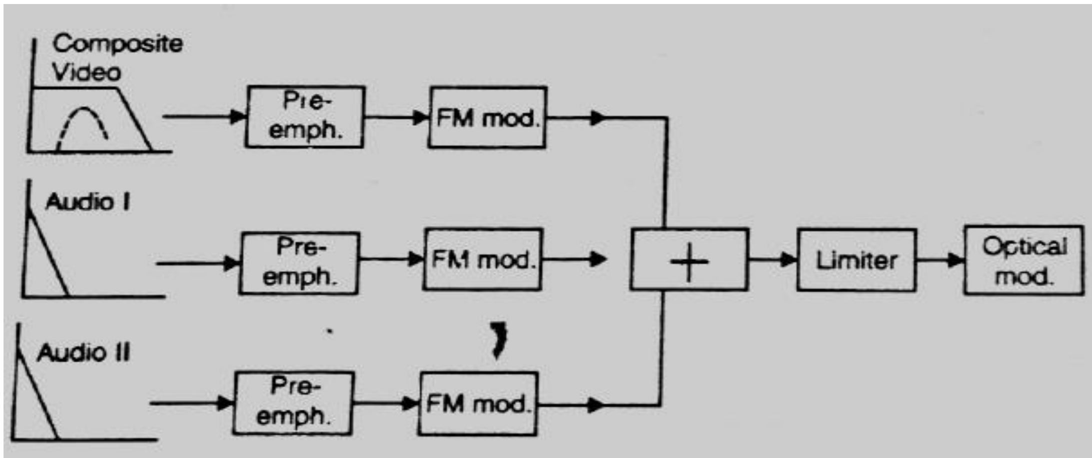


Figure.3.15 Signal processing-encoding

3.12 PLAY BACK SYSTEM

Reading back the information, the reflected light returning from the disc falls on a photodiode and its output is amplified *and corrected according* to the frequency characteristic of the player. A high-pass filter *separates* the video information and the filters have a crossover frequency at 3.5 MHz. The separated FM signals are then demodulated and a *de-emphasis* is applied to compensate for the *pre-emphasis* employed more recording, in order to achieve a better S/N ratio and a more uniform frequency response. The playback system shown in Figure.3.16.

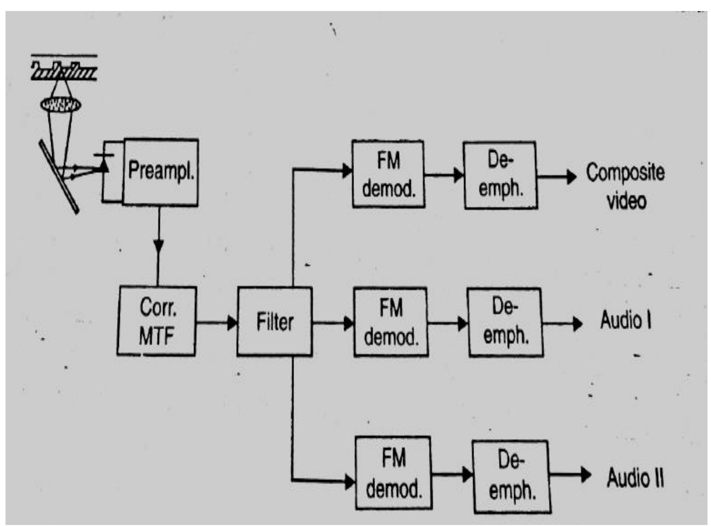


Figure.3.16 Signal processing decodings

UNIT IV

TELECOMMUNICATION SYSTEMS

THE PUBLIC SWITCHED TELEPHONE NETWORK

- The Public Switched Telephone Network (PSTN), also known as Plain Old Telephone Service (POTS), is the wired phone system over which landline telephone calls are made.
- The PSTN relies on circuit switching. To connect one phone to another, the phone call is routed through numerous switches operating on a local, regional, national or international level.
- In the early days, phone calls traveled as analog signals across copper wire. Every phone call needed its own dedicated copper wire connecting the two phones.
- The operators sat at a switchboard, literally connecting one piece of copper wire to another so that the call could travel across town or across the country.
- Long-distance calls were comparatively expensive, because you were renting the use of a very long piece of copper wire every time you made a call.
- Beginning in the 1960s, voice calls began to be digitized and manual switching was replaced by automated electronic switching. Digital voice signals can share the same wire with many other phone calls.
- The advent of fiber-optic cables now allows thousand of calls to share the same line. But fiber-optic and other high-bandwidth cables haven't changed the basic nature of circuit switching, which still requires a connection -- or circuit -- to remain open for the length of the phone call.

Routing calls requires multiple switching offices. The phone number itself is a coded map for routing the call. In the United States, for example, we have 10-digit phone numbers.

- The first three digits are the area code or national destination code (NDC), which helps route the call to the right regional switching station.
- The next three digits are the exchange, which represents the smallest amount of circuits that can be bundled on the same switch. In other words, when you make a call to another user in your same exchange -- maybe a neighbor around the corner -- the call doesn't have to be routed onto another switch.
- The last four digits of the phone number represent the subscriber number, which is tied to your specific address and phone lines.

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- The last four digits of the phone number represent the **subscriber number**, which is tied to your specific address and phone lines.
- Within a company or larger organization, each employee or department might have its own extension. Extensions from the main phone number are routed through something called a **private branch exchange (PBX)** that operates on the premises.
- To make an international call requires further instructions. The call needs to be routed through your long-distance phone carrier to another country's long-distance phone carrier. To signal such a switch, you have to dial two separate numbers, your country's **exit code** (or **international access code**) and the corresponding **country code** of the place you're calling.

Depending on geographical region, PSTN nodes are sometimes referred to by different names.

- **End Office (EO)—** Also called a Local Exchange. The End Office provides network access for the subscriber. It is located at the bottom of the network hierarchy.
- **Tandem—** Connects EOs together, providing an aggregation point for traffic between them. In some cases, the Tandem node provides the EO access to the next hierarchical level of the network.
- **Transit—** Provides an interface to another hierarchical network level. Transit switches are generally used to aggregate traffic that is carried across long geographical distances.
- There are two primary methods of connecting switching nodes. The first approach is a mesh topology, in which all nodes are interconnected. This approach does not scale well when you must connect a large number of nodes. Connect each new node to every existing node. This approach does have its merits, however; it simplifies routing traffic between nodes and avoids bottlenecks by involving only those switches that are in direct communication with each other.
- The second approach is a hierarchical tree in which nodes are aggregated as the hierarchy traverses from the subscriber access points to the top of the tree. PSTN networks use a combination of these two methods, which are largely driven by cost and the traffic patterns between exchanges.
- Figure 1 shows a generic PSTN hierarchy, in which End Offices are connected locally and through tandem switches. Transit switches provide further aggregation points for connecting multiple tandems between different networks. While actual network topologies vary, most follow some variation of this basic pattern.

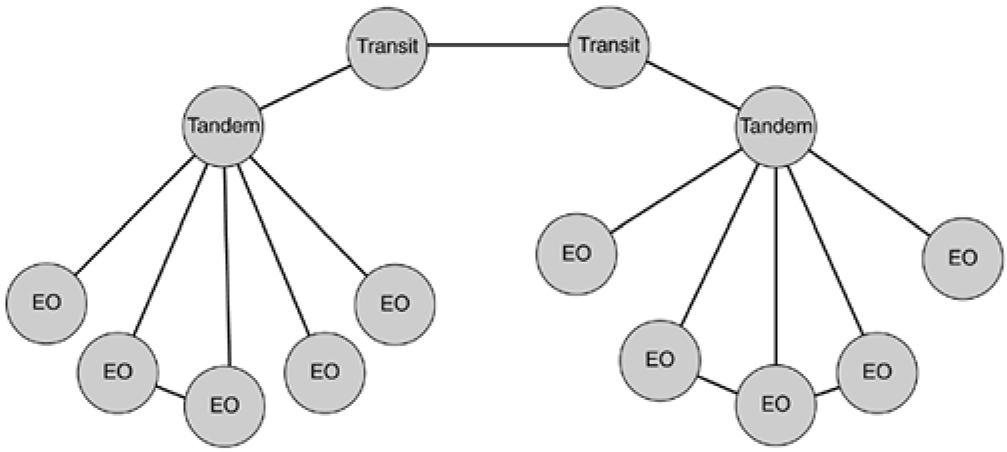

Fig.1. Hierarchy

SWITCHING PRINCIPLES

- Circuit Switching: A connection between the ingoing and outgoing segments of the transmission path is established on demand, for the exclusive use of a pair of end users until explicitly released.
- Message Switching: There does exist a permanent connection between each input and each output of the switch (like a fully connected matrix or shared memory).

PBX SWITCHING

- PBX stands for Private Branch Exchange, and each word has a very special meaning. "Private" and "branch" are fairly straightforward; private implies non-public, or something used by a single organization or group, while branch suggests some sort of remote subsidiary.
- However, both modify "exchange," and that is the most interesting word of all. In American telephony, the word "exchange" has no separate meaning in the professional literature, although an "exchange area" is usually defined as a geographical region in which telephone charges are uniform.
- In common usage, an exchange is sometimes taken to mean a telephone "central office" or CO, a telephone company building to which local customers are connected, although there may be several COs in an exchange area. Office, in turn, is further taken, incorrectly, to mean the switching system within the central office building that is used to connect one customer to another or to a trunk to another central office.
- In any event, a PBX, or Private Branch Exchange, is a (usually) small switching system on a customer's premises (remote from the telephone company's central office) and dedicated to the private use of that one business or organization.
- In recent years, "tenant service" in an office building or industrial park has permitted several organizations to share a PBX .

- A PBX differs from a central office switch in two very important ways: it must, in general, have somebody available to say "Good Morning, XYZ Company" and then complete the call. Then, if the call reaches the wrong person, some means must be provided to transfer that call to another extension.
- Central offices no longer have their own operators and, for many years, we have been conditioned to try again when we get a wrong number in the public telephone network.
- A key system may have fifty or more telephones associated with it, and many advanced features.
- However, there is a philosophical difference between a PBX and a key system: a PBX has a relatively high proportion of calling among telephones it serves, while a key system has most of its traffic with the outside world and is used very little for internal calling.
- An intercom system is like a PBX in many ways, and may use very similar equipment. However, an intercom system does not connect to the outside world. Intercoms are for internal use only.
- It is not uncommon for telephone designers to hold the belief that PBX systems are for relatively large customers, while key systems are for smaller business and institutional customers.
- A key system can render service without a PBX, but it is relatively difficult, as we will see, to render PBX service without key systems or something similar which performs their functions.
- One of the something similar is the so-called hybrid system. A hybrid looks like a key system in that it has multi-button telephone sets on user desks which can handle several lines, put calls on hold with a hold button, etc., but it is actually a small PBX with electronic telephone sets.
- The name "hybrid" was first applied in the early days of Interconnect when state PUCs permitted telephone companies to charge much higher rates for the same CO trunks if they served a PBX rather than a key system.
- Thus it became economically important not to call a small system a PBX, and various elaborate rationales were developed for the name hybrid.
- Centrex is another PBX competitor, more often than not at the large end of the customer size range. In a Centrex system, two features are added to basic PBX service: direct inward dialing (DID) (bypassing the switchboard attendant), and identified outward dialing (IOD).
- As originally offered, Centrex was divided into two types, depending on the serving vehicle: Centrex CO, using central office equipment, and Centrex CU, using a PBX modified to receive incoming calls from the public network via tie trunks rather than CO trunks.
- Obviously, any PBX that can handle tie trunks can handle DID from the CO. For years, however, very few COs could outpulse toward PBXs with information appropriate to identifying the called extension.
- A CO considers a PBX to be a piece of station equipment like a Princess Telephone; a telephone set has little reason to receive dialing information. Traditionally, a CO rings toward

station apparatus, and accepts dial pulses or DTMF signaling from the station. Thus only COs arranged for "line side out-pulsing" can provide DID service to PBXs.

ISDN (INTEGRATED SERVICES DIGITAL NETWORK):

- ISDN (Integrated Services Digital Network) is a set of CCITT/ITU standards for digital transmission over ordinary telephone copper wire as well as over other media. Home and business users who install an ISDN adapter (in place of a telephone modem) receive Web pages at up to 128 Kbps compared with the maximum 56 Kbps rate of a modem connection.

- ISDN requires adapters at both ends of the transmission so your access provider also needs an ISDN adapter. In many areas where DSL and cable modem service are now offered, ISDN is no longer as popular an option as it was formerly.

- There are two levels of service: the Basic Rate Interface (BRI), intended for the home and small enterprise, and the Primary Rate Interface (PRI), for larger users.

- Both rates include a number of B-channels and a D-channels. Each B-channel carries data, voice, and other services. Each D-channel carries control and signaling information.

- The Basic Rate Interface consists of two 64 Kbps B-channels and one 16 Kbps D- channel. Thus, a Basic Rate user can have up to 128 Kbps service. The Primary Rate consists of 23 B-channels and one 64 Kpbs.

- ISDN in concept is the integration of both analog or voice data together with digital data over the same network.

- Broadband ISDN (BISDN) is intended to extend the integration of both services throughout the rest of the end-to-end path using fiber optic and radio media.

- Broadband ISDN encompasses frame relay service for high-speed data that can be sent in large bursts, the Fiber Distributed-Data Interface (FDDI), and the Synchronous Optical Network (SONET). BISDN is intended to support transmission from 2 Mbps up to much higher, but as yet unspecified, rates.

- Integrated Services Digital Network (ISDN) is a set of communications standards for simultaneous digital transmission of voice, video, data, and other network services over the traditional circuits of the public switched telephone network.

- Prior to ISDN, the telephone system was viewed as a way to transport voice, with some special services available for data.
- The key feature of ISDN is that it integrates speech and data on the same lines, adding features that were not available in the classic telephone system. There are several kinds of access interfaces to ISDN defined as Basic Rate Interface (BRI), Primary Rate Interface (PRI) andBroadband ISDN (B-ISDN).

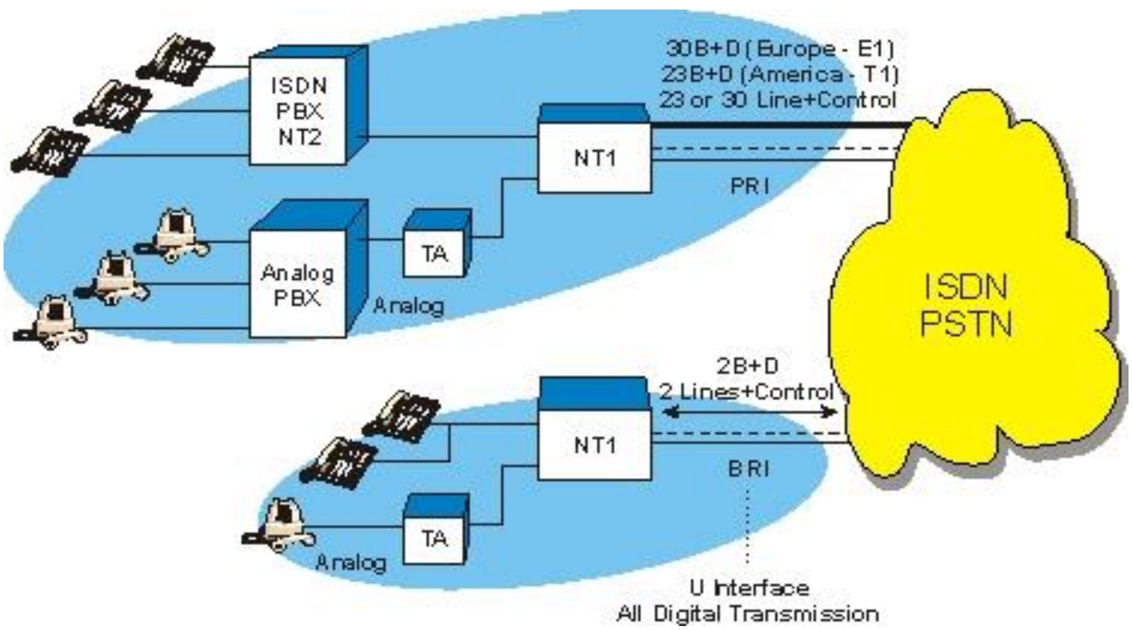

Fig.2.ISDN Network

ISDN ELEMENTS:

- Integrated services refers to ISDN's ability to deliver at minimum two simultaneous connections, in any combination of data, voice, video, and fax, over a single line. Multiple devices can be attached to the line, and used as needed.
- An ISDN line can take care of most people's complete communications needs (apart from broadband Internet access and entertainment television) at a much higher transmission rate, without forcing the purchase of multiple analog phone lines.
- It also refers to integrated switching and transmission in that telephone switching and carrier wave transmission are integrated rather than separate as in earlier technology.

BASIC RATE INTERFACE:

- The entry level interface to ISDN is the Basic(s) Rate Interface (BRI), a 128 kbit/s service delivered over a pair of standard telephone copper wires.

- The 144 kbit/s payload rate is broken down into two 64 kbit/s bearer channels ('B' channels) and one 16 kbit/s signaling channel ('D' channel or delta channel). This is sometimes referred to as 2B+D.

The interface specifies the following network interfaces:

- The U interface is a two-wire interface between the exchange and a network terminating unit, which is usually the demarcation point in non-North American networks.
- The T interface is a serial interface between a computing device and a terminal adapter, which is the digital equivalent of a modem.
- The S interface is a four-wire bus that ISDN consumer devices plug into; the S & T reference points are commonly implemented as a single interface labeled 'S/T' on an Network termination 1 (NT1).
- The R interface defines the point between a non-ISDN device and a terminal adapter (TA) which provides translation to and from such a device.

PRIMARY RATE INTERFACE:

- The other ISDN access available is the Primary Rate Interface (PRI), which is carried over an E1 (2048 kbit/s) in most parts of the world. An E1 is 30 'B' channels of 64 kbit/s, one 'D' channel of 64 kbit/s and a timing and alarm channel of 64 kbit/s.
- PRI service is delivered on one or more T1 carriers (often referred to as 23B+D) of 1544 kbit/s (24 channels). A PRI has 23 'B' channels and 1 'D' channel for signalling (Japan uses a circuit called a J1, which is similar to a T1).
- A PRI is referred to as T1 because it uses the T1 carrier format. A true T1 or commonly called 'Analog T1' to avoid confusion uses 24 channels of 64 kbit/s of in-band signaling. Each channel uses 56 kb for data and voice and 8 kb for signaling and messaging.
- PRI uses out of band signaling which provides the 23 B channels with clear 64 kb for voice and data and one 64 kb 'D' channel for signaling and messaging.
- D-channel backup allows for a second D channel in case the primary fails. NFAS is commonly used on a T3.
- Even though many network professionals use the term "ISDN" to refer to the lower-bandwidth BRI circuit.

DATA CHANNEL:

- The bearer channel (B) is a standard 64 kbit/s voice channel of 8 bits sampled at 8 kHz with G.711 encoding. B-Channels can also be used to carry data, since they are nothing more than digital channels.
- Each one of these channels is known as a DS0.
- Most B channels can carry a 64 kbit/s signal, but some were limited to 56K because they traveled over RBS lines. This was commonplace in the 20th century, but has since become less so.

SIGNALING CHANNEL

The signaling channel (D) uses Q.931 for signaling with the other side of the link.

GSM

A GSM network comprises of many functional units. These functions and interfaces are explained in this chapter. The GSM network can be broadly divided into:

- The Mobile Station (MS)
- The Base Station Subsystem (BSS)
- The Network Switching Subsystem (NSS)
- The Operation Support Subsystem (OSS)

The additional components of the GSM architecture comprise of databases and messaging systems functions:

- Home Location Register (HLR)
- Visitor Location Register (VLR)
- Equipment Identity Register (EIR)
- Authentication Center (AuC)
- SMS Serving Center (SMS SC)
- Gateway MSC (GMSC)
- Chargeback Center (CBC)
- Transcoder and Adaptation Unit (TRAU)

The following diagram shows the GSM network along with the added elements:

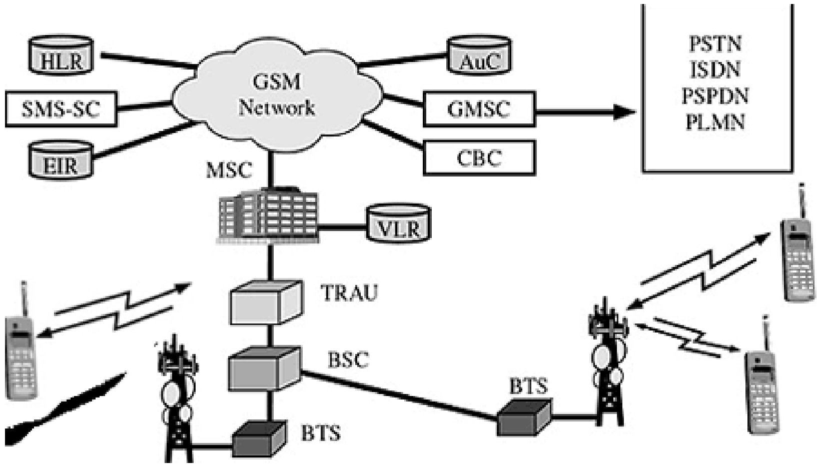

Fig.3.GSM Network

The MS and the BSS communicate across the Um interface. It is also known as the *air interface* or the *radio link*. The BSS communicates with the Network Service Switching (NSS) center across the *A* interface.

GSM network areas

In a GSM network, the following areas are defined:

- **Cell** : Cell is the basic service area; one BTS covers one cell. Each cell is given a Cell Global Identity (CGI), a number that uniquely identifies the cell.
- **Location Area** : A group of cells form a Location Area (LA). This is the area that is paged when a subscriber gets an incoming call. Each LA is assigned a Location Area Identity (LAI). Each LA is served by one or more BSCs.
- **MSC/VLR Service Area** : The area covered by one MSC is called the MSC/VLR service area.
- **PLMN** : The area covered by one network operator is called the Public Land Mobile Network (PLMN). A PLMN can contain one or more MSCs.

The requirements for different Personal Communication Services (PCS) systems differ for each PCS network. Vital characteristics of the GSM specification are listed below:

Modulation

Modulation is the process of transforming the input data into a suitable format for the transmission medium. The transmitted data is demodulated back to its original form at the receiving end. The GSM uses Gaussian Minimum Shift Keying (GMSK) modulation method.

Access Methods

- Radio spectrum being a limited resource that is consumed and divided among all the users, GSM devised a combination of TDMA/FDMA as the method to divide the bandwidth among the users. In this process, the FDMA part divides the frequency of the total 25 MHz bandwidth into 124 carrier frequencies of 200 kHz bandwidth.
- Each BS is assigned with one or multiple frequencies, and each of this frequency is divided into eight timeslots using a TDMA scheme. Each of these slots are used for both transmission as well as reception of data. These slots are separated by time so that a mobile unit doesn't transmit and receive data at the same time.

Transmission Rate

The total symbol rate for GSM at 1 bit per symbol in GMSK produces 270.833 K symbols/second. The gross transmission rate of a timeslot is 22.8 Kbps. GSM is a digital system with an over-the-air bit rate of 270 kbps.

Frequency Band

The uplink frequency range specified for GSM is 933 - 960 MHz (basic 900 MHz band only). The downlink frequency band 890 - 915 MHz (basic 900 MHz band only).

Channel Spacing

Channel spacing indicates the spacing between adjacent carrier frequencies. For GSM, it is 200 kHz.

Speech Coding

For speech coding or processing, GSM uses Linear Predictive Coding (LPC). This tool compresses the bit rate and gives an estimate of the speech parameters. When the audio signal passes through a filter, it mimics the vocal tract. Here, the speech is encoded at 13 kbps.

Duplex Distance

Duplex distance is the space between the uplink and downlink frequencies. The duplex distance for GSM is 80 MHz, where each channel has two frequencies that are 80 MHz apart.

- Frame duration : 4.615 mS

- Duplex Technique : Frequency Division Duplexing (FDD) access mode previously known as WCDMA.
- Speech channels per RF channel : 8.

The International Mobile Station Equipment Identity (IMEI) looks more like a serial number which distinctively identifies a mobile station internationally. This is allocated by the equipment manufacturer and registered by the network operator, who stores it in the Entrepreneurs-in-Residence (EIR). By means of IMEI, one recognizes obsolete, stolen, or non-functional equipment.

Following are the parts of IMEI:

- **Type Approval Code (TAC)** : 6 decimal places, centrally assigned.
- **Final Assembly Code (FAC)** : 6 decimal places, assigned by the manufacturer.
- **Serial Number (SNR)** : 6 decimal places, assigned by the manufacturer.
- **Spare (SP)** : 1 decimal place.

Thus, IMEI = TAC + FAC + SNR + SP. It uniquely characterizes a mobile station and gives clues about the manufacturer and the date of manufacturing.

International Mobile Subscriber Identity (IMSI)

Every registered user has an original International Mobile Subscriber Identity (IMSI) with a valid IMEI stored in their Subscriber Identity Module (SIM).

IMSI comprises of the following parts:

- **Mobile Country Code (MCC)** : 3 decimal places, internationally standardized.
- **Mobile Network Code (MNC)** : 2 decimal places, for unique identification of mobile network within the country.
- **Mobile Subscriber Identification Number (MSIN)** : Maximum 10 decimal places, identification number of the subscriber in the home mobile network.

Mobile Subscriber ISDN Number (MSISDN)

The authentic telephone number of a mobile station is the Mobile Subscriber ISDN Number (MSISDN). Based on the SIM, a mobile station can have many MSISDNs, as each subscriber is assigned with a separate MSISDN to their SIM respectively.

Listed below is the structure followed by MSISDN categories, as they are defined based on international ISDN number plan:

- **Country Code (CC)** : Up to 3 decimal places.
- **National Destination Code (NDC)** : Typically 2-3 decimal places.
- **Subscriber Number (SN)** : Maximum 10 decimal places.

Mobile Station Roaming Number (MSRN)

Mobile Station Roaming Number (MSRN) is an interim location dependent ISDN number, assigned to a mobile station by a regionally responsible Visitor Location Register (VLA). Using MSRN, the incoming calls are channelled to the MS.

The MSRN has the same structure as the MSISDN.

- **Country Code (CC)** : of the visited network.
- **National Destination Code (NDC)** : of the visited network.
- **Subscriber Number (SN)** : in the current mobile network.

Location Area Identity (LAI)

Within a PLMN, a Location Area identifies its own authentic Location Area Identity (LAI). The LAI hierarchy is based on international standard and structured in a unique format as mentioned below:

- **Country Code (CC)** : 3 decimal places.
- **Mobile Network Code (MNC)** : 2 decimal places.
- **Location Area Code (LAC)** : maximum 5 decimal places or maximum twice 8 bits coded in hexadecimal (LAC < FFFF).

Temporary Mobile Subscriber Identity (TMSI)

Temporary Mobile Subscriber Identity (TMSI) can be assigned by the VLR, which is responsible for the current location of a subscriber. The TMSI needs to have only local significance in the area handled by the VLR. This is stored on the network side only in the VLR and is not passed to the Home Location Register (HLR).

Local Mobile Subscriber Identity (LMSI)

Each mobile station can be assigned with a Local Mobile Subscriber Identity (LMSI), which is an original key, by the VLR. This key can be used as the auxiliary searching key for each mobile station within its region. It can also help accelerate the database access. An LMSI is assigned if the mobile station is registered with the VLR and sent to the HLR. LMSI comprises of four octets (4x8 bits).

Cell Identifier (CI)

Using a Cell Identifier (CI) (maximum 2 × 8) bits, the individual cells that are within an LA can be recognized.

GPRS

GPRS architecture works on the same procedure like GSM network, but, has additional entities that allow packet data transmission. This data network overlaps a second-generation GSM network providing packet data transport at the rates from 9.6 to 171 kbps. Along with the packet data transport the GSM network accommodates multiple users to share the same air interface resources concurrently.

Following is the GPRS Architecture diagram:

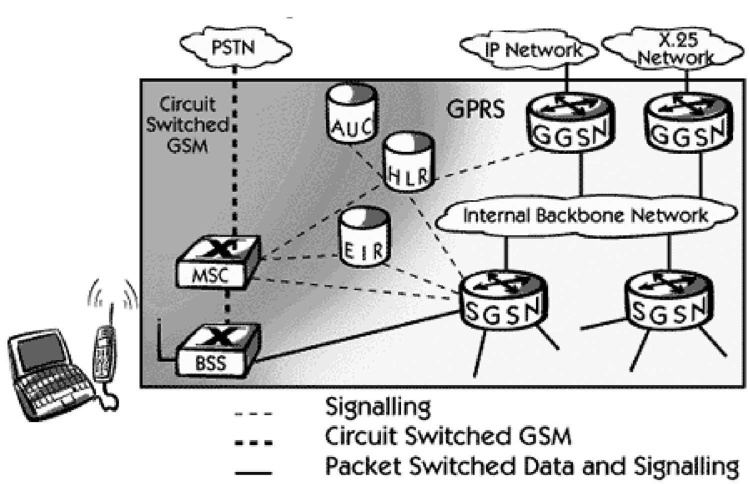

Fig.4.GPRS

GPRS attempts to reuse the existing GSM network elements as much as possible, but to effectively build a packet-based mobile cellular network, some new network elements, interfaces, and protocols for handling packet traffic are required.

Therefore, GPRS requires modifications to numerous GSM network elements as summarized below:

GSM Network Element	**Modification or Upgrade Required for GPRS.**
Mobile Station (MS)	New Mobile Station is required to access GPRS services. These new terminals will be backward compatible with GSM for voice calls.
BTS	A software upgrade is required in the existing Base Transceiver Station(BTS).
BSC	The Base Station Controller (BSC) requires a software upgrade and the installation of new hardware called the packet control unit (PCU). The PCU directs the data traffic to the GPRS network and can be a separate hardware element associated with the BSC.
GPRS Support Nodes (GSNs)	The deployment of GPRS requires the installation of new core network elements called the serving GPRS support node (SGSN) and gateway GPRS support node (GGSN).
Databases (HLR, VLR, etc.)	All the databases involved in the network will require software upgrades to handle the new call models and functions introduced by GPRS.

GPRS Mobile Stations

New Mobile Stations (MS) are required to use GPRS services because existing GSM phones do not handle the enhanced air interface or packet data. A variety of MS can exist, including a high-speed version of current phones to support high-speed data access, a new PDA device with an embedded GSM phone, and PC cards for laptop computers. These mobile stations are backward compatible for making voice calls using GSM.

GPRS Base Station Subsystem

Each BSC requires the installation of one or more Packet Control Units (PCUs) and a software upgrade. The PCU provides a physical and logical data interface to the Base Station Subsystem (BSS) for packet data traffic. The BTS can also require a software upgrade but typically does not require hardware enhancements.

GPRS Support Nodes

Following two new components, called Gateway GPRS Support Nodes (GSNs) and, Serving GPRS Support Node (SGSN) are added.

Gateway GPRS Support Node (GGSN)

The Gateway GPRS Support Node acts as an interface and a router to external networks. It contains routing information for GPRS mobiles, which is used to tunnel packets through the IP based internal backbone to the correct Serving GPRS Support Node. The GGSN also collects charging information connected to the use of the external data networks and can act as a packet filter for incoming traffic.

Serving GPRS Support Node (SGSN)

The Serving GPRS Support Node is responsible for authentication of GPRS mobiles, registration of mobiles in the network, mobility management, and collecting information on charging for the use of the air interface.

Internal Backbone

The internal backbone is an IP based network used to carry packets between different GSNs. Tunnelling is used between SGSNs and GGSNs, so the internal backbone does not need any information about domains outside the GPRS network. Signalling from a GSN to a MSC, HLR or EIR is done using SS7.

GPRS LAYERS

The flow of GPRS protocol stack and end-to-end message from MS to the GGSN is displayed in the below diagram. GTP is the protocol used between the SGSN and GGSN using the Gn interface. This is a Layer 3 tunneling protocol.

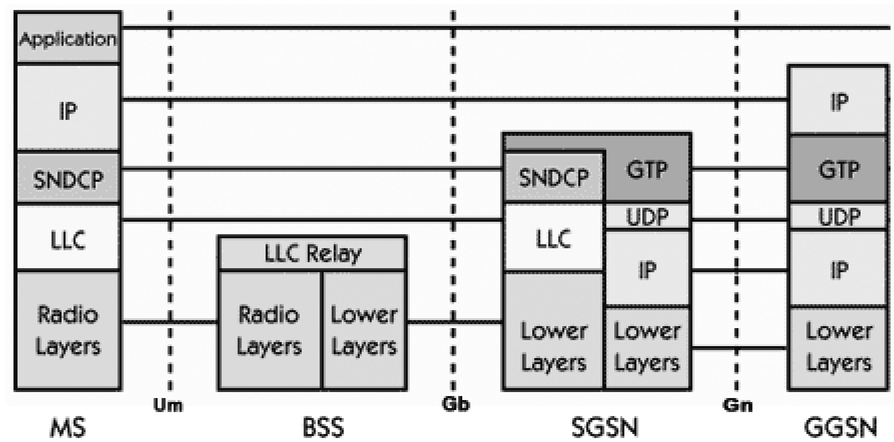

Fig.5.GPRS LAYERS

- The process that takes place in the application looks like a normal IP sub-network for the users both inside and outside the network. The vital thing that needs attention is, the application communicates via standard IP, that is carried through the GPRS network and out through the gateway GPRS.
- The packets that are mobile between the GGSN and the SGSN use the GPRS tunneling protocol, this way the IP addresses located on the external side of the GPRS network do not have deal with the internal backbone. UDP and IP are run by GTP.
- SubNetwork Dependent Convergence Protocol (SNDCP) and Logical Link Control (LLC) combination used in between the SGSN and the MS. The SNDCP flattens data to reduce the load on the radio channel. A safe logical link by encrypting packets is provided by LLC and the same LLC link is used as long as a mobile is under a single SGSN.
- In case, the mobile moves to a new routing area that lies under a different SGSN; then, the old LLC link is removed and a new link is established with the new Serving GSN X.25. Services are provided by running X.25 on top of TCP/IP in the internal backbone.

QoS

Quality of Service (QoS) requirements of conventional mobile packet data applications are in assorted forms. The QoS is a vital feature of GPRS services as there are different QoS support requirements for assorted GPRS applications like realtime multimedia, web browsing, and e-mail transfer.

GPRS allows defining QoS profiles using the following parameters :

- Service Precedence
- Reliability

- Delay and
- Throughput

These parameters are described below:

Service Precedence

The preference given to a service when compared to another service is known as **Service Precedence**.This level of priority is classified into three levels called:

- High
- Normal
- Low

When there is network congestion, the packets of low priority are discarded as compared to high or normal priority packets.

Reliability

This parameter signifies the transmission characteristics required by an application.The reliability classes are defined which guarantee certain maximum values for the probability of loss, duplication, mis-sequencing, and corruption of packets.

Delay

- The delay is defined as the end-to-end transfer time between two communicating mobile stations or between a mobile station and the GI interface to an external packet data network.
- This includes all delays within the GPRS network, e.g., the delay for request and assignment of radio resources and the transit delay in the GPRS backbone network. Transfer delays outside the GPRS network, e.g., in external transit networks, are not taken into account.

Throughput

- The throughput specifies the maximum/peak bit rate and the mean bit rate.
- Using these QoS classes, QoS profiles can be negotiated between the mobile user and the network for each session, depending on the QoS demand and the available resources.
- The billing of the service is then based on the transmitted data volume, the type of service, and the chosen QoS profile.

DECT (Digital Enhanced Cordless Telecommunications)

- This technology is widely used for residential, and business cordless phone communications. Designed for short-range use as an access mechanism to the main networks.
- DECT technology offers cordless voice, fax, data and multimedia communications, wireless local area networks and wireless PBX.
- With the flexibility offered by cordless phone communications, DECT technology has become the major standard for this application and DECT is now in use in over 100 countries worldwide.

DECT technology development

- The standard for DECT or Digital Enhanced Telecommunications system was developed by members of the European Telecommunications Standards Institute (ETSI). The first release of the standard was available in 1992 after which much of the work was focused on inter-working protocols (DECT / GSM, DECT/ISDN, etc).
- As a result of this work, DECT / GSM inter-working has been standardized and the basic GSM services can be provided over the DECT air interface.
- This enables DECT terminals to inter-work with DECT systems which are connected to the GSM infrastructure. All roaming scenarios based on SIM roaming as described in GSM specifications are applicable.
- Along with requirements arising from the growing use of DECT, this work gave rise to a number of extensions to the basic DECT standard. This led to a second release of the standard at the end of 1995.
- This included facilities including : emergency call procedures, definition of the Wireless Relay Station (WRS), and an optional direct portable to portable communication feature.

DECT codecs

- The basic telephony speech quality offered by DECT is very high compared to many other wireless systems. This is the result of the use of the ITU-T Recommendation G.726 codec that is employed.
- This is a 32 kbit/s ADPCM speech codec and although it uses 32 kbps, the quality it affords is high and there is more than sufficient bandwidth within the system to support it.

TDMA structure

- The DECT TDMA structure enables up to 12 simultaneous basic voice connections per transceiver. The system is also able to provide widely varying bandwidths by combining multiple channels into a single bearer.
- For data transmission purposes error protected net throughput rates of integral multiples of 24 kbps can be achieved. However the DECT standard defines a maximum data rate of 552 kbps with full security.

DECT GAP profile

- All DECT systems are based on a main standard that is the Common Interface (CI), which is often used in association with the Generic Access Profile (GAP). The GAP profile ensures interoperability of equipment from different providers for voice applications.
- The GAP defines the minimum interoperability requirements including mobility management and security features. It has different requirements on public and private systems.
- This means that the GAP is effectively the industry standard for a basic fall-back speech service with mobility management. This basic service is not always used, but instead it forms the fallback that is always be available, especially when requested by a roaming phone, etc

UMTS

- 3GPP UMTS, the Universal Mobile Telecommunications System is the third generation (3G) successor to the second generation GSM based cellular technologies which also include GPRS, and EDGE.
- Although UMTS uses a totally different air interface, the core network elements have been migrating towards the UMTS requirements with the introduction of GPRS and EDGE.
- In this way the transition from GSM to the 3G UMTS architecture did not require such a large instantaneous investment.
- UMTS uses Wideband CDMA (WCDMA / W-CDMA) to carry the radio transmissions, and often the system is referred to by the name WCDMA. It is also gaining a third name.

3GPP UMTS Specifications and Management

- In order to create and manage a system as complicated as UMTS or WCDMA it is necessary to develop and maintain a large number of documents and specifications.

- For UMTS or WCDMA, these are now managed by a group known as 3GPP - the Third Generation Partnership Programme. This is a global co-operation between six organisational partners - ARIB, CCSA, ETSI, ATIS, TTA and TTC.
- The scope of 3GPP was to produce globally applicable Technical Specifications and Technical Reports for a 3rd Generation Mobile Telecommunications System.
- This would be based upon the GSM core networks and the radio access technologies that they support (i.e., Universal Terrestrial Radio Access (UTRA) both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) modes).
- Since it was originally formed, 3GPP has also taken over responsibility for the GSM standards as well as looking at future developments including LTE (Long Term Evolution) and the 4G technology known as LTE Advanced.

3G UMTS capabilities

- UMTS uses Wideband CDMA - WCDMA - as the radio transmission standard. It employs a 5 MHz channel bandwidth. Using this bandwidth it has the capacity to carry over 100 simultaneous voice calls, or it is able to carry data at speeds up to 2 Mbps in its original format.
- However with the later enhancements of HSDPA and HSUPA (described in other articles accessible from the cellular telecommunications menu page) included in later releases of the standard the data transmission speeds have been increased to 14.4 Mbps.
- Many of the ideas that were incorporated into GSM have been carried over and enhanced for UMTS. Elements such as the SIM have been transformed into a far more powerful USIM (Universal SIM).
- In addition to this, the network has been designed so that the enhancements employed for GPRS and EDGE can be used for UMTS. In this way the investment required is kept to a minimum.
- A new introduction for UMTS is that there are specifications that allow both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) modes.
- The first modes to be employed are FDD modes where the uplink and downlink are on different frequencies. The spacing between them is 190 MHz for Band 1 networks being currently used and rolled out.
- However the TDD mode where the uplink and downlink are split in time with the base stations and then the mobiles transmitting alternately on the same frequency is particularly suited to a variety of applications.
- Obviously where spectrum is limited and paired bands suitably spaced are not available. It also performs well where small cells are to be used. As a guard time is required between transmit

and receive, this will be smaller when transit times are smaller as a result of the shorter distances being covered.

- A further advantage arises from the fact that it is found that far more data is carried in the downlink as a result of internet surfing, video downloads and the like. This means that it is often better to allocate more capacity to the downlink. Where paired spectrum is used this is not possible.
- However when a TDD system is used it is possible to alter the balance between downlink and uplink transmissions to accommodate this imbalance and thereby improve the efficiency. In this way TDD systems can be highly efficient when used in picocells for carrying Internet data.
- The TDD systems have not been widely deployed, but this may occur more in the future. In view of its character, it is often referred to as TD-CDMA (Time Division CDMA).

3G UMTS / WCDMA technologies

There are several key areas of 3G UMTS / WCDMA. Within these there are several key technologies that have been employed to enable UMTS / WCDMA to provide a leap in performance over its 2G predecessors.

Some of these key areas include:

- ***Radio interface:*** The UMTS radio interface provides the basic definition of the radio signal. W-CDMA occupies 5 MHz channels and has defined formats for elements such as synchronisation, power control and the like *Read more about the* ***UMTS / W-CDMA radio interface***.
- ***CDMA technology :*** 3G UMTS relies on a scheme known as CDMA or code divison multiple access to enable multiple handsets or user equipments to have access to the base station. Using a scheme known as direct sequence spread spectrum, different UEs have different codes and can all talk to the base station even though they are all on the same frequency *Read more about the* ***code division multiple access***.
- ***UMTS network architecture:*** The architecture for a UMTS network was designed to enable packet data to be carried over the network, whilst still enabling it to support circuit switched voice. All the usual functions enabling access toth e network, roaming and the like are also supported. *Read more about the* ***UMTS network architecture***.
- ***UMTS modulation schemes:*** Within the CDMA signal format, a variety of forms of modulation are used. These are typically forms of phase shift keying. *Read more about the* ***modulation schemes***.

- ***UMTS channels:*** As with any cellular system, different data channels are required for passing payload data as well as control information and for enabling the required resources to be allocated.
- ***UMTS TDD:*** There are two methods of providing duplex for 3G UMTS. One is what is termed frequency division duplex, FDD. This uses two channels spaced sufficiently apart so that the receiver can receive whilst the transmitter is also operating. Another method is to use time vision duplex, TDD where short time blocks are allocated to transmissions in both directions. Using this method, only a single channel is required
- ***Handover:*** One key area of any cellular telecommunications system is the handover (handoff) from one cell to the next. Using CDMA there are several forms of handover that are implemented within the system.

3G UMTS enhancements

- The basic 3G UMTS cellular system enabled data rates up to 2048kbps to be achieved. However as the use of data rapidly increased, these figures were no longer sufficient and further data rate increases were required.
- A scheme known as HSDPA, high speed packet download access was first introduced to enable the downlink speed to be increased. This was followed with HSUPA, high speed packet uplink access was introduced. The combined suite was then known as HSPA, high speed packet access.
- The UMTS WCDMA system offered a significant improvement in capability over the previous 2G services.

IMT

- *International Mobile Telecommunications for the year 2000* (IMT-2000) is a worldwide set of requirements for a family of standards for the 3rd generation of mobile communications. The IMT-2000 "umbrella specifications" are developed by the International Telecommunicatons Union (ITU).
- Originally it was the intention to have only one truly global standard but that turned out to be impossible. IMT-2000 should provide worldwide mobile broadband multimedia services via a single global frequency band. The frequency range should be around 2000 MHz.

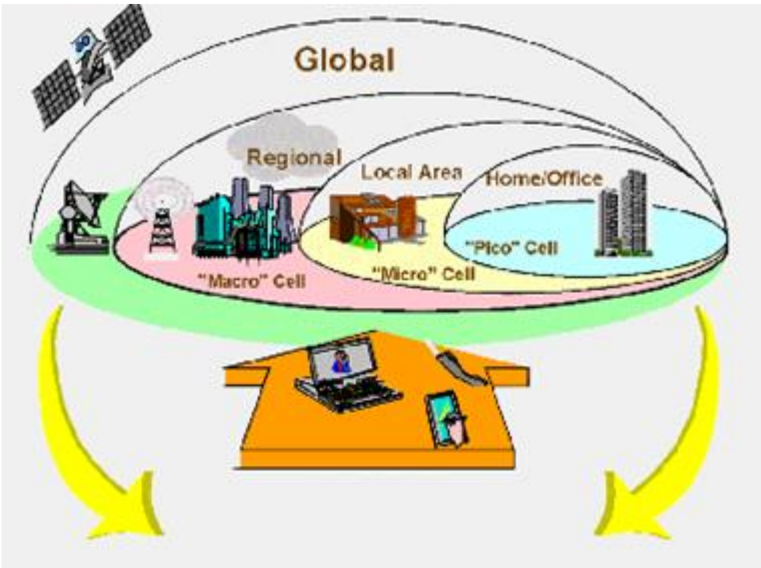

Fig.6.IMT2000

In the umbrella specification a number of characteristics are defined which the underying technologies should meet. The main characteristics are:

- Worldwide usage, integration of satellite and terrestrial systems to provide global coverage;
- Used for all radio environments, (LAN, cordless, cellular, satellite);
- Wide range of telecommunications services,(voice, data, multimedia, internet);
- Support both packet-switched (PS) and circuit-switched (CS) data transmission;
- Offer high data rates up to 2 Mbps,
  - 144 kbps for high mobility,
  - 384 kbps with restricted mobility and,
  - 2 Mbps in an indoor office environment;
- Offer high spectrum efficiency.

For the terrestrial mobile network, there are six family members identified as being IMT-2000 compatible:

- IMT Direct Spread (IMT-DS; also known as UMTS/UTRA-FDD);
- IMT Multicarrier (IMT-MC; also known as CDMA2000);
- IMT Time Code (IMT-TC; also known as UMTS/UTRA-TDD, TD-CDMA and TD-SCDMA “narrowband TDD”);
- IMT Single Carrier (IMT-SC; also known as UWC-136 or EDGE);
- IMT Frequency Time (IMT-FT; also known as DECT).
- IMT OFDMA TDD WMAN (also known as mobile WiMAX)

Frequency bands

The frequency bands 1885-2025 MHz and 2110-2200 MHz were identified for IMT-2000 by the ITU in 1992. Terrestrial IMT-2000 networks will operate in the following bands:

- 1920 – 1980 MHz paired with 2110 - 2170 MHz, FDD with mobile stations transmitting in the lower sub-band.
- 1885 - 1920 MHz and 2010 - 2025 MHz, unpaired for TDD operation.
- In Europe is the TDD band from 1885-1900 MHz not available for licenses use of IMT-2000, this is used by cordless telephony (DECT).
- In addition to this core-band the frequency band 2500 to 2690 MHz was identified in 2000, of which the edges, ranging from 2500-2520 and 2670-2690 MHz, are at first identified for satellite communications.
- Existing second generation bands (including GSM bands) 806 to 960 MHz, 1429 to 1501 MHz and 1710 to 1885 MHz are also identified for IMT-2000 in the long term.

CORDLESS PHONES

- A **cordless telephone** or **portable telephone** replaces the handset cord with a radio link. The handset communicates with a base station connected to a fixed telephone line.
- The range is limited, usually to the same building or some short distance from the base station. The base station attaches to the telephone network the same way a corded telephone does.
- The base station on subscriber premises is what differentiates a cordless telephone from a mobile telephone.
- Current cordless telephone standards, such as PHS and DECT, have blurred the once clear-cut line between cordless and mobile telephones by implementing cell handoff (handover); various advanced features, such as data-transfer; and even, on a limited scale, international roaming. In specialized models, base stations are maintained by a commercial mobile network operator and users subscribe to the service.
- In 1994, digital cordless phones in the 900 MHz frequency range were introduced. Digital signals allowed the phones to be more secure and decreased eavesdropping—it was relatively easy to eavesdrop on analog cordless phone conversations.
- In 1995, digital spread spectrum (DSS) was introduced for cordless phones. This technology enabled the digital information to spread in pieces among multiple frequencies between the receiver and the base, thereby making it almost impossible to eavesdrop on the cordless conversations.

- Unlike a corded telephone, a cordless telephone needs mains electricity to power the base station. The cordless handset is powered by a rechargeable battery, which is charged when the handset is stored in its cradle.

FACSIMILE

- A **facsimile** (from Latin *fac simile* ('make alike'), a spelling that remained in currency until the late 19th century) is a copy or reproduction of an old book, manuscript, map, art print, or other item of historical value that is as true to the original source as possible.
- It differs from other forms of reproduction by attempting to replicate the source as accurately as possible in scale, color, condition, and other material qualities. For books and manuscripts, this also entails a complete copy of all pages; hence, an incomplete copy is a "partial facsimile".
- Facsimiles are sometimes used by scholars to research a source that they do not have access to otherwise, and by museums and archives for media preservation and conservation. Many are sold commercially, often accompanied by a volume of commentary.
- They may be produced in limited editions, typically of 500–2,000 copies, and cost the equivalent of a few thousand United States dollars.

WiFi

Wi-Fi is the name of a popular wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections. A common misconception is that the term Wi-Fi is short for "*wireless fidelity*," however this is not the case. Wi-Fi is simply a trademarked phrase that means *IEEE 802.11x*.

The Wi-Fi Alliance

The Wi-Fi Alliance, the organization that owns the Wi-Fi registered trademark term specifically defines Wi-Fi as any "*wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards.*"

Initially, Wi-Fi was used in place of only the 2.4GHz 802.11b standard, however the Wi-Fi Alliance has expanded the generic use of the Wi-Fi term to include any type of network or WLAN product based on any of the 802.11 standards, including 802.11b, 802.11a, dual-band, and so on, in an attempt to stop confusion about wireless LAN interoperability.

Wi-Fi Working Principle

Wi-Fi works with no physical wired connection between sender and receiver by using radio frequency (RF) technology, a frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space.

The cornerstone of any wireless network is an access point (AP). The primary job of an access point is to broadcast a wireless signal that computers can detect and "tune" into. In order to connect to an access point and join a wireless network, computers and devices must be equipped with wireless network adapters.

WiFi

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Working of WiFi

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- The cornerstone of any wireless network is an access point (AP). The primary job of an access point is to broadcast a wireless signal that computers can detect and "tune" into.
- In order to connect to an access point and join a wireless network, computers and devices must be equipped with wireless network.

Wi-Fi Support

- Wi-Fi is supported by many applications and devices including video game consoles, home networks, PDAs, mobile phones, major operating systems, and other types of consumer electronics.

- Any products that are tested and approved as "Wi-Fi Certified" (a registered trademark) by the Wi-Fi Alliance are certified as interoperable with each other, even if they are from different manufacturers. For example, a user with a Wi-Fi Certified product can use any brand of access point with any other brand of client hardware that also is also "Wi-Fi Certified".
- Products that pass this certification are required to carry an identifying seal on their packaging that states "Wi-Fi Certified" and indicates the radio frequency band used (2.5GHz for 802.11b, 802.11g, or 802.11n, and 5GHz for 802.11a).

BLUETOOTH

- **Bluetooth** is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs).
- Invented by telecom vendor Ericsson in 1994, it was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization.
- Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 25,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics.
- The IEEE standardized Bluetooth as **IEEE 802.15.1**, but no longer maintains the standard. The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks.
- A manufacturer must make a device meet Bluetooth SIG standards to market it as a Bluetooth device.

UNIT V
HOME APPLIANCES

HOME APPLIANCES:

Basic principle and block diagram of microwave oven; washing machine hardware and software, components of air conditioning and refrigeration systems, Proximity sensors and accelerometer sensor in home appliances.

5.1 BASIC PRINCIPLE AND BLOCK DIAGRAM OF MICROWAVE OVEN

- The block diagram of a microwave over is given in the figure 5.1. The mains plug and sockets are three-pin earthing type. The fast blow ceramic fuse is of 15A, 250V. Interlock switches are linked with the oven door.
- Power will be applied to the mains transformer only when the oven door is closed. At least one interlock switch is in series with the transformer primary, hence even a spot of dirt in the relay or trial cannot turn the oven on when the door is open.

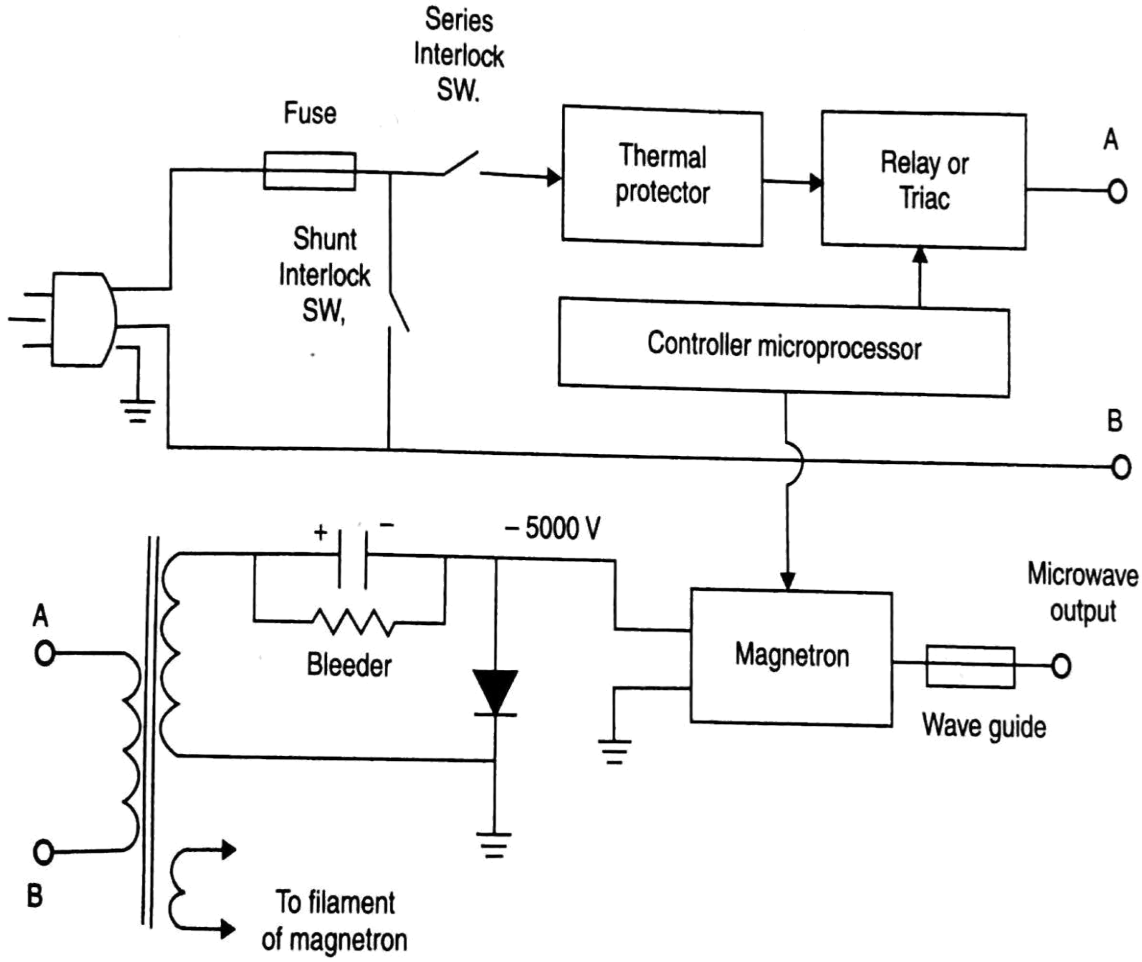

Fig 5.1 Functional block diagram of a microwave oven

- There is yet another interlock across the power supply line. It normally remains open. If the door alignment is not correct it will be activated, putting a short circuit (crowbar) across the line and making the fuse to melt. Thus, the microwave oven is a fail - safe device.
- The voltage induced in the secondary winding is about 2000v (rms) at 250 mA for normal domestic ovens. The transformer also has a tertiary winding for the magnetron filament.
- The high voltage return circuit is fastened directly to the chassis through the transformer frame. A half-wave doubler configuration is used for the rectifier; with a peak inverse voltage of about 12000 V. one end of the diode is connected to the chassis.
- The bleeder capacitor (1μF) should always be discharged before touching anything inside when the cover is removed. The high value bleeder resistor is slow to discharge; further it may be open.
- The thermal protector is a PTC thermistor. The primary current decreases when the temperature rises abnormally.
- It senses the temperature of the magnetron as it is bolted to the magnetron case and is so connected electrically that its resistance comes in series with the primary circuit.
- The controller is a microprocessor chip with a clock. It is activated by key-pad switches and sets the cooking time
- There are three power levels. For HIGH the microwave generator remains on continuously; for MEDIUM it remains on for 10 seconds and off for 10 seconds; for LOW it remains on for 5 seconds and off for 15 seconds. The controller activates the microwave generator using either a relay or a TRIAC.

5.2 WASHING MACHINE HARDWARE

A system is an assembly of components united by some form of reulated interaction to form an organised whole.

The input peripherals of washing machine consist of

1. Temperature sensor
2. Safety cut-out switch
3. Keyboard for program selection
4. Water level gauge
5. Motor for washing drum

6. Power switches for motor,heater.
7. Heater fro washing water
8. Water inlet valve
9. Water suction pump
10. Control lamps and indicators.

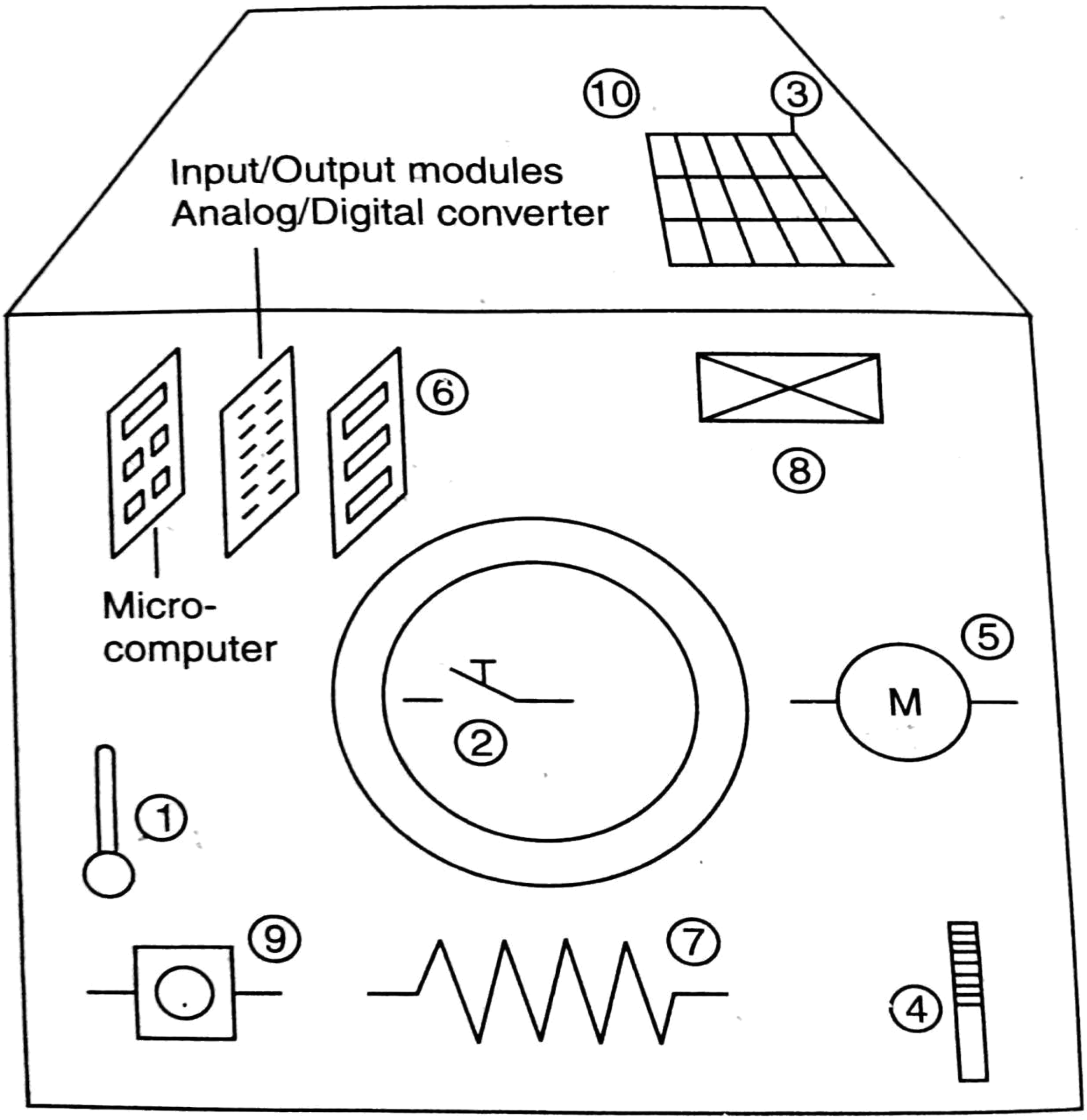

Fig 5.2 Washing Machine Hardware

5.2.1 HARDWARE AND SOFTWARE DEVELOPMENT

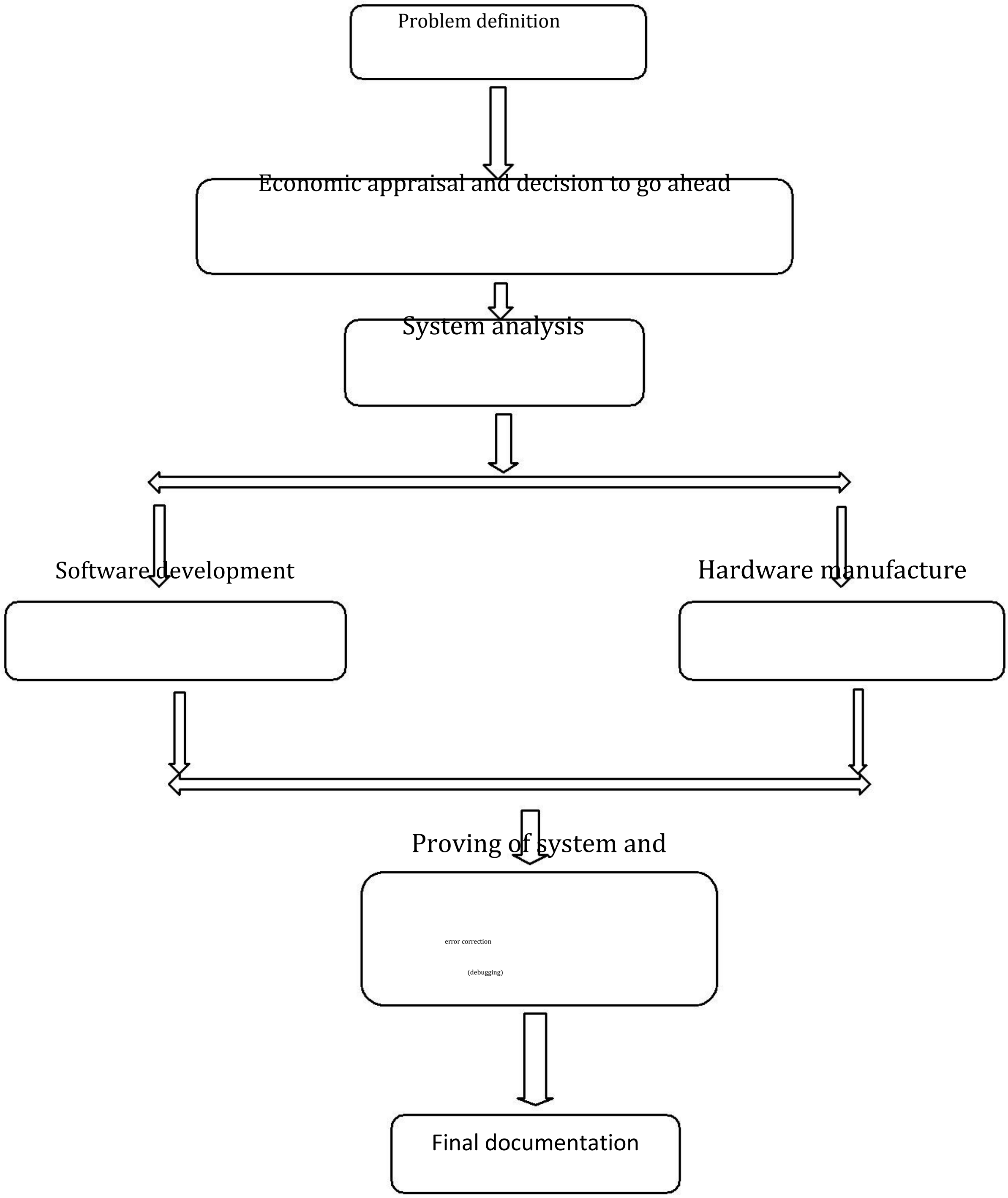

Fig 5.3 Developing the system for washing machine control

- The problem definition is based on the requirements of the specification. It is also necessary for the redesign of the existing unit.
- It is a means of determining what a system's performance is capable of and what is required from it.
- Data flow charts are used to identify all the hardware elements of a system at this stage for a general broad picture of the structure of the installation.
- Program flow charts permit the costs of the necessary software to be established in the development stage and represent useful aids for the designer.
- The decision to go ahead with the developments of a system is governed by economic appraisal and technical feasibility of the plan.
- To establish these criteria the required operating speed, memory storage capacity and costs of the component parts of the system must be determined.
- Τηερε αρε τωο αλτερνατιϖε αππροαχηεσ φορ ηαρδωαρε δεϖελοπμεντ. Ον ονε ηανδ, α υνιϖερσαλ σψστεμ μαψ βε χονσιδερεδ ωηιχη ηασ νοτ βεεν δεσιγνεδ το χοπε ωιτη ανψ ονε σπεχιφιχ προβλεμ.

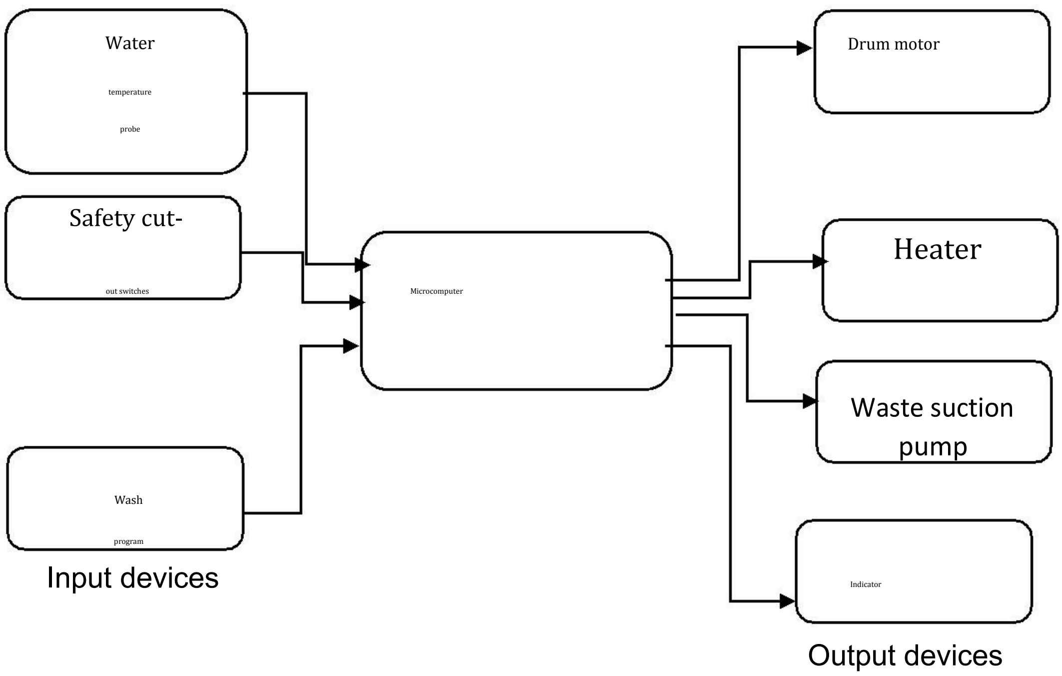

Fig 5.4 Data flow chart for a washing machine control

- For software development a detailed program sequence plan must first be established. This is then written in the appropriate code and fed into a computer or into a development system.
- The program is then translated into the language required by the machine and a simulation of the operation sequence is carried out.