DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CONSUMER ELECTRONICS (J42OG)

[R20]

B.TECH ECE
(IV YEAR – II SEM)
(2023-24)

J. B. INSTITUTE OF ENGINEERING AND TECHNOLOGY
(UGC AUTONOMOUS)
Accredited by NBA & NAAC,
Approved by AICTE & Permanently affiliated to JNTUH
Bhaskar Nagar, Yenkapally(V), Moinabad(M), Ranaga Reddy(D),Hyderabad – 500 075,
Telanagana, India.

2020-21	J. B. Institute of Engineering and Technology (UGC Autonomous)	B.Tech IV Year – II Sem			
Course Code:J42OG	CONSUMER ELECTRONICS (Open Elective-IV)	L	T	P	D
Credits: 3		3	1	0	0

Prerequisites: Nil

Course Objectives:

The students will

6. Learn how a Consumer Product is developed
7. Learn how to simulate and test that designs.
8. Learn in-depth study of systems and the use of those.
9. To understand concept of Audio Systems.
10. To implement Television Receivers & Video Systems.

Module 1

UNIT-I

Audio Fundamentals and Devices: Basic characteristics of sound signal: level and loudness, pitch, frequency response, fidelity and linearity, Reverberation. Audio level metering, decibel level in acoustic measurement. Microphone: working principle, sensitivity, nature of response, directional characteristics.

UNIT-II

Types: carbon, condenser, crystal, electrets, tie- clip, wireless. Loud speaker: working principle, characteristic impedance, watt capacity. Types: electrostatic, dynamic, permanent magnet, woofers and tweeters. Sound recording: Optical recording, stereophony and multichannel sound, MP3 standard.

Module 2

UNIT-I

Audio systems: CD player, home theatre sound system, surround sound. Digital console: block diagram, working principle, applications.

UNIT-II

FM tuner: concepts of digital tuning, ICs used in FM tuner TDA 7021T . PA address system: planning, speaker impedance matching, Characteristics, power amplifier, Specification.

Module 3

UNIT-I

Television Systems: Monochrome TV standards, scanning process, aspect ratio, persistence of vision and flicker, interlace scanning, picture resolution. Composite video signal: horizontal and vertical sync details, scanning sequence.

UNIT-II

Colour TV standards, colour theory, hue, brightness, saturation, luminance and chrominance. Different types of TV camera. Transmission standards: PAL system, channel bandwidth

Module 4

UNIT-I

Television Receivers and Video Systems: PAL-D colour TV receiver, block diagram, Precision IN Line colour picture tube. Digital TVs:- LCD, LED , PLASMA, HDTV, 3-D TV, projection TV, DTH receiver.

UNIT-II

Video interface: Composite, Component, Separate Video, Digital Video, SDI, HDMI Multimedia Interface) , Digital Video Interface . CD and DVD player: working principles, Interfaces.

Module 5

UNIT-I

Home / Office Appliances: FAX and Photocopier. Microwave Oven: types, single chip controllers, wiring and safety instructions, technical specifications. Washing Machine: wiring diagram, electronic controller for washing machine, technical specifications, types of washing machine, fuzzy logic.

UNIT-II

Air conditioner and Refrigerators: Components features, applications, and technical specification. Digital camera and cam coder: - pick up devices - picture processing - picture storage.

Text Books:

3. Consumer Electronics, Bali S.P., Pearson Education India,2010.
4. Audio video systems : principle practices & troubleshooting, Bali R and Bali S.P., Khanna Book Publishing Co. (P) Ltd., 2010Delhi , India.

REFERENCES:

1. Intellectual Property in Consumer Electronics, Software and Technology Startups, Springer Nature; 2014th edition (24 September 2013),ISBN-10:9781461479116.
2. Consumer Electronics, B.R. Gupta , V. Singhal, S.K. Kataria& Sons; 2013th edition

E- Resources:

1. https://www.allaboutcircuits.com/videos/category/consumer-electronics/
2. https://www.youtube.com/watch?v=IttXKAGl6zE

Course Outcomes:

6. **Learn** how a Consumer Product is developed
7. **Analyze** how to simulate and test that designs.
8. **Apply** in-depth study of systems and the use of those.
9. **understand** concept of Audio Systems.
10. **Develope** Television Receivers & Video Systems.

CO-PO/PSO Mapping Chart (3/2/1 indicates strength of correlation) 3 – Strong; 2 – Medium; 1 - Weak														
Course Outcomes (COs)	**Program Outcomes (POs)**												**Program Specific Outcomes**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	2											
CO2	2	2		2										
CO3	3	2		3										
CO4	3	1												
CO5	2	2	3	3										
Average	**2.4**	**2.0**	**2.5**	**2.67**										

CONSUMER ELECTRONICS

Basic characteristics of sound signal:

level and loudness:

The amplitude of a sound wave determines its loudness or volume. A larger amplitude means a louder sound, and a smaller amplitude means a softer sound. The vibration of a source sets the amplitude of a wave. It transmits energy into the medium through its vibration. More energetic vibration corresponds to larger amplitude. The molecules move back and forth more vigorously.

The loudness of a sound is also determined by the sensitivity of the ear. The human ear is more sensitive to some frequencies than to others. The volume we receive thus depends on both the amplitude of a sound wave and whether its frequency lies in a region where the ear is more or less sensitive.

The loudness is a sensation of how strong a sound wave is at a place. It is always a relative term and is a dimensionless quantity. Loudness is measured in decibel (dB). It is given as:

$L = \log(I)$, here 'I' is the intensity.

Pitch:

Pitch is a characteristic of sound by which a correct note can be distinguished from a grave or a flat note. We can identify a female and male voice without seeing them. The term 'pitch' is often used in music. Pitch depends upon the frequencies of the sound wave. A note has a higher pitch when the frequency is high and a note of low frequency has a low pitch.

Frequency response:

The audio spectrum range spans from 20 Hz to 20,000 Hz and can be effectively broken down into seven different frequency bands, with each having a different impact on the total sound.

Fidelity:

Fidelity is the quality of faithfulness or loyalty.

Sensitivity:

sensitivity It is defined as output in millivolts (or in dB below 1 volt) for the sound pressure of 1 Pa (or 10 microbars) at 1000 Hz. As the normal level of speech provides a sound pressure of I microbar ((or 0.1 Pa), the sensitivity based on this criteria for 1 microbar pressure (or 0.1 Pa) level would be one-tenth the value for 1 Pa pressure.

Selectivity:

The human ear is very sensitive to sound intensity. It can detect sound intensity as low as 10 dB below the threshold of hearing. The ear is sensitive, not to the absolute values of intensity, but to the ratios (or dB). The sound power generated by a large orchestra is a fraction of a microwatt at the softest tones and about a thousand milliwatts at the loudest ones. Similarly, speech during whispering is in picowatts, and while shouting, it is several milliwatts. It is not necessary for a sound-reproducing system to produce sound of the same magnitude of power as at the source, but the reproducing system should be capable of handling the maximum and minimum power in the same ratio.

Types of Audio systems depending on Amplifiers used:

- Mono Amplifier system
- Stereo Amplifier system

Stereo Amplifier system:

- The word ‘stereophony’ is derived from two Greek words: ‘stereos’ & ‘phone’, meaning ‘solid’ & ‘sound’, respectively. Thus stereophony means solid sound or ‘3-dimensional sound’ there is minute difference of phase & intensity in the sounds reaching the 2 ears. This difference is interpreted by the brain such a way so as to enable the listener judge the direction from which the sounds are coming.
- Stereophonic sound or, more commonly, stereo, is a method of sound reproduction that creates an illusion of directionality and audible perspective. This is usually achieved by using two or more independent audio channels through a configuration of two or more loudspeakers (or stereo headphones)in such a way as to create the impression of sound heard from various directions, as in natural hearing. Thus the term "stereophonic" applies to so-called "quadraphonic" and "surround-sound" systems as well as the more common two-channel, two-speaker systems.

It is often contrasted with monophonic or "mono" sound, where audio is in the form of one channel.

Mono Amplifier system:

In similar way the mono means single. The sound coming from single source, which is processed by single system (having single amplifier).

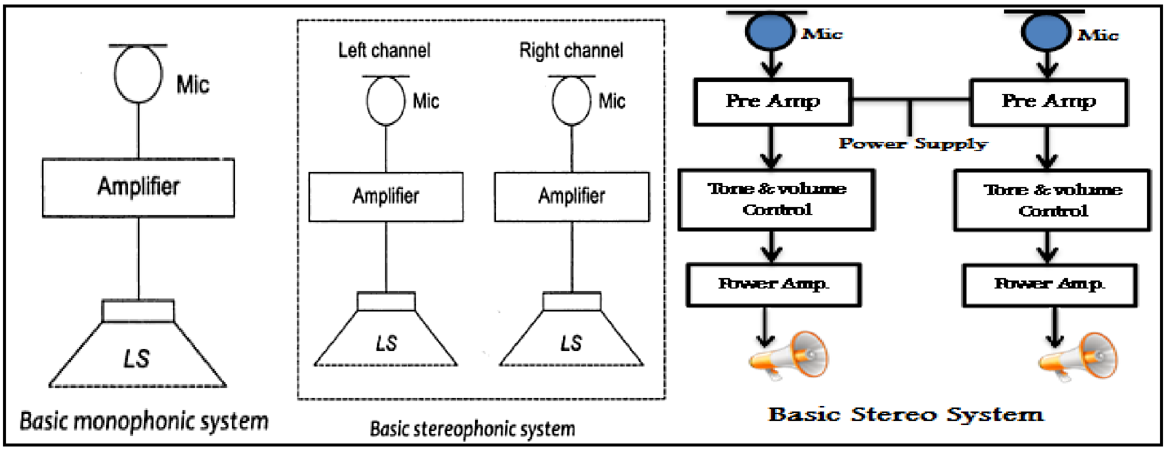


Figure: Basic structure of Mono & Stereo System

Fig above shows the basic block diagram of monophonic & stereophonic system which mainly includes

- An input source (The Microphone)
- A Processing circuit (An amplifier) &

- The output source (Loud Speaker)
- The **monophonic** system has a single set of Microphone, Amplifier & Loud Speaker. This means that the sound is captured by the single microphone & it can process through a single amplifier circuit. We can have many Loudspeaker at the output, but the signal given to all Loudspeaker will be same (same in phase).
- Whereas in **Stereophonic** system, it has two set of Microphone, Amplifier & Loud Speaker. One set for processing right sided signal & another for processing left sided signal. This means that, in stereophonic system sound is captured by two different sources (signal having different phase) & both the signals are processed with different processing circuit (here with different Amplifiers).The output is also given to two different Speakers so as to produce '3-dimensional sound'

Explanation of Components used in Basic Audio systems.

Microphone: Sound is produced when there is a vibration in the atmosphere. This vibration disturbs the air, causing air particles to bounce off other air particles, carrying the vibration throughout. We hear these changes in air pressure by translating the change to electrical signals that the brain can process.
A transducer use to convert these sound vibrations into electrical signal is called Microphone.

Amplifier: Most steps of the sound process, such as the microphone and recorder require very little electrical current to be produced. The last step of the process, moving the speaker cone, does require more of a boost in current for the audio signal. This boost has to preserve the same pattern without any distortion of the original signal. The boost is created by an amplifier. The amplifier's sole purpose to produce a more powerful audio signal in order to be heard through a speaker. Although amplifiers have just a simple purpose, the components that make then can be very complex.

Loudspeaker: A loudspeaker (or "speaker", or in the early days of radio "loud-speaker") is an electroacoustic transducer that produces sound in response to an electrical audio signal input. In other words, speakers convert electrical signals into audible signals.

PUBLIC ADDRESS SYSTEM (PA SYSTEM):

It is an electroacoustic system, in which sound is first converted into electrical signals by a microphone. The electrical audio signals are amplified, processed & fed to another transducer, the loudspeaker, which converts the audio signals into sound waves. A block diagram of a basic PA system is shown in fig. below. The function of each block of PA system is described below.

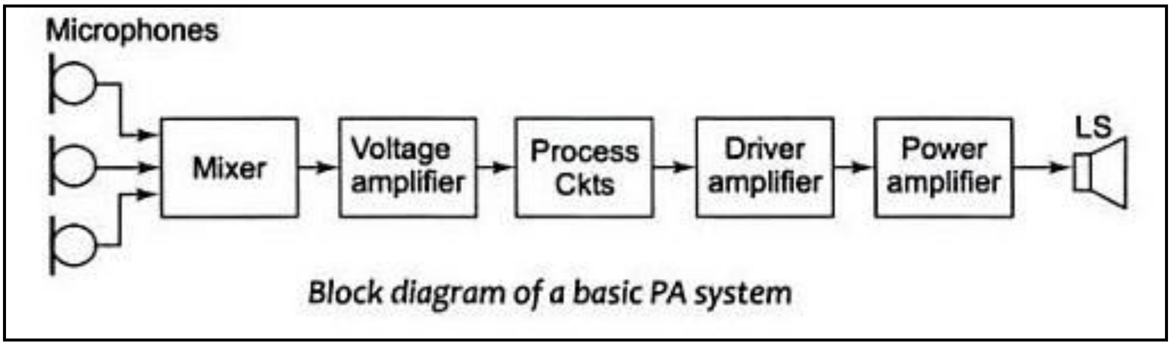


Figure: Block diagram of PA system

Microphone: It picks up sound wave & converts them into electrical variations, called audio signals. Generally, amplifiers have provision of 2 or more microphones & in addition, an auxiliary input for tape/record player.

Mixer: The output of microphones is fed to mixer stage. The function of mixer stage is to effectively isolate different channels from each other before feeding to the main amplifier. It can be either a built-in unit or a separate pluggable unit.

Voltage amplifier: It is an amplifier which further amplifies the output of the mixer.

Processing circuit: These circuits have 'Master gain control' & tone controls (Bass/Treble controls).

Driver amplifier: It gives voltage amplification to the signal to such an extent that when fed to the next stage (power amplifier stage), the internal resistance of that stage is reduced. Thus it drives the power amplifier to give more power.

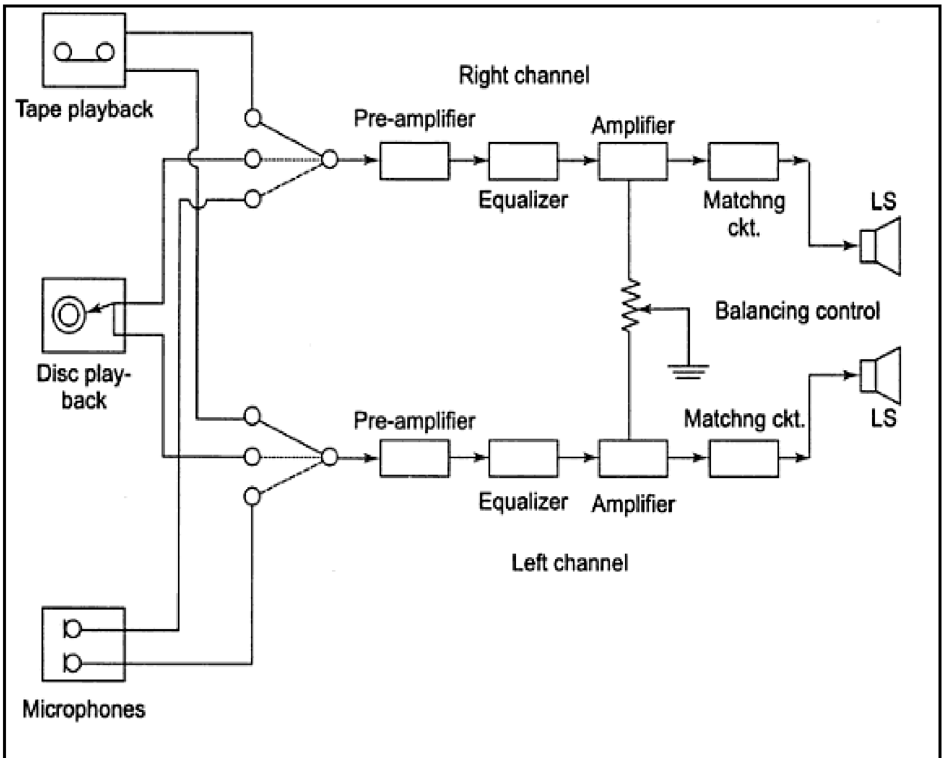
Power amplifier: It gives desired power amplification to the signal. It uses push pull type of circuit in general, so that the even harmonics are eliminated from the output, & the transformer core does not get saturated.
The output of power amplifier is connected to the loudspeaker through matching transformer to match the low impedance of the loudspeaker for maximum transfer of power.
Loudspeaker: A loudspeaker is an electroacoustic transducer that produces sound in response to an electrical audio signal input. In other words, speakers convert electrical signals into audible signals.

Difference between Stereophony system & monophony system:

	Mono	**Stereo**
Stands for	Monaural or monophonic sound	Stereophonic sound
Key feature	Audio signals are routed through a single channel	Audio signals are routed through 2 or more channels to simulate depth/direction perception, like in the real world.
Recording	Easy to record, requires only basic equipment	Requires technical knowledge and skill to record, apart from equipment. It's important to know the relative position of the objects and events.
Cost	Less expensive for recording and reproduction	More expensive for recording and reproduction
Circuit Complexity	Less Complex then	More Complex
Usage	Public address system, radio talk shows, hearing aid, telephone and mobile communication, some AM radio stations	Movies, Television, Music players, FM radio stations

Circuit Diagram	Draw circuit diagram of mono amplifier system	Draw circuit diagram stereo amplifier system
Signal to Noise ratio	Less signal to noise ratio	Better than 50 dB is the S/N ratio.
Distortion	Nonlinear distortion occurs.	Nonlinear distortion not more than input/output.
Use of equalizer	Equalizers are not used	Contains equalizer circuit.

1.2 BLOCK DIAGRAM OF HI-FI AUDIO AMPLIFIER SYSTEM:



Block diagram of hi-fi reproducing system

Figure: Block diagram of Hi-Fi audio amplifier system

Fig. shows the block diagram of high fidelity stereo reproducing system.

High fidelity sound can be obtained from the recorded ‘stereo sounds’ (stereo taps or live stereo system from microphones.). The stereo signal is fed to two independent amplification channels through tape- mic switch.

The Hi-fi system consists of:

- Pre Amplifier (LNA)
- Equalizer,
- Amplifier,
- Matching circuit &
- Loud speaker.

Pre Amplifier (LNA): This is a low noise high gain amplifier which amplifies the weak signal coming from microphones with low noise. This increases the signal strength as well as SNR of system.

Equalizer: Equalizer is utilized for adjusting frequency for providing boost & cut at a particular frequency. This improves frequency response & hence selectivity & quality factor of system.

Amplifier: It is a power amplifier for increasing strength of the signal. This is used to drive the loudspeaker with sufficient signal strength.

Matching circuit: The primary winding of transformer is connected to output of power amplifier & secondary winding is connected to loudspeaker. This transformer provides impedance matching for maximum power transfer of loudspeaker.

Balance control: Two amplifiers of a stereo system, although independent of each other, are built as matched pair to give equal output for the same input. In spite of the two amplifiers being identical, there may be variations in the output of each channel due to variations in the characteristics of transistors & ICs and positioning of loudspeaker & furnishing with respect to the listener. The circuit used is called BALANCE CONTROL.

Loudspeaker: A loudspeaker is an electroacoustic transducer that produces sound in response to an electrical audio signal input. In other words, speakers convert electrical signals into audible signals.

Characteristics of HI-FI amplifier:

1. Signal to noise ratio should be better than 50dB.

2. Frequency response should be flat within +-1dB.

3. Nonlinear distortion should not be more than 1%.

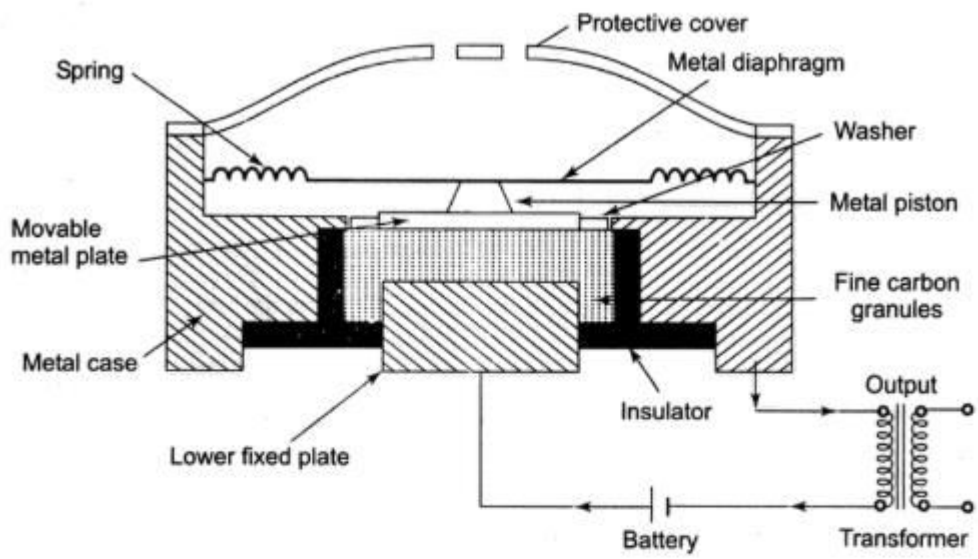
4. The system should possess dynamic range of at least 8dB.

5. Stereophonic effect should be provided.

6. Environmental conditions should be such as to eliminate the external noise in listening room.

Microphone:

Carbon Microphone:



Principle: When fine carbon granules enclosed in a case are subjected to variations of pressure, the resistance of the granules changes. When such a device of carbon granules is connected in series with a load through a dc supply, the current through the load will vary in accordance with pressure variations on the carbon granules.

Construction: The construction of a carbon microphone is shown in Fig. Fine carbon granules are enclosed between two metal plates. The upper plate called diaphragm is attached to a movable metal plate through a metal piston or plunger. The Iowa metal plate is fixed and is insulated from the diaphragm. A protective cover with holes is used to protect the unit. A battery is connected between two metal plates. When the load is connected, current flows through the carbon granules and the load. Path of the current passes from the +ve battery terminal through the fixed lower plate, the resistance of carbon granules, movable metal plate, metal casing, and output transformer, as shown in Fig. The purpose of the output transformer is to eliminate the dc content of the microphone.

Functioning: When sound waves strike the diaphragm, it moves to and fro. During compression condition, it presses the carbon granules and during rarefaction, it loosens them. When carbon granules are pressed, the resistance decreases and hence the current through the circuit increases. When carbon granules loosen, the resistance increases, decreasing the current through the circuit. In the absence of sound, a steady current flows. Thus, sound waves superimpose a varying current or audio current on the steady dc current.

Characteristics of a Carbon Microphone

Sensitivity Very high. The output of a carbon microphone is about 20 dB below IV (i.e., about 100 mV).

signal-to-noise Ratio Poor. Random variation of resistance of carbon granules generates a continuous hiss.

Frequency Response Carbon microphones have a frequency response of 200 to 5000 Hz, and therefore are unsuitable for high fidelity work. The resonance peak is at 2000 Hz and overall frequency bandwidth is usually up to 5 kHz.

Distortion High. The content is rich in harmonics unless variation in resistance (or) is a very small percentage of steady resistance R. Distortion is of the order of 10%. Also, carbon granules have a tendency to stick to each other which further increases the distortion.

Directivity A carbon microphone is substantially omnidirectional. However, high frequency response over 300 Hz falls beyond an angle of 40° from the front of the microphone.

Output Impedance It is about 100 52

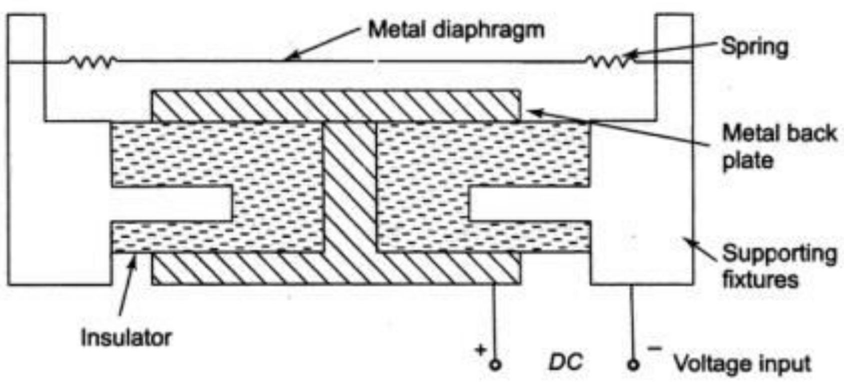
Other Features:

- It is mechanically very rigid.
- It is prone to moisture and heat.
- It is small in dimensions.
- Cost of the microphone is the lowest of all other microphones.

Condenser Microphone:

Principle: When the capacitance of a capacitor changes, the quantity of charge on the capacitor remains the same, but the level of voltage changes. The diaphragm of the microphone acts as one plate of the capacitor. The other plate, called the back plate, is fixed. When sound pressure moves the diaphragm in, the capacitance increases, and when it moves out, the capacitance decreases. The change in capacitance results in change in voltage. The capacitor microphone is a pressure microphone, as sound waves coming from all sides strike the diaphragm on the front side only.

Construction: A capacitor microphone is shown in Fig. It consists of a light-weight metal diaphragm (generally aluminium) which is suspended above a fixed metal back plate.



The metal diaphragm and the fixed metal plate are near each other and form a capacitance of a few picofarads. A fixed d.c.voltage of about 50 to 100 volts is applied between the backplate and the movable diaphragm plate. The diaphragm is in stretched condition as it remains attached to the supporting fixtures with the help of spider springs. The two plates are insulated from each other. The capacitance of this microphone is about 30 pf.

Functioning: When sound waves strike the diaphragm, it moves. During compression, it moves towards the fixed back plate and increases capacitance. During rarefaction, it moves away from the back plate and therefore decreases capacitance. The change in capacitance changes the dc voltage across the capacitor plates. As a distance between the plates changes, its capacitance changes.

<u>Characteristics of Capacitor Microphone:</u>
sensitivity The output is very low and an amplifier is built-in inside the micro-phone case. The amplifier output is about 3 mV (about 50 dB below I V) at a sound pressure of 0.1 Pa or 1 pa bar.
Signal-to-noise Ratio High, about 40 dB.
Frequency Response Excellent, 40 Hz to 15 kHz for ±1 dB. Its frequency response is so good that it is used as standard microphone against which other microphones are calibrated and loudspeakers are tested. It is therefore used in sound level meters. Its natural resonant frequency is about 6000 Hz.
Distortion Low, about 1%
Directivity Omnidirectional
Output Impedance High, about 100 Mega ohm.

<u>Other Features</u>

1. It needs an external dc bias supply.
2. It is delicate because of the narrow separation between the moving plate (diaphragm) and the fixed back plate.
3. It cannot withstand excessive heat. Moisture is also harmful as the condensation causes a crackling sound.
4. It is costly because of the necessity of a dc bias.

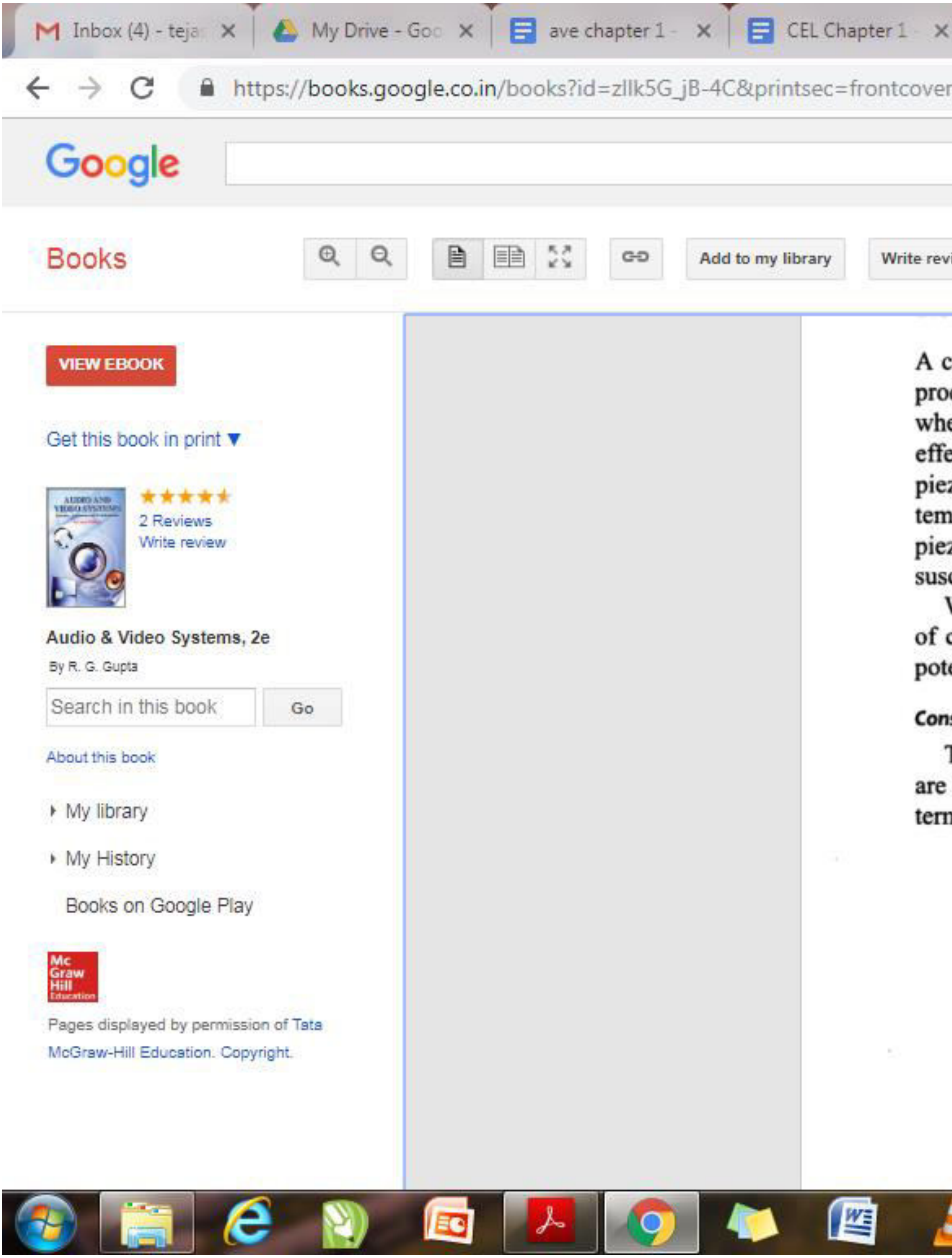
<u>Applications</u>

1. It is used as a standard microphone for calibrating other microphones.
2. It is used in sound level meters.
3. It is used in professional high-fidelity recording.

<u>Crystal Microphone:</u>

A crystal microphone is based on the principle of piezoelectric Effect, which produces difference of potential between the opposite faces of some crystals when these are subjected to mechanical pressure. The crystals which show this effect are quartz, tourmaline, rochelle salt and ceramic. Rochelle salt has high piezoelectric effect but is susceptible to moisture. Also, it cannot withstand high temperature of more than 50°C in outdoor use. Quartz and tourmaline have low piezoelectric effect. Ceramic is most suitable for crystal microphones as it is not susceptible to moisture and can also withstand high temperatures up to 100° C.

When pressure is applied to the crystal, it deforms and momentary displacement of charge takes place within the crystal structure. This creates a difference of potential between its two surfaces.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Two thin crystal slices, suitably cut, are placed in an insulating holder with an air space between them. A large number of such elements are combined to increase the emf. A diaphragm, made of aluminium, is attached to the crystal surface through a push rod. The whole unit is encased in a protective case. There is a protective mesh cover (not shown in the figure) over the diaphragm. Functioning When there is a sound wave of compression, it compresses the crystal. In the case of rarefaction, the converse takes place and the crystal is extended and is under tension. Due to this compression and extension, a varying potential difference is generated which is proportional to the mechanical pressure applied to the crystal by the sound waves (it is, therefore, 'pressure microphone'). The crystal elements are connected in such a way that the potential differences developed in the elements are added up and we get a good voltage output (about 50 mV) for feeding to the amplifier.

Characteristics of a Crystal Microphone:

Sensitivity The crystal microphone has good sensitivity, about 50 mV (or 26 dB below 1 volt) for 0.1 Pa pressure.

Signal-to-noise Ratio It is not prone to pick up background noise. Generation of noise inside the microphone is also low. Hence its signal-to-noise ratio is high. about 40 dB.

Frequency Response 100 - 8000 Hz for $\pm$1dB Distortion Low about 1%

Directivity Omnidirectional

Output Impedance High, about 1 Mega Ohm

Other Features

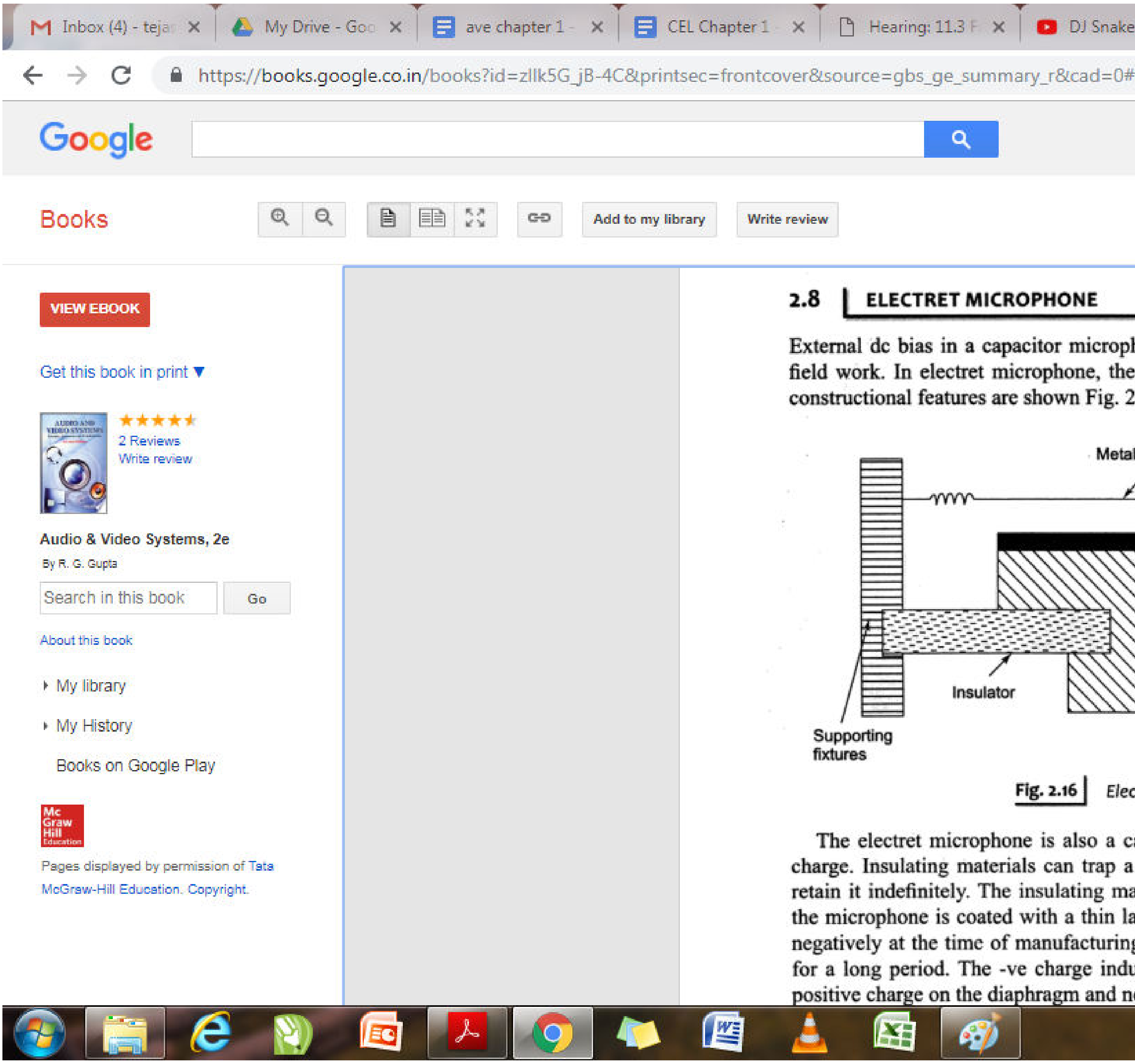
1. It is not as rugged as a moving-coil one but is more rugged than a ribbon type.
2. It can be spoken into a close range.
3. Its high impedance requires relatively short leads to the input circuit of the amplifier to prevent loss of higher audio frequencies, or pick-up of hum. The leads must be well shielded and not more than about 6 metres long
4. The mixer circuit will load it and cause severe loss of bass. Hence, it cannot be used in a multi-microphone system.
5. Unlike a moving-coil microphone and ribbon microphone, it has no frequency discrimination with direction.
6. It does not need a bias supply.
7. It should not be exposed to direct sunlight for a long time.
8. Its cost is low.

Applications

It is used for the following purposes:

- Home recording systems
- Amateur communication
- Mobile communication, However, due to the variation of the acoustic characteristics, this type of microphone is not used in broadcasting and recording studios.

Electret Microphone:



- External DC bias in a capacitor microphone makes it costly and unsuitable for field work. In electret microphone, the external dc bias is dispensed with. Its constructional features are shown Fig.
- The electret microphone is also a capacitor microphone, but it has built-in charge. Insulating materials can trap a large quantity of fixed charge and can retain it indefinitely. The insulating material used is Teflon. The back plate of the microphone is coated with a thin layer of Teflon.
- The thin layer is charged negatively at the time of manufacturing. This negative charge remains trapped for a long period. The -ve charge induces +ve charge on the

diaphragm. The positive charge on the diaphragm and negative charge on the Teflon establish an electric field across the gap of the capacitor plates.

- The charge results in a terminal voltage. When the capacitance changes due to sound pressure, the charge tends to remain constant and hence the terminal voltage changes.
- It has the same characteristics us capacitor microphone except that it does not need external bias supply and is less costly. It is also sensitive to temperature and humidity which cause leakage of charge.
- It is used in sound level meters. As the electret microphone is cheap, has good frequency response, is lugged and does not need bias supply, it is also used in small PA systems for clubs and small halls, to keep the cost low. It being very light, is also used as tie clip microphones for lecturers and as radio (wireless) microphones in sports meets.

Tie-clip Microphone

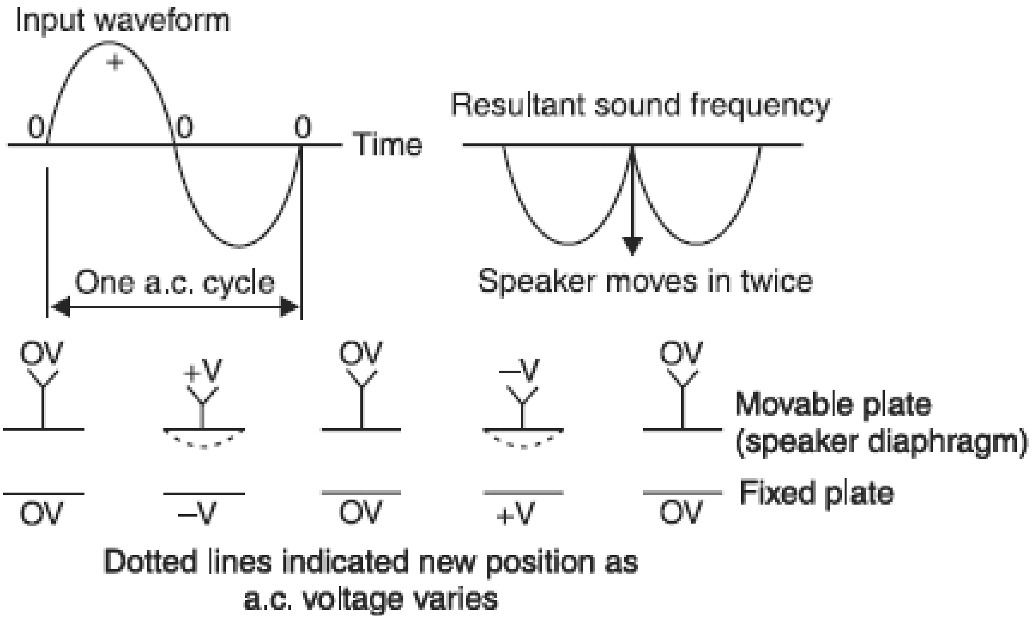
It is an eleetvet type tiny microphone which can be clipped on to a tic, lapel or any other convenient pan of the clothing. An external amplifier made on a tiny chip of silicon is used inside the microphone. Even with a tiny amplifier and its cell, it is very light.

Speaker:

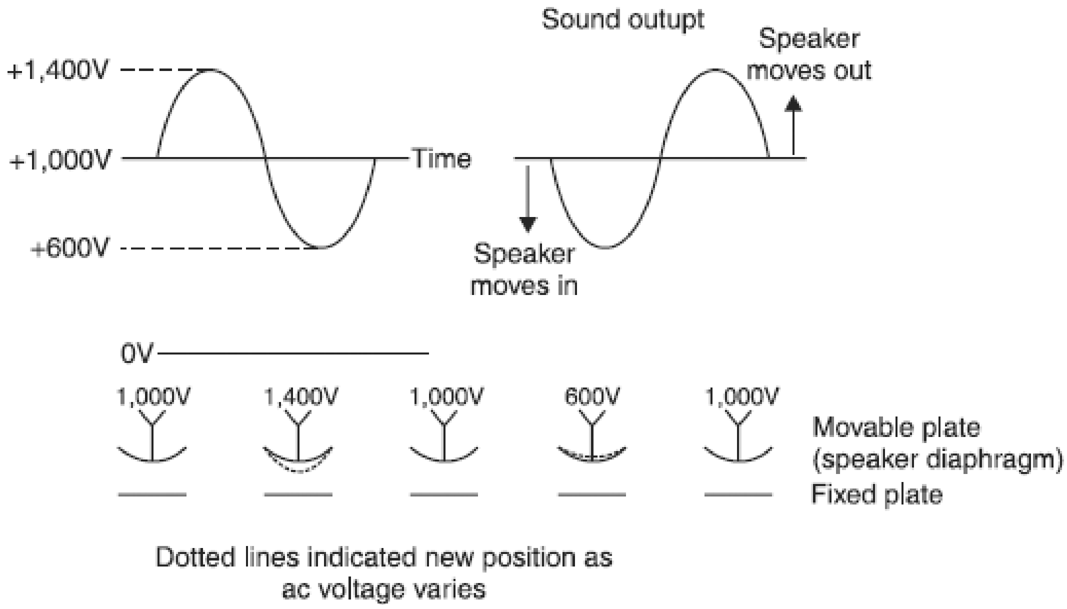
ELECTROSTATIC (CONDENSER/CAPACITOR) LOUDSPEAKERS

This type of speaker operates on the principle that a dc voltage between two parallel metal plates causes these plates to attract or repel each other. The amount of attraction or repulsion depends on the applied voltage. If one of the plates is a flexible metal, it will bend. But *the amount of attraction and repulsion is not directly proportional to the voltage applied.*

For example, consider the movable and fixed plates of Fig. 4.3 with *no voltage* applied. Now suppose we apply a *slowly varying ac voltage* to both plates. As the voltage increases from zero, the potential difference between the two plates also increases. This, in turn, produces an increasing force of attraction between the plates, so that the movable plate bends towards the fixed plate. As the ac voltage decreases once more to zero, the attractive force decreases, and the movable plate moves back to its original position. But, now we have the second half of the ac cycle, in the *negative direction.* All that this means to the metal plates is that the positive and negative voltages have **switched** plates. The attractive force is still there, and it is still the same. So, we get another bend in the movable plate on the negative half of the ac cycle. Thus, for one full cycle of ac we have two bends in the movable plate, in effect a *frequency doubling.* A 2 kHz signal would give us a 4 kHz note.

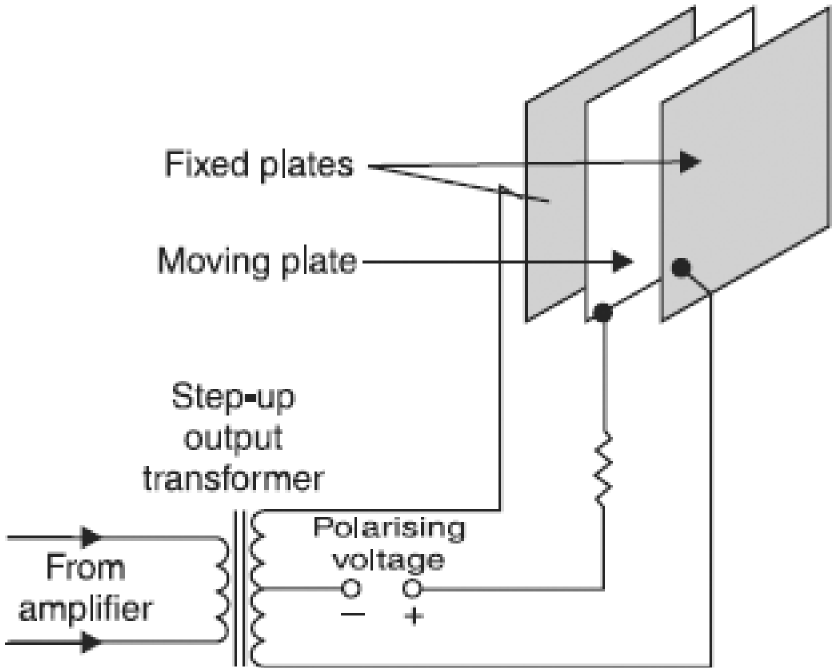


To overcome frequency doubling, we polarise the speaker, that is, we apply a high voltage (1,000 volts or so) as a sort of dc *bias*. The voltage exerts a *steady attraction* between the two plates, so that now—with no signal—*the movable plate is bent slightly toward the fixed plate.* Now suppose we apply a 400 V dc audio signal to the speaker. As the positive half cycle of the signal increases from zero the voltage between the plates *rises* from 1,000 V toward 1,400 V and the movable plate bends from its original position toward the fixed plate. As the ac passes its peak and returns to zero, the voltage between the plates *drops* from 1,000 V to 600 V. Instead of moving again toward the fixed plate, the movable plate moves farther away. *So we have a situation in which the bending of the movable plate is identical to the ac swing and there is no frequency doubling.*



A detailed view of a modern electrostatic speaker is shown in Fig. The practical speaker of today uses push-pull, with a built-in step-up transformer to work from the ordinary 8 ohm amplifier output tap. The polarising voltage is applied to the centre or movable plate through a resistor that keeps the voltage *stable* during variations in the signal voltage. The signal voltage is applied to the two outside plates. Because the diaphragm is centered between the two plates that attract it equally, there is no bending when there is no signal. Also, *because of*

the push-pull action the diaphragm can move twice as far in response to signal voltages for the same amount of compression of the dielectric material.
The major weakness of the electrostatic speaker requires the dc bias is that it to be much larger than the applied audio signal. In practical speakers, 1,000 to 1,200 volts may be used. Further, when we get into the bass frequency ranges, a great deal of power would be required to get enough output. To produce such power, the speaker area would have to be very large. So, even though full range electrostatic speakers have been constructed, *in practical use electrostatic speakers have been mostly confined to frequencies above 1,000 Hz.*



The step-up transformer and the high voltage polarising supply is usually built right into the modern electrostatic. Often the electrostatic unit and its matching woofer are sold together as a complete system.
Some high class systems use electrostatics to reproduce the high frequencies. Koss uses electrostatics on some of their stereo headphones.

<u>DYNAMIC LOUDSPEAKERS:</u>

There are two varieties of dynamic loudspeakers : electrodynamic and permanent magnet (PM) speakers. Both work in exactly the same way, the difference is in their construction.
The *electrodynamic* speaker has a *soft iron* magnetic circuit, non-retentive of magnetism, around whose centre leg, a large, multilayer field coil is wound, as shown in Fig. When dc flows through this field coil, it magnetises the iron core. *A magnetic flux field directly proportional to the strength of the current through the coil is thus set up across the air gap. The iron core is not permanently magnetised, it stays magnetised only as long as current flows through the field coil.*

Fig. A two-way electrostatic utilising a separate woofer and tweeter.

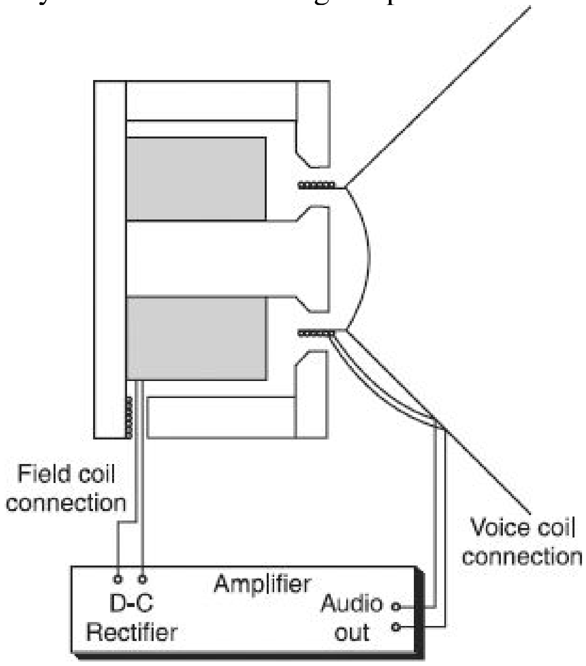


Fig Electrodynamic speaker

Improvements in permanent magnet materials have made the electrodynamic speaker *practically obsolete*, but some still exist in vintage radios. Note that these use the field coil as part of a choke filter in the power supply, a good example of killing two birds with one stone. The electrodynamic speaker has disappeared completely, so far as hi-fi is concerned, the permanent magnet speaker reigns supreme.

PERMANENT MAGNET LOUDSPEAKERS:

The *most popular* type of loudspeaker today is the permanent magnet dynamic type. Because of its comparative **simplicity** of construction and design, the **precision** that may be built into it, the **ease** with which it is interfaced with other equipment, its easy **adaptability** to many different applications, and its **comparative freedom** from electrical trouble, **the *dynamic loudspeaker* has found acceptance in all kinds of reproducing systems.** It is found in the smallest pocket radios and is a major component of the most elaborate theatre systems.

Just about all hi-fi woofers are of the permanent magnet (PM) type. Exploded view of the PM cone type speaker is given in Fig. The *cone* (diaphragm) is energised by a *moving coil.* The woofer's magnetic field is supplied by a *permanently magnetised and highly magnetic alloy* instead of the iron-cored coil used in electrodynamic speakers.

The PM speaker contains a very light coil of wire affixed to the diaphragm and located concentrically around, within, or in front of the centre of the permanent magnet. The coil (voice coil) is free to move in the field of the magnet. Electrical impulses, varying at an audio rate, are applied to the *voice coil* by the amplifier. Because these impulses are constantly changing in amplitude and direction, a changing magnetic field is set up in the voice coil. This field *reacts* with the constant field of the permanent magnet. The result is that the voice coil moves further into the gap when the fields are opposite and attract, and farther out of the gap when they are alike and repel. This causes an *in-and-out movement of the diaphragm*; consequently, we obtain sound waves from electrical impulses. The speed at which the coil and diaphragm vibrate depends upon the *frequency* of the impulses. The distance that the diaphragm moves in and out depends on their *amplitude*.

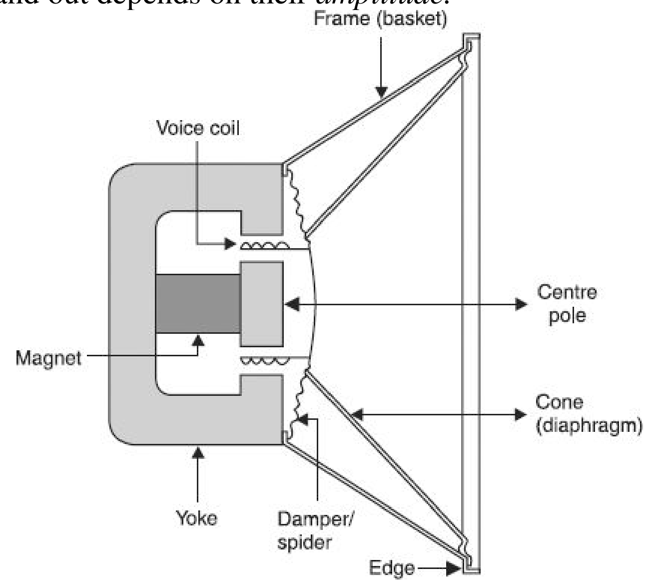


Fig. Dynamic loudspeaker

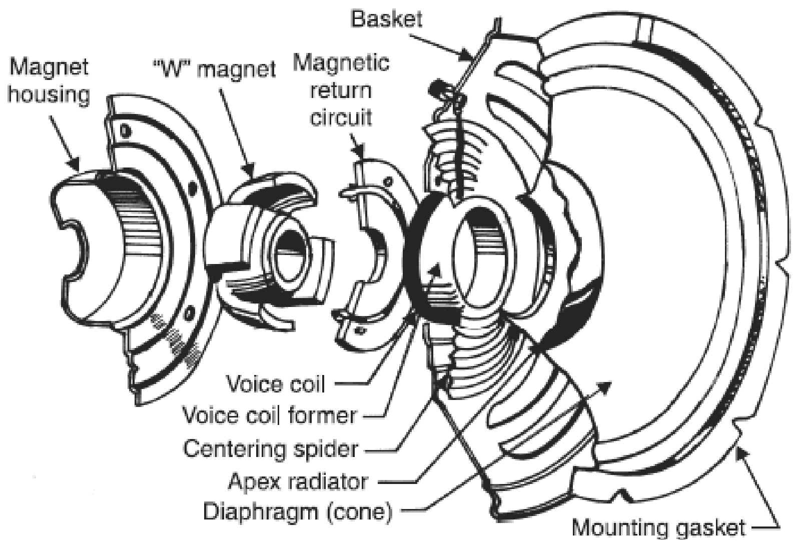


Fig. Exploded view of dynamic loudspeaker

Crossover network:

- When a multiway loudspeaker system is used to get flat frequency response for the entire range of audio frequencies, it is essential to have a crossover network to divide the incoming signal into separate frequency ranges for each speaker. In absence of crossover network, the speaker will suffer overheating & the output will be distorted when full power at frequencies outside their range is fed to them. The efficiency will be much reduced in absence of crossover network.

- Crossover network make use of the fact that
- The capacitive reactance decreases with increase in frequency [$X_c = 1/(2\pi fC)$],
- The inductive reactance increases with increase in frequency [$X_L = 2\pi fL$].
- A basic crossover network is shown in fig. below; the circuit consists of a low-pass LC filter across the woofer & a high pass LC filter across the tweeter. The LPF permits only low audio frequencies (16Hz – 1 kHz) to go to the woofer. The series reactance of L & shunt reactance of C for high audio frequencies prevents these frequencies from going to the woofer.
- The HPF consisting of series C & shunt L that allows the high audio frequencies to pass to tweeter & blocks the low frequencies.
- The response of typical crossover network is shown below.

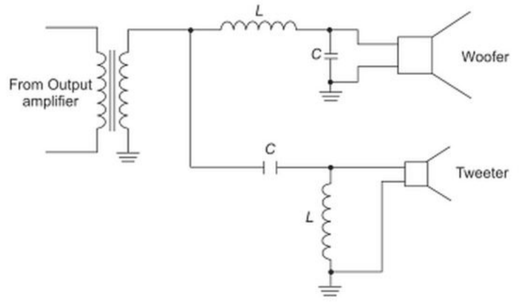


Fig. Basic crossover network

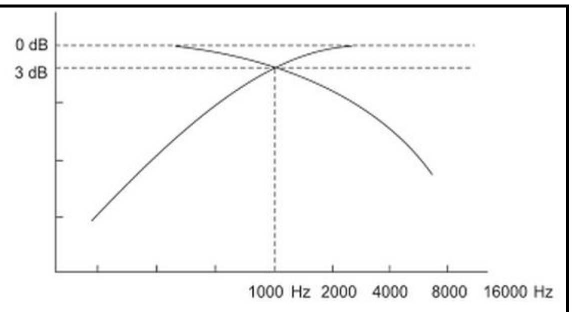


Fig. Response curve of basic crossover network

Figure: Two way crossover network

- A commercial three way crossover network is shown below the circuit consists of a low-pass L filter in series with the woofer & a high pass C filter is in series with the tweeter. The LPF permits only low audio frequencies (16Hz – 500 Hz) to go to the woofer. The mid-range frequencies are obtained either by connecting two inductors in shunt, or by connecting series L & C before the mid-range squawker. The fig. shows the three way crossover network & its response over the audio range.
- For the three way crossover network frequency coverage for the crossover point is given below:

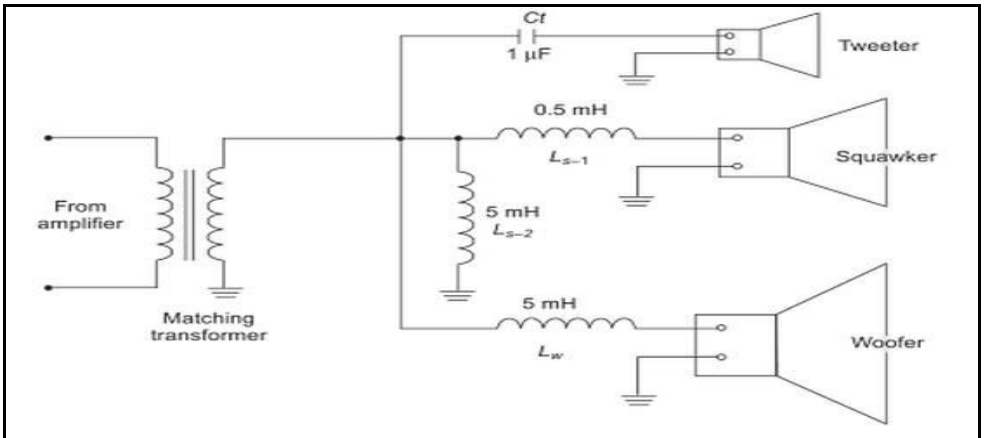


Fig. Three-way speaker system

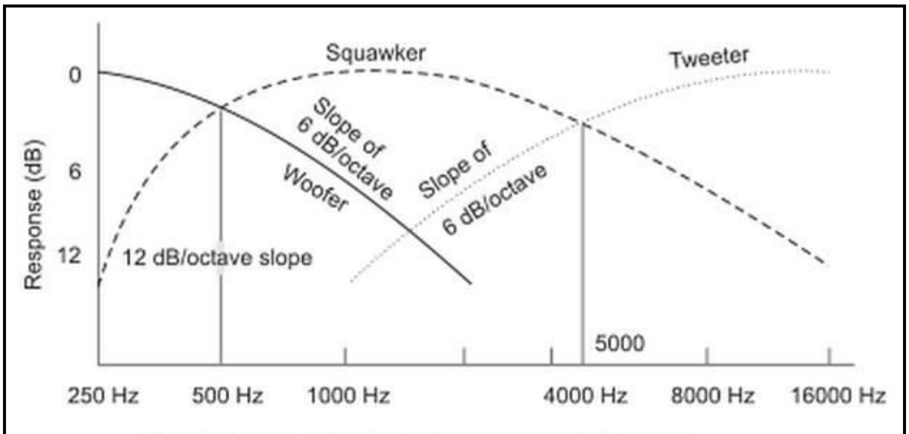


Fig. *Response curves for a three-way speaker system*

Figure: Three way crossover network

- Woofer: 16Hz-500 Hz
- Squawker: 500 Hz- 5000 Hz
- Tweeter: 5000-20000 Hz.

1.6 Types of Speakers:

Sr. No.	Parameter	Woofer	Mid-range (Squawker)	Tweeter
	Range of Frequency	16Hz to 500Hz	500Hz to 5KHz	5KHz to 20KHz
	Size & Physical Structure	Size is largest to match the impedance to the air.	They are of medium size, kept in between tweeter & woofer.	They process High frequency, hence their size is small. They are light in weight so that they can respond rapidly to applied signal.
	Placement	In the enclosure woofer is at lowest position.	These speakers are in the center.	Tweeters are at top.
	Attenuation	Attenuates frequency above 1 KHz.	Attenuates low & High frequency.	Attenuates low frequency.
	Design	Design is to produce low frequency	Design is to produce a range of frequency in the	Design is to produce highest frequency

		sound.	middle of spectrum.	
	Application	PA system	TV sets	Electrodynamics drivers.

CHAPTER : 2.

COURSE: Consumer Electronics

COURSE CODE: 22425

CHAPTER : 2. Audio Systems

Marks: 08 Marks.

Course Outcomes:

A. Troubleshoot different types of microphones and speakers.
B. Maintain audio systems.
C. Analyse the composite video signal used in TV signal transmission.
D. Troubleshoot colour TV receivers.
E. Maintain various consumer electronic appliances.

Contents:

1. Block diagram and operation of CD player, types of CD player
2. Component used for CD mechanism: . CD pick-up assembly, gear system, drive motors, CD lens
3. Block diagram of Hi Fi amplifier and its working
4. Public Address (PA) system: Block diagram and operation, Speaker impedance matching and characteristics
5. Home theatre system
6. Block diagram and working of MP3

Introduction:

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

Construction of a Compact Disc (CD):

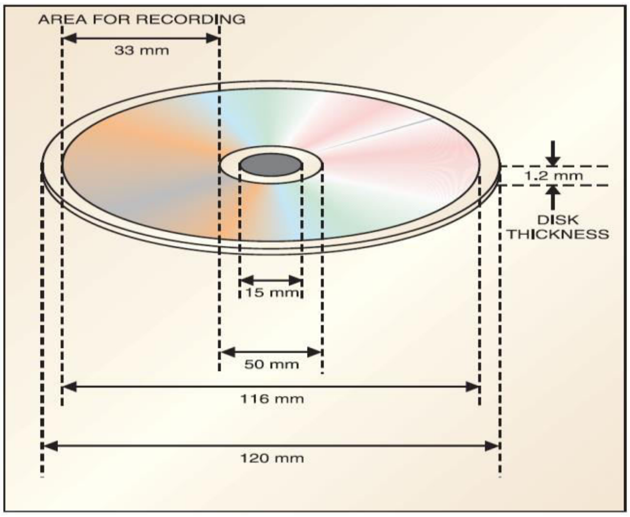


Figure: Construction of CD

Materials used for CD construction:

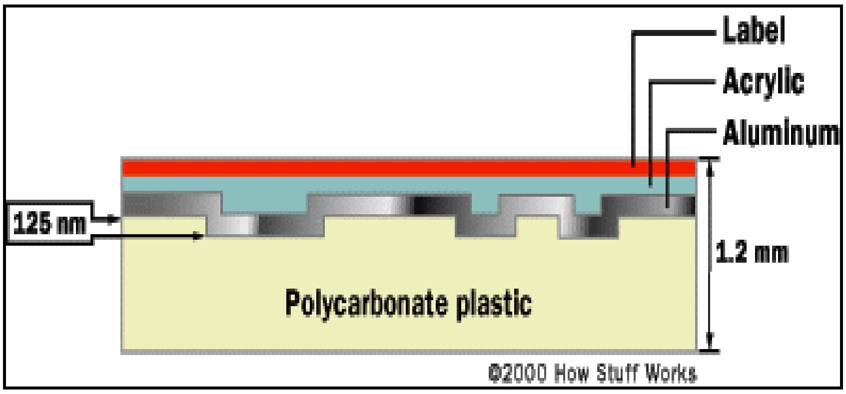


Figure: Construction of CD

CD consists of four layers:

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

Advantages of Compact Disc (CD) over Cassettes:

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

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

Block Diagram of CD player:

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

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

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

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

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

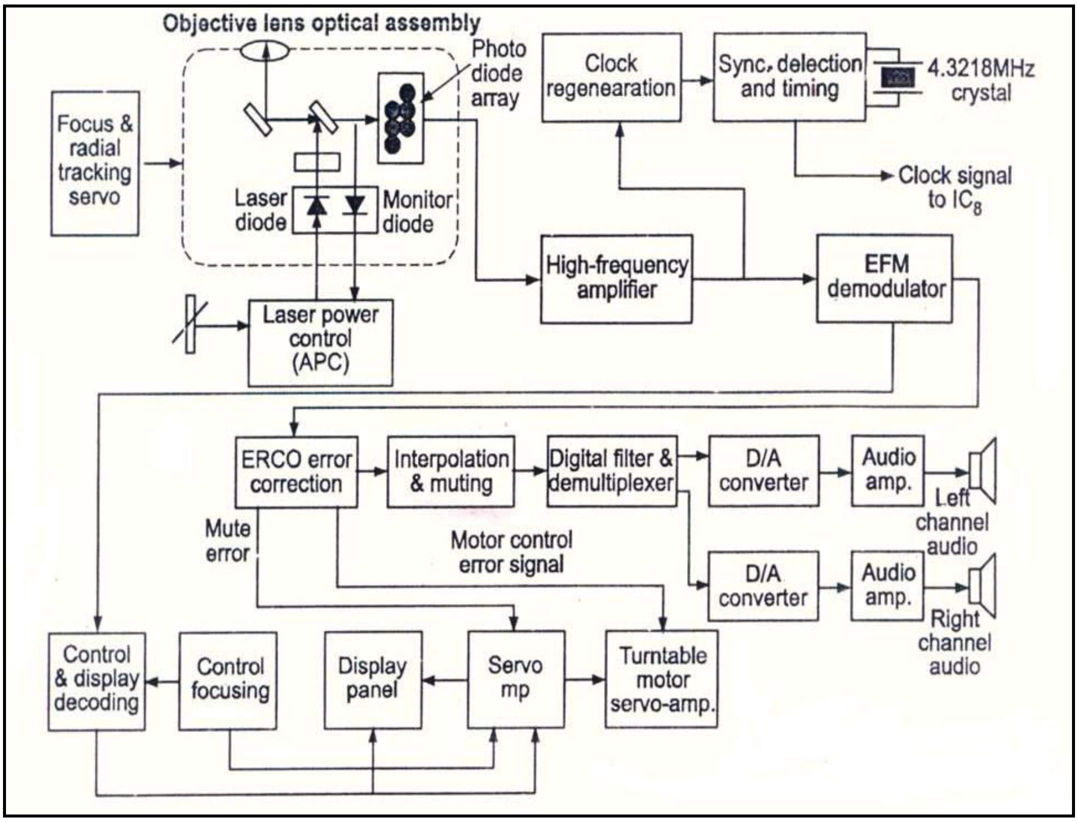


Figure: Block diagram of CD player

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

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

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

- Muting
- Last word held
- Linear Interpolation

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

2. **Previous word held:**

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

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

CLV using the Clock Signal: The ERCO also responsible for maintaining constant linear velocity of CD rotation motor , For this , The TRCO circuit compare the clock signal derived from the incoming data with reference clock frequency.

De- interleaving : Signals from the ERCO contains audio signal in the interleaved format . Before doing any further operation on this signal , it must be interleaved . The signal is then de-interleaved in the interpolation and muting section to restore the original sequence of information.

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

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

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

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

Detection used in CD player:

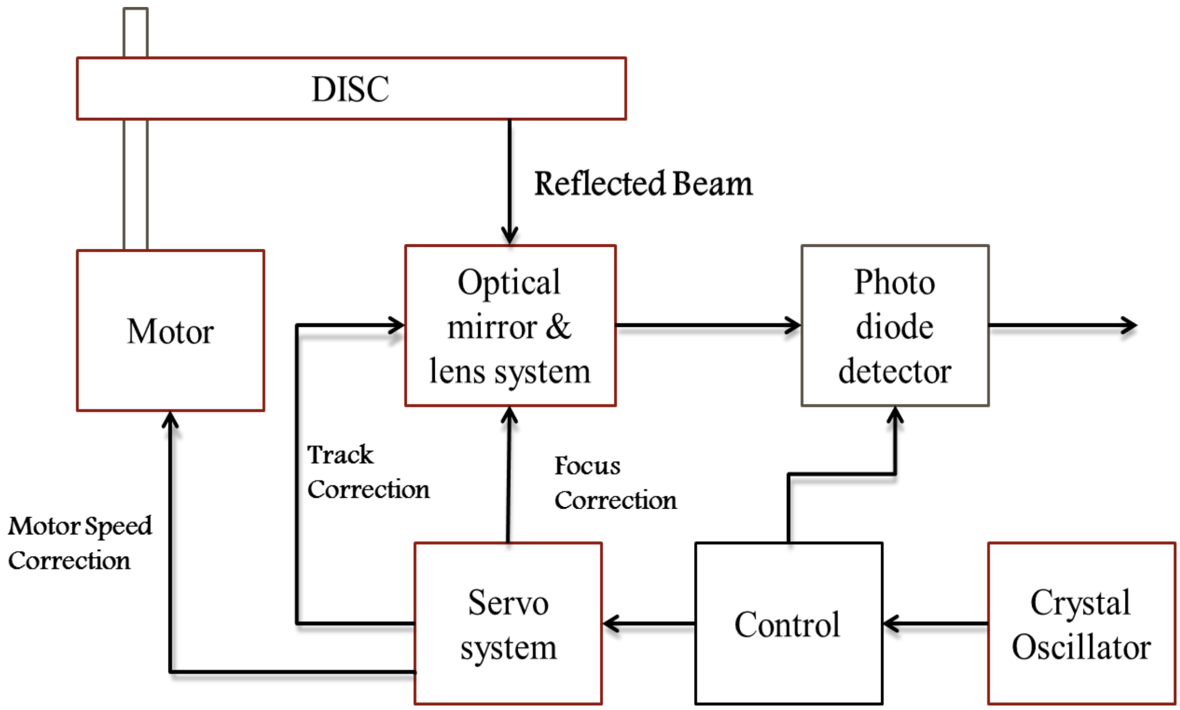


Figure: Detection used in CD player

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

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

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

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

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

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

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

Servo System:

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

Most CD players have four individual servo systems, namely,

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

CD players with radial optical assembly have only three servo systems, namely,

- The focus,
- Radial, and
- Spindle servos.

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

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

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

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

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

Optical Pickup Unit:

The pick-up assemble consist of –

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

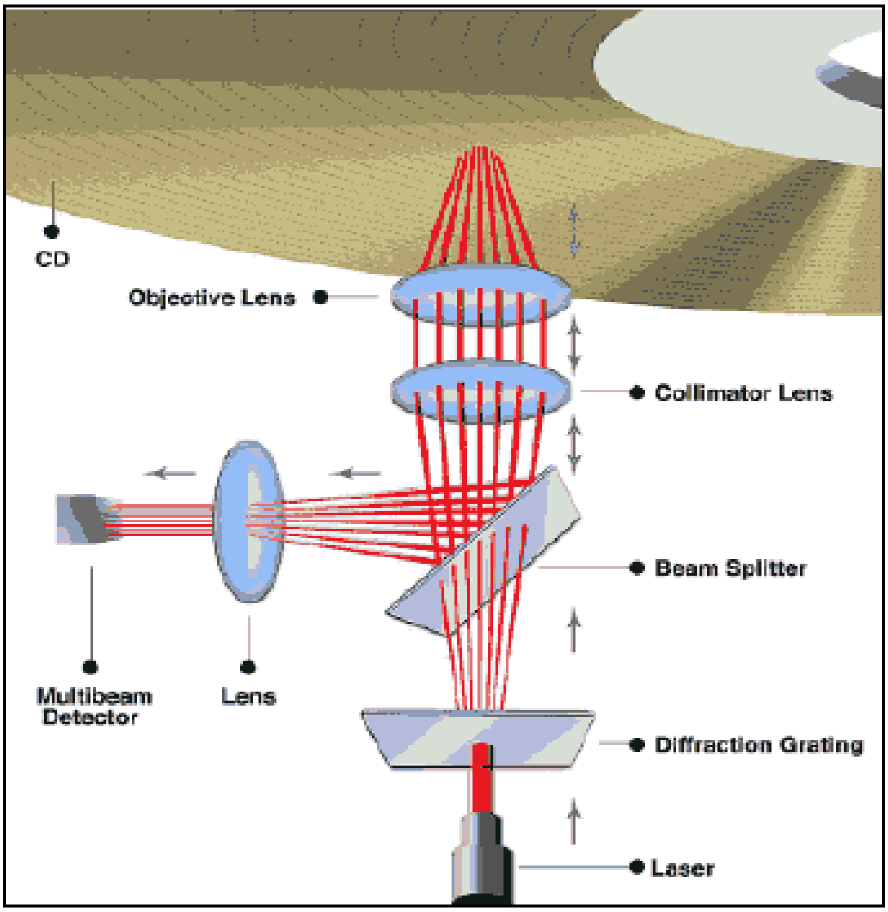


Figure: Optical pickup assembly

<u>Optical arrangement in a single-beam radial tracking pick-up assembly :</u>

- In the optical pickup unit, the laser diode emits laser beam from a small point into an elliptical or conical distribution. This beam is passed through various prism and lens to form a very small diameter light beam on the disc surface at the center of the track.
- The objective lens is controlled by the tracking and focusing coil to keep the beam focused on the CD and to keep the condensed beam at the center of the track.
- This laser beam is reflected back by the flat area and the pits on the disc surface. This reflected beam is applied to a group of photodiodes through objectives lens, collimator lens and some prism arrangement.
- These photodiodes induce voltage according to the reflected beam falling on it. Focus error and tracking error voltage generated by this photodiode array is applied to the tracking and focusing coil to control the objective lens and data signal generated by this photodiode array is sent to an amplifier to amplify the data signals picked-up from the disc. Finally, the output from the amplifier is processed to produce the audio signal stored on the disc surface.

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

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

<u>Lenses used in CD player:</u>

- In case of optical pick up assemble in CD the laser beam is emitted by laser diode for purpose of detection. The lens and prism arrangement is used to direct the laser beam to the CD surface and to direct the reflected laser beam towards photodiode array.

- If the lens systems are not used them the laser beam may scatter in other direction and hence proper detection will not take place.

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

Collimation lens:

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

Concave lens:

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

Objective lens:

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

Cylindrical lens (in Three-Beam Linear Optical Blocks):

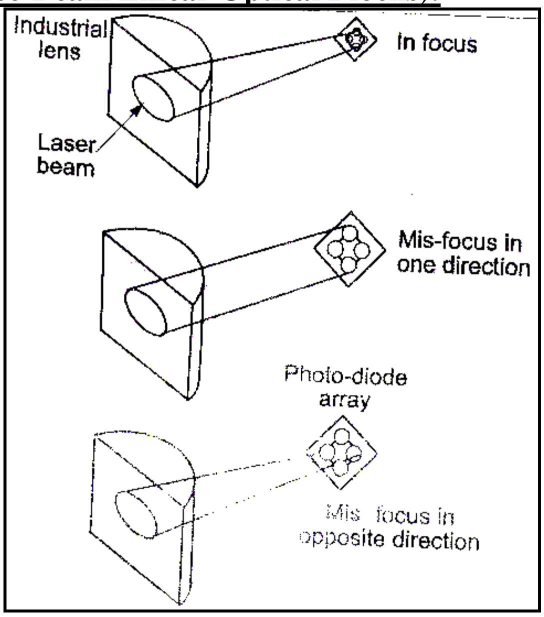


Figure: Lens

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

Motors used in CD player:

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

Different types of motors used in CD players are:

  - Tray loading or carriage motor,
  - Slide sled feed motor and
  - Spindle, disc, turntable motor.

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

PUBLIC ADDRESS SYSTEM (PA SYSTEM):

It is an electroacoustic system, in which sound is first converted into electrical signals by a microphone. The electrical audio signals are amplified, processed & fed to another transducer, the loudspeaker, which converts the audio signals into sound waves. A block diagram of a basic PA system is shown in fig. below. The function of each block of PA system is described below.

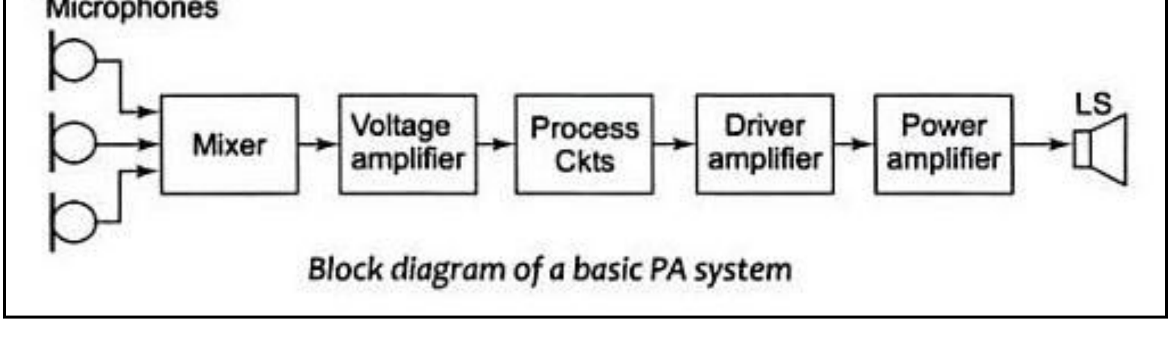


Figure: Block diagram of PA system

Microphone: It picks up sound wave & converts them into electrical variations, called audio signals. Generally, amplifiers have provision of 2 or more microphones & in addition, an auxiliary input for tape/record player.

Mixer: The output of microphones is fed to mixer stage. The function of mixer stage is to effectively isolate different channels from each other before feeding to the main amplifier. It can be either a built-in unit or a separate pluggable unit.

Voltage amplifier: It is an amplifier which further amplifies the output of the mixer.

Processing circuit: These circuits have 'Master gain control' & tone controls (Bass/Treble controls).

Driver amplifier: It gives voltage amplification to the signal to such an extent that when fed to the next stage (power amplifier stage), the internal resistance of that stage is reduced. Thus it drives the power amplifier to give more power.

Power amplifier: It gives desired power amplification to the signal. It uses push pull type of circuit in general, so that the even harmonics are eliminated from the output, & the transformer core does not get saturated.
The output of power amplifier is connected to the loudspeaker through matching transformer to match the low impedance of the loudspeaker for maximum transfer of power.
Loudspeaker: A loudspeaker is an electroacoustic transducer that produces sound in response to an electrical audio signal input. In other words, speakers convert electrical signals into audible signals.

BLOCK DIAGRAM OF HI-FI AUDIO AMPLIFIER SYSTEM:

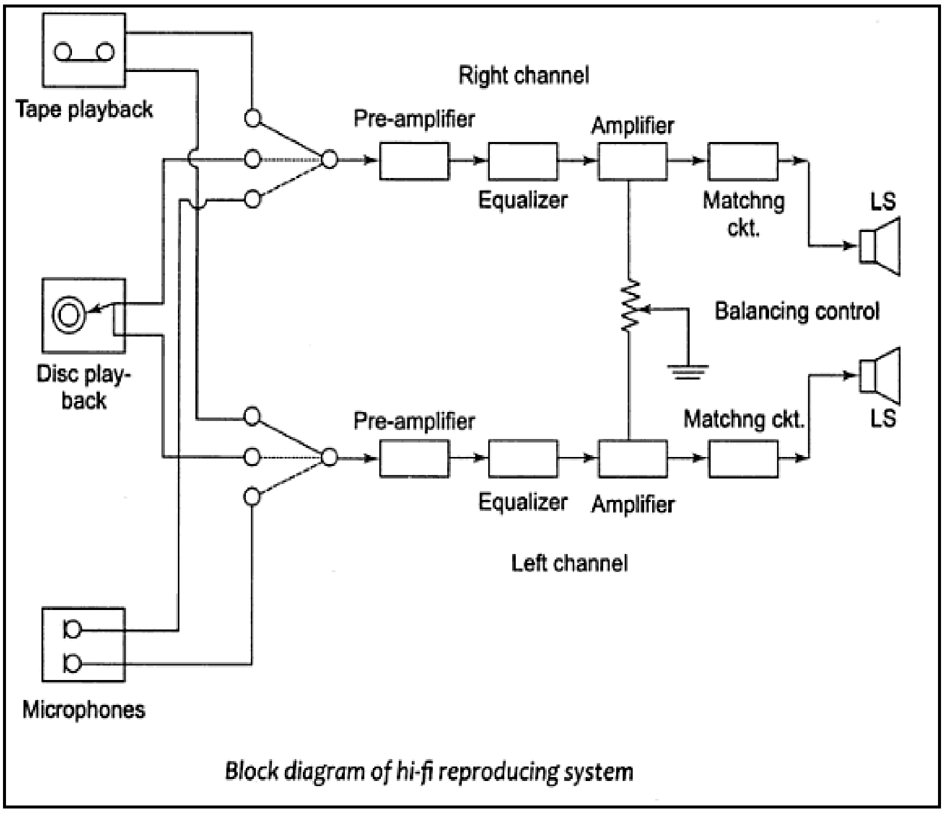


Figure: Block diagram of Hi-Fi audio amplifier system

High fidelity sound can be obtained from the recorded ‘stereo sounds’ (stereo taps or live stereo system from microphones.). The stereo signal is fed to two independent amplification channels through tape- mic switch.

The Hi-fi system consists of:

- Pre Amplifier (LNA)
- Equalizer,
- Amplifier,
- Matching circuit &
- Loud speaker.

Pre Amplifier (LNA): This is a low noise high gain amplifier which amplifies the weak signal coming from microphones with low noise. This increases the signal strength as well as SNR of system.

Equalizer: Equalizer is utilized for adjusting frequency for providing boost & cut at a particular frequency. This improves frequency response & hence selectivity & quality factor of system.

Amplifier: It is a power amplifier for increasing strength of the signal. This is used to drive the loudspeaker with sufficient signal strength.

Matching circuit: The primary winding of transformer is connected to output of power amplifier & secondary winding is connected to loudspeaker. This transformer provides impedance matching for maximum power transfer of loudspeaker.

Balance control: Two amplifiers of a stereo system, although independent of each other, are built as matched pair to give equal output for the same input. In spite of the two amplifiers being identical, there may be variations in the output of each channel due to variations in the characteristics of transistors & ICs and positioning of loudspeaker & furnishing with respect to the listener. The circuit used is called BALANCE CONTROL.

Loudspeaker: A loudspeaker is an electroacoustic transducer that produces sound in response to an electrical audio signal input. In other words, speakers convert electrical signals into audible signals.

Characteristics of HI-FI amplifier:

1. Signal to noise ratio should be better than 50dB.

2. Frequency response should be flat within +-1dB.

3. Nonlinear distortion should not be more than 1%.

4. The system should possess dynamic range of at least 8dB.

5. Stereophonic effect should be provided.

6. Environmental conditions should be such as to eliminate the external noise in listening room.

Block Diagram of MP3 player:

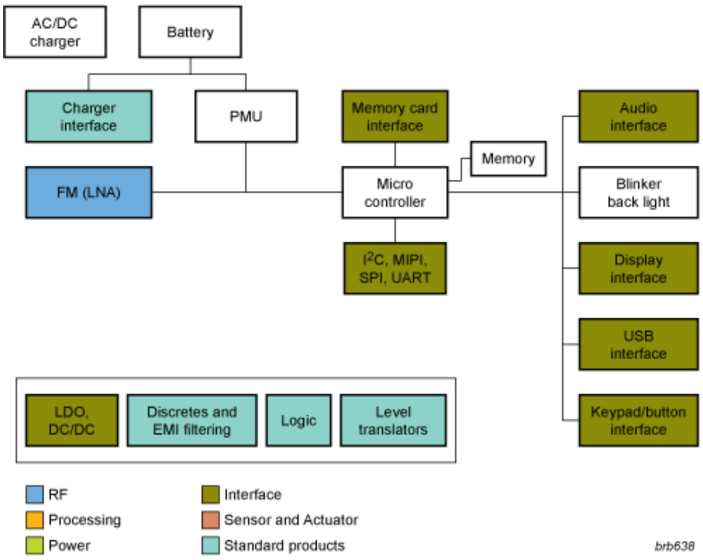


Figure: Block diagram of MP3 Player

MP3 players require energy efficient solutions, such as class D audio amplifiers and the latest interface components.

Audio

The digital audio amplifier family is built to simplify audio architecture by lowering the system cost and enabling easy interfacing. Using a digital interface eliminates the need for a D/A converter in the host processor, and the PDM or I2S format guarantees an ultra small IC footprint.

The digital interface assures low RF susceptibility in the device and the total system, and low sensitivity to input clock jitter. In addition, the digital interface eliminates the need for couple capacitors and safeguard speakers by eliminating problems coming from DC offsets due to leakage currents of an analog design.

Charger interface

Whether the device is charged via the USB port or a separate charger, it is exposed to incorrect polarity or abnormally high voltages. Any of these two occurrences poses a threat to the charger circuit and the PMU of the mobile device. In addition, the USB/charger port can be subject to ESD strikes and other transient discharges.

Memory Card Interfaces

According the IEC 61000-4-2 standard, SD host interfaces require additional high-level ESD protection, in addition to the integrated ESD protection which is typically very weak. Other strict EMI regulations and system requirements, as specified in GSM mobile phones, strongly request filters that reduce the radiated/conducted EMI. However, they must still comply with the electrical requirements of the interface specification.

The continuing trend of miniaturization of portable appliances implies that interface devices offering ESD protection and EMI filtering should also integrate biasing circuits/resistors into a single small-sized package. NXP's memory card interface solutions fully support this continuing trend and offer interface conditioning functions such as high-level ESD protection according the IEC 61000-4-2 standard. They also support EMI filtering, integrated biasing resistor networks, regulated power supply to supply SD-memory cards directly from a battery, and voltage level translation to enable the use of low-voltage host processors to communicate with 2.7 V to 3.6 V compliant SD-memory card devices.

CHAPTER : 3. TV Fundamentals & Transmitter

3.1 Basic fundamentals of colour & monochrome television.

Aspect Ratio:

The **aspect ratio** of an image describes the proportional relationship between its width and its height. The frame adopted in all television systems is rectangular with width/height ratio, i.e., aspect ratio = 4/3.

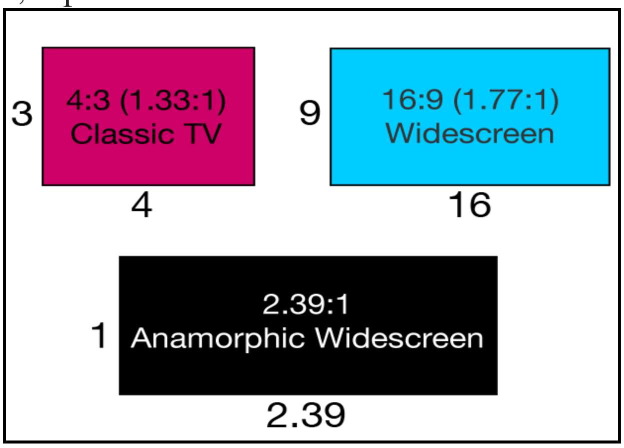


Figure: Different Aspect Ratio

$$\textbf{Aspect Ratio} = \frac{\textbf{Width of the Screen}}{\textbf{Height Of the Screen}} = \frac{4}{3} \qquad \text{-------} \ (1)$$

Why Width is more than height???

- In human affairs most of the motion occurs in the horizontal plane and so a larger width is desirable. The eyes can view with more ease and comfort when the width of a picture is more than its height.
- The usage of rectangular frame in motion pictures with a width/height ratio of 4/3 is another important reason for adopting this shape and aspect ratio. This enables direct television transmission of film programs without wastage of any film area.

Image Continuity:

- While televising picture elements of the frame by means of the scanning process, it is necessary to present the picture to the eye in such a way that an illusion of continuity is created and any motion in the scene appears on the picture tube screen as a smooth and continuous change.
- To achieve this, advantage is taken of **'persistence of vision'** or storage characteristics of the human eye. This is came from the fact that the sensation produced when the light is incident on eye's retina, it does not disappear immediately after the light is removed but persists(stays) for about **1/16th** of a second.
- Thus if the scanning rate per second is made greater than sixteen, or the number of pictures shown per second is more than sixteen, the eye is able to integrate(mix) the changing levels of brightness in the scene.
- So when the picture elements are scanned rapidly enough, they appear to the eye as a complete picture unit, with none of the individual elements visible separately.
- In present day motion pictures **twenty-four still pictures** of the scene are taken per second and later projected on the screen at the same rate.
- Each picture or frame is projected individually as a still picture, but they are shown one after the other in rapid succession to produce the illusion of continuous motion of the scene being shown.

Scanning:

The scene is scanned rapidly both in the horizontal and vertical directions simultaneously to provide sufficient number of complete pictures or frames per second to give the illusion of continuous motion. Instead of the 24 as in commercial motion picture practice, the frame repetition rate is 25 per second in most television systems.

- **Horizontal scanning:**
  - Fig. shows the trace and retrace of several horizontal lines. The linear rise of current in the horizontal deflection coils deflects the beam across the screen with a continuous, uniform motion for the trace from left to right.

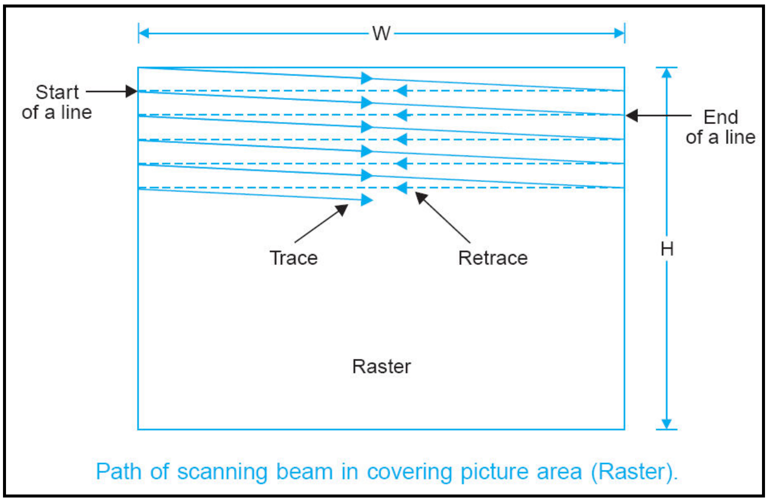


Figure: Horizontal Scanning.

- At the peak of the rise, the sawtooth wave reverses direction and decreases rapidly to its initial value. This fast reversal produces the retrace or flyback. The start of the horizontal trace is at the left edge of raster. The finish is at the right edge, where the flyback produces retrace back to the left edge.

- **Vertical scanning.**

  - The sawtooth current in the vertical deflection coils moves the electron beam from top to bottom of the raster at a uniform speed while the electron beam is being deflected horizontally. Thus the beam produces complete horizontal lines one below the other while moving from top to bottom.
  - The trace part of the sawtooth wave for vertical scanning deflects the beam to the bottom of the raster. Then the rapid vertical retrace returns the beam to the top. Note that the maximum amplitude of the vertical sweep current brings the beam to the bottom of the raster.

Number of scanning lines:

- Most scenes have brightness variations in the vertical direction. The ability of the scanning beam to allow reproduction of electrical signals according to these variations and the capability of the human eye to resolve these distinctly, while viewing the reproduced picture, depends on the total number of lines employed for scanning.
- It is possible to arrive at some estimates of the number of lines necessary by considering the bar pattern shown in Fig., where alternate lines are black and white. If the thickness of the scanning beam is equal to the width of each white and black bar, and the number of scanning lines is chosen equal to the number of bars, the electrical information corresponding to the brightness of each bar will be correctly reproduced during the scanning process.

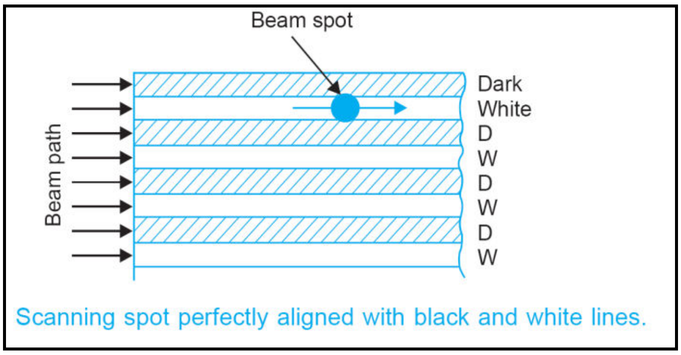


Figure: Scanning of alternate Black & White lines for calculation of TOTAL NO. OF LINES

- The maximum number of alternate light and dark elements (lines) which can be resolved by the eye is given by

$$Nv=1$$

----------(2)

where Nv= total number of lines (elements) to be resolved in the vertical direction,
α = minimum resolving angle of the eye expressed in radians, and
ρ = D/H = viewing-distance/picture height.

- For the eye this resolution is determined by the structure of the retina, and the brightness level of the picture. it has been determined experimentally that with reasonable brightness variations and a **minimum viewing distance of four times the picture height (D/H = 4)**, the **angle** that any two adjacent elements must subtend at the eye for distinct resolution is approximately **one minute (1/60 degree).**
Substituting these values of α and ρ we get

$$\mathbf{Nv=1(1801604)860}$$

----------(3)

- In practice however, the picture elements are not arranged as equally spaced segments but have random distribution of black, grey and white depending on the nature of the picture details or the scene under consideration.
- Statistical analysis and subjective tests carried out to determine the average **number of effective lines suggest that about 70 per cent of the total lines or segments get separately scanned in the vertical direction and the remaining 30 per cent get merged with other elements due to the beam spot falling equally on two consecutive lines.**
- Thus the effective number of lines distinctly resolved, i.e.,

$$\mathbf{Nr=Nvk}$$

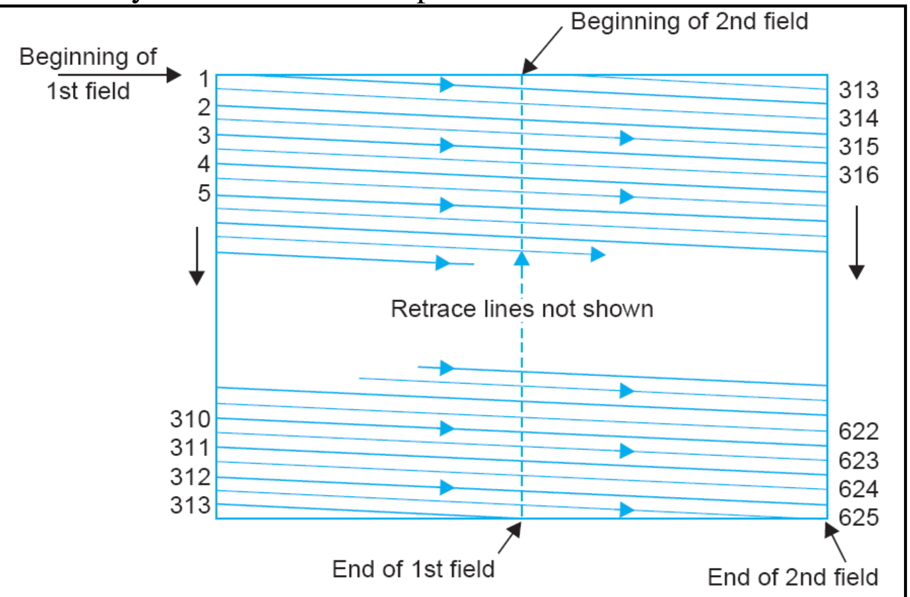
---------(4)

Where k is the resolution factor whose value lies between 0.65 to 0.75. Assuming the value of k = 0.7.

We get, **Nr=Nvk=8600.7=602** **----------(5)**

<u>Interlace scanning:</u>

- In television pictures an effective rate of **50 vertical scans per second** is utilized to reduce the flicker. This is accomplished by increasing the downward rate of travel of the scanning electron beam, so that every alternate line gets scanned instead of successive line.
- Then when the beam reaches the bottom of the picture frame it quickly returns to the top to scan those lines that were missed in the previous scanning.
- Thus, the total numbers of lines are divided into two groups called '**fields**'. Each field is scanned alternately. This method of scanning is called ***'interlaced scanning'***.
- In the 625 line TV system, for successful interlaced scanning, the 625 lines of each frame or picture are divided into sets of 312.5 lines and each set is scanned alternately to cover the entire picture area.



Principle of interlaced scanning. Note that the vertical retrace time has been assumed to be zero.

Figure: Principle of Interlaced Scanning

- To achieve this, the horizontal sweep oscillator is made to work at a frequency of 15625 Hz (i.e. 312.5 x 50 = 15625) to scan the number of lines per frame, but the vertical sweep circuit is run at a frequency of 50 Hz (i.e. 25 x 2 = 50Hz)
- Note that since the beam is now deflected from top to bottom in half the time and horizontal oscillator still operating at 15625 Hz, only half the total lines (i.e. 312.5) get scanned during each vertical sweep.
- Since the first field ends in a half line and the second field starts middle of the line on top of the screen, as shown in fig., the beam is able to scan the remaining 312.5 alternate lines during its downward journey.
- The beam scans 652 lines per frame at the same rate of 15625 lines per second. Therefore, with interlaced scanning the flicker effect is eliminated without increasing the speed of scanning, which in turn does not need any increase in channel bandwidth.

<u>Scanning periods</u>:

- The wave shapes of both horizontal and vertical sweep currents are shown in Fig.
- As shown there the retrace times involved (both horizontal and vertical) are due to physical limitations of practical scanning systems and are not utilized for transmitting or receiving any video signal.

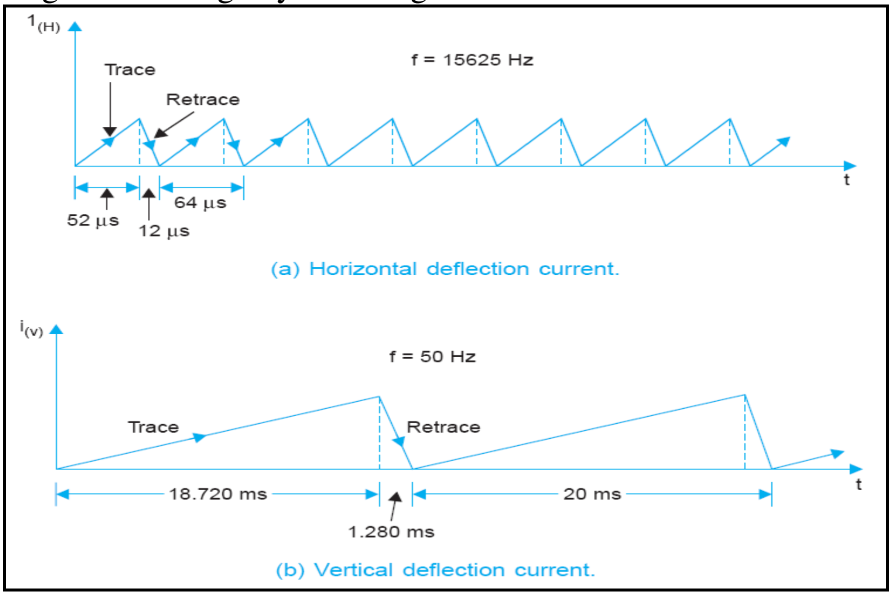


Figure: Scanning Durations

- The nominal duration of the horizontal line as shown in Fig. is 64 µs (1/15625 = 64 µs), out of which the **active line period** is **52 µs** and the remaining **12 µs** is the **line blanking period**. The beam returns during this short interval to the extreme left side of the frame to start tracing the next line.
- Similarly with the field frequency set at 50 Hz, the nominal duration of the vertical time period (see Fig.) is 20 ms (1/50 = 20 ms). Out of this period of 20 ms, **18.720 ms** are spent in **bringing the beam from top to bottom** and the remaining **1.280 ms** is taken by the beam to **return back to the top to commence the next cycle.**
- Since the horizontal and vertical sweep oscillators operate continuously to achieve the fast sequence of interlaced scanning, **20 horizontal lines** get traced during each vertical retrace interval. Thus **40 scanning lines** are **lost per frame**, as blanked lines during the retrace interval of two fields.
- This leaves the active number of lines, **Na**, for scanning the picture details equal to **625 – 40 = 585**, **instead of the 625** lines actually scanned per frame.

<u>Scanning sequence:</u>

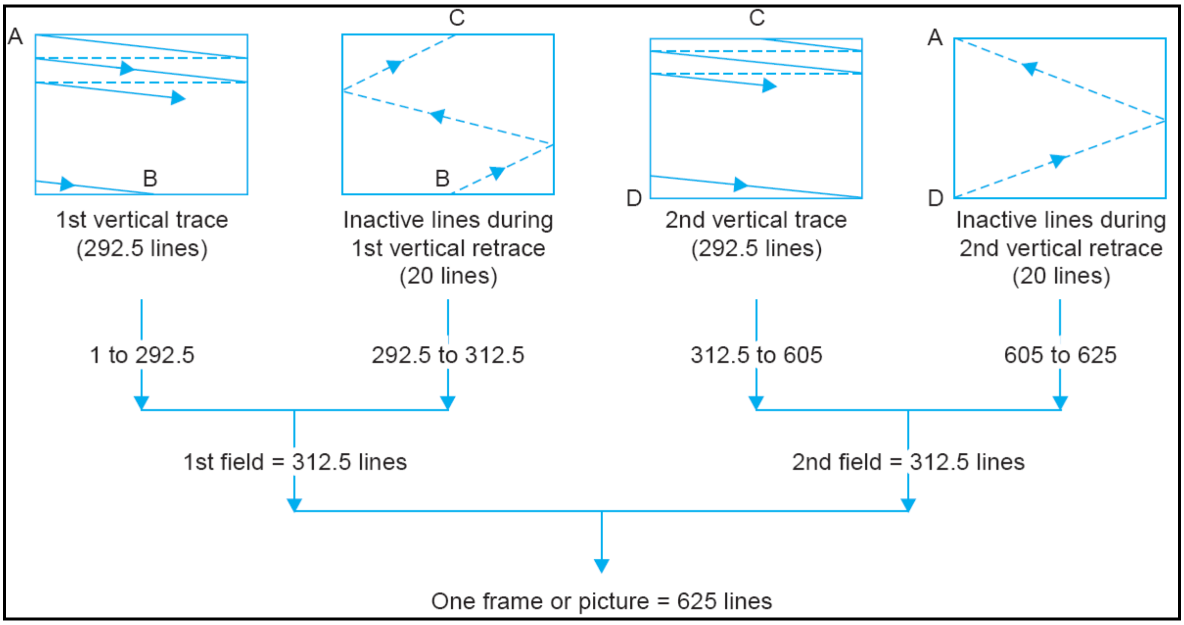


Figure: Scanning sequence/ line details for scanning

Vertical resolution:

Definition:

The ability of the scanning system to resolve picture details in vertical direction is known as vertical resolution.

1)Vertical resolution is a function of scanning lines into which the picture is divided in the vertical plane.

2)The maximum number of dark and white elements which can be resolved by the human eye in the vertical direction in a screen of height H decided by the number of horizontal lines into which picture is split while scanning.

Thus, vertical resolution can be expressed as,

Vr=Nak

----------(6)

Vr = Vertical resolution

Na = Active number of lines.

K-kell factor or resolution factor

Vr= ____

Horizontal Resolution:

Definition:

The ability of the scanning system to resolve the picture details in the horizontal direction is known as horizontal resolution.

1) While aiming at equal vertical and horizontal resolutions and assuming the same Kell factors the effective number of alternate black and white segments (N) that get scanned in one horizontal line are-

N=NaAspect Ratiok **-----------**
--(7)

N= ____________________

Vestigial sideband transmission:

- In the video signal very low frequency modulating components exist along with the rest of the signal. These components give rise to sidebands very close to the carrier frequency which are difficult to remove by physically realizable filters.
- Thus it is not possible to go to the extreme and fully suppress one complete sideband in the case of television signals. The low video frequencies contain the most important information of the picture and any effort to completely suppress the lower sideband would result in objectionable phase distortion at these frequencies.

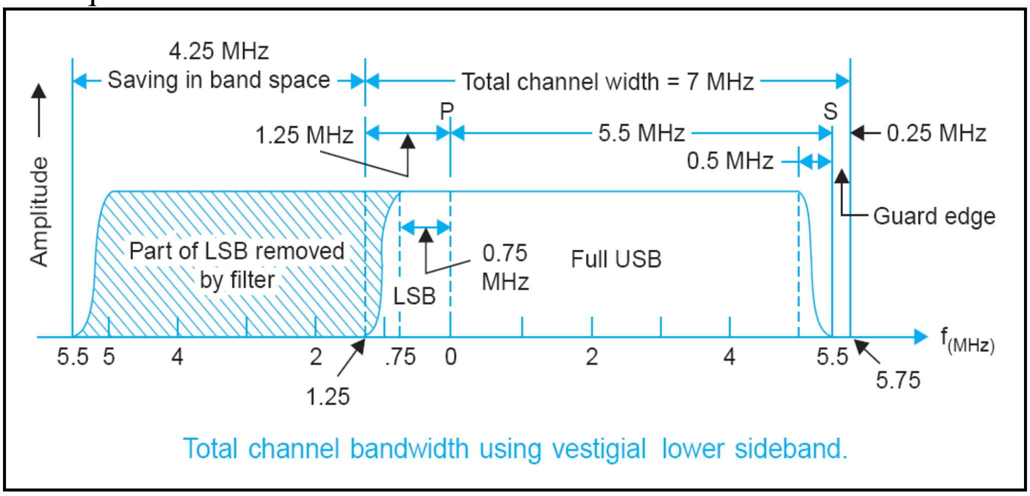


Figure: VSB

- This distortion will be seen by the eye as 'smear'(spreaded) in the reproduced picture. Therefore, as a compromise, only a part of the lower sideband is suppressed, and the radiated signal then consists of a full upper sideband together with the carrier, and the vestige (remaining part) of the partially suppressed lower sideband. This pattern of transmission of the modulated signal is known as **vestigial sideband or A5C transmission**. In the 625 line system, frequencies up to 0.75 MHz in the lower sideband are fully radiated.

Definitions:

Contrast:

This is the difference in intensity between black and white parts of the picture over and above the brightness level.

Hue:

This is the predominant spectral colour of received light which means it is the actual colour seen by the eye. Red, Green, Blue, Yellow, Magenta, represent different in the visible spectrum.

Saturation:

It represents the spectral purity of a colour light. It is the amount of white light that is mixed with a colour. A fully saturated colour will have no white light mixed with it. For example, a Pure Red without White is a saturated colour.

Luminance or Brightness: This is the amount of light intensity as perceived by the eye regardless of the colour. In black and white pictures, better lighted parts have more luminance than the dark areas.

Viewing distance:

- The viewing distance from the screen of the TV receiver should not be so large that the eye cannot resolve details of the picture. The distance should also not be so small that picture elements become separately visible. The above conditions are met when the vertical picture size subtends an angle of approximately 15° at the eye.
- The distance also depends on habit, varies from person to person, and lies between 3 to 8 times the picture heights.
- **Most people prefer a distance close to five times the picture height.**

Compatibility:

Compatibility implies that

- The colour television signal must produce a normal black and white picture on a monochrome receiver without any modification of the receiver circuitry and
- A colour receiver must be able to produce a black and white picture from a normal monochrome signal. This is referred to as **reverse compatibility.**

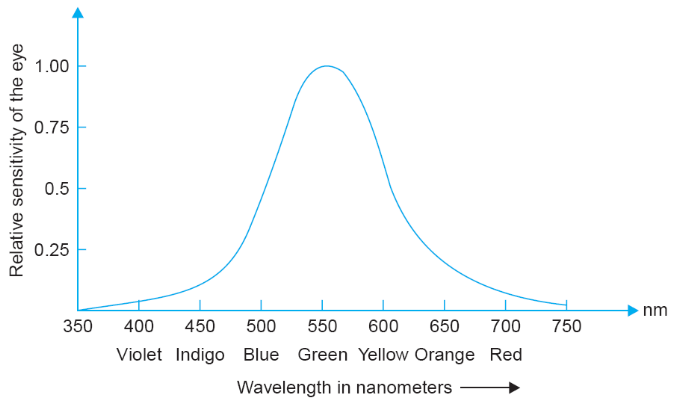
To achieve this, that is to make the system fully compatible the composite colour signal must meet the following requirements:

- It should occupy the same bandwidth as the corresponding monochrome signal.
- The location and spacing of picture and sound carrier frequencies should remain the same.
- The colour signal should have the same luminance (brightness) information as would a monochrome signal, transmitting the same scene.

- The composite colour signal should contain colour information together with the ancillary signals needed to allow this to be decoded.
- The colour information should be carried in such a way that it does not affect the picture reproduced on the screen of a monochrome receiver.
- The system must employ the same deflection frequencies and sync signals as used for monochrome transmission and reception.

3.2 Colour Theory:

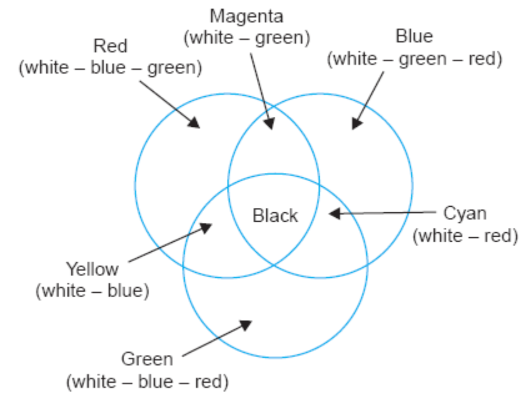
- All light sensations to the eye are divided (provided there is an adequate brightness stimulus on the operative cones) into three main groups. The optic nerve system then integrates the different colour impressions in accordance with the curve shown in Fig. to perceive the actual colour of the object being seen.



Approximate relative response of the eye to different colours.

Figure: Wavelength of different colour

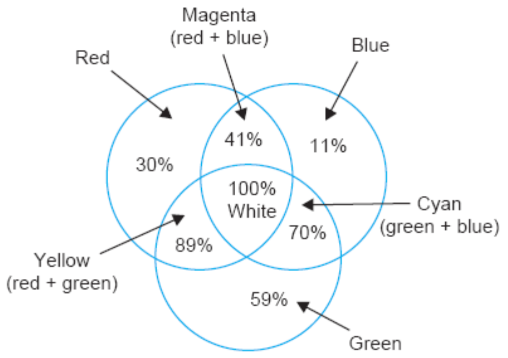
- This is known as additive mixing and forms the basis of any colour television system. A yellow colour, for example, can be distinctly seen by the eye when the red and green groups of the cones are excited at the same time with corresponding intensity ratio. Similarly and colour other than red, green and blue will excite different sets of cones to generate the cumulative sensation of that colour.
- A white colour is then perceived by the additive mixing of the sensations from all the three sets of cones.
- **Mixing of colours can take place in two ways—subtractive mixing and additive mixing**.
- In **subtractive mixing**, reflecting properties of pigments are used, which absorb all wavelengths but for their characteristic colour wavelengths. When pigments of two or more colours are mixed, they reflect wavelengths which are common to both. Since the pigments are not quite saturated (pure in colour) they reflect a fairly wide band of wavelengths. This type of mixing takes place in painting and colour printing.



Subtractive colour mixing. The diagram shows the effect of mixing colour pigments under white light.

Figure: subtractive mixing

- In **additive mixing** which forms the basis of colour television, light from two or more colours obtained either from independent sources or through filters can create a combined sensation of a different colour. Thus different colours are created by mixing pure colours and not by subtracting parts from white.



Additive colour mixing. The diagram shows the effect of projecting green, red and blue beams on a white screen in such a way that they overlap.

Figure: additive mixing

	Additive Colour Mixing		Subtractive Colour Mixing
1.	Additive mixing of three primary colours red, green and blue with proper proportions can create any colour.	1.	In subtracting mixing reflecting properties of pigments are used which absorb all wavelengths but for their characteristics colour wavelengths.
2.	Different colours are created by mixing pure colours hence used in TV.	2.	Different colours are created by subtracting parts from white so not suitable for TV.

3.	For example, Red + Blue = Magenta Red + Green = Yellow Green + Blue = Cyan	3.	For example, White – Green = Magenta White – Blue = Yellow White – Red = Cyan
4.	Additives primaries are Red, Green, and Blue.	4.	Subtractive primaries are Magenta, Yellow, and Cyan.

Grassmann's Law:

- The eye is not able to distinguish each of the colours that mix to form a new colour but instead perceives only the resultant colour. The subjective impression which is gained when green, blue and red lights reach the eye simultaneously may be matched by a single light source having the same colour.
- In addition to this, the brightness (luminance) impression created by the combined light source is numerically equal to the sum of the brightness (luminance) of the three primaries that constitute the single light.
- This ***property of the eye of producing a response which depends on the algebraic sum of the red, green and blue inputs is known as Grassman's Law.***
- White has been seen to be reproduced by adding red, green and blue lights. The intensity of each colour may be varied. This enables simple rules of addition and subtraction.

3.3 Composite Video Signal:

- In monochrome TV, the composite video signal consists of –
  1. Camera signal corresponding to light intensity in the picture.
  2. Blanking pulses to make retrace invisible.
  3. Synchronizing pulses to keep scanning at receiver in synchronous with transmitting end.
- A horizontal synchronizing pulse is sent at the end of line period, vertical sync pulse is needed after each field of scanning. In colour TV, the video signal has additional information about colours and colour sync to Synchronize colour reception. Fig. shows composite video signal for three lines having different brightness level of black and white picture.
- Video signal varies between certain amplitude limits. The level of video signal when picture information being transmitted corresponds to maximum whiteness is referred to as peak white level.
- **Peak white level is fixed at 12.5 percent of maximum value of signal and black level is fixed at 72-75 percent. Sync pulses are added at 75 percent.**
- Picture information may vary between 10 percent to about 75 percent of composite video signal depending on relative brightness of picture. **Lowest 10 percent is not used to avoid noise effect.**

- The electrical signal formed by scanning the picture image is called video signal.

Definition: *The video signal containing the horizontal and vertical sync and blanking pulses is called as Composite Video Signal.*

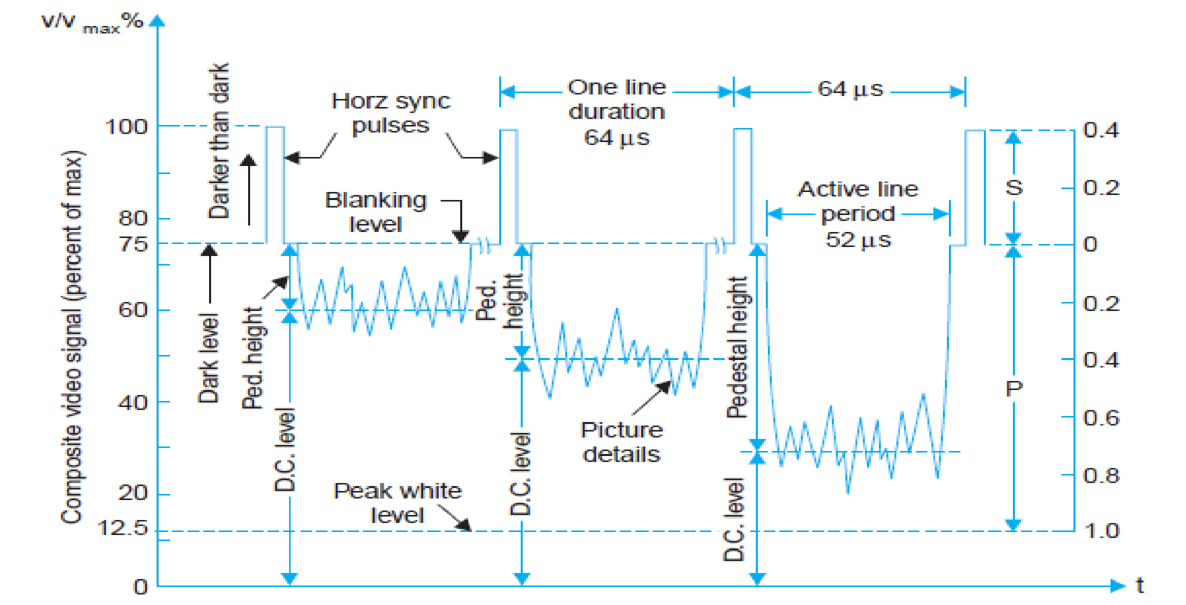


Fig. 3.1 Arbitrary picture signal details of three scanning lines with different average brightness levels. Note that picture to sync ratio P/S = 10/4.

Figure: Composite Video Signal (CVS) for 3 horizontal lines

D.C. component of the video signal:

- In addition to continuous amplitude variations for individual picture elements, the video signal has an average value or dc component corresponding to the average brightness of the scene. In the absence of dc component the receiver cannot follow changes in brightness.

Pedestal height:

- Pedestal height is the distance between the pedestal level and average value (dc level) of the video signal. This **indicates average brightness** since it measures how much the average value differs from black level.
- The output signal from TV camera is of very small amplitude. Hence, it is amplified by multistage high gain amplifiers. Sync and blanking pulses are added to it and then signal is clipped at proper value to form pedestal.
- Pedestal height determines brightness of scene. Large pedestal height makes picture brighter and vice versa. Operator who observes the picture in studio adjusts level for desired brightness by adding dc component to ac signal.

Blanking pulses:

- The composite video signal contains blanking pulses to make retrace line invisible.

- This is done by increasing the signal amplitude slightly more than the black level during retrace period
- Composite video signal contains horizontal and vertical blanking pulses.
- Repetition of rate of horizontal blanking pulses per frame is 15625 Hz (line frequency)
- Vertical blanking pulse frequency is 50Hz (field frequency)
- Sync pulses are having amplitude in upper 25 percent of video signal.

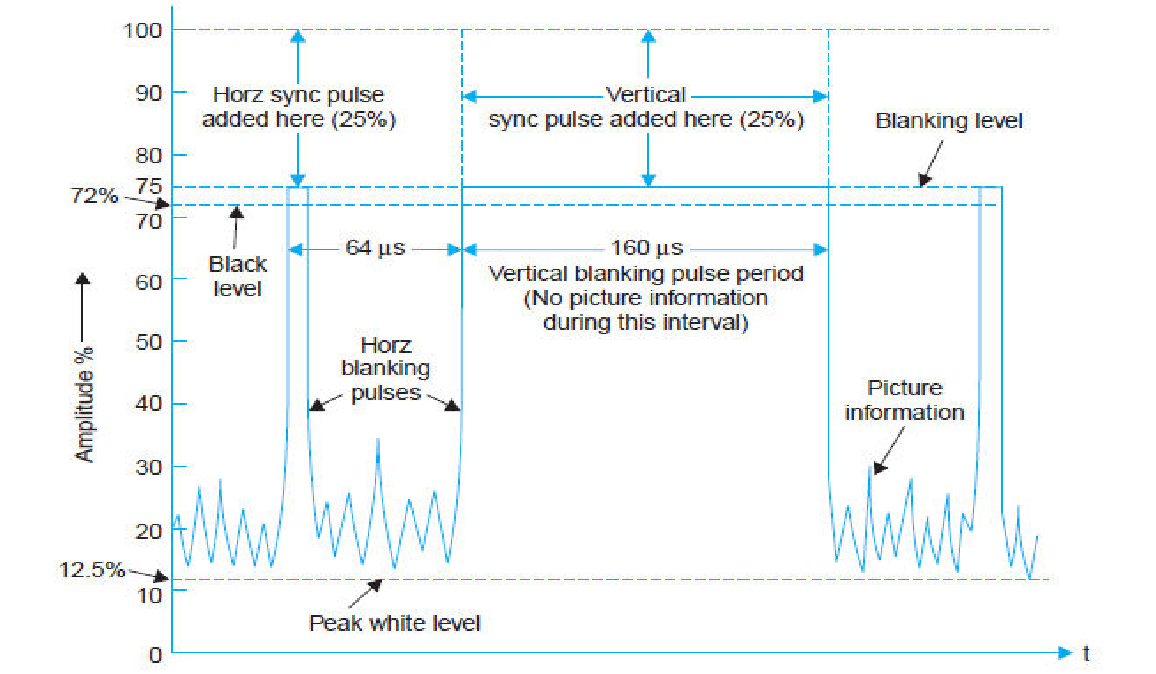


Fig. 3.2 Horizontal and vertical blanking pulses in video signal. Sync pulses are added above the blanking level and occupy upper 25% of the composite video signal amplitude.

Figure: Horizontal & Vertical Blanking pulses

Horizontal sync details:

- The horizontal blanking period and sync pulse details are illustrated in Fig. The interval between horizontal scanning lines is indicated by H.

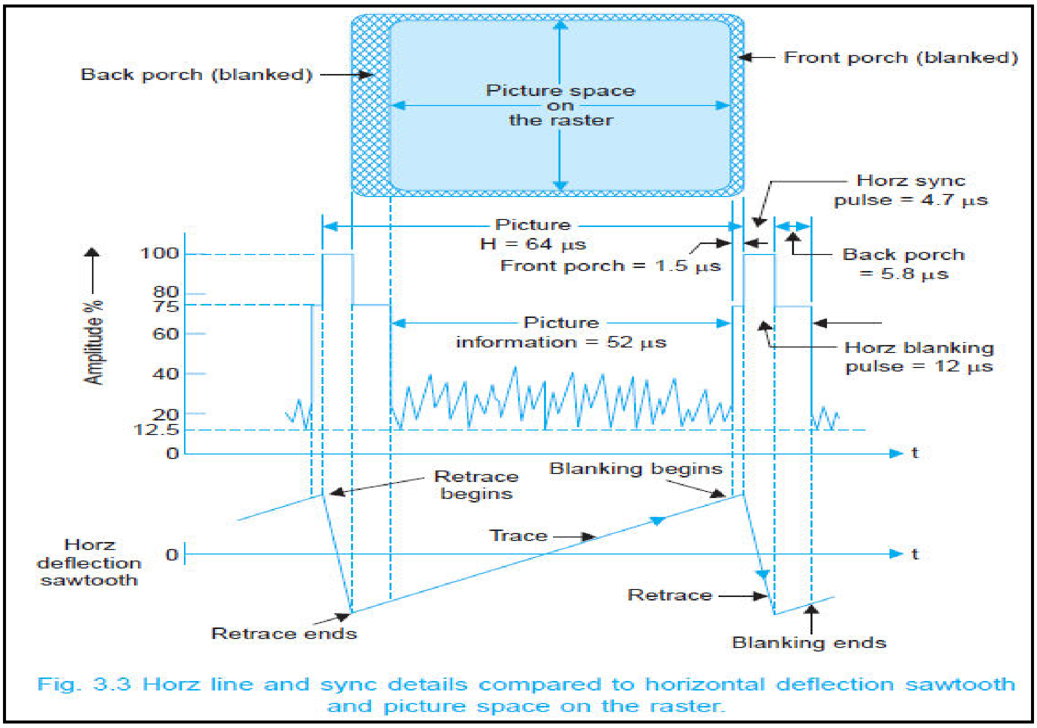


Figure: Horizontal line & sync Details

- out of a total line period of 64 µs, the line blanking period is 12 µs. During this interval a line synchronizing pulse is inserted. The pulses corresponding to the differentiated leading edges of the sync pulses are actually used to synchronize the horizontal scanning oscillator.
- The line blanking period is divided into three sections. These are the 'front porch' (1.5 µs), the 'line sync' pulse (4.7 µs) and the 'back porch' (5.8 µs).

Front porch:

- This is a **brief cushioning period of 1.5 µs** inserted between the end of the picture detail for that line and the leading edge of the line sync pulse.
- This interval allows the receiver video circuit to **settle down from whatever picture voltage level exists at the end of the picture line to the blanking level before the sync pulse occurs.**

"*Despite the existence of the front porch when the line ends in an extreme white detail, and the signal amplitude touches almost zero level, the video voltage level fails to decay to the blanking level before the leading-edge of the line sync pulse occurs. This results in late triggering of the time base circuit thus upsetting the 'horz' line sync circuit. As a result the spot (beam) is late in arriving at the left of the screen and picture information on the next line is displaced to the left. This effect is known as 'pulling-on-whites'***."(given as viva point of view)**

Line sync pulse:

- After the front porch of blanking, horizontal retrace is produced when the sync pulse starts. The flyback is definitely blanked out because the sync level is blacker than black.

- Line sync pulses are separated at the receiver and utilized to keep the receiver line time base in precise synchronism with the transmitter. The nominal time duration for the **line sync pulses is 4.7 μs.**
- During this period the beam on the **raster almost completes its back stroke** (retrace) and **arrives at the extreme left end of the raster for scanning next line.**

Back porch:

- This **period of 5.8 μs** at the blanking level allows plenty of time for line flyback to be completed. It also permits time for **the horizontal time-base circuit to reverse direction of current for the initiation of the scanning of next line.**
- The back porch also provides the necessary amplitude equal to the blanking level (reference level) and enables to **preserve the dc content of the picture information** at the transmitter.
- At the receiver this level which is independent of the picture details is utilized in the AGC (automatic gain control) circuits to develop true AGC voltage proportional to the signal strength picked up at the antenna.
- **It also contains colour burst signal for colour picture reproduction.**

Vertical sync details:

- The basic vertical sync added at the end of both even and odd fields is shown in Fig. Its width has to be kept much larger than the horizontal sync pulse, in order to drive a suitable field sync pulse at the receiver to trigger the field sweep oscillator.
- The standards specify that the vertical sync period should be 2.5 to 3 times the horizontal line period. If the width is less than this, it becomes difficult to distinguish between horizontal and vertical pulses at the receiver.
- In the 625 line system 2.5 line period ($2.5 \times 64 = 160$ μs) has been allotted for the vertical sync pulses.

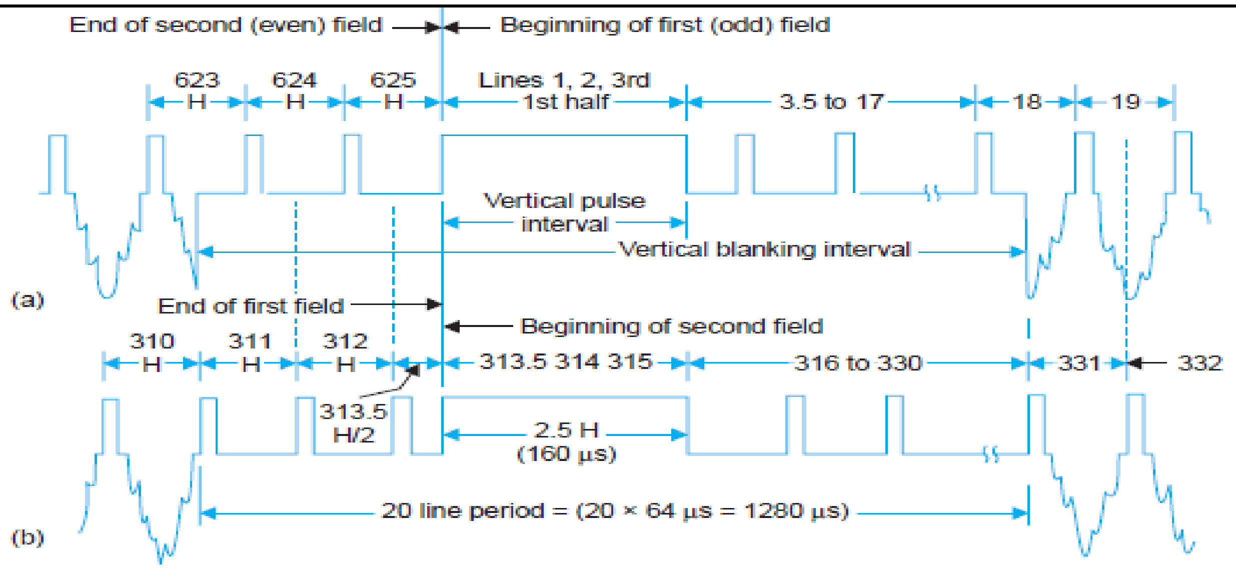


Fig. 3.4 Composite video waveforms showing horizontal and basic vertical sync pulses at the end of (a) second (even) field, (b) first (odd) field. Note, the widths of horizontal blanking intervals and sync pulses are exaggerated.

Figure: Vertical sync details

- **a vertical sync pulse commences at the end of 1st half of 313th line (end of first field) and terminates at the end of 315th line. Similarly after an exact interval of 20 ms (one field period) the next sync pulse occupies line numbers— 1st, 2nd and 1st half of third, just after the second field is over.**
- This alignment of vertical sync pulses, one at the end of a half-line period and the other after a full line period (see Fig.), results in a relative misalignment of the horizontal sync pulses and they do not appear one above the other but occur at half-line intervals with respect to each other.
- looking further along the waveform, we see that the leading edge of the vertical sync pulse comes at the wrong time to provide synchronization for the horizontal oscillator.
- Therefore, it becomes necessary to cut slots in the vertical sync pulse at half-line-intervals to provide horizontal sync pulses at the correct instances both after even and odd fields.
- The technique is to take the video signal amplitude back to the blanking level 4.7 μs before the line pulses are needed. The waveform is then returned back to the maximum level at the moment the line sweep circuit needs synchronization.
- **Thus five narrow slots of 4.7 μs width get formed in each vertical sync pulse at intervals of 32 μs. The trailing but rising edges of these pulses are actually used to trigger the horizontal oscillator.**
- The resulting waveforms together with line numbers and the differentiated output of both the field trains are illustrated in Fig. below. This insertion of short pulses is known as **notching or serration** of the broad field pulses.

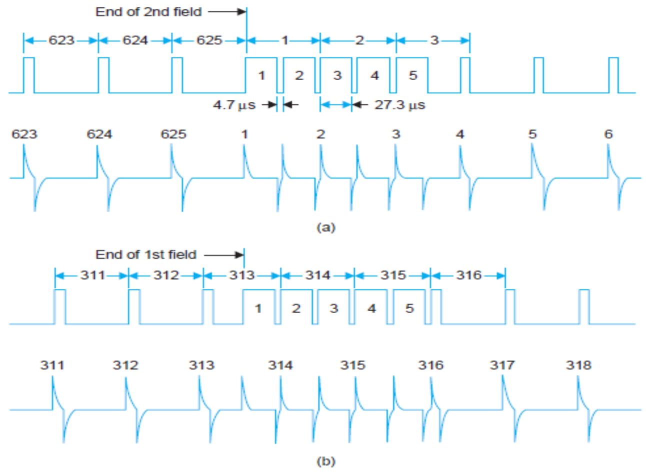


Fig. 3.6 Differentiating waveforms (a) pulses at the end of even (2nd) field and the corresponding output of the differentiator (H.P.F.) (b) pulses at the end of odd (1st) field and the corresponding output of the differentiator (H.P.F.) Note, the differentiated pulses bearing line numbers are the only ones needed at the end of each field.

Figure: Serration

- The vertical oscillator trigger potential level marked as trigger level in the diagram intersects the two filter output profiles at different points which indicates that in the case of second field the oscillator will get triggered a fraction of a second too soon as compared to the first field.
- Note that this inequality in potential levels for the two fields continues during the period of discharge of the capacitor once the vertical sync pulses are over and the horizontal sync pulses take-over.
- Though the actual time difference is quite short it does prove sufficient to upset the desired interlacing sequence.

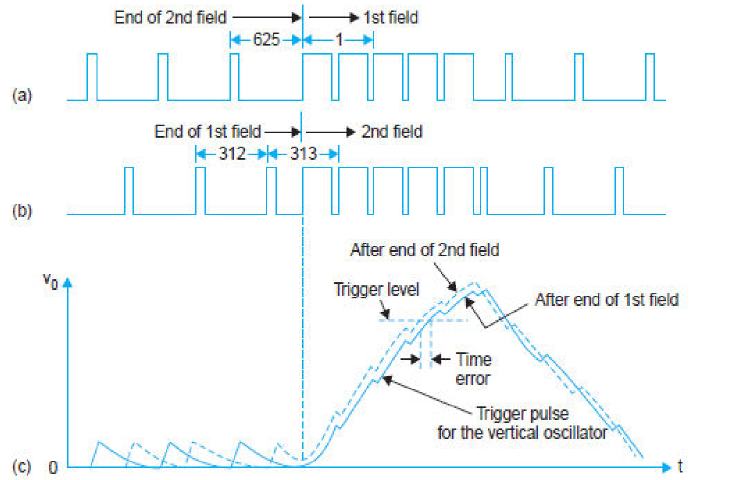


Fig. 3.7 Integrating waveforms (a) pulses at the end of 2nd (even) field (b) pulses at the end of 1st (odd) field (c) integrator output. Note the above sync pulses have purposely been drawn without equalizing pulses.

Figure: Half line Discrepancy

<u>Equalizing pulses:</u>

- To take care of this drawback which occurs on account of the half line discrepancy five narrow pulses are added on either side of the vertical sync pulses. These are known as pre-equalizing and post-equalizing pulses.
- Each set consists of **five narrow pulses occupying 2.5 lines period** on either side of the vertical sync pulses. Pre-equalizing and post equalizing pulse details with line numbers occupied by them in each field are given in Fig.

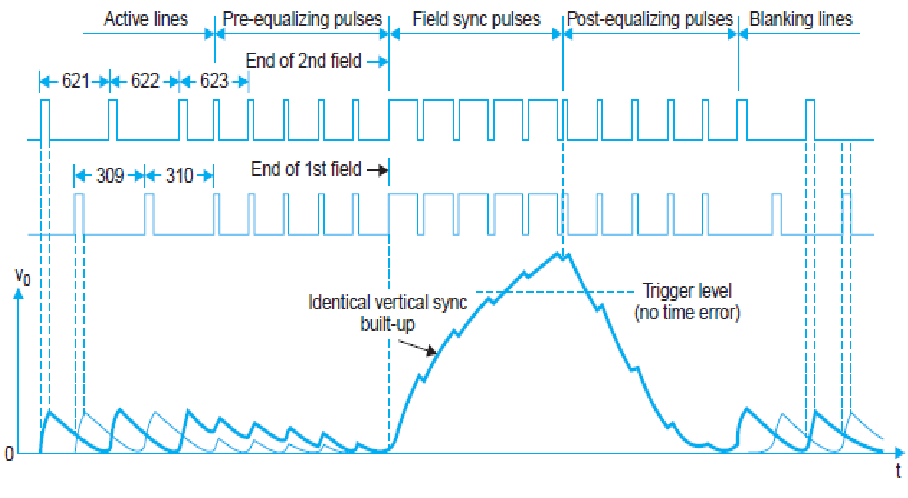


Fig. 3.9 Identical vertical sync voltage built-up across the integrating capacitor.

Figure: Pre & Post equalizing pulses.

- The effect of these pulses is to shift the half-line discrepancy away both from the beginning and end of vertical sync pulses.
- Pre-equalizing pulses being of 2.3 μs duration result in the **discharge of the capacitor** to **essentially zero** voltage in both the fields, despite the half-line discrepancy before the voltage buildup starts with the arrival of vertical sync pulses.
- Post-equalizing pulses are necessary for a **fast discharge of the capacitor to ensure triggering of the vertical oscillator at proper time**. If the decay of voltage across the capacitor is slow as would happen in the absence of post-equalizing pulses, the oscillator may trigger at the trailing edge which may be far-away from the leading edge and this could lead to an error in triggering.

Colour burst signal:

- The transmitted signal does not contain the subcarrier frequency but it is necessary to generate it in the receiver with correct frequency and phase relationship for proper detection of the colour sidebands. To ensure this, a short sample of the subcarrier oscillator, (8 to 11 cycles) called the "colour burst" is sent to the receiver along with sync signals. Subcarrier frequency is 4.43MHz.

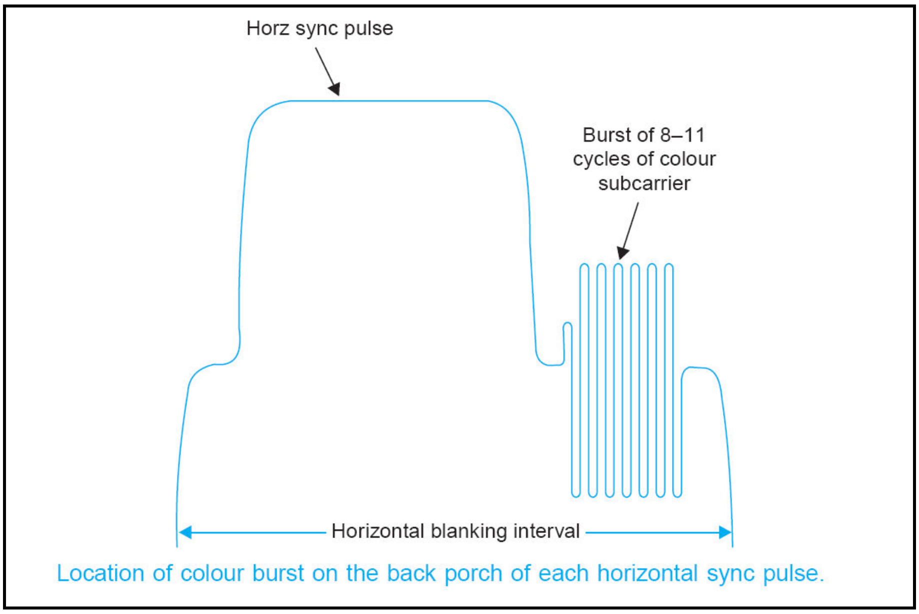


Figure: Colour burst signal

- The colour burst is gated out at the receiver and is used in conjunction with a phase comparator circuit to lock the local subcarrier oscillator frequency and phase with that at the transmitter.
- As the burst signal must maintain a constant phase relationship with the scanning signals to ensure proper frequency interleaving, the horizontal and vertical sync pulses are also derived from the subcarrier through frequency divider circuits.

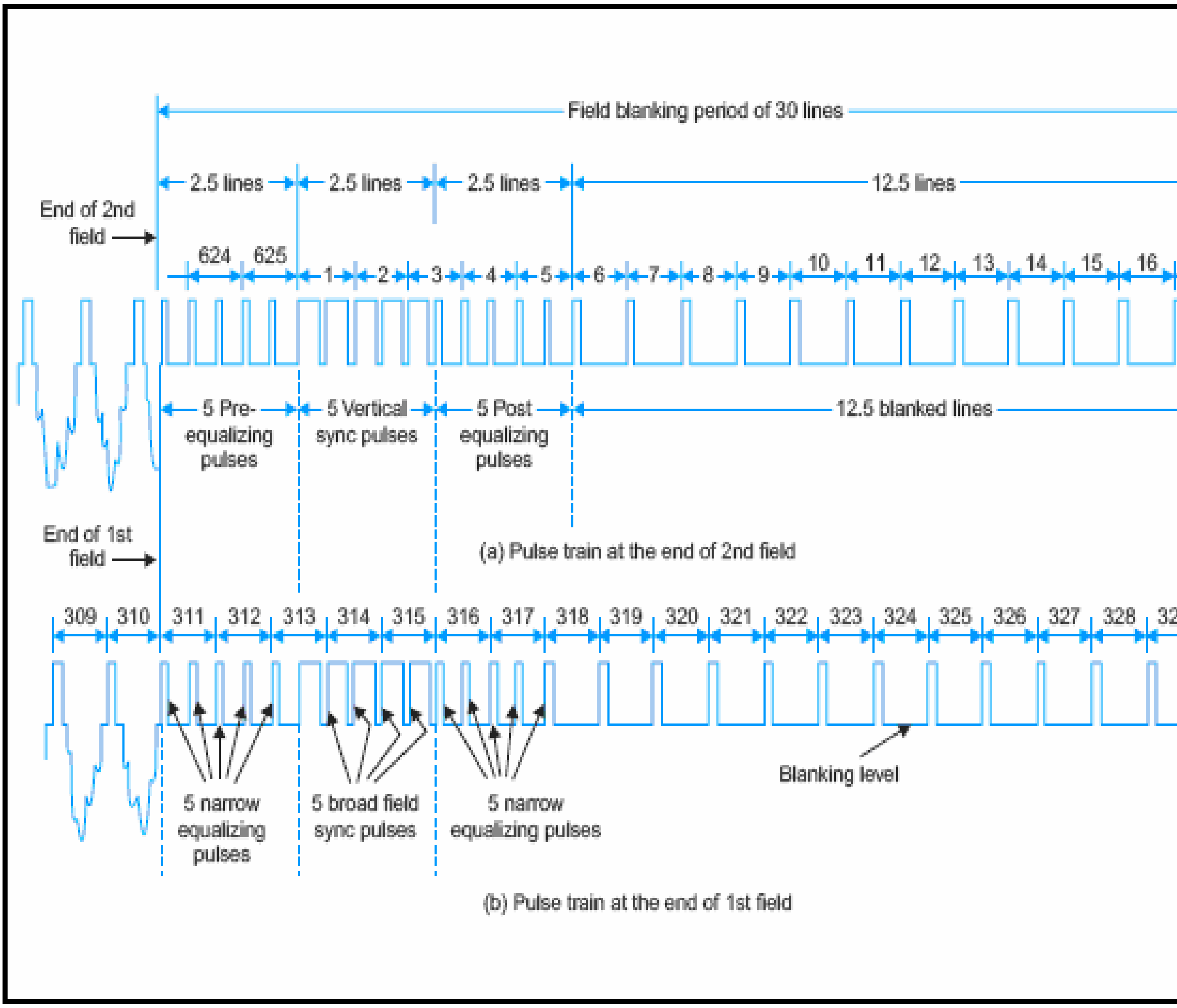


Figure: complete Line details

3.4 CCIR B standards for Colour signal transmission & reception:

Reception	
Camera output	R, G, and B video signals
Luminance signals	Y=0.30R+0.59G +0.11B
Colour difference signals chosen for transmission	(B-Y) and(R-Y)
Type of colour signal modulation	Suppressed carrier amplitude modulation Of two subcarriers in quadrature having same numerical value.

Colour difference signals	U=0.493(B-Y) V=0.877(R-Y)
Composite colour signal	Y+U sin ωm t+-Vcos ωmt
Amplitude of modulated Chroma signal	u2+v2
Colour subcarrier frequency	4.433185 MHz
Duration of burst	10+1
Chroma encoding	Phase and amplitude modulation
Bandwidth for colour signals (u and v)	Fsc-1.3 MHz to fsc+0.6 MHz
Transmission	
No. of lines per picture (frame)	625
Field frequency (Fields/second)	50
Interlace ratio, i.e., No. of fields/picture	2/1
Picture (frame) frequency, i.e., Pictures/second	25
Line frequency and tolerance in lines/second,(when operated non-synchronously)	15625 ± 0.1%
Aspect Ratio (width/height)	4/3
Scanning sequence	(i) Line: Left to right (ii) Field: Top to bottom
System capable of operating independently of power supply frequency	YES

Approximate gamma of picture signal	0.5
Nominal video bandwidth, i.e., highest video modulating frequency (MHz)	5
Nominal Radio frequency bandwidth, i.e., channel bandwidth (MHz)	7
Sound carrier relative to vision carrier (MHz)	+5.5
Sound carrier relative to nearest edge of channel (MHz)	– 0.25
Nearest edge of channel relative to picture carrier (MHz)	–1.25
Fully radiated sideband	Upper
Nominal width of main sideband (upper) (MHz)	5
Width of end-slope of full (Main) sideband (MHz)	0.5
Nominal width of vestigial sideband	0.75 MHz
Vestigial (attenuated) sideband	Lower
Peak white level as a percentage of peak carrier	10 to 12.5
Type of sound modulation	FM, ± 50 KHz
Pre-emphasis	50 µs
Resolution	400 max

Why AM is preferred for video (picture) transmission & FM is preferred for Audio signal transmission?

AM is preferred for picture because the following reasons,

- The distortion which arises due to interference between multiple signals is more objectionable in FM than AM because the frequency of the FM signal continuously changes.
- Hence, hardly any steady picture is produced.

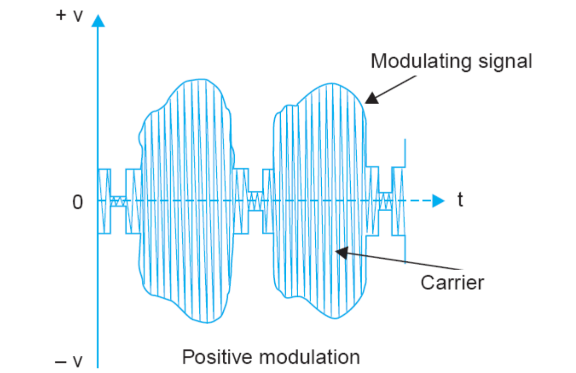
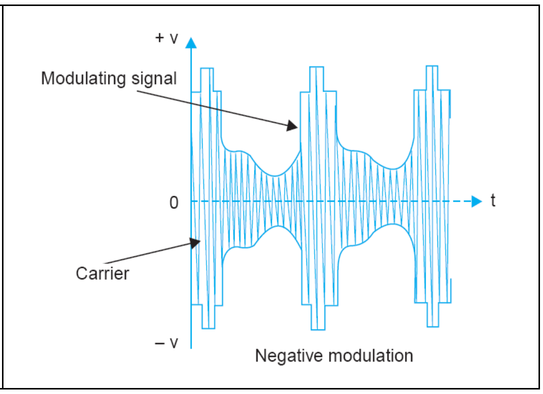
- Alternatively if AM were used, the multiple signal paths can at most produce a ghost image which is steady.
- In addition to this, circuit complexity and bandwidth requirements are much less in AM than FM.

FM is preferred for sound because the following reasons,

- The bandwidth assigned to the FM sound signal is about 200 kHz of which not more than 100 kHz is occupied by sidebands of significant amplitude.
- The latter figure is only 1.4 per cent of the total channel bandwidth of 7 MHz. Thus, without encroaching much, in a relative sense, on the available band space for television transmission all the advantages of FM can be availed.

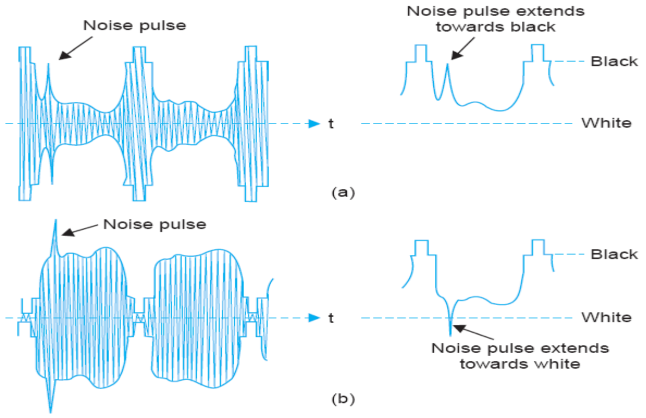
Positive and Negative modulation:

	Positive Modulation		Negative Modulation
1.	When increase in brightness of that picture results in an increase of the amplitude of modulated envelope.it is called positive modulation.	1.	When increase in brightness reduces amplitude of the modulated envelope, it is called negative modulation.
2.	White level of video signal corresponds to 100% total magnitude.	2.	White level of video signal correspondence to 12.5% of the total amplitude.
4.	Noise pulses do not affect synchronization but cause white spot in the picture	4.	Noise pulses are seen as less annoying black spot.
5.	More power is required with less efficiency	5.	If peak power available from transmitter is considered them less power is required for more efficiency.
6.	Black level of video signal correspondence to 25% of total magnitude.	6.	Blanking level starts at 75%

7.		7.	

Effect of Noise Interference on Picture Signal:

- In negative system of modulation, noise pulse **extends in black direction** of the signal when they occur during the active scanning intervals. They extend in the direction of sync pulses when they occur during blanking intervals.
- In the positive system, the noise extends in the **direction of the white** during active scanning, i.e., in the opposite direction from the sync pulse during blanking.



Effect of noise pulses (a) with negative modulation,
(b) with positive modulation.

Figure: Effect of noise in modulation techniques

Effect of Noise Interference on Synchronization:

- Sync pulses with positive modulation being at a lesser level of the modulated carrier envelope are not much affected by noise pulses.
- However, in the case of negatively modulated signal, it is sync pulses which exist at maximum carrier amplitude, and the effect of interference is both to mutilate(serious damage) some of these, and to produce lot of spurious random pulses.

Peak Power Available from the Transmitter:

- With positive modulation, signal corresponding to white has maximum carrier amplitude. The RF modulator cannot be driven harder to extract more power because the non-linear distortion thus introduced, that would affect the amplitude scale of the picture signal and introduce brightness distortion in very bright areas of the picture.

- In negative modulation, the transmitter may be over-modulated during the sync pulses without adverse effects, since the non-linear distortion thereby introduced, does not very much affect the shape of sync pulses. Consequently, the negative polarity of modulation permits a large increase in peak power output and for a given setup in the final transmitter stage the output increases by about 40%.

Use of AGC (Automatic Gain Control) Circuits in the Receiver:

- In negative system of modulation, stable reference level is the peak of sync pulses which remains fixed at 100 per cent of signal amplitude and is not affected by picture details. This level may be selected simply by passing the composite video signal through a peak detector.
- In the positive system of modulation the corresponding stable level is zero amplitude at the carrier and obviously zero is no reference, and it has no relation to the signal strength.

Merits of Negative Modulation:

- Lesser noise interference on picture signal.
- Possible to obtain larger peak power output.
- Less picture signal distortion.
- Easy to develop true AGC voltage.
- More efficient operation.
- More power available from the transmitter
- Saving in transmission power

Demerits of Negative Modulation:

- The synchronization of the receiver is affected by spurious random pulses produced due to the effect of noise.
- The loss of horizontal and vertical synchronization may cause diagonal or vertical rolling of picture.

3.5 Block diagram of Colour TV transmitter:

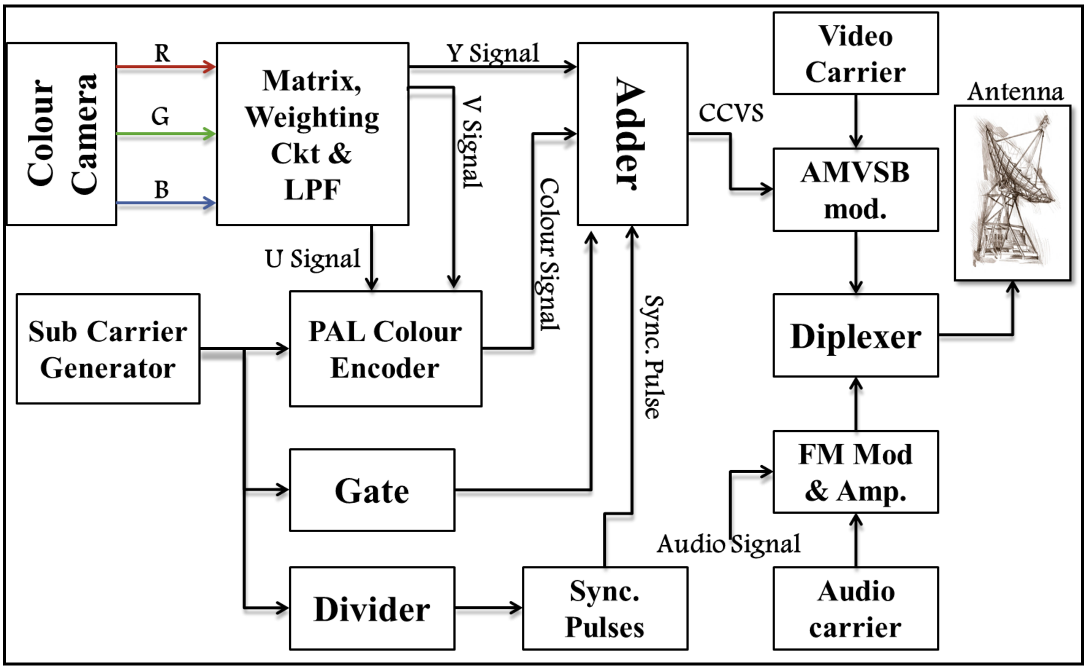


Figure: Block Diagram of Colour TV transmitter

A PAL colour TV transmitter consists of following three main sections.

1. Production of Luminance (Y) and Chrominance (U and V) signals
2. PAL encoder
3. Video and Audio modulators and transmitting antenna

<u>Production of Luminance (Y) and Chrominance (U and V) signals:</u>

- Colour camera tube produces R, G and B voltages pertaining to the intensity of red, green and blue colours respectively in pixels. The luminance signal Y is obtained by a resistive matrix, using grassman's law. **Y=0.3R+0.59G+0.11B.**
- For colour section Y is inverted colours R&B obtained from the colour camera tubes are added to it to get (R-Y) and (B-Y) colour difference signal. These signals are weighted by two resistive matrix network which gives U & V signals as **U=0.493 (B-Y) & V=0.877(R-Y)**

<u>PAL encoder:</u>

- PAL switch which operates electronically at 7812.5Hz with the help of bistable multivibrator and feeds the sub-carrier to balanced modulator with phase difference of +90 degree on one line and -90 degree on the next line.
- The PAL encoder consists of a **subcarrier generator and two balanced modulator with filters to produce modulated subcarrier signal**. These signals are added vertically to give Chroma signal (C). Then Chroma signal is mixed with Y signal along with sync. And blanking pulses to produce Colour Composite Video Signal (CCVS).

<u>Video and Audio modulators and transmitting antenna:</u>

- CCVS amplitude modulates the main video carrier. It is followed by a sharp VSB filter to attenuate the LSB to give AMVSB signal for transmitter. Audio signal modulates separate carrier. This modulation is FM type.
- AMVSB video signal along with audio signal passes to the transmitting antenna through Diplexer Bridge which is a wheatstone's bridge.

TV channel allocation for band I & band III:

	Ch No.	***Frequency range***	***Picture carrier Frequency (MHz)***	***Sound carrier Frequency (MHz)***
BAND I (41-68 MHz)	1	41–47 (not used)		
	2	47–54	48.25	53.75
	3	54–61	55.25	60.75
	4	61–68	62.25	67.75
BAND III (174-230 MHz)	5	174–181	175.25	180.75
	6	181–188	182.25	187.75
	7	188–195	189.25	194.75
	8	195–202	196.25	201.75
	9	202–209	203.25	208.75
	10	209–216	210.25	215.75
	11	216–223	217.25	222.75
	12	223–230	224.25	229.75

COURSE: Consumer Electronics

COURSE CODE: 22425

CHAPTER : 4. TV Receivers

Marks: 14 Marks.

Course Outcomes:

A. Troubleshoot different types of microphones and speakers.
B. Maintain audio systems.
C. Analyse the composite video signal used in TV signal transmission.
D. Troubleshoot colour TV receivers.
E. Maintain various consumer electronic appliances.

Contents:

1. Block Diagram of color TV receiver (PAL D type).
2. Operation of PAL-D Decoder
3. HDTV: Development of HDTV, NHK MUSE System and NHK Broadcast
4. LCD/LED Technology: Principle and working of LCD and LED TV systems.
5. Direct to Home System (DTH)
6. Block Diagram and Working of OLED TV

Block Diagram of color TV receiver (PAL D type):

- A colour TV receiver contains all the necessary circuits of a monochrome receiver plus additional circuits required for the reproduction of a colored picture. Basically a colour TV receiver is a black-and-white receiver with a decoder for the colour signals and a colour picture tube.
- The figure is the functional block diagram of a colour TV receiver. The block diagram shows that the circuits like the RF tuner, VIF amplifier, the video

amplifier, the deflection sync, the sweep circuits and the EHT sections are virtually the same as in black-and-white receiver.

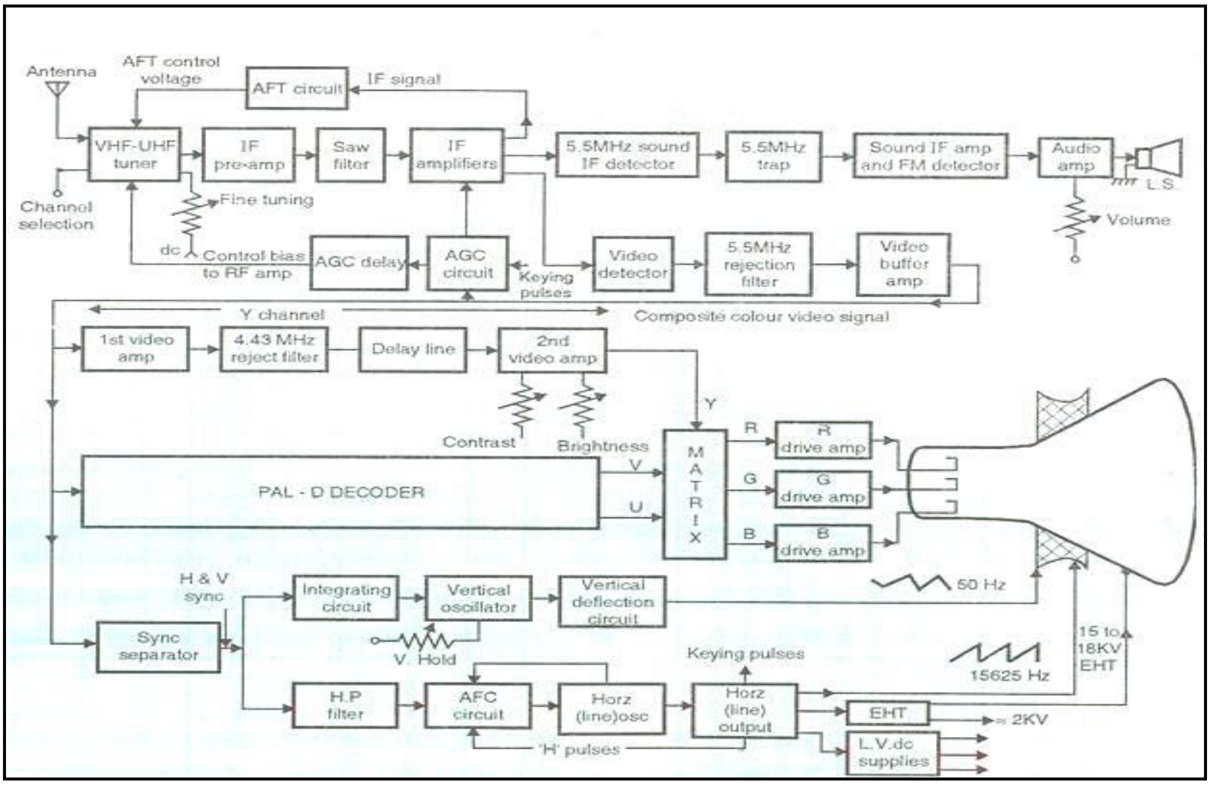


Figure: PAL D RECEIVER

- However there are some minor differences in design and details. For example the RF response in case of colour TV is kept more uniform than in monochrome receiver; this is to avoid any attenuation of the colour sub-carrier.
- The tuning of a colour TV is critical. To avoid any mistuning of the receiver, an arrangement called AFT (Automatic Fine Tuning) is used in most cases. This arrangement is similar to the AFC and can be switched off whenever manual tuning is required. The colour TV uses the inter carrier sound system with one difference.
- The sound take-off point is at the last VIF stage immediately before the video detector. This is done to avoid interference between the sound IF and the Chroma signal. A separate diode detector is used to produce the sound IF but the rest of the audio circuits are the same as in a monochrome receiver.
- The two main circuits which **distinguish a colour TV from a monochrome TV** are the colour **picture tube and the Chroma section** containing the colour circuits.

Block diagram and operation of PAL-D decoder:

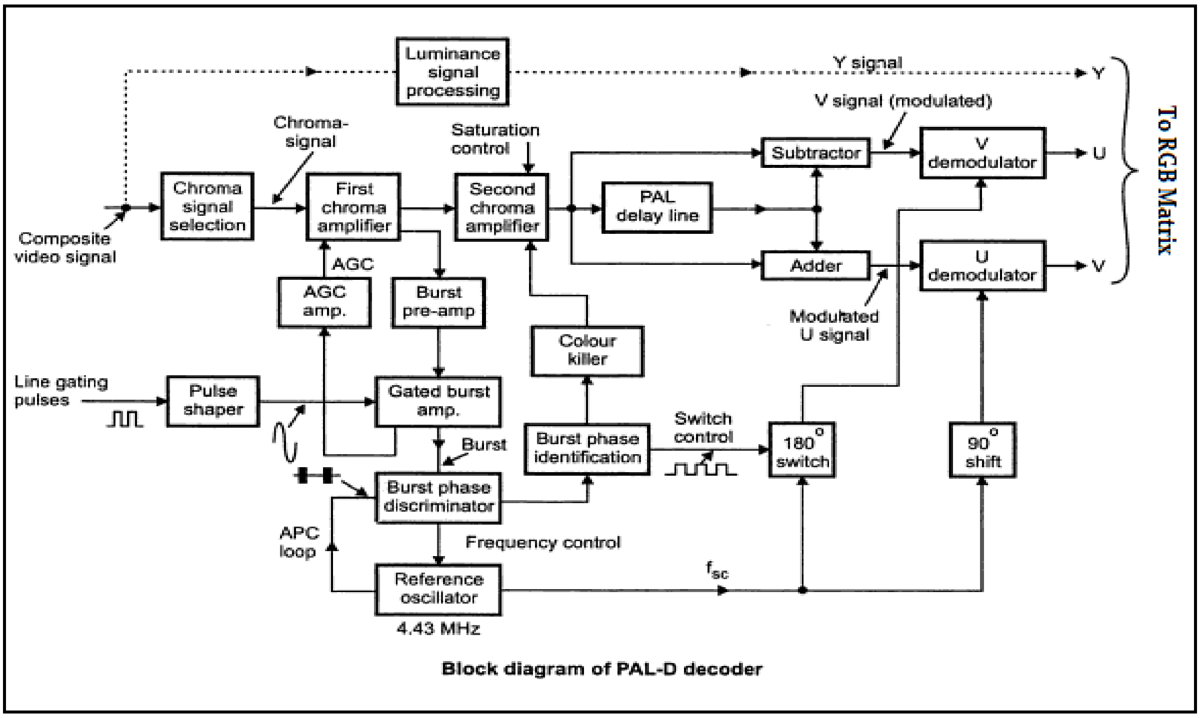


Figure: Block Diagram of PAL D decoder

Chroma signal selection:

Its function is to select Chroma and colour burst signal from the incoming CCVS signal. It essentially consist of band pass circuit whose center frequency is chosen to be equal to that of Chroma sub-carrier itself i.e.4.43MHz.

1st Chroma amplifier:

The Chroma and burst signals are amplified by first Chroma amplifier which is controlled by DC voltage developed by the Automatic Chroma Control (ACC) amplifier.

2nd Chroma amplifier:

The second Chroma amplifier incorporates colour saturation control circuit. The output of colour killer also feeds into it.

PAL delay line (separation of U and V colour phasors):

This network separated U and V signals with are then fed to respective demodulator.

Gated burst amplifier:

The gated burst amplifier separates the burst pulses and amplifies them a level suitable to operate the burst phase discriminator.

Automatic Chroma Control (ACC):

The magnitude of the voltage so fed back is proportional to the magnitude of the burst and therefore to the amplitude of Chroma signal itself. This voltage is used to control the first stage of Chroma amplifier in such way to ensure constant Chroma signal amplitude.

Burst phase discriminator:

It is sensitive to burst pulses and is designed to detect any differences which might exist between the phase of burst pulse and that of the reference oscillator. It produces at its output a dc voltage whose magnitude and polarity are proportional to the magnitude and direction of the detected phase difference.

Burst phase identifier:

This circuit is able to identify the phase relationship of the colour burst.

180^o switch:

This switch is used to periodically invert the waveform fed to the v-signal demodulator.

Colour killer control:

This is just a half wave rectifier which produces a steady dc potential from the succession of burst pulses. During black and white transmission the dc potential is absent and hence biases the 2nd Chroma amplifier to cut off state.

HDTV

- MUSE stands for Multiple Sub-Nyquist Sampling Encoding and is an HDTV bandwidth compression scheme developed by NHK.
- It uses fundamental concepts for performance exchange in the spatio – temporal (transitory transformation) domain along with motion compensation to reduce the transmission bandwidth down to near about 10 MHz.
- The processed HDTV signal can be then transmitted using a single BDS channel. Temporal Interpolation In MUSE the luminance and colour information are sent by time multiplexed components (TMC) The colour information is sent sequentially with a time compression of four.
- The TMC signal is bandwidth reduced means of 3 – dimensional offset subsampling pattern over a four – field sequence.The stationary areas of the picture are reconstructed by temporal interpolation of samples from four fields.
- ***Spatial Interpolation***
- For a moving picture area the final picture is reconstructed by spatial interpolation using samples from a single field. Hence moving portions of the picture are reproduced with one- quarter the spatial resolution of the stationary areas. The spatial frequency response for both stationary and moving areas of the picture is shown in figure below. The lack of resolution during movements of the entire scene as in case of camera panning, zooming or tilting is prevented

by introducing spatial motion compression technique. A vector representing the motion of the scene is calculated for each field at the encoder. This signal is multiplexed in the vertical blanking interval and transmitted to the receiver.

- In decoder, the read – out addresses of picture elements (pixels) from previous fields are shifted according to the information provided by the motion vector so that the data can be processed in still – picture mode.
- These two modes of interpolation, the inter – frame processing for stationary pictures and infra field averaging for moving portions of the picture are switched by detecting the moving areas at the decoder.
- Audio transmission is done by 4 – phase DPSK which is multiplexed with the processed video signal in the vertical blanking interval after frequency modulation of the transmission carrier by the video signal.

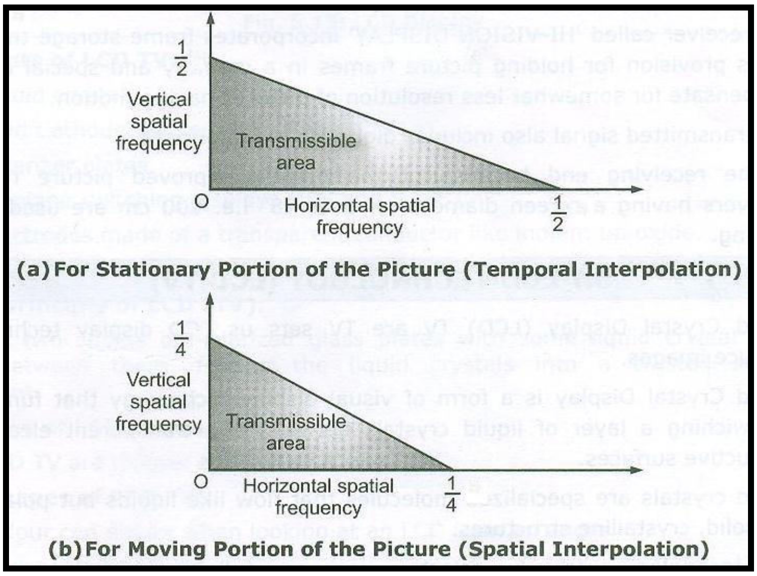


Figure: Interpolation

LCD/LED Technology:

*LCD (**L**iquid **C**rystal **D**isplay) TECHNOLOGY:*

- LCD technology is quite different to that found in other TV types such as the original CRT (Tube television) and in Plasma TVs. A liquid crystal layer is stimulated by an electrical current, causing individual pixels to either shut out light, or let it pass through.
- In this way each pixel can be either light or dark, and the use of colour filters gives the necessary red, green and blue light with which to create an image of many millions of colours.
- *The main principle behind liquid crystal molecules is that when an electric current is applied to them, they tend to untwist. This causes a change in the light angle passing through them. This causes a change in the angle of the top polarizing filter with respect to it. So little light is allowed to pass through that particular area of LCD. Thus that area becomes darker comparing to others.*

- Because the light source is a bulb at the back of the screen, rather than light-emitting phosphors at the front of the screen, this technology is referred to as 'transmissive'.

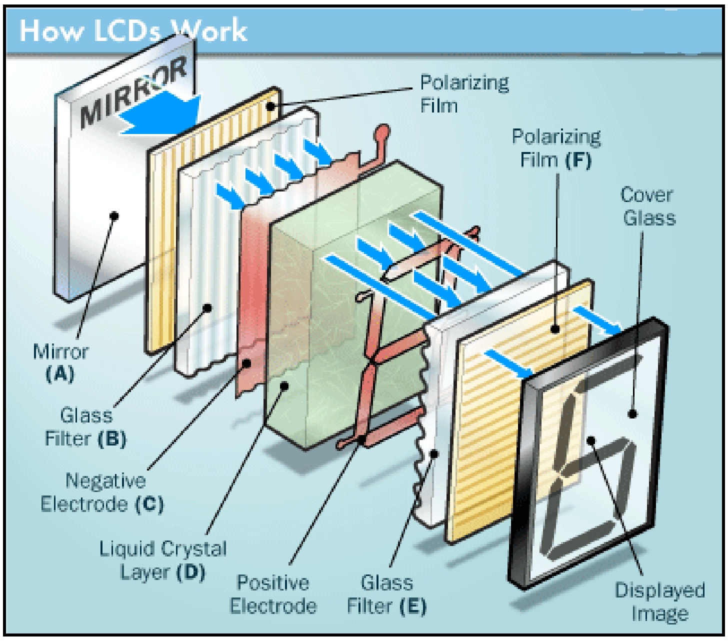
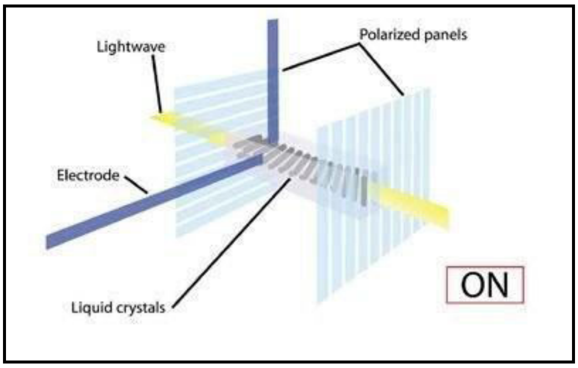


Figure: Construction of LCD

- Liquid crystals exhibit some of the qualities of both a solid and a gas. There is uniformity to the structure, but it can be influenced by an electrical current.
- Let's look at a very basic LCD structure. Two layers of polarized glass encase a layer of liquid crystal. The rear panel of glass is vertically polarized, while the front panel is horizontally polarized. If in light was simply shined through from behind, none would emerge from the front.
- Microscopic grooves are cut into each sheet of glass – vertical grooves for the vertically polarized glass, horizontal grooves for the horizontally polarized glass.
- The liquid crystal between the layers of glass then conforms to these grooves, creating a 90-degree twist. Activate the light source now and the liquid crystal will turn the light through 90 degrees so that it emerges from the front.

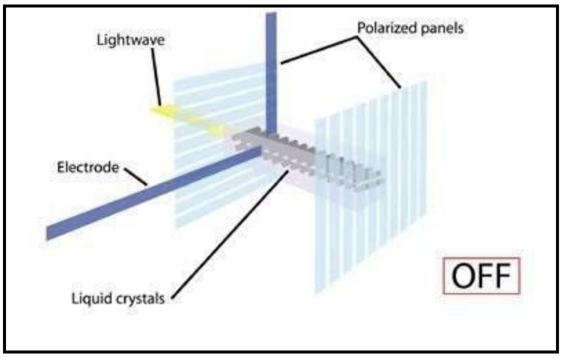
<u>LCD Screen On</u>

- If an electrical current is applied to the liquid crystal, it will untwist, effectively blocking out the light. Different strengths of current result in more or less of the light being blocked, so different shades of light become possible.



__LCD Screen Off__

- If this principle is multiplied many times you get a basic LCD screen. Early applications used a 'passive matrix' display, where a grid of conductors lies alongside the LCD pixels.
- This allows individual pixels to be switched on and off, but also introduced blurring to the image because some electrical current would find its way into neighboring pixels.



- The development of 'active matrix' LCDs, using thin film transistors (TFTs) was critical in bringing LCD displays up to the necessary specification for TV usage.
- TFTs are best viewed as very small switching transistors and capacitors. The transistors act as switches, enabling the activation of pixels with no effect on neighboring pixels in an LCD screen.
- The capacitors are able to store the charge, maintaining voltage for one frame scan. With each pixel having its own dedicated transistor and capacitor it is possible to target individual pixels with complete accuracy.

__LCD Structure:__

- LCD Structure Control over the strength of the current applied also brings a workable greyscale into the equation. A weaker current cause the liquid crystals to unbend to a lesser degree, blocking out only part of the light source – in this way it is possible to achieve 256 shades.
- The addition of a colour filter layer, and the division of each LCD pixel into three sub-pixels (red, green and blue) means that 256 x 256 x 256 combination are possible, giving the familiar colour palette of 16.7 million colours.

LED TV TECHNOLOGY:

- LED, which stands for "light emitting diodes," differs from general LCD TVs in that LCDs use fluorescent lights while LEDs use those light emitting diodes.
- An LED TV illuminates its LCD panel with light-emitting diodes. LEDs consist of small semiconductors, which glow during exposure to electric current. Specifically, this current flow between LED anodes, which are positively charged electrodes, and LED cathodes, which are negatively charged electrodes.
- In contrast, a traditional LCD TV utilizes fluorescent lamps for backlighting. These lamps function by using mercury vapor to create ultraviolet rays, which in turn cause the phosphor coating of the lamps to glow.
- LEDs have several advantages over fluorescent lamps, including requiring less energy and being able to produce brighter on-screen colors.

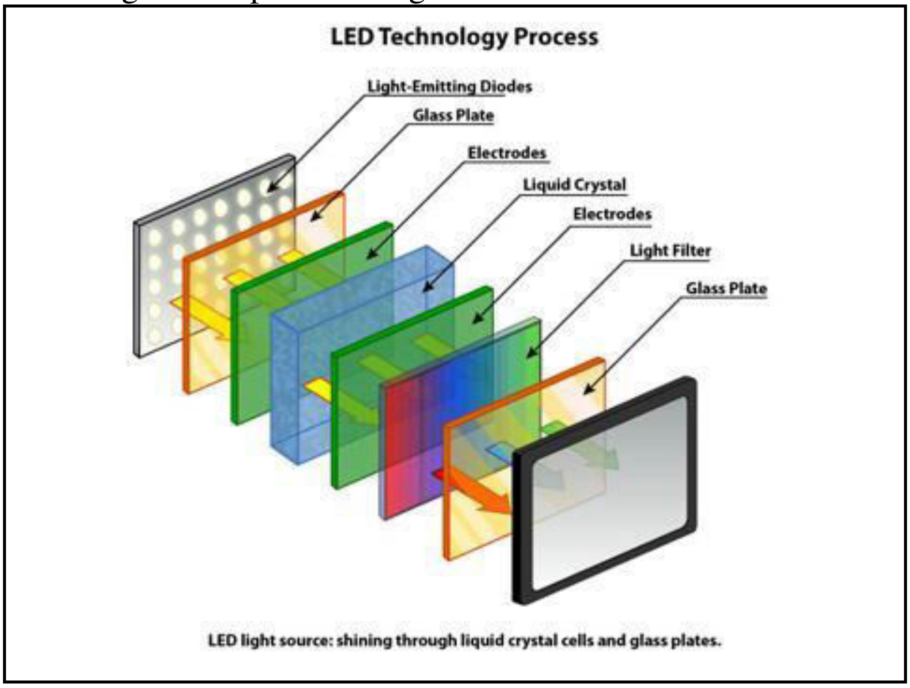


Figure: LED Construction

Full-Array vs Edge-Lit

- There are two primary forms of LED lighting technology that LED TVs can utilize: full-array LED backlighting and edge-lit LED backlighting. Also known as local-dimming technology, full-array technology employs arrays or banks of LEDs that cover the entire back surfaces of LED TV screens.
- In contrast, edge-lit technology employs LEDs only around the edges of LED TV screens. Unlike an edge-lit LED TV, an LED TV with full-array technology can selectively dim specific groups of LEDs, allowing for superior contrast ratio and superior overall picture quality.

Energy Consumption:

- As with any TV, an LED TV needs energy in order for its components to function. Specifically, an LED TV needs electric current for stimulating the liquid crystals in its LCD panel and for activating its LED backlighting.
- In comparison to standard LCD TVs, LED TVs consume less energy, qualifying many of them for the EPA's Energy Star energy-efficiency standard. As the online TV resource LED TV notes, an LED TV will typically consume between 20 and 30 percent less energy than an LCD TV with the same screen size.

What's the difference between LCD and LED?

- LCD stands for "liquid crystal display" and technically, both LED and LCD TVs are liquid crystal displays. The basic technology is the same in that both television types have two layers of polarized glass through which the liquid crystals both block and pass light. So really, LED TVs are a subset of LCD TVs.
- LED, which stands for "light emitting diodes," differs from general LCD TVs in that LCDs use fluorescent lights while LEDs use those light emitting diodes. Also, the placement of the lights on an LED TV can differ.
- The fluorescent lights in an LCD TV are always behind the screen. On an LED TV, the light emitting diodes can be placed either behind the screen or around its edges.
- The difference in lights and in lighting placement has generally meant that LED TVs can be thinner than LCDs, although this is starting to change. It has also meant that LED TVs run with greater energy efficiency and can provide a clearer, better picture than the general LCD TVs.
- LED TVs provide a better picture for two basic reasons. First, LED TVs work with a color wheel or distinct RGB-colored lights (red, green, blue) to produce more realistic and sharper colors. Second, light emitting diodes can be dimmed. The dimming capability on the back lighting in an LED TV allows the picture to display with a truer black by darkening the lights and blocking more light from passing through the panel. This capability is not present on edge-lit LED TVs; however, edge-lit LED TVs can display a truer white than the fluorescent LED TVs.
- Because all these LCD TVs are thin-screen, each has particular angle-viewing and anti-glare issues. The backlit TVs provide better, cleaner angle viewing than the edge-lit LED TV. However, the backlit LED TV will usually have better angle viewing than the standard LCD TV.
- Both LED and LCD TVs have good reputations for their playback and gaming quality.

DTH Technology:

Overview:

- Direct to home technology refers to the satellite television broadcasting process which is actually intended for home reception. This technology is originally referred to as direct broadcast satellite (DBS) technology.
- The technology was developed for competing with the local cable TV distribution services by providing higher quality satellite signals with more number of channels.
- In short, DTH refers to the reception of satellite signals on a TV with a personal dish in an individual home. The satellites that are used for this purpose is geostationary satellites. The satellites compress the signals digitally, encrypt them and then are beamed from high powered geostationary satellites. They are received by dishes that are given to the DTH consumers by DTH providers.
- Though DBS and DTH present the same services to the consumers, there are some differences in the technical specifications.
- While DBS is used for transmitting signals from satellites at a particular frequency band [the band differs in each country], DTH is used for transmitting signals over a wide range of frequencies [normal frequencies including the KU and KA band].

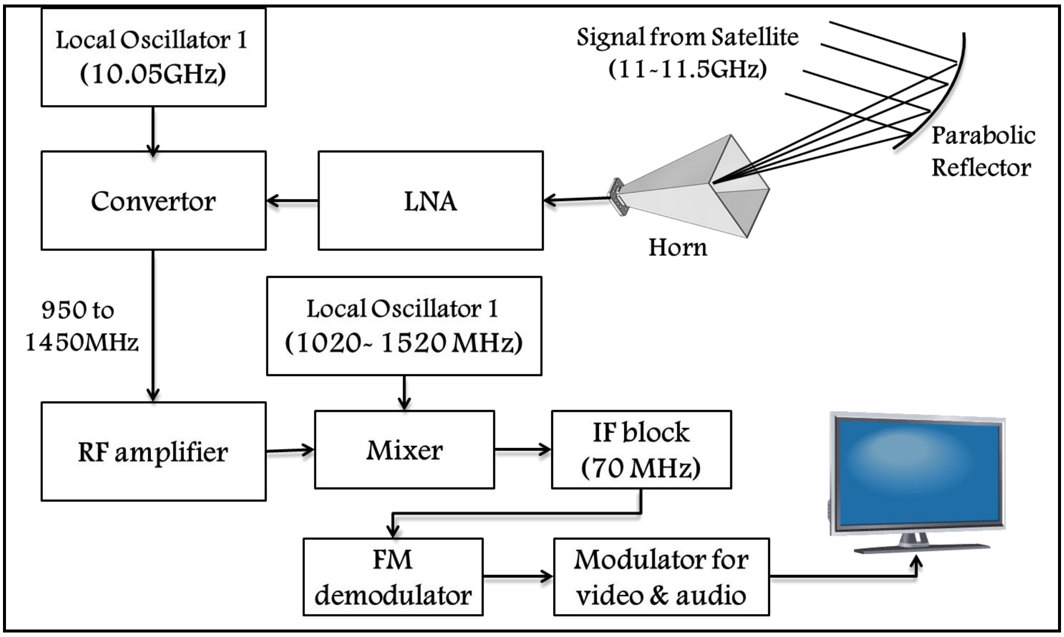


Figure: Block diagram of DTH system

Outdoor unit:

- It consists of a receiving antenna, low noise amplifier & converter the receiving antenna is parabolic reflector with a horn as the active element. The horn can be directly in front of reflector, or it may use an offset feed as shown in fig. The reflector diameter may be 0.6m for 11GHz & still smaller for K & Ka bands.
- The low noise block consists of a low noise wide band amplifier followed by a convertor. The output of convertor consists of a signal of UHF frequency ranging from 950-1450MHz.

- The advantage of using UHF frequency is that a low cost coaxial cable can be used as feeder from the outdoor unit to the indoor unit.
- LNB cannot be kept indoor because long cable between horn & the first amplifier will cause substantial degradation of the overall noise figure of the set.

Indoor unit:

- The wideband signal from the LNB is fed to an RF amplifier. The amplified signal is fed to a channel selector circuit which selects the wanted band.
- The selected channel is down converted to a fixed IF of 70MHz by local oscillator & mixer. IF amplifier amplifies the signal which then goes to FM detector.
- The detector recovers original baseband signal, consisting of CVS & audio signal. These modulated signals are fed to the normal domestic TV receiver, which after due processing reproduces picture & sound.

Advantages of DTH Technology

- The main advantage is that this technology is equally beneficial to everyone. As the process is wireless, this system can be used in all remote or urban areas.
- High quality audio and video which are cost effective due to absence of mediators.
- Almost 4000 channels can be viewed along with 2000 radio channels. Thus the world's entire information including news and entertainment is available to you at home.
- As there are no mediators, a complaint can be directly expressed to the provider.
- With a single DTH service you will be able to use digital quality audio, video and also high speed broadband.

Signal Processing in cable TV:

The signal processing unit, also called 'Head-End Equipment' consists of power dividers, satellite receivers, channel modulators, signal processors/amplifiers, VCRs, C.D. players and a combining network. Fig. shows necessary details of processing different types of input signals which are briefly described.

LNBC Output: The 500 MHz wide IF signal (950 MHz to 1450 MHz) is actually a multiplexed output of 12 separate transponder channels each having an effective bandwidth of 36 MHz (actual 40 MHz). In communication satellites, most of these channels carry television signals of different TV stations.

Power Divider: The IF signal from the LNBC is delivered to a signal splitter which is actually a multicoupler that divides the signal into independent paths. The signal splitter is commonly called a ‘Power Divider’ because it enables equal division of signal power at its output ports.

Compare NTSC, PAL, SECAM System

Sr. No.	Parameter	PAL	NTSC	SECAM
1.	Full form of system	Phase Alternation of Line	National Television System Committee	Sequential Colour A Memory
2.	Inventing country.	Germany in 1967	USA in 1957	France in 1970
3	Countries where used.	Germany, India, UK	USA, Canada, Japan, Mexico.	France, East Europe, Africa.
4	Transmission of colour.	By colour difference signals.	By colour difference signals.	By colour difference signals.
5	Video bandwidth.	5 MHz	4 MHz	6 MHz
6	Noise	High	High	Very high.
7	Identification signal	Needed	Not needed	Needed
8	Cost	Costliest	Less than PAL but higher than SECAM	Cheapest

What is an OLED?

OLED’s are simple solid-state devices (more of an LED) comprised of very thin films of organic compounds in the electroluminescent layer. These organic compounds have a special property of creating light when electricity is applied to it. The organic compounds are designed to be in between two electrodes. Out of these one of the electrodes should be transparent. The result is a very bright and crispy display with power consumption lesser than the usual LCD and LED.

OLED – Comparison with LCD and LED

Like a LCD, the OLED does not require a backlight for its normal working. This makes them more advantageous in saving space and also weight. It also helps them in displaying deeper black levels than LCD’s. OLED is also capable of making a high contrast ratio when it is displayed in a dark room than LCD as well as LED.

Introduction of OLED

The discovery of the electroluminescence property in organic materials in 1950s is considered to be the stepping stone of OLED.

Later in 1960, a scientist called Martin Pope discovered an ohmic, dark injecting electrode contact to organic nature of crystals. With this he was also able to explain the work functions for both the holes and electrons while injecting electrode contacts. These dark injecting holes and electrons formed to be the base for an OLED device. The technique was further experimented with DC electroluminescence under different conditions. Later it was found that electroluminescent materials can also act as doped insulators. Thus came the discovery of a double injection induced OLED device.

OLED's, as can be seen here are simple solid-state devices (more of an LED) comprised of very thin films of organic compounds in the electroluminescent layer.The first proper OLED was manufactured in 1980 by Dr. Ching W Tang and Steven Van Slyke. The OLED had a double layer structure. When the holes and electrons were transported separately and when combined together produced a light in the organic layer centre. This light was produced at a very low operating voltage with high efficiency. Now more research is being done with the application of OLED on polymer so as to obtain a higher efficiency OLED.

Components in an OLED

The components in an OLED differ according to the number of layers of the organic material. There is a basic single layer OLED, two layer and also three layer OLED. As the number of layers increase the efficiency of the device also increases. The increase in layers also helps in injecting charges at the electrodes and thus helps in blocking a charge from being dumped after reaching the opposite electrode. Any type of OLED consists of the following components.

1. An emissive layer
2. A conducting layer
3. A substrate
4. Anode and cathode terminals.

As the emissive layer and the conducting layer is made up of organic molecules (both being different), OLED is considered to be an organic semiconductor, and hence its name. The organic molecules have the property of conducting electricity and their conducting levels can be varied form that of an insulator to a conductor.

The emissive layer used in an OLED is made up of organic plastic molecules, out of which the most commonly used is polyfluorene.

The conducting layer is also an organic molecule, and the commonly used component is polyaniline.

The substrate most commonly used may be a plastic, foil or even glass.

The anode component should be transparent. Usually indium tin oxide is used. This material is transparent to visible light. It also has a great work function which helps in injecting holes into the different layers.

The cathode component depends on the type of OLED required. Even a transparent cathode can be used. Usually metals like calcium and aluminium used because they have lesser work functions than anodes which helps in injecting electrons into the different layers.

Working of an OLED

Before going on to the detailed explanation of its working, it is important to know how the emissive layers and conducting layers are added to the substrate. There are mainly three basic methods for this operation. They are:-

1. Inkjet Printing Technique –

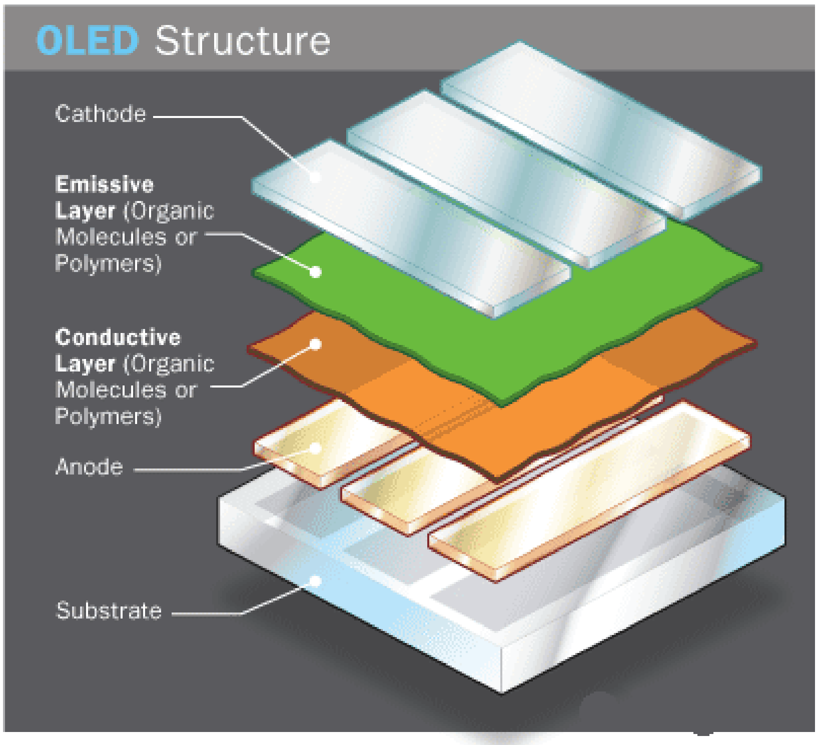
- This is the cheapest and most commonly used technique. The method is same as the paper printing mechanism where the organic layers are sprayed onto the substrates. This method is also highly efficient and they can be used for printing very large displays like billboards and also big TV screens.

2. Organic Vapour Phase Deposition (OVPD) –

- This is also an efficient technique which can be carried out at a low cost. A cooled substrate is being hit by the organic molecules, which was evaporated in a low pressure, high temperature chamber. The gas is carried onto the substrate with the help of a carrier gas.

3. Vacuum Thermal Evaporation (VTE) –

- This method is also commonly known as vacuum deposition method. This operation is carried out by gently heating the organic molecules so that they evaporate and subside on the substrates. As the heating method is complicated and the strictness of parameters should be highly accurate, this method is economical as well.
- After the organic material has been applied to the substrate the real working of the OLED begins.
- The substrate is used to support the OLED. The anode is used to inject more holes when there is a path of current. The conducting layer is used to carry the holes from the anode. The cathode is used to produce electrons when current flows through its path. The emissive layer is the section where the light is produced. This layer is used to carry the electrons form the cathode.
- First, the anode is kept positive w.r.t the cathode. Thus there occurs an electron flow from the cathode to the anode. This electron flow is captured by the emissive layer causing the anode to withdraw electrons from the conductive layer. Thus, there occurs a flow of holes in the conductive layer. As the process continues, the conductive layer becomes positively charged and the emissive layer becomes negatively charged.
- A combination of the holes and electrons occur due to electrostatic forces. As the electrons are less mobile than the holes, the combination normally occurs very close to the emissive layer. This process produces light in the emissive region after there has been a drop in the energy levels of the electrons. The emissive layer got its name as the light produced in the emissive region has a frequency in the visible region. The colour of the light produced can be varied according to the type of organic molecule used for its process. To obtain colour displays, a number of organic layers are used. Another factor of the light produced is its intensity. If more current is applied to the OLED, the brighter the light appears. Take a look at the diagram given below.



OLED Diagram

- Now consider the process when the anode is negative w.r.t the cathode. This will not make the device work as there will not be any combination of the holes and electrons. The holes will move towards the anode and the electrons to the cathode.

Different types of OLED's

According to the type of manufacture and the nature of their use, OLED's are mainly classified into 8 types. They are

1. Active Matrix OLED (AMOLED)

This type of OLED is suitable for high resolution and large size display. Though the manufacturing process is the same, the anode layers have a Thin-film transistor (TFT) plane in parallel to it so as to form a matrix. This helps in switching each pixel to it's on or off state as desired, thus forming an image. This is the least power consuming type among others and also has quicker refresh rates which makes them suitable for video as well.

2. Passive Matrix OLED (PMOLED)

The design of this type of OLED makes them more suitable for small screen devices like cell phones, MP3 players and so on. Though this type is less power consuming than an LCD and LED (even if connected to other external circuitry's), it is the most power consuming comparative to other OLED's. This type is very easy to make as strips of anode and cathode are kept perpendicular to each other. When they are both intersected light is produced. As there are strips of anode and cathode, current is applied to the selected strips and is applied to them. This helps in determining the on or off pixels.

3. Inverted OLED

This type uses a bottom cathode, which is connected to the drain end of an n-channel TFT backplane. This method is usually used for producing low cost OLED with little applications.

4. Foldable OLED

This type is mainly used in devices which have more chance of breaking. As this material is strong it reduces breakage and therefore is used in cell phones, computer chips, GPS devices and PDA's. They are also flexible, durable and lightweight. As its name explains, these

OLED’s are foldable and can also be connected to clothes. They use different types of substrates like flexible metallic foils, plastics and so on.

5. Top Emitting OLED

This type of OLED is integrated with a transistor backplane that is not transparent. Such devices are suitable for matrix applications like smart cards. The substrate used for this device is of the opaque/reflective type. As a transparent substrate is used the electrode used is either semi-transparent or fully transparent. Otherwise the light will not pass through the transparent substrate.

6. Transparent OLED

This device has a good contrast even in bright sunlight so it is applicable in head-up displays, mobile phones, smart windows and so on. In this device, the entire anode, cathode and the substrate are transparent. When they are in the off position, they become almost completely transparent as their substrate. This type of OLED can be included in both the active and passive matrix categories. As they have transparent parameters on both the sides, they can create displays that are top as well as bottom emitting.

7. White OLED

This device creates the brightest light of all. They are manufactured in large sheets. Thus they can easily replace fluorescent lamps. They are also cost-effective and also consumes less power.

8. Stacked OLED

This device uses the composite colours as sub pixels and also on top of each other. This causes the reduction in pixel gap and also an increase in colour depth. Thus they are being introduced as television displays.

Advantages of OLED’s

- The manufacture of OLEDD is highly economical and is more efficient than LCD and flat panel screens.
- It will be a great surprise to see displays on our clothing and fabrics. This technology will help in carrying huge displays in our hands.
- There is much difference in watching a high-definition TV to a OLED display. As the contrast ratio of OLED is very high (even in dark conditions), it can be watched from an angle of about 90 degrees without any difficulty.
- No backlight is produced by this device and the power consumption is also very less.
- OLED has a refresh rate of 100,000 Hz which is almost 9900 HZ greater than an LCD display.
- The response time is less than 0.01 ms. LCD needs a response time of 1 ms.

Disadvantages of OLED

- The power consumption of this device depends upon the colour that is displayed on the screen. Less than 50% power is only consumed when a black image is displayed, compared to an LCD. But the percentage increases to almost three times when a bright image such as a white colour is displayed. Thus, this device is disadvantageous for mobile applications.
- The OLED technology is only rising and due to this, the commercial availability of OLED products are very less. Though they can be easily made the fabrication process is considered expensive and thus the initial amount is expensive.
- As there is no reflective light technology used in such a device it has a very poor reading effect in bright light surroundings. Even if this is to be overcome additional power should be used.
- With time, the brightness of the OLED pixels will fade.

- The images displayed in this device are created by an artificial light source. So, the whole electricity has to be used to perform such an operation. LCD's, on the other hand use some percentage of light from sunlight and also e-ink.
- The device is not at all water resistant.
- The lifetime of this device is much lesser when compared with an LCD or LED.

Applications of OLED

- OLED's are used as mobile phone screens, MP3 players, digital cameras, car radios, PDA's and so on.

CHAPTER : 4. TV Receivers

Marks: 14 Marks.

Block Diagram of color TV receiver (PAL D type):

- A colour TV receiver contains all the necessary circuits of a monochrome receiver plus additional circuits required for the reproduction of a colored picture. Basically a colour TV receiver is a black-and-white receiver with a decoder for the colour signals and a colour picture tube.
- The figure is the functional block diagram of a colour TV receiver. The block diagram shows that the circuits like the RF tuner, VIF amplifier, the video amplifier, the deflection sync, the sweep circuits and the EHT sections are virtually the same as in black-and-white receiver.

CHAPTER : 5. Consumer Electronics

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Photocopier :

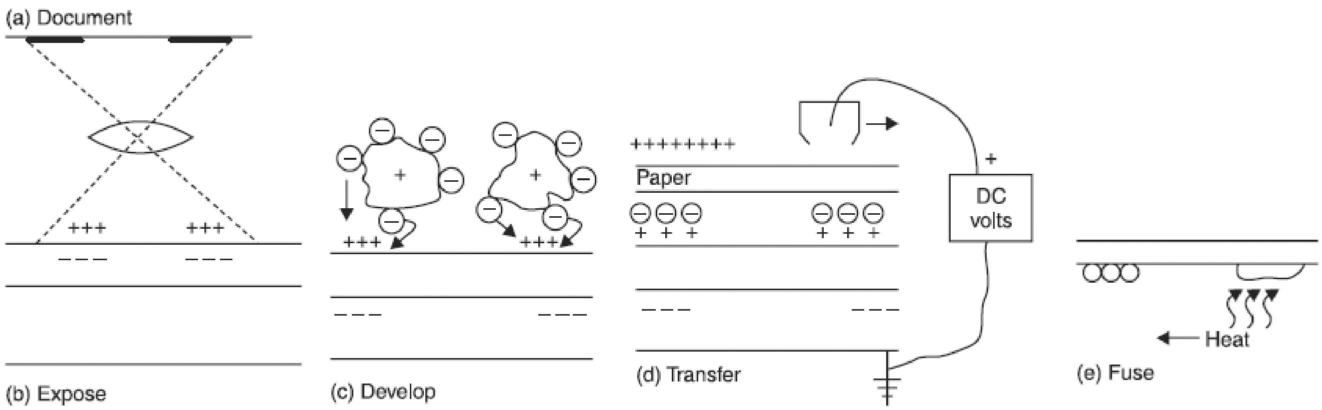


Fig. 1: The basic steps of xerography

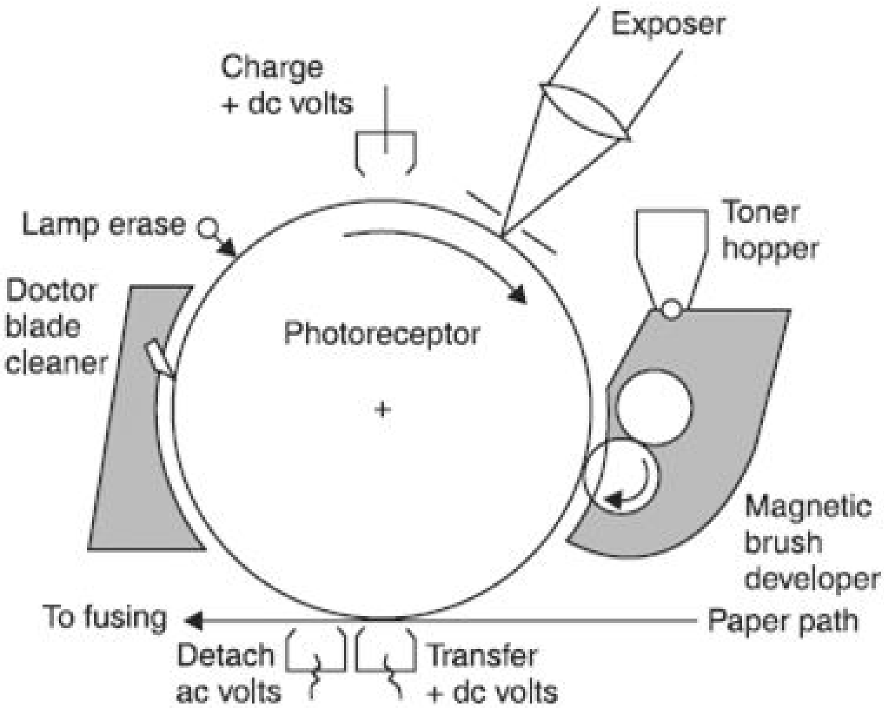


Fig. 2 Xerographic copier schematic

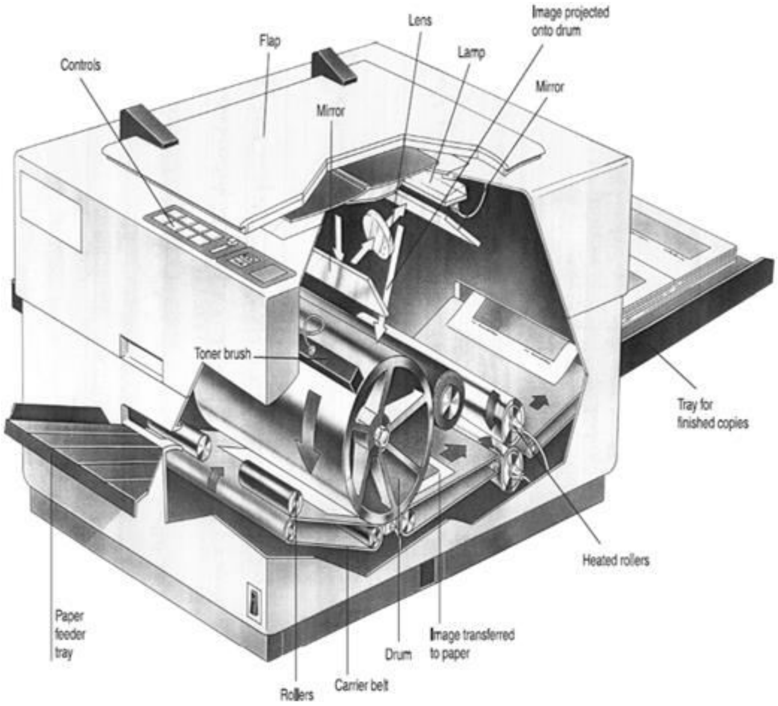


Fig. 3 An exploded view of a xerographer

Chester Carlson invented a six step process in which the image was transferred from one surface to another using opposite electrical charges and conductors.

1. Charging

Inside every copier and laser printer is a light sensitive surface called a photoreceptor. This has a thin layer of photoconductive material that is applied to a belt or drum. The photoreceptor is insulator when it is in the dark, but becomes a conductor when it is exposed to light. It is charged in the dark by applying a high voltage to adjoining wires, which then produces an intense electrical field near to the wires that causes the air molecules to ionize. Ions of the same polarity as the voltage on the wires deposit on the photoreceptor surface, creating an electric field across it.

2. Exposure

In digital copiers or printers, the image is exposed on the photoreceptor with a scanning modulated laser or a light emitting diode image bar. In older analog copiers, light reflected from an illuminated image is projected onto the photoreceptor. In both cases, the areas of the photoreceptor exposed to light are selectively discharged, causing a reduction in the electric field. The darker areas of the photoreceptor retain their charge.

3. Development

Pigmented powder used to develop the image is called toner. Toner particles made of colorant and plastic resin have precisely controlled electrostatic properties and range from about five to 10 micrometers in diameter. The particles are mixed with and charged by magnetized carrier beads that transport them to the development zone. The particles are charged by the phenomenon of Static Electricity. The electric field associated with the charge pattern of the image on the photoreceptor exerts an electrostatic force on the charged toner, which adheres to the image. A color document is formed by a printer with four separate xerographic units that create and develop separate cyan, magenta, yellow and black images. The superposition of these powder images produces full colour documents.

4. Transfer

The powder image is transferred from the photoreceptor onto paper by bringing the paper in contact with the toner and then applying a charge with polarity opposite to that of the toner. The charge must be strong enough to overcome the powder's adhesion to the photoreceptor. A second precisely controlled charge releases the paper, now containing the image, from the photoreceptor.

5. Fuse

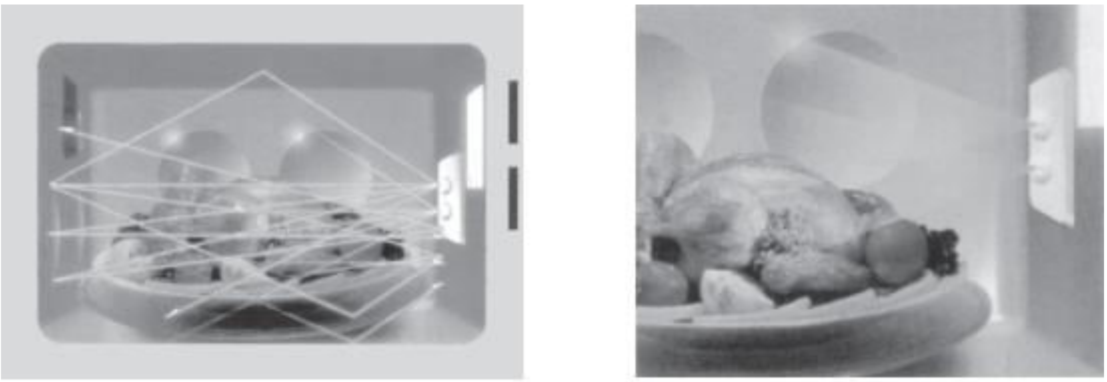
In the fusing process, the toner comprising the image is melted and bonded to the paper. This is accomplished by passing the paper through a pair of rollers. A heated roll melts the toner, which is fused to the paper with the aid of pressure from the second roll.

6. Clean

Toner transfer from the photoreceptor to the paper is not 100 percent efficient, and residual toner must be removed from the photoreceptor before the next print cycle. Most medium and high speed copiers and printers accomplish this with a rotating brush cleaner.

Microwaves:

A microwave is a signal that has a wavelength of one foot (30.5 cm) or less. This converts to a frequency of 984 MHz, so all frequencies above 1000 MHz (1 GHz) are considered microwaves. The frequencies immediately below this border are considered ultra-high frequencies. The upper end of the microwave range contains the light frequencies, about 1015 Hz. However, because electronic transmission is so closely geared to *half-wavelength devices*, the practical upper limit is about 300 GHz, where one wavelength is about 0.04 inch (0.1 cm). Smaller devices are being made, but their *power handling abilities* are also micro.
Normally microwaves spread outwards as they travel through the atmosphere and disappear without effect.



(a) (b)

Fig. 4 (a) The wave reflector system (WRS) (b) The dual-wave emission system (DES)
The word magnetron is a conjunction of the words *magnet* and *electrons* and identifies one of the major components, a very powerful magnet. The second major component is a cylindrical copper block, drilled and channeled as shown in Fig. 50.2. The centre opening is called the *interaction chamber.* The holes drilled around the outer edge have a diameter equal to one-half wavelength at the operating frequency and are called *resonant chambers.* There will always be an *even* number of resonant chambers, usually not less than 6 and not more than 16.

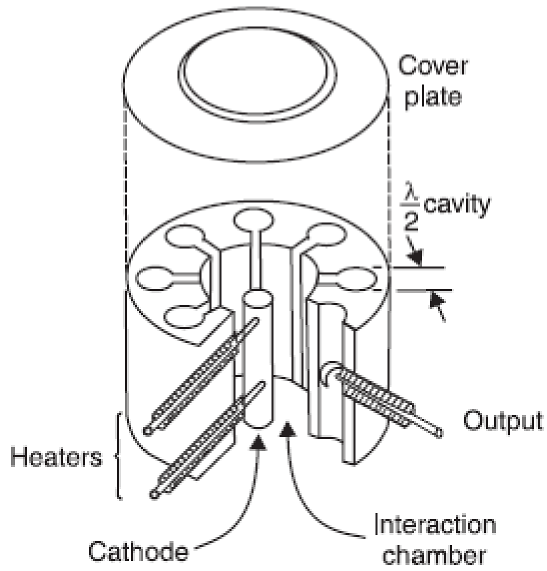


Fig. 5 The anode cylinder block of a multi-cavity magnetron

<u>Working:</u>

1. Inside the strong metal box, there is a microwave generator called a magnetron. When you start cooking, the magnetron takes electricity from the power outlet and converts it into high-powered, 12cm (4.7 inch) radio waves.
2. The magnetron blasts these waves into the food compartment through a channel called a wave guide.
3. The food sits on a turntable, spinning slowly round so the microwaves cook it evenly.
4. The microwaves bounce back and forth off the reflective metal walls of the food compartment, just like light bounces off a mirror. When the microwaves reach the food itself, they don't simply bounce off. Just as radio waves can pass straight through the walls of your house, so microwaves penetrate inside the food. As they travel through it, they make the molecules inside it vibrate more quickly.
5. Vibrating molecules have heat so, the faster the molecules vibrate, the hotter the food becomes. Thus the microwaves pass their energy onto the molecules in the food, rapidly heating it up.

Block Diagram:

The block diagram of a microwave oven is given in Fig. 6. The mains plug and socket are three-pin earthing type. The fast blow ceramic fuse is of 15 A, 250 V. *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.

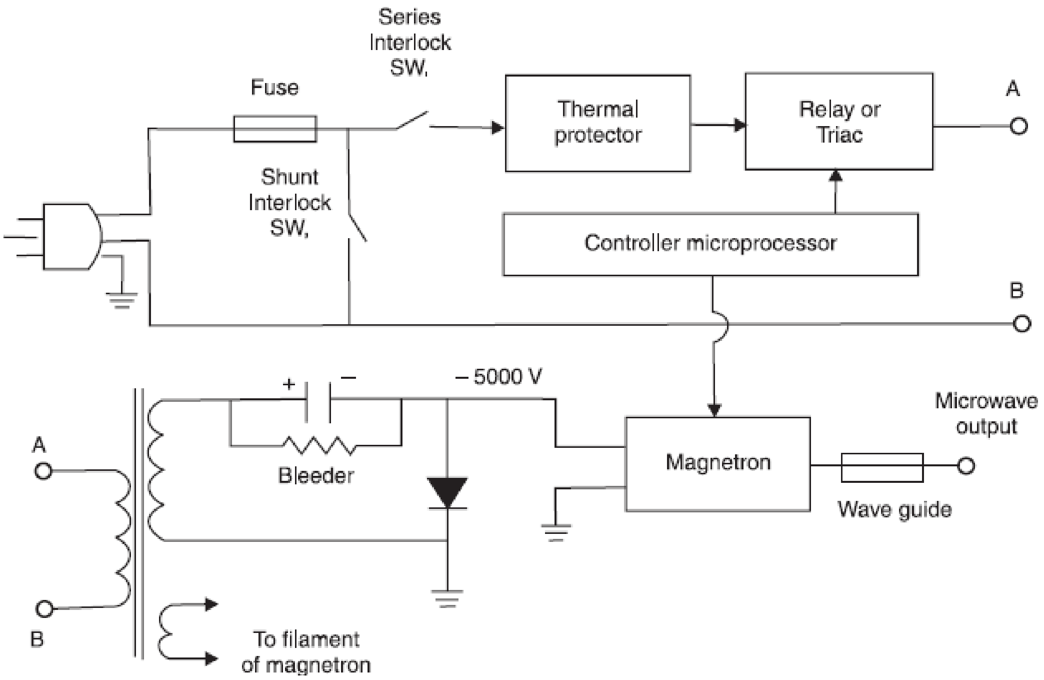


Fig.6 Functional block diagram of a microwave oven

- 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 2000 V (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 (1 pF) 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. It senses the temperature and moisture, sets the power levels and runs the display. There are three power levels. For HIGH the microwave generator remains on continuously; forMEDIUM 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.

SINGLE CHIP CONTROLLERS:

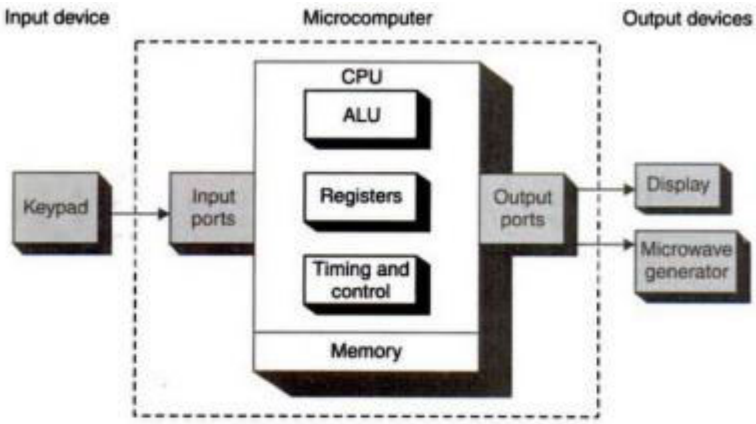


Fig: 7 Block diagram of Single chip Microwave

- Most of us are familiar with general-purpose microcomputers such as the IBM PC and its clones and the Apple Macintosh. which are used in more than half of our homes and in almost all of our businesses? These microcomputers can perform a wide variety of tasks in a wide range of applications depending on the software (programs) they are running.
- There is a more specialised type of microcomputer call a microcontroller which is not a general-purpose computer. Rather, it is designed to be used as a dedicated or embedded controller which helps monitor and control the operation of a machine, a piece of equipment, or a process. Microcontrollers are microcomputers because they use a microprocessor chip as the CPU.
- But they are much smaller than general-purpose microcomputers because the input/output devices they normally use are much smaller. In fact, some of the input/output devices—as well as memory— are usually right on the same chip as the microprocessor. These single-chip microcontrollers are employed in a wide variety of control applications such as: appliance control, metal-working machines. VCRs.
- Automated teller machines. photocopiers. automobile ignition systems. anti lock brakes, medical instrumentation, and much more. A very typical application of an embedded microprocessor is a microwave oven control system. A block diagram of such a system is shown in Fig. 7. If we were to try to analyse all of the machine-language instructions needed to program an actual microwave oven, you would find it overwhelming.
- Its purpose is to determine if a non-zero value has been placed in the accumulator. The value in the accumulator represents the number of seconds that the microwave should cook the food. If a non-zero value is in A. it displays the number of seconds on an output port and counts down in I second interval until it reaches 0.
- It then continues with the rest of the program. The program starts executing at address 0000 when power is first applied, which resets the system. The instruction that is generally stored at the reset address is a jump instruction that sends the micro to the main program. The main program, in this case, starts at 0100.
- where it makes a decision either to jump immediately to the rest of the program at 010A or to execute the instructions from 0102-0109. In either case, it eventually executes the rest of the program from 010A until it is told to jump back to 0100 and do it all over again.

Wiring Instructions:

- The wires in this mains cord are coloured in accordance with the following code.

- Green : Earth
- Black : Neutral
- Red : Live

- As the colours of the wires of the mainscord of this appliance may not correspond with the coloured marking identifying the terminals in your plug, proceed as follows : The wire which is coloured *green* must be connected to the terminal in the plug which is marked with the 'E' or by the earth symbol or green. The wire which is coloured *black* must be connected to the terminal which is marked with the letter 'N' or coloured black. The wire which is coloured red must be connected to terminal which is marked with the letter 'L' or coloured red.

SAFETY INSTRUCTIONS:

Listed below are, as with other appliances, certain rules to follow and safeguards to assure best performance from this oven :

1. Do not use the oven for drying clothes, paper or any other *non food item.*
2. Do not use the oven *without* food items, this could damage the oven and may cause smoke emission.
3. Do not use the oven for *storage* of papers, cookbook, cookware, etc.
4. Do not operate the oven without glass tray. *Be sure it is properly placed on the rotating base.*
5. Ensure *removal* of caps or lids prior to cooking when you cook food sealed in bottles.
6. Do not put *foreign material* between the oven surface and door which could result in excessive leakage of harmful microwave energy.
7. Do not use *recycled paper products* for cooking.

ELECTRONIC CONTROLLER FOR WASHING MACHINES:

The task here is simply to identify the input and output devices used in electronic washing machines and to construct a block diagram showing their connections to the controller. Detailed information about the characteristics of sensors and actuators can be added at a later stage.

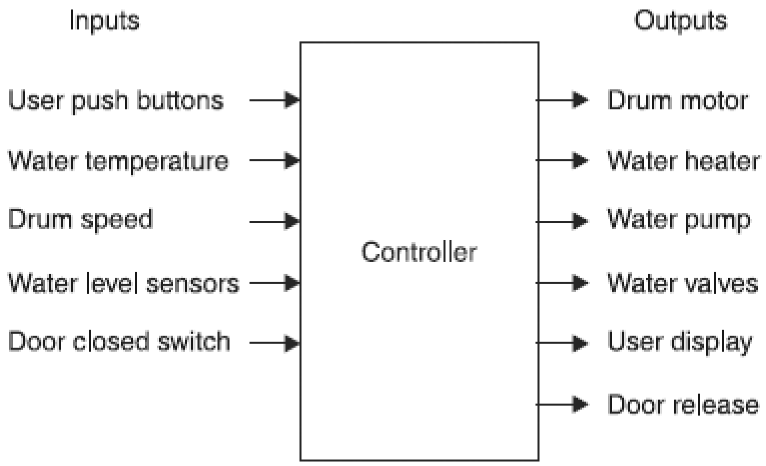


Fig. 8 Inputs and outputs in an electronic washing machine

The block diagram in Fig. 8 shows a possible representation of the system. There are many acceptable ways of representing the system. It would, for example, be possible to consider the display to be internal to the controller and therefore not show it separately.

Similarly clock circuitry used to time the operation of the machine is considered here to be contained within the controller. It could equally well be considered as an external component. The block diagram is a good starting point for the generation of the specification since it shows very clearly the structure of the complete system.

The block diagram makes no assumptions of the form of the controller. It could be implemented using an electromechanical timer, or a microcomputer, or a range of other technologies.Many modern washing machines now use microcomputer to control their various functions, replacing the electromechanical controllers used in earlier models. Clearly it is not practical to consider all aspects of such a system, but it is instructive to look at some elements of the design. At various stages of the washing cycle the drum is required to rotate at different speeds.

These include: a low speed of about 30 revolutions per minute (rpm) while clothes are washed: an intermediate speed of about 90 rpm while the water is pumped out and a high speed of either 500 or 1000 rpm to spin dry the clothes. Let's consider how the microcomputer should control the speed of the motor.

Since a domestic washing machine is a very high-volume product, the design should attempt to minimise the amount of hardware required. This necessitates a close look at the choice of sensors and actuators to select low-cost items. Our first decision must be whether the system will be open loop or closed loop. Since although an open-loop system is theoretically possible using a synchronous motor the cost of such a system for high-power variable-speed applications is prohibitive.

The system will therefore be closed loop using a motor to drive the drum and some form of sensor to measure its speed. One of the simplest methods of speed measurement is to use a counting technique illustrated in Fig. 10. It uses a fixed inductive sensor to produce a pulse each time it is passed by a magnet which rotates with the drum.

This produces one pulse per revolution of the drum which can be used to determine its speed.The speed of the motor will be controlled by the power dissipated in it. The simplest way of speed control is to use a triac. The power could be controlled by some form of electronic circuitry, but the hardware requirement can be reduced if the microcomputer controls the power directly by firing the triac at an appropriate time during its cycle. To do this the controller must detect the zero crossing of the ac supply. This will require circuitry to detect the crossing point while protecting the processor from high voltages. A block diagram of the system is shown in Fig. 9.

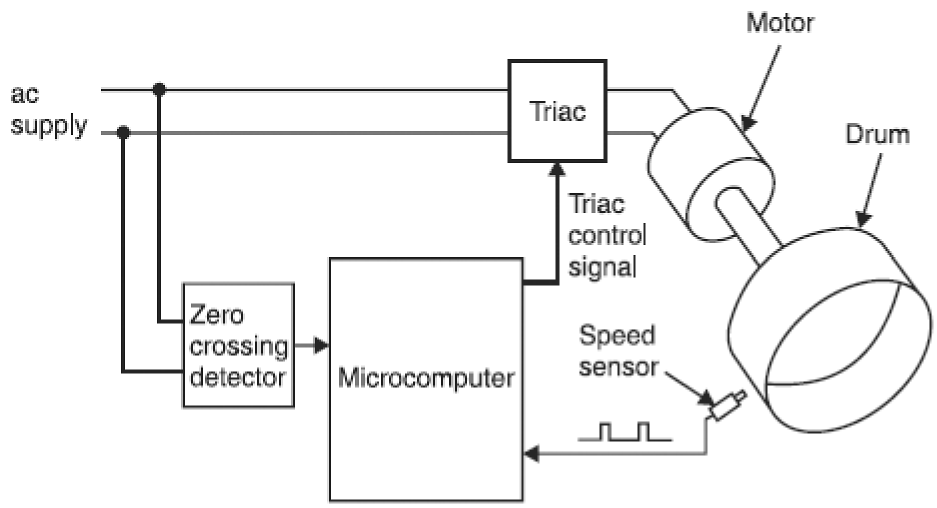


Fig 9: Block Diagram of Washing Machine

Fig. 9 Washing machine control At any time in the washing cycle the program determines at what speed the drum should rotate. From a knowledge of the required speed and the actual speed as obtained above, the controller can determine whether to increase or decrease the power dissipated in the motor.

The motor power is determined by the timing of the triac firing pulse. If the triac is fired at the beginning of each half of mains cycle it will remain on for the remainder of the half cycle and the motor will operate at full power. The longer the processor waits before firing the triac, the less will be the motor power. The processor thus varies the delay time with respect to the zero crossing point of the mains by an appropriate amount to increase or decrease the power in the motor as determined by the difference between the actual and required speeds.This method of controlling the motor speed is very processor intensive. It consumes a large amount of processor time and will require a considerable amount of effort in writing and developing the software. However, this approach uses very little hardware and is thus very attractive for such a high-volume application.

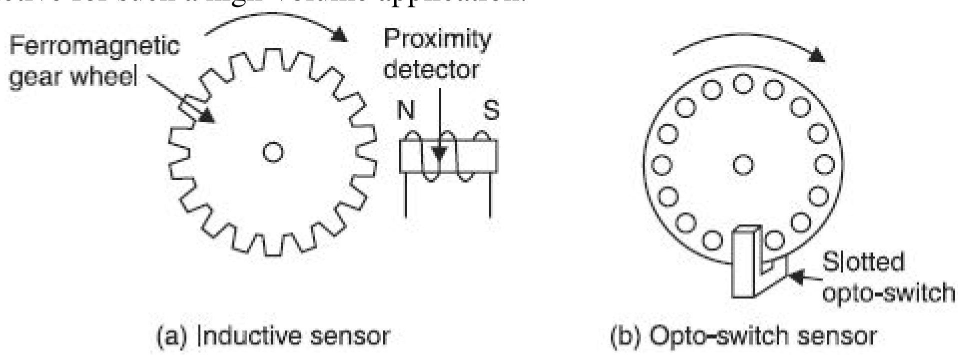


Fig. 10 Displacement sensors using counting

WASHING MACHINE HARDWARE:

A *system* is an assembly of components united by some form of regulated interaction to form an organised whole. We will examine a microcomputer system, using a washing machine control as an example. The input peripherals consist of (Fig. 11).

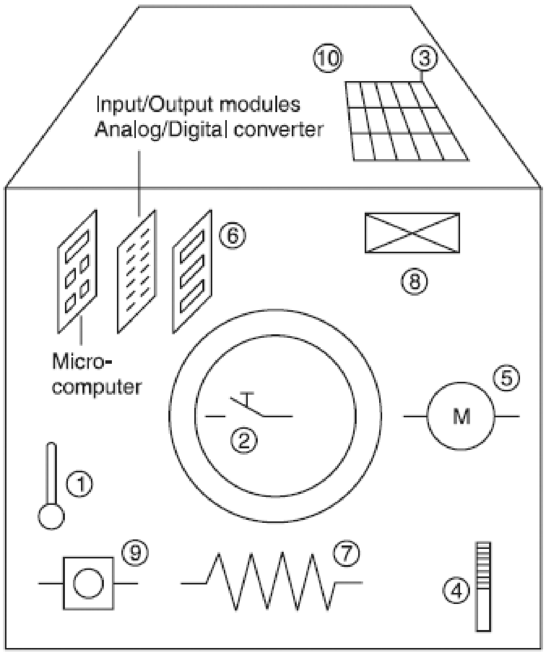


Fig. 11 Washing machine—hardware

1. temperature sensor which senses the washing water temperature. (The analog/digital converter changes the analog values to binary numbers).
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, etc.
7. heater for washing water.
8. water inlet valve.
9. water suction pump.
10. control lamps and indicators.

The units listed above i.e. the washing machine as well as its mechanical components, electrical units and electronic components are known as *hardware.*
The push-button keyboard enables the desired program to be selected. The control—the microcomputer checks firstly that the safety cut-out is in the ON position. The water is then admitted (valve opened) and the water level is constantly monitored. When the required quantity of water has been provided the valve closes.
The water temperature is measured and the heater is switched until the water reaches the required temperature. In the meantime, the washing powder is admitted from a container and the hardness of water is noted, at the same time the drum motor is switched on so that the dirty washing is *evenly* moved through the water. After the required time has elapsed, according to the selected program, the motor is switched to *high speed spinning* and the suction pump is switched on to remove the washing water and the rinsing water to waste. At the end of the *washing cycle* the machine switches off and provides a signal to indicate this.
Washing machines are mainly of three types, namely washer, semi-automatic and automatic. *Washers Are* single tub machines that only wash. Since washers don't have the facilities for drying the clothes, these cost less than semi-automatic and fully automatic machines.

Fig 12 semi-automatic machine

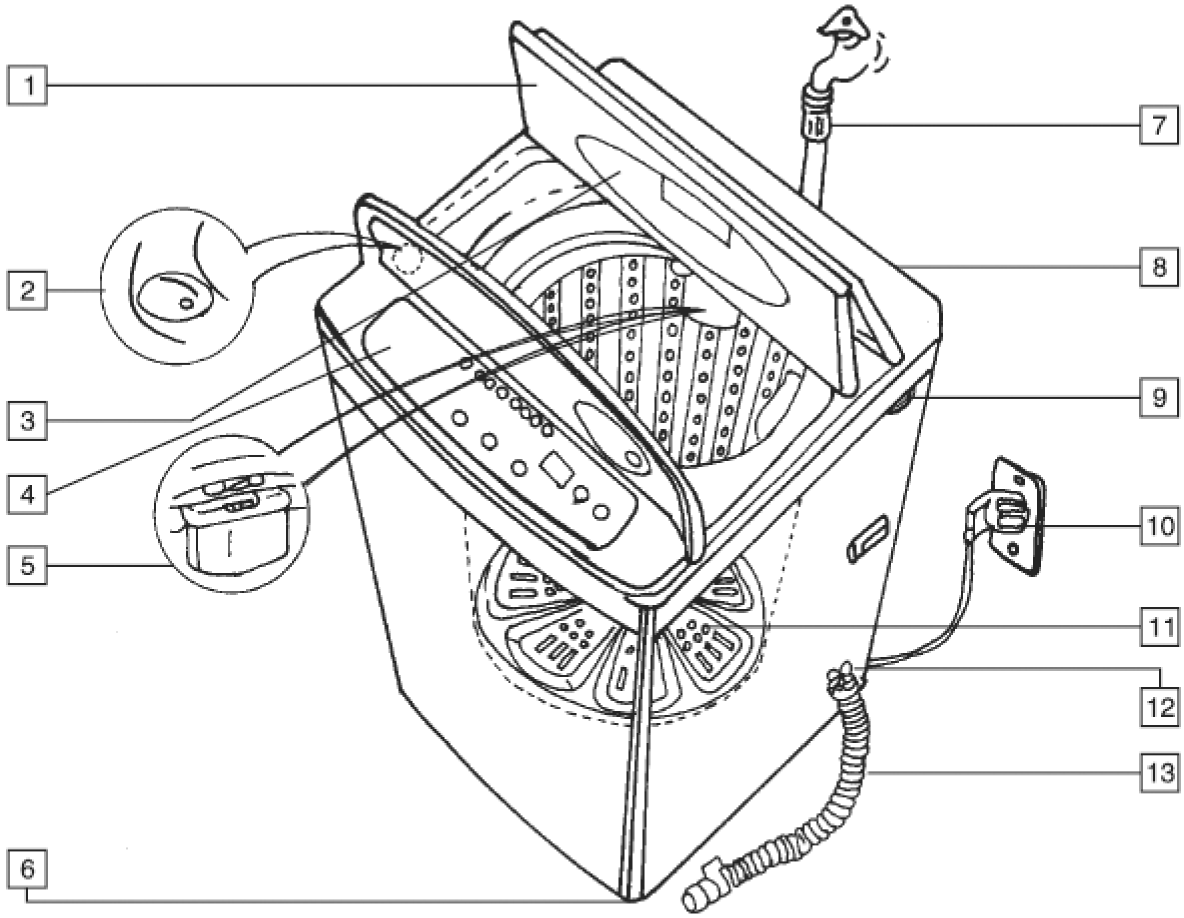
Fig 13 Fully automatic machine

In *semi-automatic* machine, Fig.12, the controls are not fully automatic and manual intervention is required.

In *fully automatic* machines, Fig.13, no manual intervention is required during the washing process. For automatic machines, programs have to be selected and set by the user prior to the start of washing cycle. Sensors sense the wash load and decide the program ideal for washing the clothes, water level, time required to wash, number of rinses and spins, type of fabric etc.

Although *washer dryer* (semi-automatic) machines don't operate with the efficiency of *stand alone* washing machines, they offer enormous space saving. However, you have to drain all the soap water before drying. Also, you can't wash and dry at the same time and the drying performance is inferior to that of stand alone machines. But then washer-dryers cost less and allow you to wash and dry your clothes without having to reset the machines.

1. **Capacity :** The capacity of a washing machine is expressed in terms of the *wash load*, which in turn depends on the type of fabric. It is expressed in kg. The maximum load for the washer is the amount that will move freely in the wash tub. A higher capacity machine offers the convenience of washing more clothes at one go but consumes more power. Smaller capacity machines wash fewer clothes and consumes less power, but these machines can easily fit in a limited space.
2. **Wash programs :** High-end washing machines feature different wash programs to suit different types of clothes. The program includes *regular* for normal wash, *gentle* for delicate clothes and *tough/hard* for rugged clothes. In addition, you are able to select the temperature of wash and the number of runs for better cleaning. The number of cycles specifies the number of *preset programs* available on the machine. This is important for clothes that require different temperatures.
3. **Spin Speed :** The higher the spin speed, the dryer the clothes at the end of the *washing cycle* and hence the shorter the drying time in the tumbler dryer. Thus a high spin speed results in less *washing time.* Some machines spin at more than 1000 rpm, some machines spin as fast as 7000 rpm during *drying cycle.*

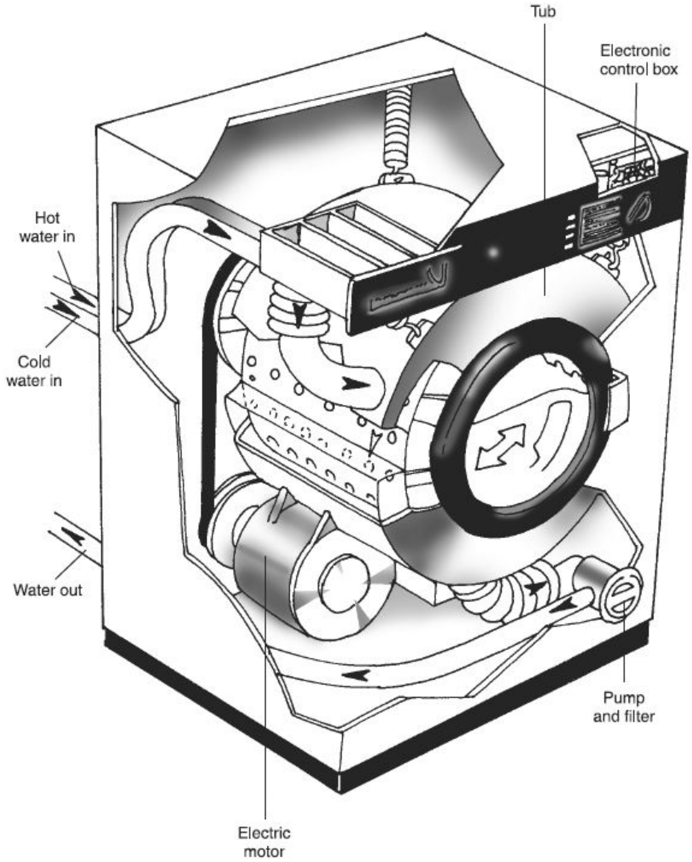


1. **Lid**
2. **Bleach inlet**
3. **Transparent window**
   You can see the laundry being washed through this window.
4. **Front control panel**
   Open the panel lid, and then choose the function you want to use.
5. **Softener case**
6. **Adjustable legs**
   Adjust the length of the legs when installing the washer.
7. **Water supply hose**
8. **Lint filter**
   Lint will collect in the lint filter pouch during washing.
9. **Drain hose hook**
10. **Power cord**
11. **Pulsator**
12. **Drain hose clamp**
13. **Drain hose**

Fig. 14 Controls and features of a typical top loading washing machine

4. **Washing Technique :** In some machines a *pulsator disk* at the bottom, circulates water upwards in large circles while rotating, providing better and gentler cleaning of clothes. In the *agitator wash technique* a rod with fins is used at the centre of the washing machine. A rubbing action squeezes the dirt out of clothes. But it restricts the space and the clothes tend to get entangled. The *tumble wash technique* is used in front loaders. A steel drum rotates along a horizontal axis and the clothes rub against its metal surface due to

centrifugal action. The cleaning is, of course, superior but there is a risk of ruining gentle fabrics.



5.

Fig. 15 Controls and features of a typical front loading washing machine

6. In *LG punch + 3 technique* the water punch propels the detergent rich water vertically into every thread of the fabric. The action is supported by three *mini pulsators* which work with the main pulsator to generate powerful micro water-eddies. The mini pulsators rotate in the *opposite* direction to the main pulsator. This helps in reducing entanglement of clothes, resulting in less wear and tear and better wash technology.

7. **Loading the machine :** *Top loaders* allow you to easily remove clothes, without having to bend even during power failure. These are compact and require normal detergents. You can add clothes even during the wash cycle. The larger the porthole, the more convenient the loading and unloading. Most top loading machines have an agitator. *Front loaders* are usually more expensive than top loaders as these incorporate heftier motors and suspensions. However, these machines consume less water and dry clothes much faster, thereby reducing energy bill. The hot wash option allows better cleaning. You cannot open a front loader midway through a wash cycle. You need to use detergents producing less lather and if the power fails you can't open the door due to water in the drum. Also you need to leave room for door opening/closing on the front side.

8. **Automation :** On fully-automatic washing machines you don't need to wet your hands, just put in the wash load, turn the machine on and wait for it to finish washing and drying. *Automatic machines require a dedicated running water supply from a tap.* A single tub carries out all the actions. The washing machine does washing, rinsing and drying and beeps when it is through with all the tasks.

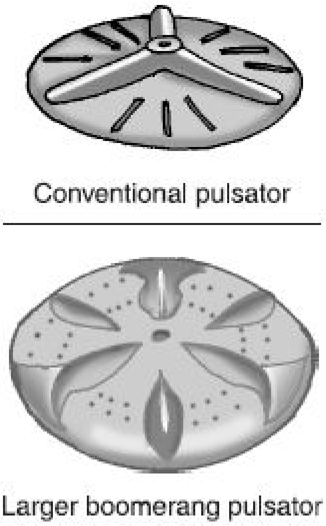



Fig. 16 The pulsator disk **Fig. 17** The agitator rod **Fig. 18** LG punch +3 technique

On semi-automatic machines you have to *manually* transfer the clothes from the washer to the dryer. Semi-automatic machines featuring microprocessor based controls with feather-touch buttons consume less power and are *preferable where running water is not available.*

<u>WIRING INSTRUCTIONS:</u>

The wires in this mains cord are coloured in accordance with the following code.

Green : Earth
Black : Neutral
Red : Live
As the colours of the wires of the mainscord of this appliance may not correspond with the coloured marking identifying the terminals in your plug, proceed as follows : The wire which is coloured *green* must be connected to the terminal in the plug which is marked with the 'E' or by the earth symbol or green. The wire which is coloured *black* must be connected to the terminal which is marked with the letter 'N' or coloured black.
The wire which is coloured *red* must be connected to terminal which is marked with the letter 'L' or coloured red. Ensure *proper wiring* of the socket which should be of *15 Amps* capacity. Line terminals should confirm to the above.
Warning : This appliance must be *earthed properly.*

<u>SAFETY INSTRUCTIONS:</u>

Listed below are, as with other appliances, certain rules to follow and safeguards to assure best performance from this oven :

1. Do not use the oven for drying clothes, paper or any other *non food item.*
2. Do not use the oven *without* food items, this could damage the oven and may cause smoke emission.
3. Do not use the oven for *storage* of papers, cookbook, cookware, etc.
4. Do not operate the oven without glass tray. *Be sure it is properly placed on the rotating base.*

5. Ensure *removal* of caps or lids prior to cooking when you cook food sealed in bottles.
6. Do not put *foreign material* between the oven surface and door which could result in excessive leakage of harmful microwave energy.
7. Do not use *recycled paper products* for cooking. They may contain impurities which could cause sparks and/or fires when used during cooking.
8. Use *recommended & commercially packaged* popcorn. Microwave popped corn produces a lower yield than conventional popping, there will be a number of unpopped kernels. Do not use oil unless specified by the manufacturer.
9. Do not pop popcorn longer than the manufacturer's directions *(popping time* is generally below 3 minutes). Longer cooking does not yield more popped corn, it can cause scorchings and fire. Also, the cooking tray can become too hot to handle or may break.

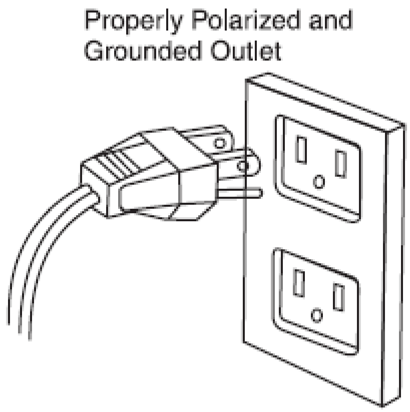


Fig. 19 Properly polarised and grounded outlet

11. Do not cook any food surrounded by a membranes such as egg yolks, potatoes, chicken livers, etc., *without piercing them.*
12. Should the microwave oven emit smoke indicating a fire, *keep the oven door shut*, switch the appliance off and disconnect the mains cord from the outlet.
13. When flammable food containers are used in the oven (e.g. packet popcorn) be sure to *check the cooking process frequently* to check for fire.
14. Always *stir and/or shake* the containers of baby foods prior to testing their temperature and serving the contents.
15. Always *test the temperature* of food or drink which has been heated in a microwave oven before serving, especially to children or elderly people. This is important because things which have been heated in a microwave oven keep on getting hotter even though the microwave oven cooking has stopped.

<u>Digital Camera and Camcorder:</u>

- A digital camera or digicam is a camera that captures photographs in digital memory. Most cameras produced today are digital, and while there are still dedicated digital cameras, many more are now incorporated into devices ranging from mobile devices to vehicles. However, high-end, high-definition dedicated cameras are still commonly used by professionals.
- Digital and movie cameras share an optical system, typically using a lens with a variable diaphragm to focus light onto an image pickup device. The diaphragm and

shutter admit the correct amount of light to the imager, just as with film but the image pickup device is electronic rather than chemical. However, unlike film cameras, digital cameras can display images on a screen immediately after being recorded, and store and delete images from memory. Many digital cameras can also record moving videos with sound. Some digital cameras can crop and stitch pictures and perform other elementary image editing.

- The two major types of digital image sensor are **CCD and CMOS**. A CCD sensor has one amplifier for all the pixels, while each pixel in a CMOS active-pixel sensor has its own amplifier.Compared to CCDs, CMOS sensors use less power. Cameras with a small sensor use a backside-illuminated CMOS (BSI-CMOS) sensor. Overall final image quality is more dependent on the image processing capability of the camera, than on sensor type.

Sensor resolution:

- The resolution of a digital camera is often limited by the image sensor that turns light into discrete signals. The brighter the image at a given point on the sensor, the larger the value that is read for that pixel. Depending on the physical structure of the sensor, a color filter array may be used, which requires demosaicing to recreate a full-color image. The number of pixels in the sensor determines the camera's "pixel count". In a typical sensor, the pixel count is the product of the number of rows and the number of columns. For example, a 1,000 by 1,000 pixel sensor would have 1,000,000 pixels, or 1 megapixel.

Image sharpness:

- Final quality of an image depends on all optical transformations in the chain of producing the image. Carl Zeiss points out that the weakest link in an optical chain determines the final image quality. In case of a digital camera, a simplistic way of expressing it is that the lens determines the maximum sharpness of the image while the image sensor determines the maximum resolution. The illustration on the right can be said to compare a lens with very poor sharpness on a camera with high resolution, to a lens with good sharpness on a camera with lower resolution.

Methods of image capture:

- Since the first digital backs were introduced, there have been three main methods of capturing the image, each based on the hardware configuration of the sensor and color filters.
- ***Single-shot*** capture systems use either one sensor chip with a Bayer filter mosaic, or three separate image sensors (one each for the primary additive colors red, green, and blue) which are exposed to the same image via a beam splitter (see Three-CCD camera).
- ***Multi-shot*** exposes the sensor to the image in a sequence of three or more openings of the lens aperture. There are several methods of application of the multi-shot technique. The most common originally was to use a single image sensor with three filters passed in front of the sensor in sequence to obtain the additive color information. Another multiple shot method is called Microscanning. This method uses a single sensor chip with a Bayer filter and physically moved the sensor on the focus plane of the lens to construct a higher resolution image than the native resolution of the chip. A third version combined the two methods without a Bayer filter on the chip.

- The third method is called *scanning* because the sensor moves across the focal plane much like the sensor of an image scanner. The *linear* or *tri-linear* sensors in scanning cameras utilize only a single line of photosensors, or three lines for the three colors. Scanning may be accomplished by moving the sensor (for example, when using color co-site sampling) or by rotating the whole camera. A digital rotating line camera offers images of very high total resolution.
- The choice of method for a given capture is determined largely by the subject matter. It is usually inappropriate to attempt to capture a subject that moves with anything but a single-shot system. However, the higher color fidelity and larger file sizes and resolutions available with multi-shot and scanning backs make them attractive for commercial photographers working with stationary subjects and large-format photographs.
- Improvements in single-shot cameras and image file processing at the beginning of the 21st century made single shot cameras almost completely dominant, even in high-end commercial photography.

Block Diagram:

A digital image is the result of three main steps, the optical image formation through the lenses system, the conversion of the light into electrical signal and some image processing operations, including: demosaicing, white balancing, noise removing, gamma curve adjustment, etc.

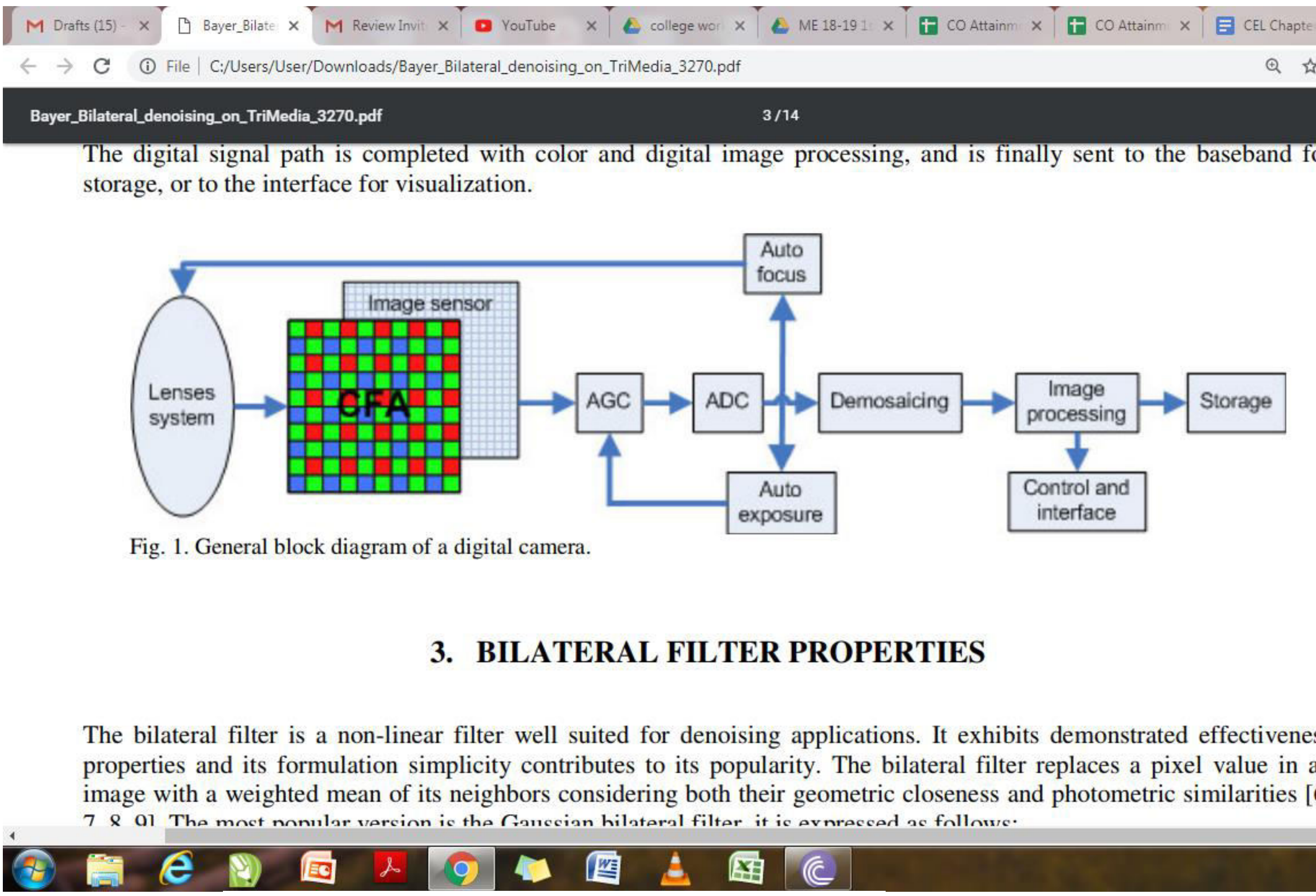


Fig. 20. General block diagram of a digital camera.

Figure 20 shows a block diagram of a common imaging system. Such a system includes the optical lenses, the color filter array (CFA) and the image sensor (CCD, CMOS). It also includes the main control systems, as automatic gain control (AGC), analog to digital converter (ADC), auto focus and auto exposure circuitry. The digital signal path is completed with color and digital image processing, and is finally sent to the baseband for storage, or to the interface for visualization.

Camcorders:

When video recording was invented, photographic film was replaced by magnetic videotape, which was simpler, cheaper, and needed no photographic developing before you could view the things you'd recorded. Modern electronic camcorders use digital video. Instead of recording photographic images, they use a light sensitive microchip called a charge-coupled device (CCD) to convert what the lens sees into digital (numerical) format. In other words, each frame is not stored as a photograph, but as a long string of numbers. So a movie recorded with a digital camcorder is a series of frames, each stored in the form of numbers. In some camcorders, the digital information is recorded onto videotape; in others, you record onto a DVD; and in still others, you record onto a hard drive or flash memory. The advantage of storing movies in digital format is that you can edit them on your computer, upload them onto websites, and view them on all kinds of different devices (from cell phones and MP3 players to computers and televisions).

A typical analog camcorder contains two basic parts:

- A camera section, consisting of a CCD, lens and motors to handle the zoom, focus and aperture
- A VCR section, in which a typical TV VCR is shrunk down to fit in a much smaller space.
- The camera component's function is to receive visual information and interpret it as an electronic video signal. The VCR component is exactly like the VCR connected to your television: It receives an electronic video signal and records it on video tape as magnetic patterns

Working of Camcorder:

- Like a film camera, a camcorder "sees" the world through lenses. In a film camera, the lenses serve to focus the light from a scene onto film treated with chemicals that have a controlled reaction to light. In this way, camera film records the scene in front of it: It picks up greater amounts of light from brighter parts of the scene, and lower amounts of light from darker parts of the scene. The lens in a camcorder also serves to focus light, but instead of focusing it onto film, it shines the light onto a small semiconductor image sensor. This sensor, a charge-coupled device (CCD), measures light with a half-inch (about 1 cm) panel of 300,000 to 500,000 tiny light-sensitive diodes called photosites.
- Each photosite measures the amount of light (photons) that hits a particular point, and translates this information into electrons (electrical charges): A brighter image is represented by a higher electrical charge, and a darker image is represented by a lower electrical charge. Just as an artist sketches a scene by contrasting dark areas with light areas, a CCD creates a video picture by recording light intensity. During playback, this information directs the intensity of a television's electron beam as it passes over the screen.

- Of course, measuring light intensity only gives us a black-and-white image. To create a color image, a camcorder has to detect not only the total light levels, but also the levels of each color of light. Since you can produce the full spectrum of colors by combining the three colors red, green and blue, a camcorder actually only needs to measure the levels of these three colors to be able to reproduce a full-color picture.

Block diagram:

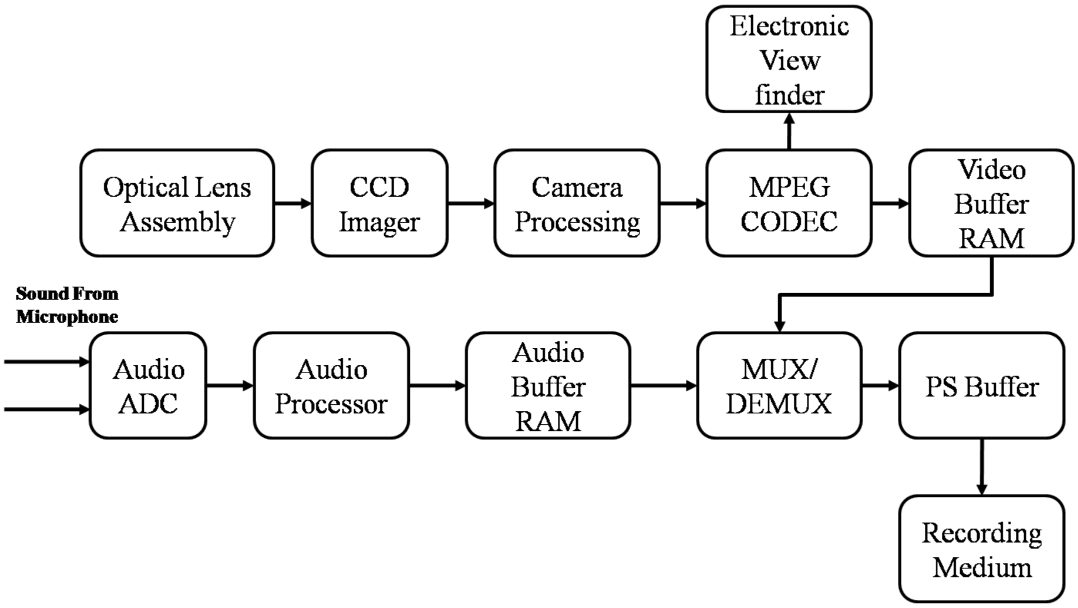


Fig 21: Block diagram of Camcorder

Figure 22.21 shows the functional block diagram of a digital camcorder system. Light from the optical lens assembly projects an image onto the *charged coupled device* (*CCD*) imager. The CCD is a photosensitive array which is charged by the light falling on it. The charge is then converted into a continuous analogue voltage when the CCD charged elements are scanned line by line. After the scan is completed, the CCD elements are reset to start the exposure process for the next video frame. Embedded within the CCD is an analogue-to-digital converter to produce a digital output for further processing by the camera processing block ready for data compression by the MPEG codec. The camera processing chip carries out such functions as '*steady shot*', zoom and focus motor control and digital picture effects. The MPEG-coded data are fed into a video buffer. Digitised Y/C data are also fed into the *electronic viewfinder* (*EVF*) for monitoring by the user. Stereo sound from audio microphones are A/D converted and the PCM audio data placed into an audio buffer. The MUX/DEMUX receives the compressed video and PCM audio streams from the corresponding buffers, packetises and multiplexes them into a standard MPEG-2 program stream (PS) to be stored in a PS buffer. Data in the PS buffer are then used to write on the recording medium which could be a DVD disc, an HDD or a magnetic tape. In the playback mode, the process is reversed and this is the reason for using an MPEG codec chip instead of just a coder and MUX/DEMUX instead of just a MUX. In the playback mode, data from the recording medium are demultiplexed and decompressed and fed into the EVF for display.

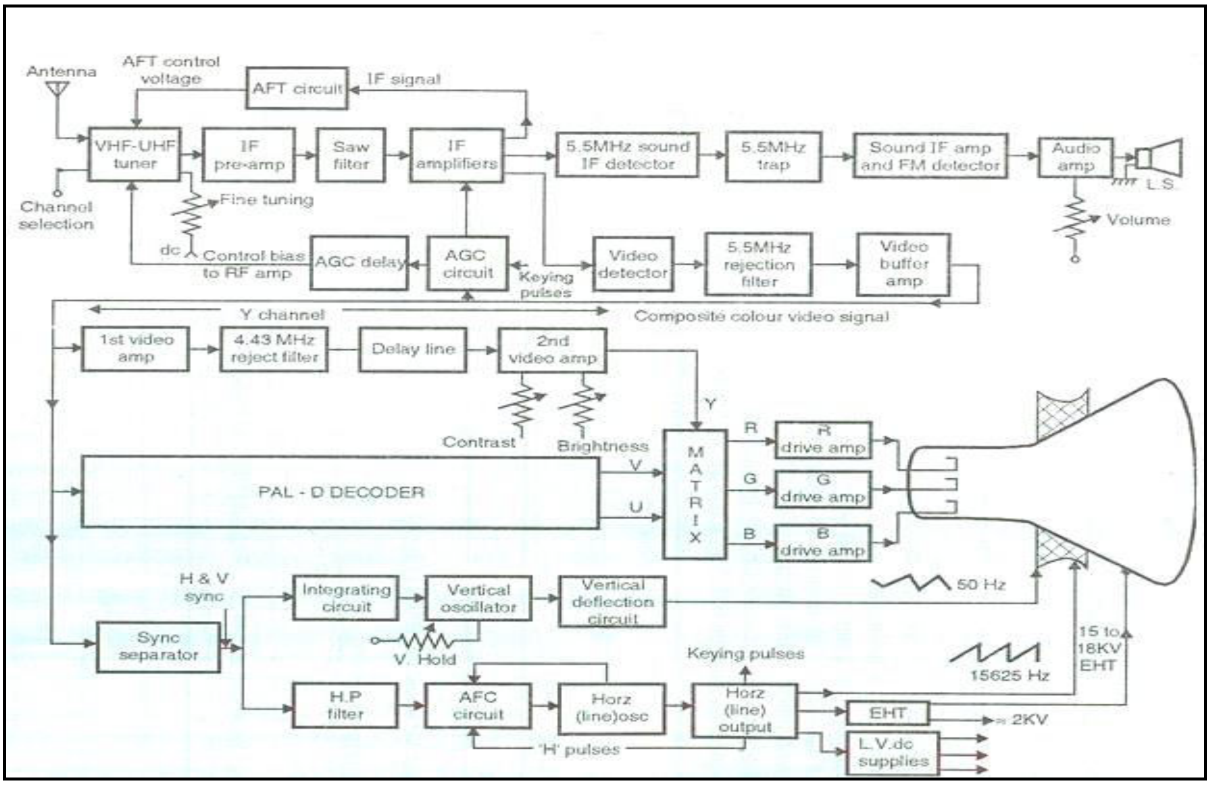


Figure: PAL D RECEIVER

- However there are some minor differences in design and details. For example the RF response in case of colour TV is kept more uniform than in monochrome receiver; this is to avoid any attenuation of the colour sub-carrier.
- The tuning of a colour TV is critical. To avoid any mistuning of the receiver, an arrangement called AFT (Automatic Fine Tuning) is used in most cases. This arrangement is similar to the AFC and can be switched off whenever manual tuning is required. The colour TV uses the inter carrier sound system with one difference.
- The sound take-off point is at the last VIF stage immediately before the video detector. This is done to avoid interference between the sound IF and the Chroma signal. A separate diode detector is used to produce the sound IF but the rest of the audio circuits are the same as in a monochrome receiver.
- The two main circuits which **distinguish a colour TV from a monochrome TV** are the colour **picture tube and the Chroma section** containing the colour circuits.

Block diagram and operation of PAL-D decoder:

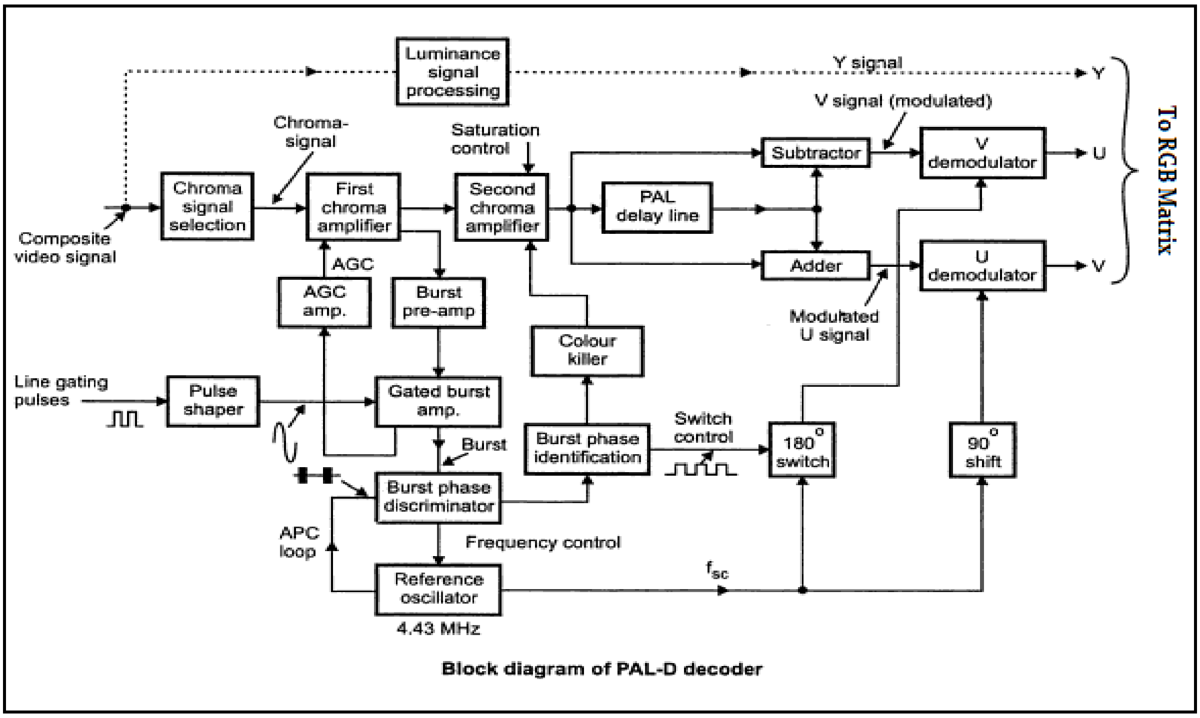


Figure: Block Diagram of PAL D decoder

Chroma signal selection:

Its function is to select Chroma and colour burst signal from the incoming CCVS signal. It essentially consist of band pass circuit whose center frequency is chosen to be equal to that of Chroma sub-carrier itself i.e.4.43MHz.

1st Chroma amplifier:

The Chroma and burst signals are amplified by first Chroma amplifier which is controlled by DC voltage developed by the Automatic Chroma Control (ACC) amplifier.

2nd Chroma amplifier:

The second Chroma amplifier incorporates colour saturation control circuit. The output of colour killer also feeds into it.

PAL delay line (separation of U and V colour phasors):

This network separated U and V signals with are then fed to respective demodulator.

Gated burst amplifier:

The gated burst amplifier separates the burst pulses and amplifies them a level suitable to operate the burst phase discriminator.

Automatic Chroma Control (ACC):

The magnitude of the voltage so fed back is proportional to the magnitude of the burst and therefore to the amplitude of Chroma signal itself. This voltage is used to control the first stage of Chroma amplifier in such way to ensure constant Chroma signal amplitude.

Burst phase discriminator:

It is sensitive to burst pulses and is designed to detect any differences which might exist between the phase of burst pulse and that of the reference oscillator. It produces at its output a dc voltage whose magnitude and polarity are proportional to the magnitude and direction of the detected phase difference.

Burst phase identifier:

This circuit is able to identify the phase relationship of the colour burst.

180^o switch:

This switch is used to periodically invert the waveform fed to the v-signal demodulator.

Colour killer control:

This is just a half wave rectifier which produces a steady dc potential from the succession of burst pulses. During black and white transmission the dc potential is absent and hence biases the 2nd Chroma amplifier to cut off state.

HDTV

- MUSE stands for Multiple Sub-Nyquist Sampling Encoding and is an HDTV bandwidth compression scheme developed by NHK.
- It uses fundamental concepts for performance exchange in the spatio – temporal (transitory transformation) domain along with motion compensation to reduce the transmission bandwidth down to near about 10 MHz.
- The processed HDTV signal can be then transmitted using a single BDS channel. Temporal Interpolation In MUSE the luminance and colour information are sent by time multiplexed components (TMC) The colour information is sent sequentially with a time compression of four.
- The TMC signal is bandwidth reduced means of 3 – dimensional offset subsampling pattern over a four – field sequence.The stationary areas of the picture are reconstructed by temporal interpolation of samples from four fields.
- ***Spatial Interpolation***
- For a moving picture area the final picture is reconstructed by spatial interpolation using samples from a single field. Hence moving portions of the picture are reproduced with one- quarter the spatial resolution of the stationary areas. The spatial frequency response for both stationary and moving areas of the picture is shown in figure below. The lack of resolution during movements of the entire scene as in case of camera panning, zooming or tilting is prevented

by introducing spatial motion compression technique. A vector representing the motion of the scene is calculated for each field at the encoder. This signal is multiplexed in the vertical blanking interval and transmitted to the receiver.

- In decoder, the read – out addresses of picture elements (pixels) from previous fields are shifted according to the information provided by the motion vector so that the data can be processed in still – picture mode.
- These two modes of interpolation, the inter – frame processing for stationary pictures and infra field averaging for moving portions of the picture are switched by detecting the moving areas at the decoder.
- Audio transmission is done by 4 – phase DPSK which is multiplexed with the processed video signal in the vertical blanking interval after frequency modulation of the transmission carrier by the video signal.

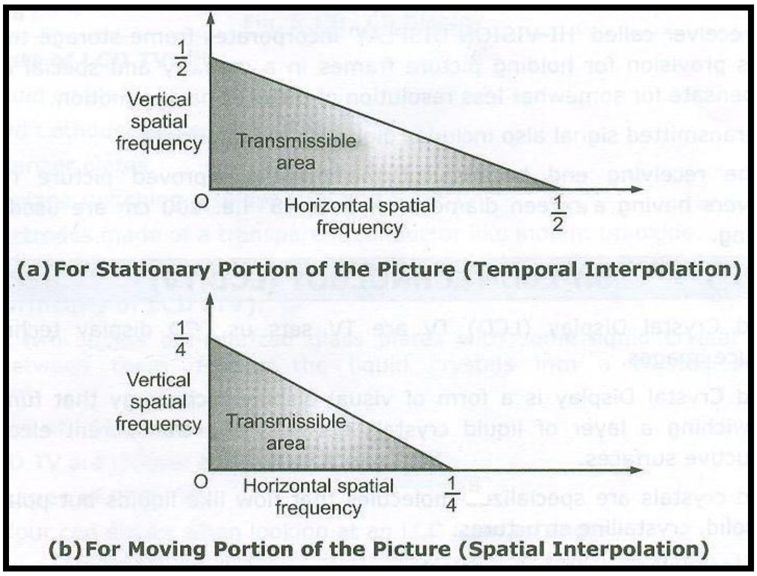


Figure: Interpolation

<u>LCD/LED Technology:</u>

*<u>LCD (**L**iquid **C**rystal **D**isplay) TECHNOLOGY:</u>*

- LCD technology is quite different to that found in other TV types such as the original CRT (Tube television) and in Plasma TVs. A liquid crystal layer is stimulated by an electrical current, causing individual pixels to either shut out light, or let it pass through.
- In this way each pixel can be either light or dark, and the use of colour filters gives the necessary red, green and blue light with which to create an image of many millions of colours.
- *The main principle behind liquid crystal molecules is that when an electric current is applied to them, they tend to untwist. This causes a change in the light angle passing through them. This causes a change in the angle of the top polarizing filter with respect to it. So little light is allowed to pass through that particular area of LCD. Thus that area becomes darker comparing to others.*

- Because the light source is a bulb at the back of the screen, rather than light-emitting phosphors at the front of the screen, this technology is referred to as ‘transmissive’.

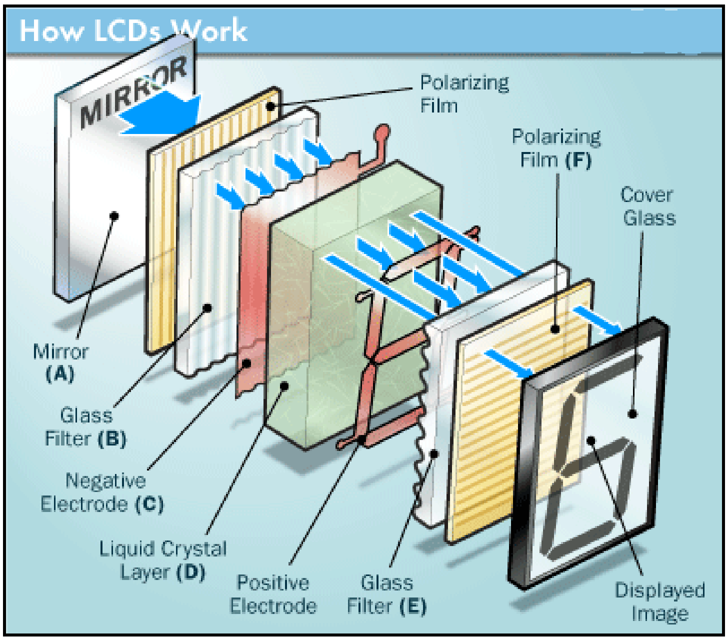
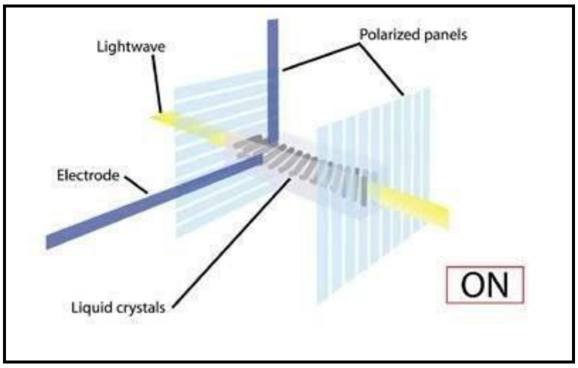


Figure: Construction of LCD

- Liquid crystals exhibit some of the qualities of both a solid and a gas. There is uniformity to the structure, but it can be influenced by an electrical current.
- Let’s look at a very basic LCD structure. Two layers of polarized glass encase a layer of liquid crystal. The rear panel of glass is vertically polarized, while the front panel is horizontally polarized. If in light was simply shined through from behind, none would emerge from the front.
- Microscopic grooves are cut into each sheet of glass – vertical grooves for the vertically polarized glass, horizontal grooves for the horizontally polarized glass.
- The liquid crystal between the layers of glass then conforms to these grooves, creating a 90-degree twist. Activate the light source now and the liquid crystal will turn the light through 90 degrees so that it emerges from the front.

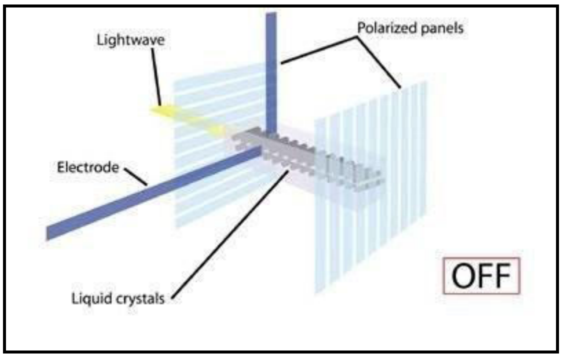
<u>LCD Screen On</u>

- If an electrical current is applied to the liquid crystal, it will untwist, effectively blocking out the light. Different strengths of current result in more or less of the light being blocked, so different shades of light become possible.



LCD Screen Off

- If this principle is multiplied many times you get a basic LCD screen. Early applications used a 'passive matrix' display, where a grid of conductors lies alongside the LCD pixels.
- This allows individual pixels to be switched on and off, but also introduced blurring to the image because some electrical current would find its way into neighboring pixels.



- The development of 'active matrix' LCDs, using thin film transistors (TFTs) was critical in bringing LCD displays up to the necessary specification for TV usage.
- TFTs are best viewed as very small switching transistors and capacitors. The transistors act as switches, enabling the activation of pixels with no effect on neighboring pixels in an LCD screen.
- The capacitors are able to store the charge, maintaining voltage for one frame scan. With each pixel having its own dedicated transistor and capacitor it is possible to target individual pixels with complete accuracy.

LCD Structure:

- LCD Structure Control over the strength of the current applied also brings a workable greyscale into the equation. A weaker current cause the liquid crystals to unbend to a lesser degree, blocking out only part of the light source – in this way it is possible to achieve 256 shades.
- The addition of a colour filter layer, and the division of each LCD pixel into three sub-pixels (red, green and blue) means that 256 x 256 x 256 combination are possible, giving the familiar colour palette of 16.7 million colours.

LED TV TECHNOLOGY:

- LED, which stands for "light emitting diodes," differs from general LCD TVs in that LCDs use fluorescent lights while LEDs use those light emitting diodes.
- An LED TV illuminates its LCD panel with light-emitting diodes. LEDs consist of small semiconductors, which glow during exposure to electric current. Specifically, this current flow between LED anodes, which are positively charged electrodes, and LED cathodes, which are negatively charged electrodes.
- In contrast, a traditional LCD TV utilizes fluorescent lamps for backlighting. These lamps function by using mercury vapor to create ultraviolet rays, which in turn cause the phosphor coating of the lamps to glow.
- LEDs have several advantages over fluorescent lamps, including requiring less energy and being able to produce brighter on-screen colors.

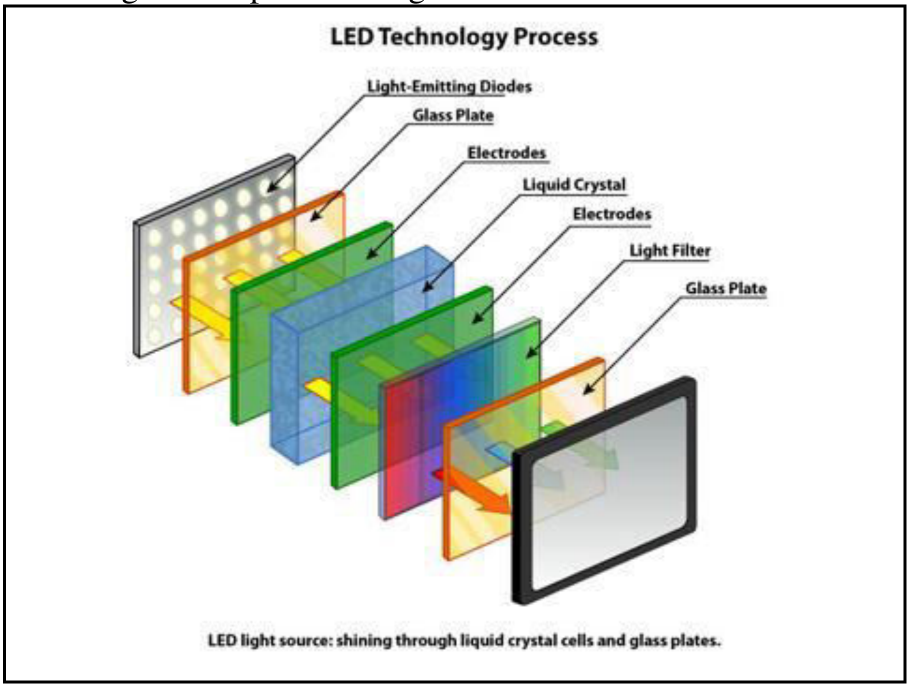


Figure: LED Construction

Full-Array vs Edge-Lit

- There are two primary forms of LED lighting technology that LED TVs can utilize: full-array LED backlighting and edge-lit LED backlighting. Also known as local-dimming technology, full-array technology employs arrays or banks of LEDs that cover the entire back surfaces of LED TV screens.
- In contrast, edge-lit technology employs LEDs only around the edges of LED TV screens. Unlike an edge-lit LED TV, an LED TV with full-array technology can selectively dim specific groups of LEDs, allowing for superior contrast ratio and superior overall picture quality.

Energy Consumption:

- As with any TV, an LED TV needs energy in order for its components to function. Specifically, an LED TV needs electric current for stimulating the liquid crystals in its LCD panel and for activating its LED backlighting.
- In comparison to standard LCD TVs, LED TVs consume less energy, qualifying many of them for the EPA's Energy Star energy-efficiency standard. As the online TV resource LED TV notes, an LED TV will typically consume between 20 and 30 percent less energy than an LCD TV with the same screen size.

What's the difference between LCD and LED?

- LCD stands for "liquid crystal display" and technically, both LED and LCD TVs are liquid crystal displays. The basic technology is the same in that both television types have two layers of polarized glass through which the liquid crystals both block and pass light. So really, LED TVs are a subset of LCD TVs.
- LED, which stands for "light emitting diodes," differs from general LCD TVs in that LCDs use fluorescent lights while LEDs use those light emitting diodes. Also, the placement of the lights on an LED TV can differ.
- The fluorescent lights in an LCD TV are always behind the screen. On an LED TV, the light emitting diodes can be placed either behind the screen or around its edges.
- The difference in lights and in lighting placement has generally meant that LED TVs can be thinner than LCDs, although this is starting to change. It has also meant that LED TVs run with greater energy efficiency and can provide a clearer, better picture than the general LCD TVs.
- LED TVs provide a better picture for two basic reasons. First, LED TVs work with a color wheel or distinct RGB-colored lights (red, green, blue) to produce more realistic and sharper colors. Second, light emitting diodes can be dimmed. The dimming capability on the back lighting in an LED TV allows the picture to display with a truer black by darkening the lights and blocking more light from passing through the panel. This capability is not present on edge-lit LED TVs; however, edge-lit LED TVs can display a truer white than the fluorescent LED TVs.
- Because all these LCD TVs are thin-screen, each has particular angle-viewing and anti-glare issues. The backlit TVs provide better, cleaner angle viewing than the edge-lit LED TV. However, the backlit LED TV will usually have better angle viewing than the standard LCD TV.
- Both LED and LCD TVs have good reputations for their playback and gaming quality.

DTH Technology:

Overview:

- Direct to home technology refers to the satellite television broadcasting process which is actually intended for home reception. This technology is originally referred to as direct broadcast satellite (DBS) technology.
- The technology was developed for competing with the local cable TV distribution services by providing higher quality satellite signals with more number of channels.
- In short, DTH refers to the reception of satellite signals on a TV with a personal dish in an individual home. The satellites that are used for this purpose is geostationary satellites. The satellites compress the signals digitally, encrypt them and then are beamed from high powered geostationary satellites. They are received by dishes that are given to the DTH consumers by DTH providers.
- Though DBS and DTH present the same services to the consumers, there are some differences in the technical specifications.
- While DBS is used for transmitting signals from satellites at a particular frequency band [the band differs in each country], DTH is used for transmitting signals over a wide range of frequencies [normal frequencies including the KU and KA band].

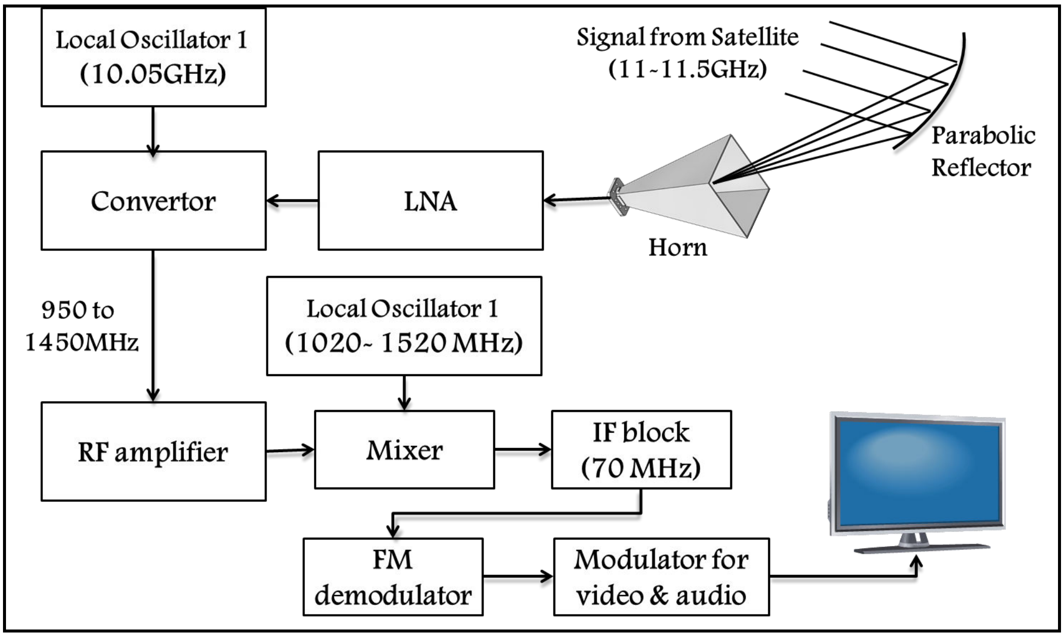


Figure: Block diagram of DTH system

Outdoor unit:

- It consists of a receiving antenna, low noise amplifier & converter the receiving antenna is parabolic reflector with a horn as the active element. The horn can be directly in front of reflector, or it may use an offset feed as shown in fig. The reflector diameter may be 0.6m for 11GHz & still smaller for K & Ka bands.
- The low noise block consists of a low noise wide band amplifier followed by a convertor. The output of convertor consists of a signal of UHF frequency ranging from 950-1450MHz.

- The advantage of using UHF frequency is that a low cost coaxial cable can be used as feeder from the outdoor unit to the indoor unit.
- LNB cannot be kept indoor because long cable between horn & the first amplifier will cause substantial degradation of the overall noise figure of the set.

Indoor unit:

- The wideband signal from the LNB is fed to an RF amplifier. The amplified signal is fed to a channel selector circuit which selects the wanted band.
- The selected channel is down converted to a fixed IF of 70MHz by local oscillator & mixer. IF amplifier amplifies the signal which then goes to FM detector.
- The detector recovers original baseband signal, consisting of CVS & audio signal. These modulated signals are fed to the normal domestic TV receiver, which after due processing reproduces picture & sound.

Advantages of DTH Technology

- The main advantage is that this technology is equally beneficial to everyone. As the process is wireless, this system can be used in all remote or urban areas.
- High quality audio and video which are cost effective due to absence of mediators.
- Almost 4000 channels can be viewed along with 2000 radio channels. Thus the world's entire information including news and entertainment is available to you at home.
- As there are no mediators, a complaint can be directly expressed to the provider.
- With a single DTH service you will be able to use digital quality audio, video and also high speed broadband.

Signal Processing in cable TV:

The signal processing unit, also called 'Head-End Equipment' consists of power dividers, satellite receivers, channel modulators, signal processors/amplifiers, VCRs, C.D. players and a combining network. Fig. shows necessary details of processing different types of input signals which are briefly described.

LNBC Output: The 500 MHz wide IF signal (950 MHz to 1450 MHz) is actually a multiplexed output of 12 separate transponder channels each having an effective bandwidth of 36 MHz (actual 40 MHz). In communication satellites, most of these channels carry television signals of different TV stations.

Power Divider: The IF signal from the LNBC is delivered to a signal splitter which is actually a multicoupler that divides the signal into independent paths. The signal splitter is commonly called a ‘Power Divider’ because it enables equal division of signal power at its output ports.

<u>Compare NTSC, PAL, SECAM System</u>

Sr. No.	Parameter	PAL	NTSC	SECAM
1.	Full form of system	Phase Alternation of Line	National Television System Committee	Sequential Colour A Memory
2.	Inventing country.	Germany in 1967	USA in 1957	France in 1970
3	Countries where used.	Germany, India, UK	USA, Canada, Japan, Mexico.	France, East Europe, Africa.
4	Transmission of colour.	By colour difference signals.	By colour difference signals.	By colour difference signals.
5	Video bandwidth.	5 MHz	4 MHz	6 MHz
6	Noise	High	High	Very high.
7	Identification signal	Needed	Not needed	Needed
8	Cost	Costliest	Less than PAL but higher than SECAM	Cheapest

What is an OLED?

OLED’s are simple solid-state devices (more of an LED) comprised of very thin films of organic compounds in the electroluminescent layer. These organic compounds have a special property of creating light when electricity is applied to it. The organic compounds are designed to be in between two electrodes. Out of these one of the electrodes should be transparent. The result is a very bright and crispy display with power consumption lesser than the usual LCD and LED.

OLED – Comparison with LCD and LED

Like a LCD, the OLED does not require a backlight for its normal working. This makes them more advantageous in saving space and also weight. It also helps them in displaying deeper black levels than LCD’s. OLED is also capable of making a high contrast ratio when it is displayed in a dark room than LCD as well as LED.

Introduction of OLED

The discovery of the electroluminescence property in organic materials in 1950s is considered to be the stepping stone of OLED.

Later in 1960, a scientist called Martin Pope discovered an ohmic, dark injecting electrode contact to organic nature of crystals. With this he was also able to explain the work functions for both the holes and electrons while injecting electrode contacts. These dark injecting holes and electrons formed to be the base for an OLED device. The technique was further experimented with DC electroluminescence under different conditions. Later it was found that electroluminescent materials can also act as doped insulators. Thus came the discovery of a double injection induced OLED device.

OLED's, as can be seen here are simple solid-state devices (more of an LED) comprised of very thin films of organic compounds in the electroluminescent layer.The first proper OLED was manufactured in 1980 by Dr. Ching W Tang and Steven Van Slyke. The OLED had a double layer structure. When the holes and electrons were transported separately and when combined together produced a light in the organic layer centre. This light was produced at a very low operating voltage with high efficiency. Now more research is being done with the application of OLED on polymer so as to obtain a higher efficiency OLED.

Components in an OLED

The components in an OLED differ according to the number of layers of the organic material. There is a basic single layer OLED, two layer and also three layer OLED. As the number of layers increase the efficiency of the device also increases. The increase in layers also helps in injecting charges at the electrodes and thus helps in blocking a charge from being dumped after reaching the opposite electrode. Any type of OLED consists of the following components.

1. An emissive layer
2. A conducting layer
3. A substrate
4. Anode and cathode terminals.

As the emissive layer and the conducting layer is made up of organic molecules (both being different), OLED is considered to be an organic semiconductor, and hence its name. The organic molecules have the property of conducting electricity and their conducting levels can be varied form that of an insulator to a conductor.

The emissive layer used in an OLED is made up of organic plastic molecules, out of which the most commonly used is polyfluorene.

The conducting layer is also an organic molecule, and the commonly used component is polyaniline.

The substrate most commonly used may be a plastic, foil or even glass.

The anode component should be transparent. Usually indium tin oxide is used. This material is transparent to visible light. It also has a great work function which helps in injecting holes into the different layers.

The cathode component depends on the type of OLED required. Even a transparent cathode can be used. Usually metals like calcium and aluminium used because they have lesser work functions than anodes which helps in injecting electrons into the different layers.

Working of an OLED

Before going on to the detailed explanation of its working, it is important to know how the emissive layers and conducting layers are added to the substrate. There are mainly three basic methods for this operation. They are:-

1. Inkjet Printing Technique –

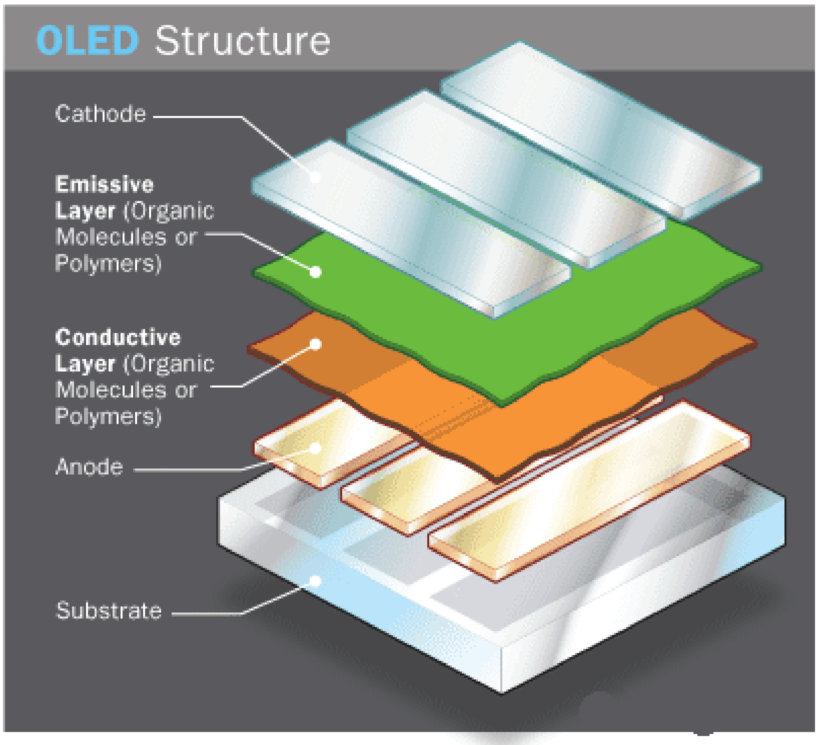
- This is the cheapest and most commonly used technique. The method is same as the paper printing mechanism where the organic layers are sprayed onto the substrates. This method is also highly efficient and they can be used for printing very large displays like billboards and also big TV screens.

2. Organic Vapour Phase Deposition (OVPD) –

- This is also an efficient technique which can be carried out at a low cost. A cooled substrate is being hit by the organic molecules, which was evaporated in a low pressure, high temperature chamber. The gas is carried onto the substrate with the help of a carrier gas.

3. Vacuum Thermal Evaporation (VTE) –

- This method is also commonly known as vacuum deposition method. This operation is carried out by gently heating the organic molecules so that they evaporate and subside on the substrates. As the heating method is complicated and the strictness of parameters should be highly accurate, this method is economical as well.
- After the organic material has been applied to the substrate the real working of the OLED begins.
- The substrate is used to support the OLED. The anode is used to inject more holes when there is a path of current. The conducting layer is used to carry the holes from the anode. The cathode is used to produce electrons when current flows through its path. The emissive layer is the section where the light is produced. This layer is used to carry the electrons form the cathode.
- First, the anode is kept positive w.r.t the cathode. Thus there occurs an electron flow from the cathode to the anode. This electron flow is captured by the emissive layer causing the anode to withdraw electrons from the conductive layer. Thus, there occurs a flow of holes in the conductive layer. As the process continues, the conductive layer becomes positively charged and the emissive layer becomes negatively charged.
- A combination of the holes and electrons occur due to electrostatic forces. As the electrons are less mobile than the holes, the combination normally occurs very close to the emissive layer. This process produces light in the emissive region after there has been a drop in the energy levels of the electrons. The emissive layer got its name as the light produced in the emissive region has a frequency in the visible region. The colour of the light produced can be varied according to the type of organic molecule used for its process. To obtain colour displays, a number of organic layers are used. Another factor of the light produced is its intensity. If more current is applied to the OLED, the brighter the light appears. Take a look at the diagram given below.



OLED Diagram

- Now consider the process when the anode is negative w.r.t the cathode. This will not make the device work as there will not be any combination of the holes and electrons. The holes will move towards the anode and the electrons to the cathode.

Different types of OLED's

According to the type of manufacture and the nature of their use, OLED's are mainly classified into 8 types. They are

1. Active Matrix OLED (AMOLED)

This type of OLED is suitable for high resolution and large size display. Though the manufacturing process is the same, the anode layers have a Thin-film transistor (TFT) plane in parallel to it so as to form a matrix. This helps in switching each pixel to it's on or off state as desired, thus forming an image. This is the least power consuming type among others and also has quicker refresh rates which makes them suitable for video as well.

2. Passive Matrix OLED (PMOLED)

The design of this type of OLED makes them more suitable for small screen devices like cell phones, MP3 players and so on. Though this type is less power consuming than an LCD and LED (even if connected to other external circuitry's), it is the most power consuming comparative to other OLED's. This type is very easy to make as strips of anode and cathode are kept perpendicular to each other. When they are both intersected light is produced. As there are strips of anode and cathode, current is applied to the selected strips and is applied to them. This helps in determining the on or off pixels.

3. Inverted OLED

This type uses a bottom cathode, which is connected to the drain end of an n-channel TFT backplane. This method is usually used for producing low cost OLED with little applications.

4. Foldable OLED

This type is mainly used in devices which have more chance of breaking. As this material is strong it reduces breakage and therefore is used in cell phones, computer chips, GPS devices and PDA's. They are also flexible, durable and lightweight. As its name explains, these

OLED’s are foldable and can also be connected to clothes. They use different types of substrates like flexible metallic foils, plastics and so on.

5. Top Emitting OLED

This type of OLED is integrated with a transistor backplane that is not transparent. Such devices are suitable for matrix applications like smart cards. The substrate used for this device is of the opaque/reflective type. As a transparent substrate is used the electrode used is either semi-transparent or fully transparent. Otherwise the light will not pass through the transparent substrate.

6. Transparent OLED

This device has a good contrast even in bright sunlight so it is applicable in head-up displays, mobile phones, smart windows and so on. In this device, the entire anode, cathode and the substrate are transparent. When they are in the off position, they become almost completely transparent as their substrate. This type of OLED can be included in both the active and passive matrix categories. As they have transparent parameters on both the sides, they can create displays that are top as well as bottom emitting.

7. White OLED

This device creates the brightest light of all. They are manufactured in large sheets. Thus they can easily replace fluorescent lamps. They are also cost-effective and also consumes less power.

8. Stacked OLED

This device uses the composite colours as sub pixels and also on top of each other. This causes the reduction in pixel gap and also an increase in colour depth. Thus they are being introduced as television displays.

Advantages of OLED’s

- The manufacture of OLEDD is highly economical and is more efficient than LCD and flat panel screens.
- It will be a great surprise to see displays on our clothing and fabrics. This technology will help in carrying huge displays in our hands.
- There is much difference in watching a high-definition TV to a OLED display. As the contrast ratio of OLED is very high (even in dark conditions), it can be watched from an angle of about 90 degrees without any difficulty.
- No backlight is produced by this device and the power consumption is also very less.
- OLED has a refresh rate of 100,000 Hz which is almost 9900 HZ greater than an LCD display.
- The response time is less than 0.01 ms. LCD needs a response time of 1 ms.

Disadvantages of OLED

- The power consumption of this device depends upon the colour that is displayed on the screen. Less than 50% power is only consumed when a black image is displayed, compared to an LCD. But the percentage increases to almost three times when a bright image such as a white colour is displayed. Thus, this device is disadvantageous for mobile applications.
- The OLED technology is only rising and due to this, the commercial availability of OLED products are very less. Though they can be easily made the fabrication process is considered expensive and thus the initial amount is expensive.
- As there is no reflective light technology used in such a device it has a very poor reading effect in bright light surroundings. Even if this is to be overcome additional power should be used.
- With time, the brightness of the OLED pixels will fade.

- The images displayed in this device are created by an artificial light source. So, the whole electricity has to be used to perform such an operation. LCD’s, on the other hand use some percentage of light from sunlight and also e-ink.
- The device is not at all water resistant.
- The lifetime of this device is much lesser when compared with an LCD or LED.

Applications of OLED

- OLED’s are used as mobile phone screens, MP3 players, digital cameras, car radios, PDA’s and so on.