TROUBLESHOOTING & MAINTENANCE OF ELECTRONIC EQUIPMENTS

Student Handbook

CLASS XII

CENTRAL BOARD OF SECONDARY EDUCATION

Shiksha Kendra, 2, Community Centre, Preet Vihar, Delhi-110092

TROUBLESHOOTING & MAINTENANCE OF ELECTRONIC EQUIPMENTS

Student Handbook, Class-XII

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भारत का संविधान

उद्देशिका

हम, भारत के लोग, भारत को एक सम्पूर्ण [1]प्रभुत्व-संपन्न समाजवादी पंथनिरपेक्ष लोकतंत्रात्मक गणराज्य बनाने के लिए, तथा उसके समस्त नागरिकों को:

सामाजिक, आर्थिक और राजनैतिक न्याय,
विचार, अभिव्यक्ति, विश्वास, धर्म
और उपासना की स्वतंत्रता,
प्रतिष्ठा और अवसर की समता
प्राप्त कराने के लिए
तथा उन सब में व्यक्ति की गरिमा
[2]और राष्ट्र की एकता और अखंडता
सुनिश्चित करने वाली बंधुता बढ़ाने के लिए

दृढ़संकल्प होकर अपनी इस संविधान सभा में आज तारीख 26 नवम्बर, 1949 ई॰ को एतद्द्वारा इस संविधान को अंगीकृत, अधिनियमित और आत्मार्पित करते हैं।

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1. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977) से "प्रभुत्व-संपन्न लोकतंत्रात्मक गणराज्य" के स्थान पर प्रतिस्थापित।
2. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977) से "राष्ट्र की एकता" के स्थान पर प्रतिस्थापित।

भाग 4 क

मूल कर्त्तव्य

51 क. मूल कर्त्तव्य – भारत के प्रत्येक नागरिक का यह कर्त्तव्य होगा कि वह –

(क) संविधान का पालन करे और उसके आदर्शों, संस्थाओं, राष्ट्रध्वज और राष्ट्रगान का आदर करे;

(ख) स्वतंत्रता के लिए हमारे राष्ट्रीय आंदोलन को प्रेरित करने वाले उच्च आदर्शों को हृदय में संजोए रखे और उनका पालन करे;

(ग) भारत की प्रभुता, एकता और अखंडता की रक्षा करे और उसे अक्षुण्ण रखे;

(घ) देश की रक्षा करे और आह्वान किए जाने पर राष्ट्र की सेवा करे;

(ङ) भारत के सभी लोगों में समरसता और समान भ्रातृत्व की भावना का निर्माण करे जो धर्म, भाषा और प्रदेश या वर्ग पर आधारित सभी भेदभाव से परे हों, ऐसी प्रथाओं का त्याग करे जो स्त्रियों के सम्मान के विरुद्ध हैं;

(च) हमारी सामासिक संस्कृति की गौरवशाली परंपरा का महत्त्व समझे और उसका परिरक्षण करे;

(छ) प्राकृतिक पर्यावरण की जिसके अंतर्गत वन, झील, नदी, और वन्य जीव हैं, रक्षा करे और उसका संवर्धन करे तथा प्राणी मात्र के प्रति दयाभाव रखे;

(ज) वैज्ञानिक दृष्टिकोण, मानववाद और ज्ञानार्जन तथा सुधार की भावना का विकास करे;

(झ) सार्वजनिक संपत्ति को सुरक्षित रखे और हिंसा से दूर रहे;

(ञ) व्यक्तिगत और सामूहिक गतिविधियों के सभी क्षेत्रों में उत्कर्ष की ओर बढ़ने का सतत प्रयास करे जिससे राष्ट्र निरंतर बढ़ते हुए प्रयत्न और उपलब्धि की नई उंचाइयों को छू ले;

[1](ट) यदि माता-पिता या संरक्षक है, छह वर्ष से चौदह वर्ष तक की आयु वाले अपने, यथास्थिति, बालक या प्रतिपाल्य के लिये शिक्षा के अवसर प्रदान करे।

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1. संविधान (छयासीवां संशोधन) अधिनियम, 2002 की धारा 4 द्वारा प्रतिस्थापित।

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a [1]**SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the[2] unity and integrity of the Nation;

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

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1. Subs, by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs, by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "unity of the Nation" (w.e.f. 3.1.1977)

THE CONSTITUTION OF INDIA

Chapter IV A

FUNDAMENTAL DUTIES

ARTICLE 51A

Fundamental Duties - It shall be the duty of every citizen of India-

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;

[1](k) who is a parent or guardian to provide opportunities for education to his/her child or, as the case may be, ward between age of 6 and 14 years.

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1. Subs. by the Constitution (Eighty - Sixth Amendment) Act, 2002

Preface

As the Electronics Technology industry evolves to meet the technology demands of today's workplace, different challenges are arising and professionals are striving to meet them. Electronics has created a revolution in each and every field. CBSE has introduced Electronics Technology course in class-XI (Level-3) and XII (Level-4).

This Student Handbook titled "Troubleshooting & Maintenance of Electronics Equipments" for class-XII prepared by CBSE for the benefit of the students for easy understanding the concept of Troubleshooting and Maintenance of the various digital devices and integrated circuits, which becomes essential for successful participation in almost all professions.

A special care has been taken to align the subject with National Occupation Standards (NOS) which are competency based standards identified by the Electronics and Telecom Sector Skill Councils to train Sr. Secondary students in knowledge and skills that equip students to perform effectively with confidence.

This book is authored by competent educationists in the field of Electronic and Communication in association of CBSE with focus on helping the students to learn without any difficulty and use this book as a tool for easy learning.

I congratulate everyone who is associated in developing this book which is a very useful resource for the benefit of the students.

Chairman, CBSE

Acknowledgements

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Contents


UNIT - 1

BASIC OCCUPATIONAL SAFETY AND PRECAUTIONS

1.1 OVERVIEW

This unit deals with the precautions, safety and health issues of the working personnel in the various kinds of industries. We can get the knowledge about the basic safety measures while working for small scale, medium scale or large scale industries. Some standard guidelines are provided in this book. Electrical, mechanical, electromagnetic radiations in the form of hazards are discussed precisely and the proper safety precautions are elaborated. That will be the guiding light for human being to minimize the accidents and possible health care.


Knowledge and Skill Outcomes

The students will equipped with in depth understanding of different kind of possible accidents, health issues concerned with job profile. They are also aware about the possible precautions to avoid the accidents.

Resource Materials

1. *http://www.hse.gov.uk/toolbox/emergency.htm*
2. *http://spgs-ground.com/information/shock-hazard*
3. *http://www.surgelabamerica/learning-center/shock-hazard*
4. *http://www.reliableplant.com/read/24759/safety-tips-electrical-injuries*
5. *http://en.wikipedia.org/wiki/occupational_safety_and_health*
6. *http://www.cfesa.com/techtips/electricalsafety.htm*
7. *http://www.uksafetystore.com/blog/workplace-emergency-procedure.html*
8. *http://engineeringesolution.blogspot.com/2014/05/electrical-safety.html*
9. *http://hrm-mkt.blogspot.com/2011/05/safety-and-security.html*

Duration

Total hours: 21 Hrs

Assessment Plan

- Question and answers
- Group discussion
- Mock tests.

1.2 INTRODUCTION

Occupational health and safety is of key importance for working industry to safeguard interests of working personnel. It is of prime importance for a personnel working in hazardous environment, to make their life always secure and safe. It adapts working environment to workers for the promotion and maintenance of their physical, mental and social well being for workers in all occupations. The question of occupational health and safety is a global issue and is now taking a new turn with most countries having safety department an essential part of their work culture. This is largely due to the industrial and agricultural outgrowth and development in the developing countries and the emergence of new products and product processes from these occupational health and safety places. Many of these countries are shifting from manual labour to automated or


machine-operated in the main productive sectors, such as manufacturing, mining engineering and agriculture. Hence, it can affect the potential occupational health.

These underdeveloped and developing countries import heavy machinery and equipment to aid and speed up the work process, not only in the industrial production sector, but also to services and commerce. This has for technical advancement through a change in the structure of labour force as a whole including a rise in employment of women. As would be expected, the health problems would also differ. For example, more detailed study and the efficiency of people in the workplace and occupational psychosocial factors would be required in the services industry. This obviously raises a new challenge for occupational health and safety practice in most of the underdeveloped or developing countries because the expertise is not yet advanced there as compared to the already developed countries. The advantage of the health service in developing countries is locally on a national level. The positive effect of occupational health service locally may be observed in reducing work-related long-term health ill-effects and work-related injuries.

The advent of skilled labour and the skilled labour is globally 1^{0}s in demand in every department of industry, especially in countries where there is shortage of skilled labour. Keeping this in mind, we need to possibly think and secure lives of skilled labour in a health hazard-free working environment. The interest of workers, employers, government and public lies in making working conditions healthy, safe and hazard-free. Although, it seems simple and obvious, this idea has not yet gained meaningful universal recognition. Still one can find working personnel risking their precious life to get a task completed, which can account for work-related injuries and raise the percentage in work-related deaths. Human life needs to be safe and secure in every possible way, especially when they risk their life to lead a task to its perfect completion. This means inclusion of the idea of healthy safety measures of utmost importance in risky conditions of work. Millions of people in industrial world today work in conditions that can possibly be unsafe or would lead to work-related injuries and diseases, resulting in severe illnesses later on in their lives e.g. respiratory and cardiovascular diseases, hearing loss, musculoskeletal and reproductive disorders, mental and neurological illnesses. An increasing number of workers in industrial countries complain about psychological stress and overwork, which can lead to sleep disorders, depression, fatigue and burn-out syndromes, as well as with elevated risks of cardiovascular diseases. A good number of workers in developing countries and similar number of workers in industrial countries (with a few exceptions) could possibly be exposed to occupational health hazards. Even in advanced economies, a large proportion of work sites are not regularly inspected for occupational health and safety.

1.3 OCCUPATIONAL SAFETY AND HEALTH

Safety is defined as the protection from harm, danger, risk, accident or injury. It is very necessary in usual lives to follow the safety rules and regulation at all the works. Almost all the accidents


usually occur due to lack of safety. Therefore safety is the most important in any industrial or occupational setup.

Need of occupational health and safety:

- We have to ensure in all business about the care of workers and all the persons involved in business for good health all the time.
- It provides employees lives and health.
- Occupational safety and health rules can decrease worker injury and illness.

Occupational Health

It is concerned with the identification and control of the danger arising due to physical, chemical and other work places hazards to maintain a healthy working environment. The hazards may cause due to chemical agent, heavy metals, physical agents, electricity, dangerous machinery etc. The prime goal of existence of man power inside industry to get maximum output from their mental and physical health. Therefore the health of work force must be considered on the top of management agenda. To ensure their healthy life they must have a proper and concrete planning. Some of the factors to be considered while planning for their health issues are listed below:

- Standard working hours
- Weekly / medical / casual leave
- Hygienic canteen facility for meal
- Pure drinking water
- Rest room
- Hygienic wash room
- Ambulance facility

Occupational Hygiene

It is the discipline of anticipating, recognizing, evaluating and controlling health hazards in the working environments with the objective of protective worker health, well-being and safe guarding the community at large.

Anticipation: The identification of hazards and its associated effects on the health is called anticipation.

Recognition: It is the process to establish hazardous place or agent at the work place.

Evaluation: It is the measure of hazards which can be evaluated with the help of some tools or technique.


Control of work place hazards: It is the process to control the evaluated hazards by some techniques. The controlling can be of various types such as administrative control, use of protective safety tools, health examination etc.

Occupational Hazards

Occupational hazards are very closely related with the occupational health. It occurs commonly because of negligence in safety. If the industrial organizations follow the standard safety measures that definitely lead to decrease in such kind of danger due to various types of hazards. Occupational hazards can be can be categorized as follows:

- Related to hygiene
- Related to tools and machine
- Related to flammables/explosives
- Related to the working at height
- Related to the noise
- Related to the electricity
- Related to the fire

Occupational Disease

Occupational disease in general caused by pathetic work or working condition. Sometimes the diseases develop due to repetitive work, weight lifting, biological and chemical related work, stress and other psychological disorder. Resulting different kind of occupational diseases developed are categorized as:

- Tennis elbow
- Allergy
- Hearing loss
- Asthma
- Lungs disease
- Lead poisoning
- CO (carbon monoxide) poisoning
- Skin diseases
- Jaundice


1.4 WHO GUIDELINES

WHO (World Health Organisation) taken the occupational health and hazards issues very seriously for the welfare of human being. They have developed certain guidelines for the safety of people associated with the industry. All the small scale, medium scale and large scale industries are thereby adhere to follow the WHO guidelines to minimize the accidents. According to WHO, occupational safety and health can be stated as a multidisciplinary activity with the following:

- To protect and promote health of workers by eliminating occupational ill-effects and conditions hazardous to health and safety at work.
- To enhance physical, mental and social well-being of workers and support for the development and healthy maintenance of their working capacity, as well as professional and social development at work.
- To develop and promote sustainable work environments and work organizations. The ILO/ WHO definition of occupational health is "The promotion and maintenance of the highest degree of physical, mental, social well-being of workers in all occupation." Occupational Health is a diverse science by occupational health professionals, engineers, environmental health practitioners, chemists, toxicologists, safety professionals and some agencies working towards protecting or safeguarding the health of workers at the workplace.

The discipline covers following key features:

- The availability of occupational health and safety guidelines for workplace.
- The availability of active and functional occupational health and safety committee at workplace.
- Monitoring and minimizing factory hazards to health.
- Supervised monitoring of hygiene and sanitary facilities for health and welfare of the workers.
- Inspection of health safety of protective devices.
- Pre-employment and periodical physical health examination.
- Introduction of health safety measures and devices available.
- Reporting of occupational deaths, diseases, injuries, disabilities, hazards and their related measures at work.

The relative future challenges for occupational health:

- Occupational health problems related to new information technologies and automation.
- New chemical substances and physical exposure to them.


- Health hazards related with new biotechnology innovations.
- Transfer of hazardous technologies etc.

1.5 ELECTRICAL SAFETY ENGINEERING

Electric Shock

Electric shock may be defined as physiological reaction or injury due to electric current passing through the human body. Electric shock may happen when any part of human body comes in contact with an object through which electric current is flowing. Though, a small amount of current may not be injurious but a larger and continuous current passing through the human body may cause severe damage to vital organs and even death.

All electrical cords must have sufficient insulation to prevent direct contact. It is of foremost importance to check all cables and leads before use since corrosive chemicals or solvent Vapours may erode the insulation. Damaged cables must be repaired or removed out of service immediately.

Equipment with three-prong plugs should be used. The third prong provides a path to ground (earth) that helps prevent the buildup of voltages that may result in an electrical shock. This does not guarantee that no one will receive a shock or be injured. It will, however, substantially reduce the possibility of such accidents.

Electrical Prevention Guide

- Do not work alone with electricity. A co-worker can be of use in saving your life in an emergent situation.
- If there is fire, do not attempt to pour water. Only use a fire extinguisher made for electrical fires.
- If the floor is wet, try not to enter that area where electrical equipments used.
- Fire extinguishers for use of electrical fires will be labeled as a C, BC or ABC extinguisher.
- Avoid contact with energised electrical circuit assume that they all are alive.
- During service or repair disconnect the power source.
- Use standard tools while working on electrical devices.
- When working with electrical devices avoid wearing metal watch band, ringing etc.
- Be sure while working on live electrical circuits yours hands are dry, wear nonconductive gloves, protective shoes and clothes.
- Try to work by one hand when working on live electrical circuit and keep other hand away from all conducting materials that may cause danger.


- If by mistake an individual comes in contact with electrical circuit, do not touch them try to disconnect the power source.
- Try to avoid use of other person equipment/devices.
- While working on electrical contacts and joints shield them properly so that no one gets in contact with them.
- Avoid wearing loose clothes or tying while working on electrical devices.

Factors in Lethality of Electric Shock

- **The Quantity of Current Flowing Through The Body**

  Current (amperes) is the killing factor in electrical shock, not the voltage. The voltage only determines how much current will flow through a given body resistance. In general, the body's resistance to electrical shock is minimal.

- **The Current Path Through The Body from Entry to Exit**

  Hand-to-hand-or head-to-foot and ear-to-ear current paths are the most dangerous because they may cause severe damage to the heart, lungs and brain. This is why it is important not to wear metal jewelry, not to lean against or use both hands on electrical equipment, so as not to become part of the circuit.

- **The Period of Time The Body is in The Circuit**

  The longer the body is in the loop of circuit, the greater the damage caused. The body temperature may increase possibly damaging tissues, bones and organs.

1.6 ELECTROMAGNETIC RADIATION

The continuous electromagnetic radiations due to modern communication system, commercial power to medical x-rays and even some home appliances lead to different kind of diseases. The electromagnetic spectrum includes items of everyday use ranging from R-F hazards, laser radiation.

R-F Hazards

Radiation from antennas fed by powerful R-F transmitters can potentially injure personnel in the vicinity of radiating antennas. Transmitters and microwave ovens found on ships, aircrafts and shore stations are potential source of harmful radiation. The exposure may not be noticeable at some frequencies. Touching of metal objects with induced high R-F voltage levels can cause R-F burns. The ill-effects may vary from inflammation to painful burns.

Fig.1. Different Symbols used For R-F Hazard

There are various symbols used to indicate high radiation place/zone. Some of them are shown in Fig.1. The workers are advised while working nearby such places takes proper precautions and guidelines.

Laser Radiation

Laser stands for light amplification by stimulated emission radiation. To simply put, it is a concentrated beam of optical radiation. The advancement of technologies will give rise to increased use of laser equipment's for various purposes. Lasers can cause corneal inflammation or burn, accelerated ageing of skin and skin burn. For those involved in laser related works, it is always advisable to make sure that they follow the safety guidelines.

Fig.2 Symbol for LASER Hazard

The symbol used to indicate high radiation place/zone is shown in Fig.2. The workers are advised while working nearby such places takes proper precautions and guidelines.

1.7 PROTECTIVE EQUIPMENT

For the safety of electronics personnel, wearing the correct protective gear is always advisable. We will discuss these protective equipment's here under:

Electrical Safety Shoes

For safety, one should always wear and take care of electrical safety shoes whenever one works in the vicinity of energized equipment's. Unlike regular safety shoes, electrical safety shoes do not have any exposed metal parts. These are specially designed using non-conducting materials to provide insulation from electric shock.

Fig.3 Safety shoes


Rubber Gloves

Based on the wall thickness and maximum safe voltage rating, the rubber insulating gloves are classified in various categories. Some of the generally used gloves are shown below in Fig.4.

Fig. 4 Safety gloves

Safety Shorting Probe

Some electronic equipment use large capacitors to filter the electrical power. These capacitors must be discharged before working on the equipment. A safety authority probe will be required for this. The procedures to be minimally followed are:

- Ensure that input power has been unplugged.
- Open the equipment to discharge the capacitors. Don't touch any naked terminals without safety gloves on.

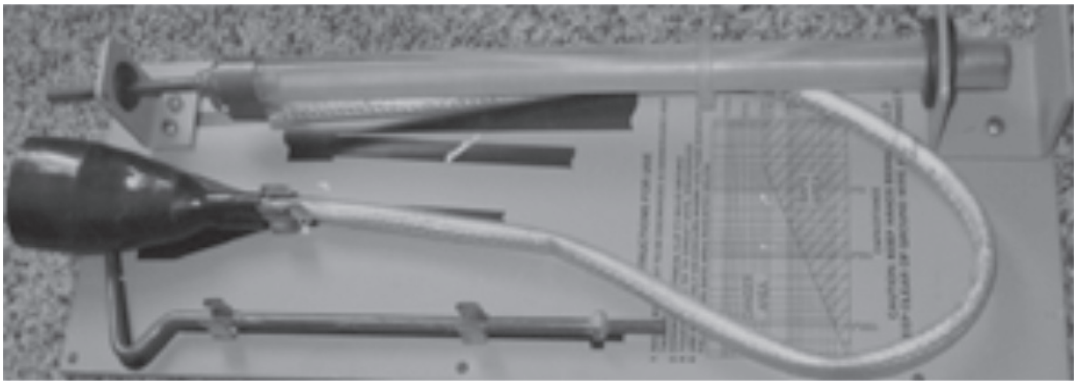


Fig.5 Safety shorting probe

Retina Protection

An electronics technician must protect his eyes for this, he needs to know:

- When to wear eye protection.
- Which eye protection to wear.
- Whenever you are doing something that could potentially damage your eyes, you must have eye protection on.

Fig.6 Safety goggles

Hearing Protection

Working around noisy equipment, may cause damage to eardrums. Generally, this damage manifests itself slowly. Working at places with high vibration field could cause slow and consistent hearing deficit leading to complete or partial deafness. This can be minimized by wearing hearing protection. The various types of hearing protective aids are shown below.

Fig.7 Hearing protection

Respiratory Protection

Whenever you work with materials that can possibly lead to respiratory issues, one must take precautions and wearing safety masks is advisable. Some of the masks used in industry are shown in Fig.8.

Fig.8 Respiratory protection aids

The work area should be well-aerated and good ventilation. Make certain to protect your airways and pulmonary anatomy vital to have good air entry to lungs. If the victim is unconscious due to blockage or obstruction to lungs, check to see if breathing and have a pulse. If the person is unconscious, initiate and follow step rules as below;

- If the victim is not breathing, begin rescue breathing.
- If it is needed, begin cardiopulmonary resuscitation.
- Do not attempt to move the victim as other injuries may have occurred that one is unaware off.


1.8 RESCUE A VICTIM OF ELECTRICAL SHOCK

- Do not risk yourself if the victim is still in contact with the electrical current, you must be careful.
- Do not touch the victim as the current can pass through you as well. Try to break the current source.
- Before you do anything else, you must get the victim free from the current. There are two ways to do this:

Fig.9 Rescue operation

i. Put off the current at the power source.

ii. If no circuit breaker is immediately available, use a non-conducting item to move the victim, such as a wooden broomstick, blanket, or rope.

1.9 STANDARD SAFETY TIPS

Occupational hazards cause more severe loss of life and injuries in the workplace each year, disrupting lives and impacting the productivity including mental well-being of working personnel. While occupational hazards are not the leading cause of on-the-job injuries, accidents and fatalities, they are disproportionately fatal and costly. These injuries are not isolated to one industry or field of work and most could be easily avoided. Awareness of these hazards is critical to avoiding and preventing accidents. Whether you are an employer, safety director or maintenance professional –safety is of prime important for anyone who works on or around any potentially hazardous equipment. The standard safety ruling recognizes electricity as a long-time serious workplace hazard. These include but are not limited to dangers such as electric shock, electrocution, fires and explosions. Whether employed at a large manufacturing plant or in a small installation, there are certain guidelines that should serve as a helpful reminder of basic electrical safety practices.

It is important to ensure an employee is pre-trained and qualified for a job. Not understanding the nature of the job can lead to minor to fatal accidents and injuries. Even well-qualified workers are vulnerable to accidents. This is why it is important to make safety and ensure it as an integral part of the planning process for every job.

Important safety tips to help avoid injuries, which may include:

- Identify the electric shock and arc flash hazards.
- Use appropriate tools for the job.


- Isolate equipment from power sources.
- Check every circuit and every conductor for power before you touch it.
- Begin working on electrical equipment only when de-energized.
- Ensure ground before working on equipment.
- Treat de-energized electrical equipments energized until lockout/tag out, test and ground procedures are met.
- Use protective equipment and use insulated tools in areas where there are possible electrical shock.

Following and adherence to these basic safety tips and tools will help avoid serious injuries while working with electrical equipment.

1.10 ELECTRICAL EMERGENCY PROCEDURES

Workplace needs to have safety plan for emergencies that can have a broader impact. Special safety measures are needed for emergencies such as serious injuries, explosion, floor, poisoning, electrocution, fire, radiation release and chemical spills.

Quick and swift effective action may help to ease the situation and reduce the consequences. However, in emergencies people are more likely to respond reliably if they:

- Well trained and competent.
- Participate in regular and mock practice.
- Clearly agreed, recorded and rehearsed plans, actions and responsibilities.

Points to include in Emergency Procedures

- Consider what could happen and how alarm should be raised. Don't forget night and shift working, weekends and times when the premises are closed.
- Plan properly how to combat emergency situation. Chalk out effective plan by clearly marking your premises. Consider drawing up a simple plan showing the location of hazardous items.
- Point out how to reach a safe place or to get rescue equipment.
- Make sure there are enough emergency exits for everyone to escape swiftly and keep escape routes unobstructed and clearly marked.
- Competent team for such disasters readily should be able to take control.
- Plan essential action such as emergency shutdown, isolation or making processes safe.


- Train staff for emergency procedures. Do not forget panic can cause great loss.
- Do not resume work after an emergency situation until danger has been cleared. If you have any doubts, ask for help from the emergency services.

1.11 SAFETY ISSUES IN THE MANUFACTURING INDUSTRIES

The manufacturing industries contain a large section of workers. So we need to look at the labour health issues in those industries. We have considered different kind of manufacturing industries such as electronic components, plastics, textiles, battery. These industries utilize large mechanical, electrical and control units. The employees working there are at the risk of industrial accidents and injuries.

Fig.10 Working with proper safety in manufacturing industry

As we know the heavy mechanical machines used in industry produces noise and continuously exposed to those noises for prolonged basis causes the hearing loss. So we need hearing protection in such kind of environment. Some types of machines can through dust, metals and other particles which can causes injury to eye. Some chemical can also cause eye itching or eye burning problem. The workers working on welding, drilling, sanding, spraying, hammering should require eye protection equipment. Safety goggles can be used to protect the worker eye from such kind of hazards.

Some of the manufacturing industries use hazardous chemicals which can cause danger to health. In such industries protective uniforms should be used to avoid danger. Personnel care should be taken by the workers. There must be a first aid box in the premises. Each and every worker should know the location of first aid box.

Fig.11 Working with chemical gas

The big mechanical machines which contain moving parts would be taken care properly. Those machines can cause the mechanical accident at the work place. There should be small machine guard to reduce the risk of accidents. The maintenance and servicing of machine of the machines are on the regular interval of time. There should be emergency line for the hazardous situation and worker should know the contact numbers. Taking these precautions we can reduce the risk of accidents.

The big industries deal in heavy machine which produces heat and fire. So it is at higher risk of fire hazard. There should be proper fire exit plan for the workers. The worker should be aware of fire extinguisher and should be train for the use of extinguisher in case of fire. The emergency call system should be there to call fire brigade in case of fire.

1.12 SAFETY CONCERN IN MANUFACTURING INDUSTRY

Poor maintenance: In the manufacturing industry the equipment and the machinery may not sometime properly maintained causes severe danger. To minimize the risk of accident these equipment must be properly inspected by an expert person on regular basis.

Untrained employee: Again because of employment of untrained personnel in the manufacturing industry may cause danger to the equipment as well as the person itself. The employee should be trained properly for all the equipment which is being used by the employee. In case of up gradation/ replacement of machines, the training should be according to the upgraded/replaced machines.

Carelessness: Most of the accident in the manufacturing industry caused due to the carelessness of the administrative staff. They are not vigilant and even not enforce safety codes resulting mild to severe accident.

1.13 PROVISIONS AND BENEFITS OF SAFETY

- There should be proper lighting arrangement inside the industry.
- Employment of human being on dangerous machinery is to be avoided. Use robots at the danger places.


- Avoid lifting heavy load by human being for the prevention of injuries. Machine lifting system should be implemented for heavy load.
- No human being should be permitted to enter in chamber tank vat, pit, pipe, fluor other confined space inside the industry, in which dangerous gases vapour and dust is expected to present in such an extent that may cause danger.
- If an employee certified sick will receive the following benefits such as
  - He will entitle to treatment in the hospital with all medical aids.
  - Women worker during pregnancy or miscarriage, she will be entitled for proper leave with medical facilities.
  - If any disabilities happen by chance then the disabled person will be provided all service facility provided by the govt. of India.
  - If employee's family members need any medical attention, they may be provided all benefits as per the rule of govt. of India.

Review Questions

1. Describe the effect of electrical current on human body.
2. Describe in detail the basic occupational safety mechanism.
3. Explain the safe work practice requirement in brief.
4. What are the guidelines provided by WHO for occupational safety and precautions?
5. Explain different kind of hazards in the industry.
6. Discuss the different protective equipment used in industry.
7. Write notes over the following:
   i) Electrical safety engineering
   ii) Electrical shock
   iii) Accident safety tips
   iv) Electrical emergency procedure
   v) RF hazards
8. Explain the procedure of rescue when a person is a victim of electrical shock.
9. Describe in detail the safety issues in manufacturing industries.
10. Write notes over provision and benefits of the safety.
11. Discuss electrical prevention methods in brief.


UNIT - 2

MICROPHONES AND LOUDSPEAKERS

2.1 UNIT OVERVIEW AND DISCRIPTION

OVERVIEW

This unit deals with the construction, working principle and frequency response of various types of microphone. The basics constituents of the different types of microphones are discussed in student friendly language for better understanding. Moving coil loudspeaker is described with construction and working principle. The intensity and dynamic range with impedance and power level of loudspeaker are also discussed in the easiest language possible. At the end of the unit


charecteristics of practical loudspeaker like woofer, tweeter, squaker with loudspeaker enclosure are discussed briefly.

KNOWLEDGE AND SKILL OUTCOMES

- Student will be in position to understand the different categories of microphones and loudspeakers.
- Working principle of microphones.
- Construction of different kind of microphones.
- Construction and working principle of moving coil loudspeaker.
- Frequency ranges of various musical instruments.
- Merits, demerits, frequency ressponse and application of microphones and loudspeakers.

RESOURCE MATERIAL

1. *http://www.samhallas.co.uk/repository/po_docs*
2. *https://en.wikipedia.org/*
3. *http://micsandmikes.blogspot.com*

DURATION

7 Hours

ASSESSMENT PLAN

- Question and answers
- Group discussion
- Mock tests

2.2 INTRODUCTION

Microphone is an electrical device required for transformation of sound energy into corresponing electrical energy. They are widely used in the field of acoustical engineering. It is a kind of transducer. So the acoustic pressure is changed into electrical pulses. The electrical pulse having weak strength. Hence an high gain amplifier is used before further processing or transmission of this electrical signal. A loudspeaker works just like in a reverse process of a microphone. Whose function is to convert electrical pulses into acoustic pressure. There are various types and confuguration of loudspeakers are available. As per the requirement different kind of loudspeakers are used. For example, in a public address system when a person is speaking and a large audience


is hearing at that moment of time it is the microphone that picks the speaker sound transform into equivalent electrical pulses. With proper amplification and processing, it is the loudspeaker that again converts these amplified electrical signal into the acoustic wave. Thus, the large audience can hear the voice of a speaker by the application of microphone and loudspeaker.

2.3 CARBON MICROPHONE

The carbon microphone is invented by D.E.Hughs. It is the first microphone comes into practical existence. The carbon microphone is the direct prototype of today's microphones and was critical in the development of telephony, broadcasting and the recording industries.

It works on the principle of varying the density of carbon particles in proportion to the variable pressure developed by sound wave. It consists of DC source, step up transformer, diaphragm, chamber containing carbon particles. When the soundwave incident on the diaphragm, it starts vibrating in proportion to the air pressure that causes variation in density of carbon particles resulting in generation of electrical signals in proportion to the change in carbon particles. That electrical signal is fed for processing through the step up transformer. The carbon microphone works at very low bias voltage without additional amplifier or other source of energy. So it is very advantageous over other microphones as per the use of microphone in telephones, because at the distant location the voltage of telephone lines drops severely.

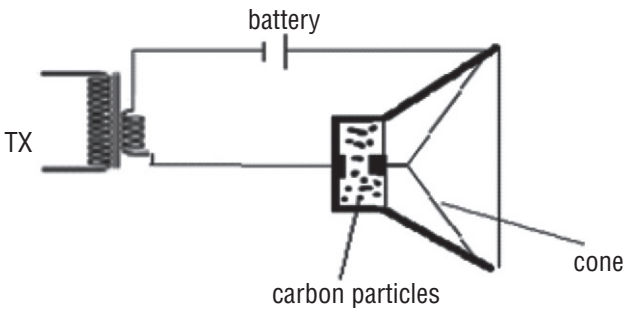


Fig.1 Carbon microphone

Merits

- It amplifies audio frequency signal.
- It provides low impedance usually 200 ohms.
- It provides almost uniform frequency response over the lower audible range.
- It is highly sensitive.

Demerits

A noise (hissing sound) is appeared at the output due to variation in the density of carbon particles.

Application

They are widely used in telephone and transmitters; however they have wide industrial application too.


Frequency Response

Frequency response of the microphones depends upon the nature of metal diaphragm, shape of the case, its method of mounting. A typical plot between test frequencies and corresponding output is shown below. The output is taken with respect to reference output which is taken as pressure of 1 dyne per centimetre square is produced by 1mV. This reference is made for the comparative analysis of various types of microphones.

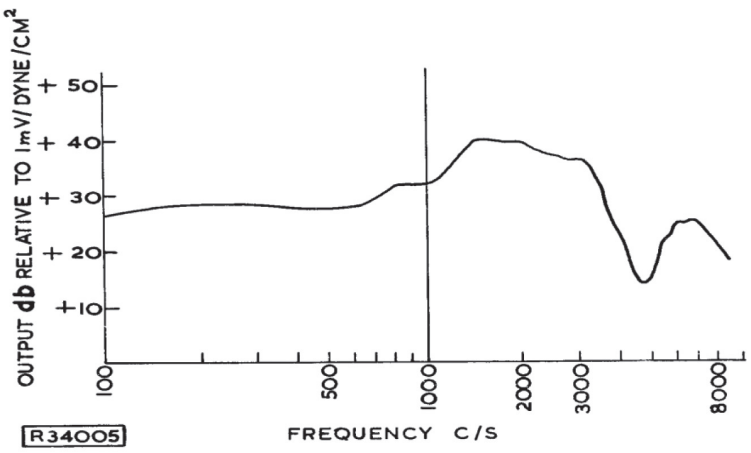


Fig.2 Frequency response of carbon microphone (courtsey http://www.samhallas.co.uk/repository/po_docs)

2.4 CAPACITANCE MICROPHONE

Capacitance microphone is also known as condenser microphone. It is invented by E.C.Wente at Bell laboratory. It consists of parallel plate capacitor, DC source and load resistance at the output. The parallel plate capacitor has one fixed plate and another one is movable. The movable plate is facing the input sound pressure. When the sound signal strikes on the front plate of the capacitor, it causes the vibration in the plate. That results in the change in capacitance of the capacitor, which is in the series with the DC source. Thus, we get an electrical signal at the output of the microphone in proportion with the sound input.

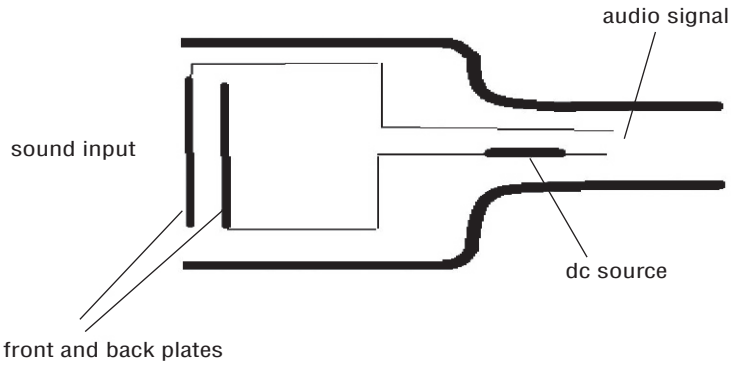


Fig.3 Capacitor microphone

Merits

- It also provides uniform frequency range.
- It can also work for powerful sound wave.


Demerits

- A DC source is required for it.
- It has high impedance

Application

- It is widely used in laboratories to pick-up sound wave to be measured.

Frequency Response

As we know the frequency response the microphone depends on various factors. A typical curve is shown below for the various test frequencies taken on capacitor microphone. It is clear from the graph that the frequency response is uniform for wide range of frequencies. Its reference is also taken as 1mV produced a pressure of 1 dyne per centimetre square.

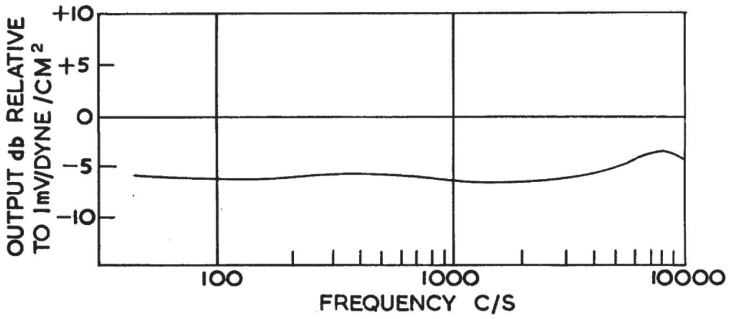


Fig.4 Frequency response of capacitor microphone (courtsey http://www.samhallas.co.uk/repository/po_docs)

2.5 MOVING COIL MICROPHONE

Moving coil microphone is also known as dynamic microphone. It consists of cylindrical magnet, voice coil and diaphragm. It works on the principle of electromagnetic induction. When the incident sound wave strikes on the diaphragm, it causes diaphragm to vibrate. That results in the movement of coil in the magnetic field which produces electromagnetic force. Hence, we get at the output load an electrical signal which is in accordance with the input sound wave.

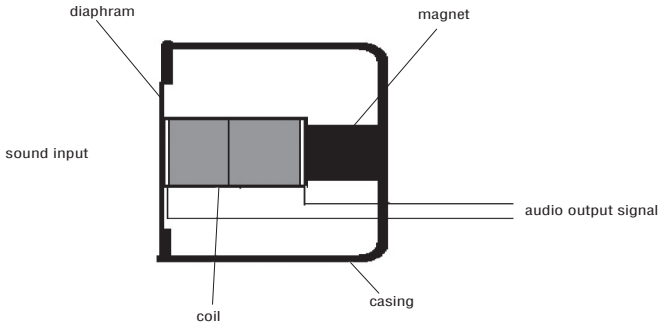


Fig.5 Moving coil microphone

Merits

- It is highly sensitive microphone.
- It has uniform frequency range.
- Can be used at higher temperature.
- Does not require external source for its operation.


Demerits

- It has low impedance.

Application

- Widely used in public meeting and broadcasting.

Frequency Response

The frequency response of moving coil microphone is depending upon various factors. We have taken a typical plot for a specified moving coil microphone. The response is almost flat over the audible range of frequencies. Some ripples are available for higher frequencies as depicted in the graph. These ripples indicate the variation in the output in accordance with the frequency. So we get a varying sound intensity with a slight variation in audio frequency. Hence it's working at lower frequency is quiet good as compare to higher frequency range.

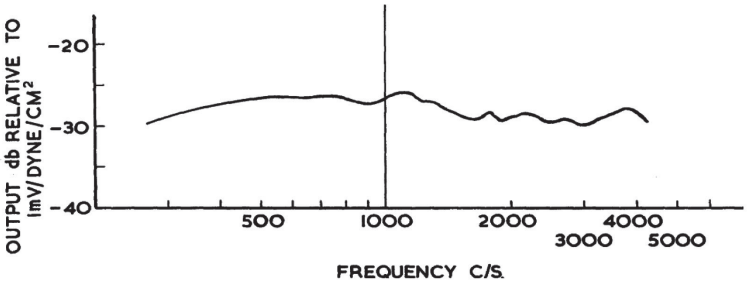


Fig.6 Frequency response of moving coil microphone
(courtsey http://www.samhallas.co.uk/repository/po_docs)

2.6 PIEZO-ELECTRIC MICROPHONE

Piezoelectric microphone is also known as crystal microphone. It works on the principle of piezoelectric effect. Some of the materials show piezoelectricity. Under some mechanical pressure it exhibit voltage. The vibration or oscillation of pressure produces corresponding electrical signal. It consists of fine crystal that is placed in between electrodes. When a sound pressure strikes on the electrode, the crystal starts vibrating according to the sound pressure.Consequently, an electrical audio signal is generated. In this way, we get the audio output signal in the form of electrical signal.

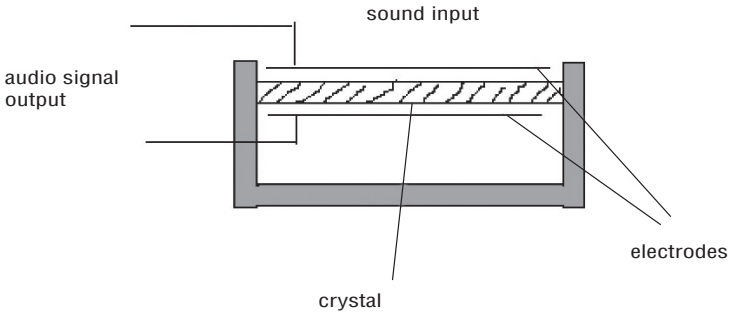


Fig.7 Piezoelectric microphone

Merits

- It is among light category of microphones.
- It has high impedance.
- It provides uniform frequency response.
- External source is not required for its operation.


Demerits

- It requires high gain power audio power amplifier.
- It cannot be used at high temperature.

Application

- It is usually used in public meeting, tape recorders etc.

Frequency Response

The frequency response of piezoelectric microphone is shown in following figure. It shows the output sound wave intensity with respect to test frequencies. There is nonlinearity in graph at higher frequencies and it is linear for the lower range of audio frequencies.

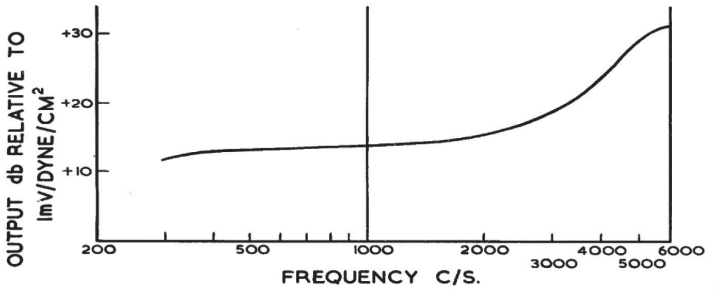


Fig.8 Frequency response of piezo-electric microphone (courtsey http://www.samhallas.co.uk/repository/po_docs)

2.7 LOUDSPEAKER

Loudspeaker is invented during the development of the telephone system in the late 18th century. Invention of electrical amplifiers makes it practical use of loudspeakers. Initially loudspeakers were used in radio, motion picture theatre, public address system (PAS) etc. They are broadly categorized into three groups.

i. **Direct radiator:** In these type of loudspeaker radiator is directly coupled with air.

ii. **Horn loudspeaker:** In these types of loudspeaker the diaphragm is coupled with air by means of horn.

iii. **Ionic loudspeaker:** In these category of loudspeaker no diaphragm is used.

Frequency ranges of musical instruments: The typical range of some of the musical instruments is listed in table with their frequency ranges.

S. No.	Musical instruments	Frequency range
1.	Soprano	250 Hz-1 kHz
2.	Bass	80 Hz-320 Hz
3.	Flute	240 Hz-2.5 kHz
4.	Basset horn	90 Hz-1.1 kHz
5.	Bassoon	25 Hz-200 Hz


6.	Saxophone	80 Hz-1 kHz
7.	Valve horn	70 Hz-800 Hz
8.	Violin	250 Hz-3 kHz
9.	Cello	70 Hz-500 Hz
10.	Guitar	80 Hz-650 Hz
11.	Piano fort	30 Hz-4 kHz
12.	Organ	20 Hz-650 kHz
13.	Xylophone	800 Hz-4 kHz

2.8 INTENSITY AND DYNAMIC RANGE

The human ear can detect large band width of intensities. To represent intensity for wide range of frequencies logarithmic scale is used. This logarithmic scale is represented in decibels. Decibel is the unit used to measure sound intensity.

Dynamic range can be defined as the ratio of largest signal in a circuit that is capable of dealing highest amplitude frequency component. It represents the range of input signal level that can be measured simultaneously. That is the ability to measure small signal in presence of large signal. It is measured in decibel (dB). Some of the standard dynamic ranges are presented in the table:

S. No.	Audio equipment	Range
1.	Audio cassette	32dB
2.	VCR	50dB
3.	Beta video deck	60dB
4.	CD player	90dB
5.	Human ear	120dB

Dynamic range often described as the ratio of amplitude of the highest sine wave to the rms noise amplitude.

2.9 CONSTRUCTION AND WORKING PRINCIPLE OF MOVING COIL LOUDSPEAKER

Moving coil loudspeaker is also known as dynamic loudspeaker. It is very commonly used loudspeaker. It consists of permanent magnet, voice coil and diaphragm and with supporting arrangements. When an electrical audio signal is passes through the voice coil, it causes the vibration of coil due to the magnetic fields. The voice coil is attached with the diaphragm with some arrangement. Diaphragm produces the audible sound wave in accordance with the input electrical audio signal.

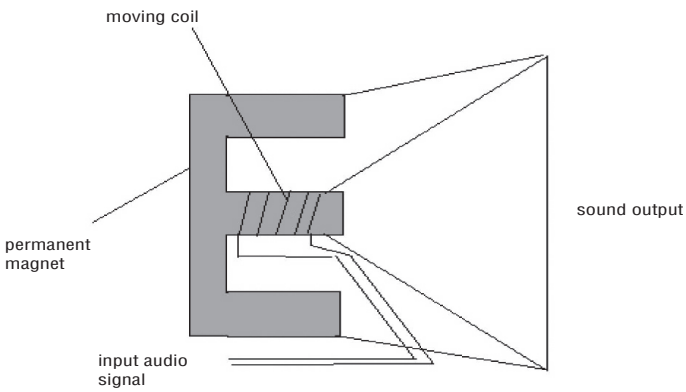


Fig.9 Moving coil loudspeaker

Application

- They are used mostly to listen to the programme broadcasted at the receiving device.
- Used in public address system (PAS).
- Used in studio monitors.

2.10 IMPEDANCE AND POWER LEVEL OF LOUDSPEAKER

Impedance in general is the opposition to the current. The power delivered by the power amplifier at the output stage of loudspeaker. The current at the output depends on the impedance. The higher impedance causes less current and vice-versa. The movement of voice coil depends upon the current flowing through the coil. This is the reason for the production of sound wave in moving coil loudspeaker. The loudness depends upon the larger or smaller vibration of coil. Larger vibration causes louder sound and vice-versa. It is clear from above discussion the movement of voice coil depends on the current flowing through it. Hence, larger the current, louder the sound output and smaller the current smaller the sound wave amplitude.

The output power level is inversely proportional to the output impedance of the loudspeaker. We know the power relation with impedance as follows:

Power= (Potential difference)2/ Resistance.

2.11 FREQUENCY CHARACTERISTICS OF PRACTICAL LOUDSPEAKER

The practical loudspeaker has a wide range of frequencies to reproduce. A single driver is not able to provide a good quality audio for the whole range. The solution is that to use multiple drivers for the reproduction purpose. The combination of different kind of drivers in the same enclosure would solve the problem. According to the frequency ranges the drivers are broadly classified into three categories. They are called woofer, tweeter and squawker.


1. **Woofer:** It is a kind of driver used for low frequency range. For reproducing low frequencies woofer combines with enclosure design. In some of the applications the woofer is also used for the reproduction of mid-range frequencies. That can be achieved by selecting a tweeter which can work on comparatively low frequencies to combine with the woofer to reproduce the whole range of frequencies. The frequency range varies according to the design of woofer. A typical range of woofer is about 20Hz-600Hz. It provides almost uniform frequency response at lower frequency ranges. However at very low frequency the output attenuates and also at the end of the higher frequency range of the woofer the output lowers slightly attenuates.

2. **Tweeter:** It is used for reproduction of highest frequencies. Its design is difficult because of the nature of high frequency audio wave. A tweeter is applied form of speaker that is specially designed to respond in high frequency audio ranges (2kHz-20kHz). It has flat frequency response at high audible frequency ranges. Three different kinds of tweeters are mostly used in accordance with their application. They are named as soft-dome tweeter, horn loaded compression tweeter and ribbon tweeter. Soft-dome tweeter is used in home stereo system where as horn loaded compression tweeter is used in reproduction of professional sound. In recent time ribbon tweeter are also used in place of horn loaded compression tweeter because it can handle larger amount of output power.

3. **Squawker:** It is used to reproduce the mid-frequencies in loudspeaker system. It can be of either direct radiation driver (like woofer) or compression driver (like tweeter). It can be mounted on the front baffle of loudspeaker or can be mounted on the throat of horn depending upon the type of driver i.e. direct radiation driver, compression driver. It is designed to work in a moderate frequency ranges of audio signal (500Hz-5kHz). Its frequency range is in between the range of woofer and squawker. Its frequency response is flat for the intermediate frequencies of audio signals.

2.12 LOUDSPEAKER ENCLOSURE

In most of the practical applications, a single speaker can't handle the audio frequency bands so we need different categories of speakers designed for different ranges to reproduce audio output. For this a single column speaker having all the three categories of speakers are assembled for the production of different range of frequencies audio signals. For the above said task a suitable enclosure is required to put together all the types of driver.

Sound waves in the back side are 1800 out of phase with respect to sound wave in the front side of individual speaker. Therefore sound wave from the back side are not presented and meet the wave in the front, then the two waves are cancelled out each other causing drastically drop in intensity. This phenomenon will more noticed at low frequencies. To save low frequencies from attenuation, it is necessary to increase the path difference by using a physical barrier called baffle.


To combat with this situation a proper enclosure is required. It should be designed in such a way that the path difference of back side signal would be changed to avoid cancellation with the front wave produced.

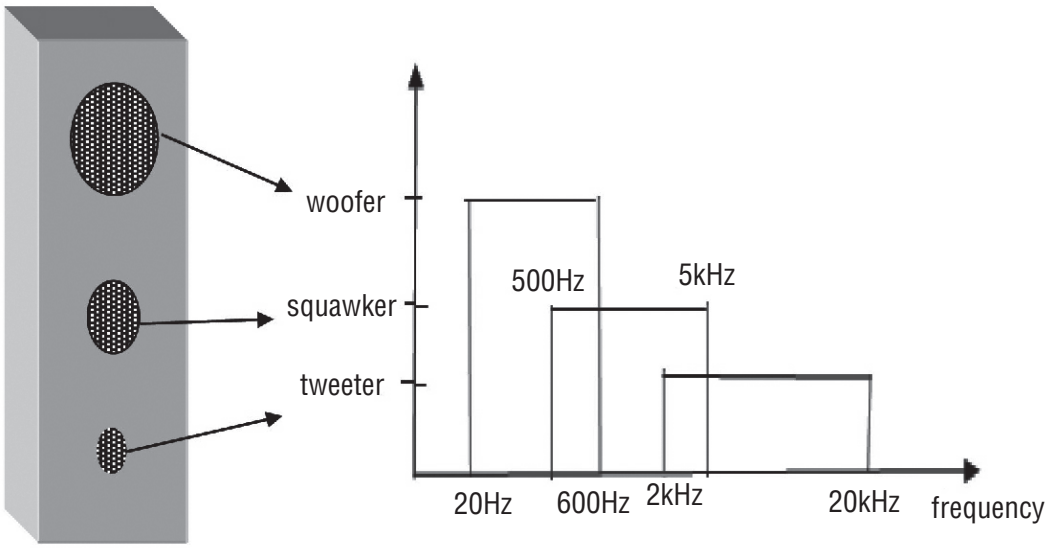


Fig.10 frequency response of practical loudspeaker

Review Questions

1. What is microphone? Explain the construction and working principle of the following microphone.
   a) Carbon microphone
   b) Capacitor microphone
   c) Piezoelectric microphone
   d) Moving coil microphone
2. In a tabular form enlist the frequency ranges of any five musical instruments.
3. Explain the construction and working principle of moving coil loudspeaker.
4. Discuss briefly the frequency characteristics of practical loudspeaker such as woofer, tweeter and squawker.
5. Write notes over
   i) Intensity and dynamic range of loudspeaker.
   ii) Impedance and power level of loudspeaker.


UNIT - 3

RECORDERS

3.1 UNIT OVERVIEW AND DESCRIPTIONS

OVERVIEW

Various kinds of analog and digital recorders are discussed in this unit. Disc recording and reproduction system with the help of block diagram are described in very reader friendly manner. The reader will get knowledge of magnetic recording and tape recorder system, CD/DVD system. The manufacturing process of CD/DVD is defined in various steps to understand easily. The reader gets general idea of the trouble shooting procedure for the different kinds of recorders.


Knowledge and Skill Outcomes

Reader will get knowledge and equipped with the following

- Analog and digital recorders.
- Analog recording principle.
- Magnetic recording principle and tape recorder system.
- Principle of optical recording.
- Manufacturing process of CD/DVD.
- Fault findings and repairing of different kind of recorders.

Resource Material

1. *http://www9.dw-world.de/rtc/infotheque/magn_recording/magrec_03.html*
2. *http://www9.dw-world.de/rtc/infotheque/magn_recording/magrec_04.html*
3. *https://www.scribd.com/doc/78387634/Magnetic-Sound-Recording*
4. *http://www9.dw-world.de/rtc/infotheque/magn_recording/magrec_01.html*
5. *http://analysis3.com/LECTURE-7-MAGNETIC-PROPERTIES-OF-MATERIALS-pdf-e7128.html*
6. *https://www.mam-a.com/dvd_specs*

Duration

14 hours

Assessment Plan

- Question and answers
- Group discussion
- Mock tests.

3.2 ANALOG AND DIGITAL SOUND RECORDING

In this section we will discuss various methods of sound recording and reproduction system. Basically sound recording system broadly classified into analog and digital sound recording system. The media used for the recording purpose are mainly vinyl disc, magnetic tape, compact disc (CD), digital versatile disc (DVD). Vinyl disc and magnetic tape are used for analog sound recording whereas compact disc (CD) and digital versatile disc (DVD) are used for digital sound recording. Following are the graphical representation of analog and digital signal.

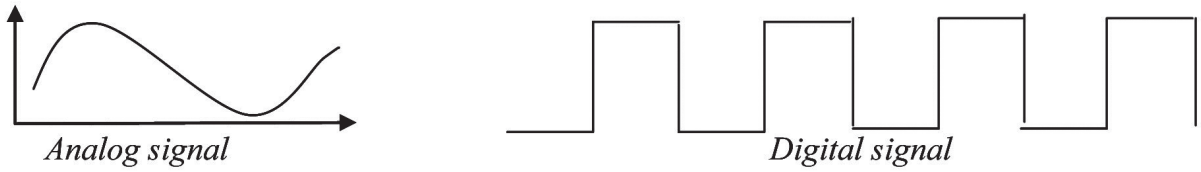



Fig.1 Examples of analog and digital signals

Analog Sound Recording

The sound waves are analog in nature when produced. Microphone is used to convert this analog signal into electrical signal. This electrical signal is first amplified by the pre-amplifier. Desired frequency equalisation for recording purpose is carried out at equaliser. The process of equalisation depends upon the recording media used. Now the signal is fed to the analog recorder. The analog recording is carried out either on vinyl disc or on magnetic tape as shown from the block diagram in Fig.2.

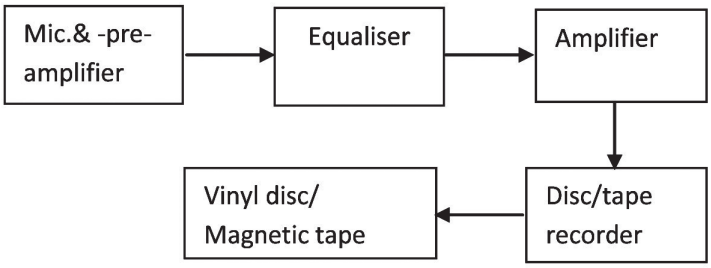


Fig.2 Block diagram of analog sound recorder

On the vinyl disc the sound is recorded in the form of grooves on the disc. These grooves are made with the help of stylus. The vibration of stylus is in accordance with the electrical signal. In the magnetic tape recording, the sound is recorded on the magnetic tape in the form of magnetic flux. These flux are stored on the tape with the help of tape recording head which carries the electrical sound signal. Magnetic field can be produced through the flow of current in any conductor. The magnetic field produced in this way is spread out in the space, the produced field is varies through the distance from the current carrying conductor. The field depends upon the current and the distance from the conductor as the distance from the conductor increases the strength of the field decreases. The magnetic oxide is used for the magnetisation purpose, which retains the magnetism even after the removal of the current. Hence, the analog signal can be stored in the form of magnetic flux pattern in the magnetic oxide material.

Digital Sound Recording

The digital sound recording is most popular these days. Digital recording has various advantages over the analog recording system. The sound wave to be recorded is first converted into electrical signal with the help of microphone. The signal is then amplified and filtered with the help of amplifier and anti-aliasing filter. We know the audio signal is analog in nature and the corresponding electrical signal produced by the microphone is also analog in nature. For digital recording, it is

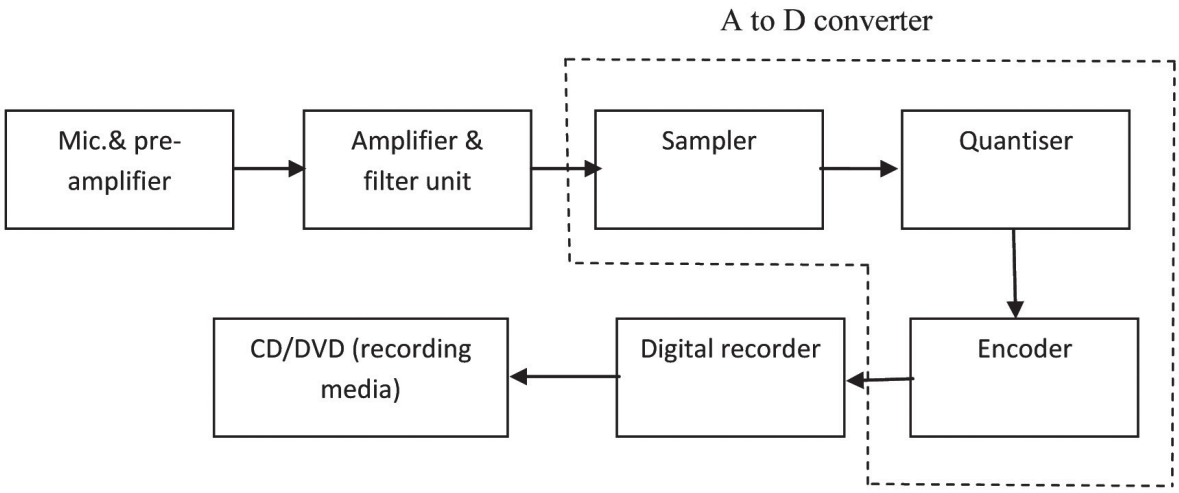



Fig.3 Block diagram of Digital sound recorder system

required to convert this continuous electrical signal into digital pulses. The digital recorder system is shown in the form of block diagram in Fig.3.

For the conversion of analog signal to digital signal we use analog to digital converter. In the conversion process, we first sample the signal at the sampling frequency equal to the twice of the input analog signal. After sampling of the continuous signal, it is in the form of discrete time signal. In next stage, we quantise the amplitude level of the discrete time signal. It is called quantisation. Each quantised value is encoded through the encoder to give digital signal. The digital signal produced in this way carries the information of the audio signal i.e. we get the digital form of the audio input signal. These digital signals can be easily stored in digital recording media. In our case the media is either CD/DVD.

3.3 DISC RECORDING AND REPRODUCTION WITH WORKING PRINCIPLE

Edison was the first scientist who developed an idea of sound recording and reproduction. He uses wax cylinder for the recording purpose. An American scientist Berliner developed gramophone for recording on a flat disc. Initial recording were on the principle that when a person speaks or sings which causes to agitate the diaphragm. These oscillations are transferred to the disc in the form of grooves with the help of stylus. The reproduction of sound from the disc is done again with the help of stylus, oscillating the diaphragm. There are various limitations in that system. The major disadvantage is the poor audio quality. In the near past coated aluminium disc are used for the disc recording purpose. The sharp cutting tool causes the grooves on the coated disc in accordance with the audio signal. The reproduction process uses the stylus to vibrate in accordance with the grooves on the disc and is caused to vibrate the diaphragm. In this way sound is reproduced.


Disc Recording

The vinyl disc is used as recording media. Spiral grooves on the surface of these disc are used for recording purpose. There are two techniques used for the recording on the disc as either the sound is stored in the form of variation in the depth of the grooves or sound can be recorded in the form lateral variation in the grooves. The lateral recording are widely accepted and used. The sound is recorded on the disc with the help of recording stylus. The vibration of stylus is in accordance with the sound wave to be recorded. It contains sharp needle that moves laterally with the input sound wave. That in turn cuts in the grooves in the recording disc. The recording starts edges of the disc and proceeds towards the centre of the disc spirally. So in this way recording can be performed and the sound wave will be recorded on the disc.

Disc Reproduction

As clear from above discussion the sound is stored on the disc in the form of lateral variation in the grooves. The variation is first converted to an electrical signal by application of pickup unit. The pickup unit has pickup needle mounted on it. This needle oscillates in accordance with the variation in grooves. That will produce electrical signal corresponding to the recorded signal. This electrical signal is further processed for excitation of diaphragm. There are many pickup methods used such as moving coil, capacitor, crystal etc.

Block Diagram and Working Principle of Disc Recording System

We can also understand the reproduction principle through the block diagram as shown in Fig.4. The first stage of block diagram is sound pick up unit. The function of this unit is to convert sound waves into desired electrical signals for the next section. It contains microphone and pre-amplifier. Microphone converts the sound waves into electrical signal. Since this electrical signal is very weak, so it requires amplification. Pre-amplifier is used to amplify this signal with keeping high signal to noise ratio. The amplifier section further amplifies the electrical signal. Equaliser unit is used for the processing of the frequency according to the recording characteristics. The signal is passed through the power amplifier. Power amplifier amplifies the power of the signal

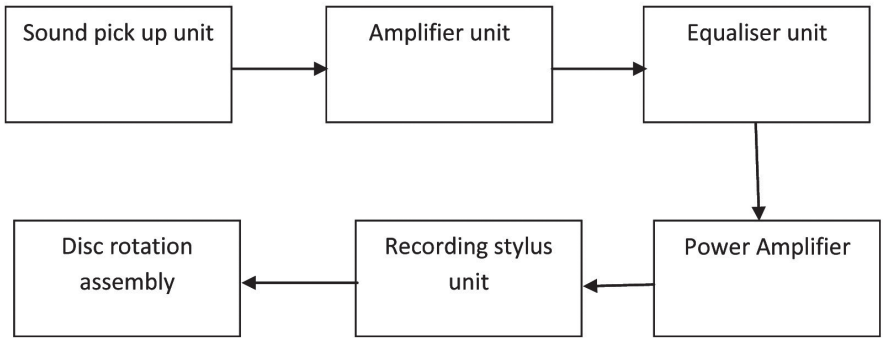


Fig.4 Block diagram of disc recording system


to the desired level, which drives the stylus unit. The stylus is oscillates on the rotating disc in accordance with the input electrical signal. It marks lateral cut on the disc to be recorded.

The disc rotation assembly is responsible for the uniform rotation of the disc on the disc table. The information is recorded on the disc in the form of these marks. The disc contains spiral grooves on it. The stylus moves from edge towards the centre of the disc through the grooves.

Block Diagram and Working Principle of Disc Reproduction System

Disc reproduction is the inverse process of disc recording process. The block diagram of disc reproduction system is shown in Fig.5. The first step in reproduction process is to place the disc on the disc table. The disc rotation assembly is consisting of disc rotation table disc and the motor used for the rotation of disc. It is responsible for the uniform rotation of the disc. Pickup and preamplifier unit contains stylus assembly and pre-amplifier. The stylus is used to read the recorded sound in the form of lateral variation of the grooves. The oscillation of stylus is in accordance with the lateral variation in the grooves. It is converted by the unit in the form of electrical signal. The electrical signal produced in this way is very weak in nature. So pre-amplifier is used to amplify this electrical signal with high signal to noise ratio. Then this signal is passes through equaliser, which conditions the signal for the reproduction process.

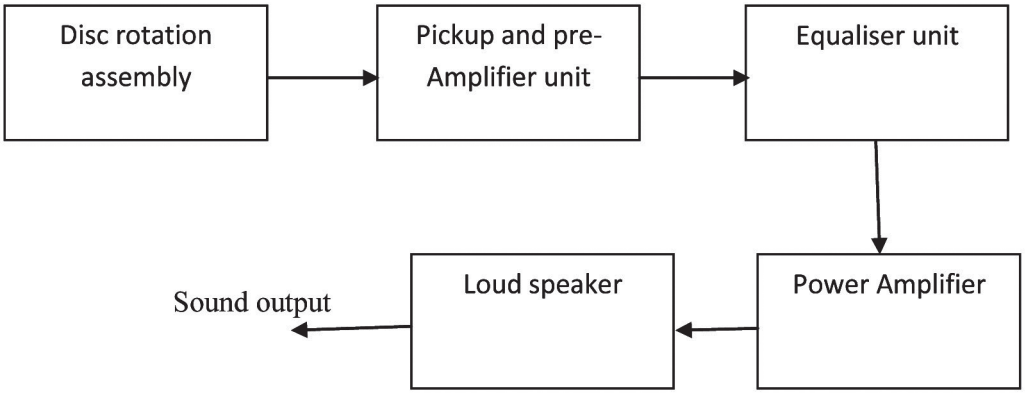


Fig.5 Block diagram of disc reproduction system

After that the power level of the signal is amplified by power amplifier unit. The power level of the signal is increased because it can able to drive the diaphragm of the loudspeaker section. The diaphragm of the loudspeaker oscillates in accordance with the input signal. Hence the electrical signal is converted into the acoustical pressure. This is the desired sound output, which was recorded on the disc. So the recorded sound on the disc is reproduced.

3.4 PRINCIPLE OF MAGENITIC RECORDING AND PLAYBACK

The world famous scientist Edison invented an instrument that could reproduce sound wave. Later other scientist invented a device for recording of sound on magnetic tape in Denmark. That is


because the instrument known as tape recorder. The first recorders using plastic tape with an iron oxide layer were used.Since then, magnetic sound recording has become the most popular way of storing broadcast programmes for transmission at anytime. Early attempts with temporary disc recording and photographic recording proved unsuitable for broadcast applications.

It is well known that the magnetic heads in a tape recorder or disk drive are the one of the important components of recording in a given media and playback of the signal from the recorded media. These heads have a magnetic core, which either guides a concentrated magnetic field for recording (or erasing).The information senses the magnetic flux from recorded information in a media. For efficient recording or sensing, the understanding of magnetic circuit, selection of magnetic core materials for various types of heads, response of core materials to generate field, losses due to eddy current in various materials are very much essential. Also, with increasing the areal density in the media, the average size of the recorded bits decreases, and hence, one needs to use different types of heads for recording and sensing.

3.5 WORKING PRINCIPLE WITH BLOCK DIAGRAM OF TAPE RECORDER SYSTEM

Tape recorder is made up of particles of magnetic material which passes through magnetic field that varies in accordance with audio frequency signal. Magnetic recording involves a magnetic tape/disk and a recording head. The principle relies on a current-carrying coil placed close to the magnetic medium, such as a magnetic tape/disk.In this technique, the required current to magnetize the recording medium can be quite large and coil of many windings is used. Magnetic recordings serve the purpose of recordings and reproducing the audio signals. Audio signals are analog time varying signals. Magnetic system recording must provide a system to represent the time varying air pressure and constantly varying time.

The varying air pressure is converted into electrical signals and then to magnetic field strength in the recording head. The field strength causes a proportional flux change in the tape. The playback

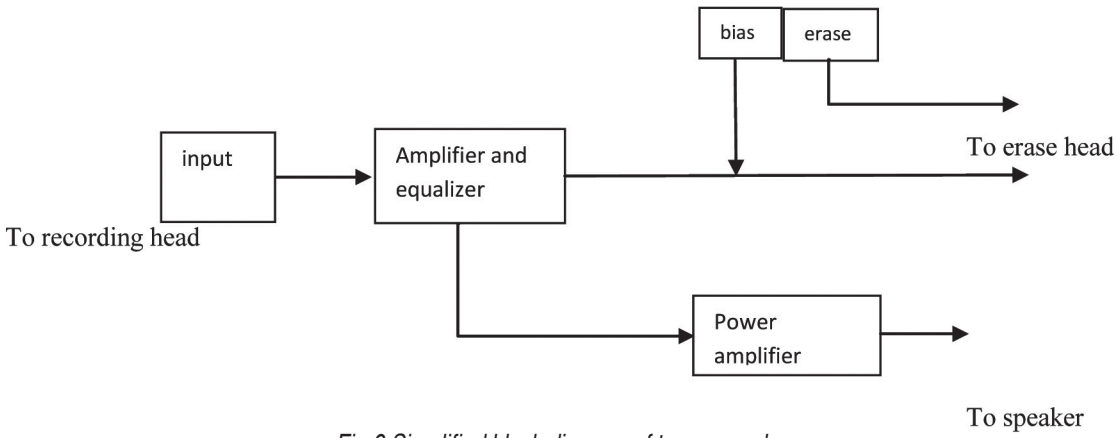


Fig.6 Simplified block diagram of tape recorder


process is the inverse of the recording process. The constantly varying time is converted to length by passing the tape at constant speed along the heads.

The tape recorder takes the input from the microphone for the recording on the magnetic tape. The electrical signal produced by the microphone is amplified by the amplifier unit. This signal is transmitted to the recording head of the tape recorder. Through the head the recording is performed on the magnetic tape. For the reproduction of recorded items on the tape is read by the playback head and the produced electrical signal in proportion to the magnetised portion of the tape. This is amplified by the power amplifier. This amplified signal is the excitation for the loudspeaker section of the tape recorder. Loudspeaker converts this electrical signal into sound waves accordingly.

Steps for The Recording Process Followed as:

- Erase the tape
- Record the new signal
- Reproduce the signal

Tapes and Tracks

A material that remains permanently magnetized is used in magnetic recording systems to record the flux variations in the record head gap. This material is usually a very thin layer of Ferric Oxide coated on a tape. It is a metallic coating which receives and retains the magnetic image. The record slides over the head in contact with the ring at the air gap.The tape is lying below the gap is influenced by the flux to assure adequate contact at the gap. Each point of the tape experiences a flux for a very short time as it moves past the gap. In this manner tape retains along its length a magnetization impression of the current variations in the coil.

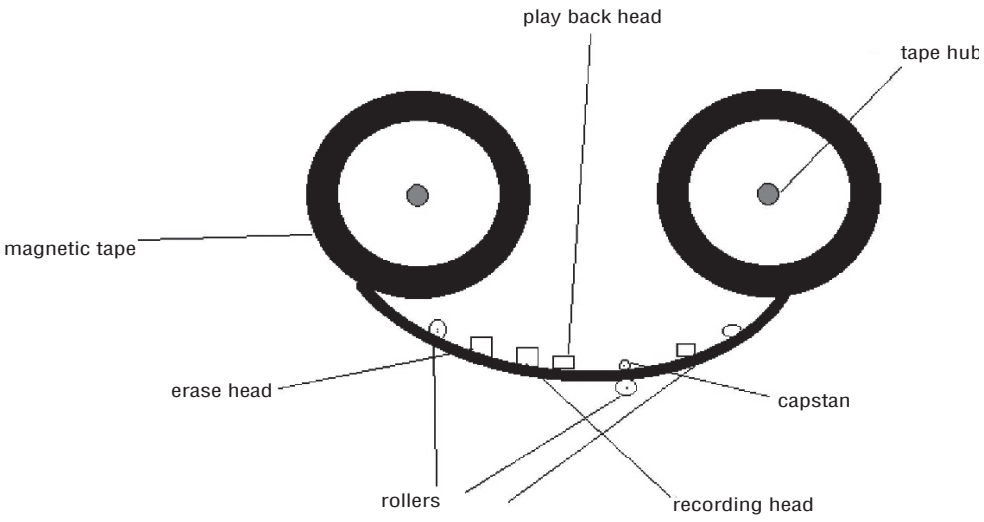


Fig.7 Tape head and magnetic recording


From the above Fig.7, we can see that a bar magnet is moved past the gap.The magnetic flux intercepted by gap causes by the meter needle to deflect to the right, indicating that an electric current is being produced. If the magnet were simply hold to close to the gap but stationary, no current would be generated and needle would be stayed in the centre of the scale. If the magnet were moved past the gap in the same direction, but in increased rate, the needle would deflect even further to the right. If however, the magnet moved past the gap in opposite direction from which it had been flowing and the meter needle would deflect to the left.

A practical magnetic recorder, however many refinements are necessary to ensure that the reproducing signals is exactly like the one originally used to make recording.Sound entering in to the microphone which is converted into an alternating electric signal. This current flows through the coil of the record head and sets up on the tape alternately polarized, magnetized bits of information. Further, this tape passes the gap in the reproduced head and causes an alternating current to be generated in its coil and then this current is to be recorded.The tape speed is compromise between the sound quality, time consumption, running time and reel size. There is a direct relationship between tape speed and the shortest magnetic wavelength on the tape. Reduced tape speeds require more sophisticated tape machine and else they lead to reduction in sound quality.

The Recording Process

During the recording process the tape maintain constant speed at the recording head. The recording head consist of a core with a coil. The core has an air gap at the front side. When current flows through the coil, a magnetic flux is produced in the core. At the gap the flux will be forced out of the gap. The tape is moved at a constant speed while it is in close contact with the working gap of a recording head. The flux of the recording head leaves the core at the gap and penetrates into the tape.

The magnetic field strength in the recording head will cause a certain magnetic flux density in the core and in the tape at the gap. When a certain point of the tape moves away from the gap, the residual flux will remain in the tape. A signal can be recorded on to the tape if the tape is magnetically fully neutral. And this process is achieved by erasing. Erasing can also be understood as recording a tape with zero-signal.

Signal can be erased by applying strong magnetic field to the tape, which drives all magnetic particles with full and equal reminisce. As a result the tape will not contain any signal and it is permanently magnetized but not magnetically neutral. Recording on such tape would result strong DC noise.

The process of erasing can be understood on hysteresis loop as follows:

A certain flux on the tape is first driven to saturation. Then the flux decays reaches at zero-reminisce by running tape through hysteresis loop several times in some spiral way.

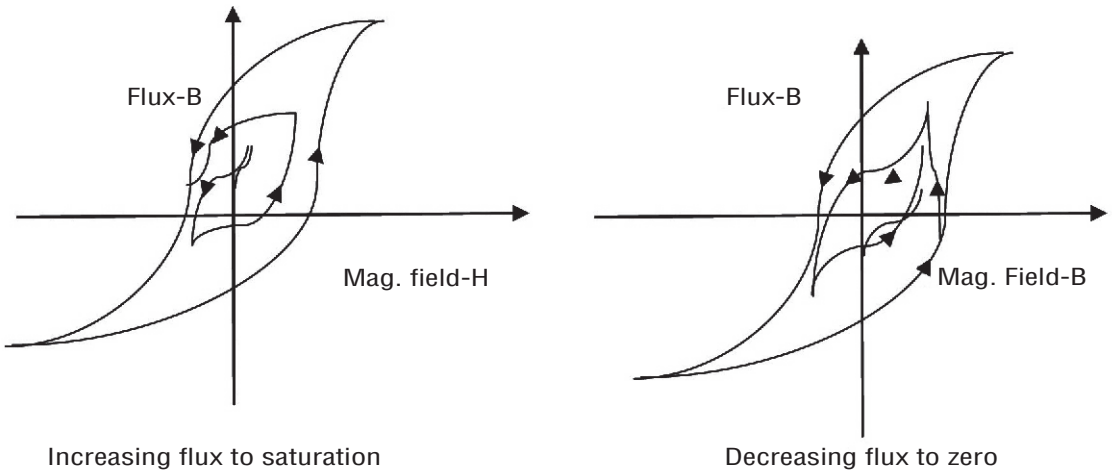


Fig.8 Erasing process

In the tape machine the erasing is done by the erase head, which is fed with the high frequency of signal, which is also used for biasing. The erase signal is normally relatively strong, to ensure the tape is driven in to saturation while it passes the erase head, the signal voltage is often several tens of volt at the erase head. The variations of field strength in the tape while it passes the erase head. It can be seen that while the tape approaches the erase head gap the final strength increases and drive the tape flux into saturation. While tap is leaving the gap, the flux decays over several periods and finally approaches zero.

Playback

The reverse process of recording is known as playback. For the playback the signal from magnetic tape is read by the playback head. During the process of playback the playback head comes in contact with the magnetic tape. The head is induced with the current due to the movement of the magnetic tape. The level of induced current in the playback head is very low. So it requires to be strengthen the signal received from the playback head, hence is amplified by the amplifier. To produce flat frequency response at the output the signal is equalised. It is further amplified with controlled gain amplifier. This stage provides low impedance for the output stage. The output can be taken at a distance with the help of cable. The transmission losses are considered during the transmission due to the presence of capacitance in the cable.

3.6 REQUIREMENT OF BIAS

Biasing is used to avoid the non-linearity of the characteristics. There are two types of biasing

1. DC Biasing
2. H. F. Biasing


1. **DC Biasing:** This is the simplest form of biasing similar to transistor biasing in which DC through the recording head shifts the working point into the centre of upper or lower part of the transfer characteristic. This part is fairly linear because the transfer characteristic is not symmetric in this area, and the record signal will contain a considerable amount of second order even harmonics.

   In DC biasing the working area is not clearly defined and even minor changes of the biasing current or the tape parameters will result in an inadequate working point.DC bias was only used in some early low-price cassette recorders and it is used only in small cassette dictating recorders. It is never used in professional recorders.

2. **H. F. Biasing:** HF biasing is used in all cases of magnetic analog sound recording. Function of HF biasing is fairly complex, but easily adjusted in optimum performance. In HF biasing positive and negative parts of the transfer characteristics are used for recording the audio signal and HF also have low noise and biasing of HF usually occur at 100 KHz.

   HF biasing is carried audio signal and this can be distorted during the magnetization of the tape, but its envelope the audio signal, will remain unaffected by the non-linear remanence characteristic. This is because the strong of HF signal is always driving the magnetization through the critical zero-remanence area. But the frequency of HF biasing is much too high to be actually recorded. When the tapes move Away from the recording head gap, the HF is erased only its mean value, the audio signal remains on the tape.The methods for the bias alignment require separate record and play-back heads and amplifiers and are therefore only applicable to professional tape machines.

3.7 PRINCIPLE OF OPTICAL RECORDING

The optical recording system is used for the storage of information for computers and computerized systems. The storage device would be optical disc. These discs are removable. We can remove the disc and place it on the shelf. The process of optical recording is carried out in digital manner. The data on the disc is in the form of pits and bumps. These are binary in nature one is considered as '1' and another is considered as '0'. We use these devices as secondary memory. It can be of two kinds that is read only and read-write. The optical disc storage capacity varies depending upon the manufacturing technology. The disc recording or read operation is carried out in the disc player. The disc is placed in the player. The player consists of rotating table on which the disc is placed. The rotating table rotates with the help of motor. Light beams are used to read and write the disc.

3.8 CD/DVD MANUFACTURING AND RECORDING

The manufacturing process of CD and DVD are quite similar but having few differences. The

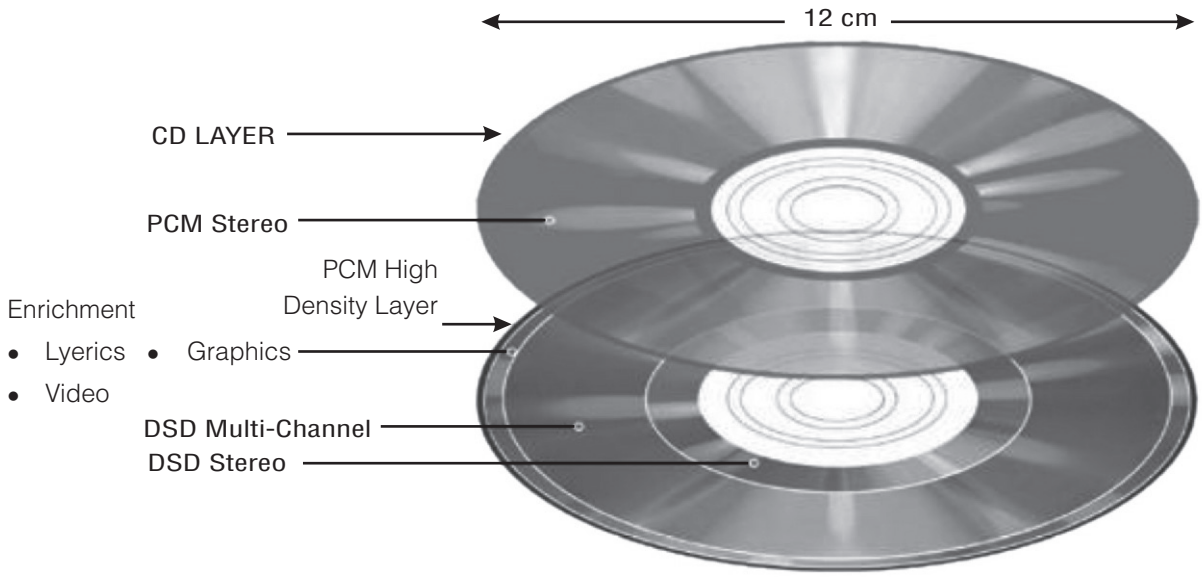


Fig.9 CD image (courtesy http://www.sa-cd.net/faq)

standard CD/DVD is having 12 cm (smaller diameter is also available now) in diameter and 1.2 mm in thickness.

The CD is made up of polycarbonate substrate masked by aluminium on the other hand the DVD uses two substrates and masked by two metallic layers and they are tight together. The DVD can be single sided or double sided and have one or two layers on each side. So far as the storage capacity of data is concerned CD is of 0.65 GB and DVD can be of 4.5 GB, 9GB. It can be single side single layer/single layer double side/double layer single side.

The manufacturing process involves following steps:

1. Premastering
2. Glass Mastering
3. Replication
4. Printing
5. Packaging

1. Premastering: In the manufacturing of CD/DVD we use a master CD/DVD for replication purpose. If some fault exist in the master that will be inherent in the new

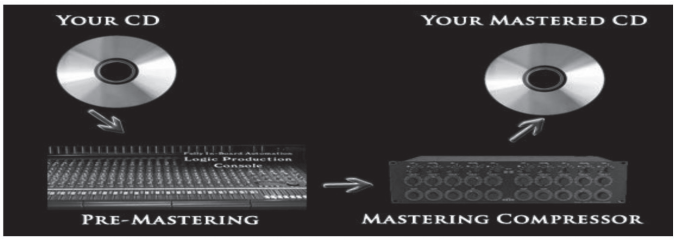


Fig.10 Pre-mastering stage (courtesy http://www.mastering1.com)


produced CD/DVD. Hence to eliminate this problem a copy of master is prepared. The copy is prepared in such a way that the faults of original master CD/DVD are eliminated by applying some technique. The preparation of new CD/DVD from original master CD/DVD as described is called pre mastering. This new CD/DVD is now contains all new standards with original information and is used for replication process for the production of large number of CD/DVD.

2. **Glass master :** is also called stamper because digital information is punched into the CD/DVD glass master. All the information available is replicated on a special coating of circular glass block. Since scratches, dust, smokes can affect the quality of CD/DVD. Hence extra care is taken to maintain the quality by polishing this glass master. They can be developed by processing them through the following steps:

   Photo-resist Mastering and Laser Beam Recording : In this process the plate of glass is cleaned with washing powder then photosensitive LASER light is applied because of the chemical reaction photo resistive material hardens it.

   Metallisation of Glass Master : The glass master of photo resists mastering of step-I is exposed to vapour deposition. A heated nickel wire vapour is deposited on to the glass master inside the suitable chamber.

   Electroforming : The metalized master of step-II is rotated in the chamber of nickel salt solution to develop a layer of 0.3mm. it will take around 1-2 hours. The resultant glass master is called the 'father' and the negative of the father the 'mother' needs to be created to punch all the information into the pits and grooves of the membrane. Carrying all the information CD/DVD are available in the market. The mother is generated from father using electro forming process used to punch holes on the membrane layer on replicated CD/DVD.

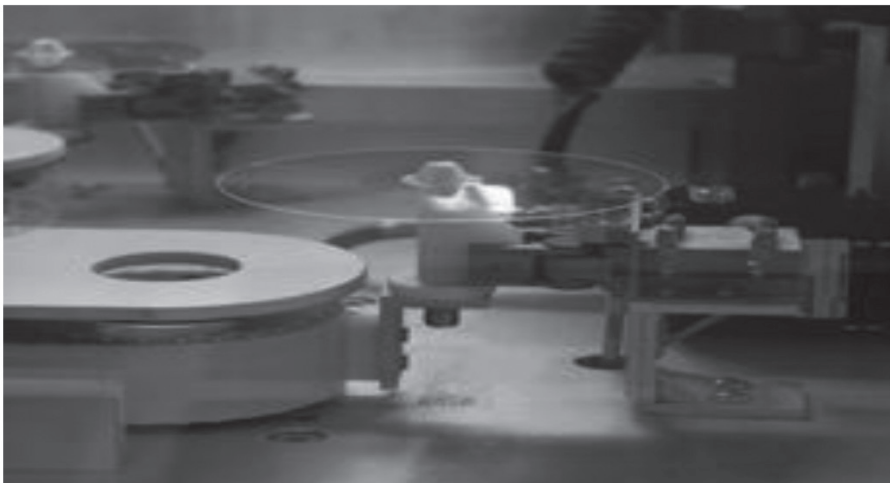


Fig.11 A polycarbonate layer of an actual DVD disc prior to application of the reflective aluminium surface (courtesy https://www.wizbit.net/cd-dvd_production_faqs/glass-master/)

3. **Replication:** This process employs the finished stamper into the moulding machine to start moulding process of CD/ DVD. It actually involves manufacturing disc based on master on a large scale. CD moulding machines have high temperature. They have average throughput of 600-900 disc per hour per moulding line. The moulded disc is removed from the mould. They are then moved onto the finishing line in preparation for metallisation. At this point of time the disc are cleared and contains all necessary information required. The disc is now passed into the metaliser that contains metal target mostly alloy of aluminium. When the disc is rotating into the processing position by robotic arms in the chamber, a small amount of inert gas is injected into the process chamber. This produces a plasma from the target and the resulting plasma vapour is deposited over the disc. The metal coats the data side of the disc covering the pits. After metallisation the discs pass through ultraviolet liquor that dispensed over the newly metallised layer by proper spinning and rotation over the entire disc.

Fig.12 Printed CD/DVD

4. **Printing:** CD/DVD can be printed on upper side of the disc. The brief description of the CD/DVD is necessary for the user to identify and separates them according to the printed description provided over the CD/DVD.

5. **Packaging:** Packaging is essential for the safe transportation manufactured CD/DVD. It depends upon the type of CD/DVD and also on the means of transportation. The CD/ DVD can have various kinds of packages. Some of them are as follows:

- Clear vinyl pocket
- Plastic hubs
- Leather CD/DVD cases
- Aluminum CD/DVD case
- Plastic clam shell CD/ DVD case etc.

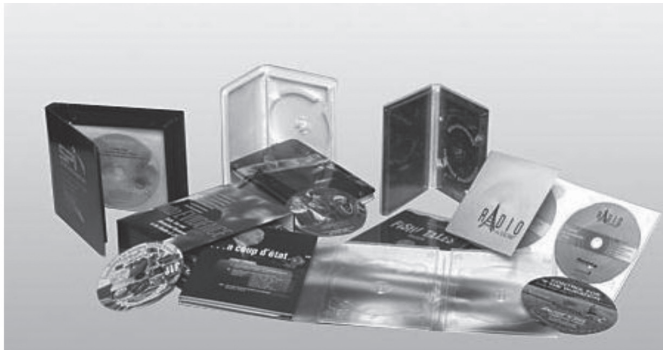


Fig.13 Different types of packages


Specification of CD/DVD

S.N.	Parameter	Standard value	
		CD	DVD
1.	Play time	74 min	480 min
2.	Diameter	120 mm	120 mm
3.	Thickness	1.2 mm	1.2 mm
4.	Material	Polycarbonate	Polycarbonate
5.	Storage capacity	690 MB	4.7GB
6.	Disc structure	Single substrate	Two bounded substrate 0.6 mm each
7.	LASER wave length	780 nm	650 nm
8.	Numerical aperture	0.45	0.6

3.9 CD/DVD PLAYER SYSTEM

The advanced form phono-record is a compact disc player. The CD/DVD player is composed of complicated electronic circuits. The package of electronic circuits is placed inside an outer insulating casing. On the front panel of casing the buttons are placed for various operations. The CD/DVD player is used for playing the data as well as to write the data on the CD/DVD. It has pits and bumps on their track which holds the data that needs to be played. These data can be audio, video or both. While reading the CD/DVD, pits are considered as '1' and bumps are as '0'.

Fig.14 DVD Player (Courtesy Sony Inc.)

Parts of a CD/DVD Player

1. Disc Drive Mechanism

It consists of a disc loading tray and a motor. In disc loading tray we load the CD/DVD then motor is used to rotate the CD/DVD in circular motion. The proper rotation of the CD/DVD is carried out with the help of spindle, gears and belt that are attached internally in the system.


2. Optical System

The optical system needs motor for the movement of lenses, mirror, laser beams, prism and photo-detector. There operation is to provide input to the disc-drive. They are assembled in a glass case.

3. Printed Circuit Board

It is an electronic circuit board. It contains various electronics components such as IC's, resistors, Capacitors etc. They are mounted on the board with proper soldering. The circuit is designed to perform the required application.

Working Principle and Block Diagram of CD/DVD Player

The simplest block diagram of CD recorder is shown in Fig.15. The electrical information signal is fed to the amplifier. The amplified version of electrical signal is the input to the analog to digital converter (ADC). It converts continuous electrical signal into the equivalent digital signal. It is operating at the sampling frequency, which is double to the input frequency. The next stage is multiplexer stage, which combines the digital data with error control, control and sync word to give output which is the input for the laser unit.

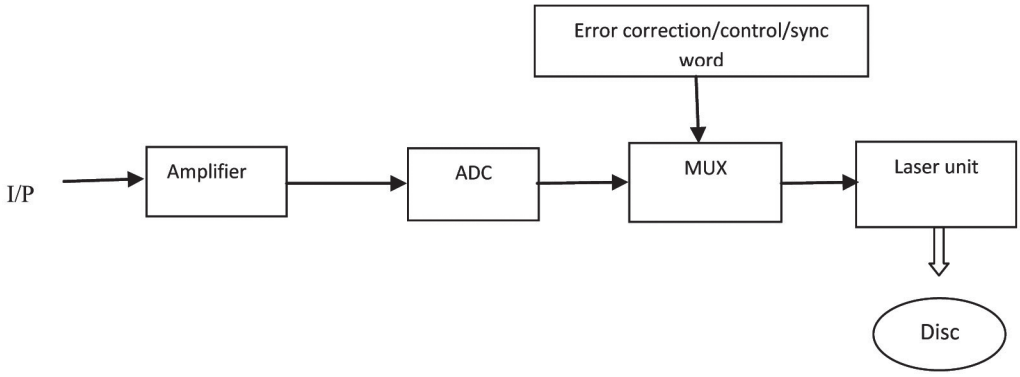


Fig.15 Simplified block diagram of disc recording

Thus, the input to the laser unit is the single interleaved digital signal. Laser unit is exposed to the photo resistive master disc. The material of this disc is highly sensitive to the laser beam. Hence, according to the data to be recorded is then recorded on the CD and is used for the mass production for commercial application of CDs.

The block diagram explains the operational function of the CD/DVD reproduction as shown in Fig.16. The portion hit by pits and bumps of laser beam, resulting reflection is changed accordingly. Laser beam hits a single spot. The position of this spot is gradually changed with the help of mirror and the circular motion of the disc provides the coverage of entire CD/DVD by the laser beams.


These reflected beams from the CD/DVD are collected by photo-detector.Since pits and bumps reflect two kind of laser beams that are collected by photo-detector in binary code (digital signal).

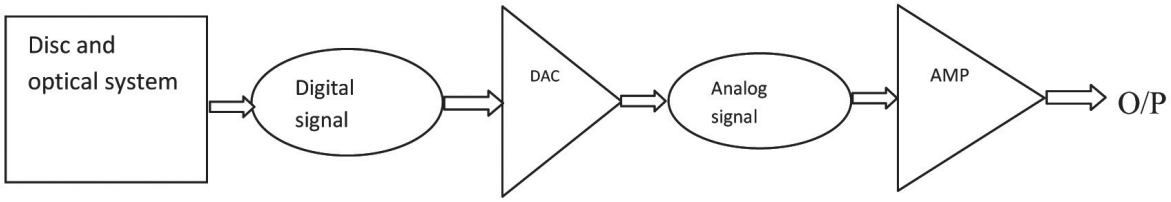


Fig.16 Block Diagram of CD/DVDreproduction

The digital signal is then converted into analog signal with help of digital to analog converter (DAC). This DAC is an electronic circuit mounted on the PCB to perform this task. The analog signal is further amplified by amplifier, which is also mounted on PCB. Thus the amplified signal is obtained at the output. This signal is fed to the audio/graphic unit. The audio/graphic unit gives us audio or video output.

Advantages and Disadvantages

Advantages

- It saves time when backup is taken by the system. The time is saved due to the backup is taken once and can't be changed continuously.
- It is easy to locate backup files on the disc.
- It provides back of several kinds of files.
- Can be used to copy files from the directories.
- Write protection is available.
- Free space on disc can be utilized with the help of software.
- Error concerned with incompatibility has built-in protection.

Disadvantages

- Can't be used to spread a backup job on several disc.
- Whole of the space in disc can't be utilized for backup.
- Software is required for the write operation of disc.

3.10 TROUBLE SHOOTING OF DIFFERENT TYPES OF RECORDER/PLAYER

The troubleshooting requires the basic understand the circuits and drives. It also needs the fundamental principles of working of the system to be diagnosed. The whole system is divided into several functional unit so that to locate/identify a particular nature of fault. We search the faulty components or parts in that possible functional area and then proceed further. We further needs proper service of the device at regular interval so that the problem persist due to dust on lens/heads, jamming of movable parts etc. may not produce problem. It is also advisable keep regular cleaning of the device with soft brush and oiling of the movable parts of the player such as spindle, lever, pulley, clutches, gears etc. Sometimes various kind of distortion may result poor performance such as variation in tape speed results wow and flutter, mechanical vibration causes rumble, small irregularities in tape coating results hissing sound. During playback any of the above problems persist due to distortion look into motor, capstan and quality of the tape.

Therefore the troubleshooting may be defined as the process of finding and rectifying the problem in the recorder/player. So that the optimum performance of the device can be achieved. If recorder/player deviates in the performance, the first step is to establish the presence of fault. Then with proper diagnosis pin point the fault location and accordingly rectifying the problem.

Flow Chart for Fault Finding and Rectification of Recorder/Player

Get the previous symptom if any from the user

↓

Inspect visually for physical damage

↓

Look recorder/player for burning smell

↓

Look the manual for test point provided by manufacturer

↓

As per instruction of manual find out the sub-section in which fault occur

↓

Check proper dc voltage/current in that sub-section


↓

If found improper voltage/current replace faulty parts/section

↓

Test for performance for satisfactory result

↓

If fault persist repeat the process

Some General Causes of Failure

Failure of recorder/player refers to its inability to perform the required function. Failures may be partial of required function or complete failure. A partial failure may be caused by open or short circuit failure in capacitors or in potentiometers. A gradual failure may happen because of poor design, production deficiency and improper storage. Some of the causes of failures are listed below:

- Wrong choice of components.
- Excessive heat because of lack of cooling.
- Excessive continuous use.
- Sub-standard manufacturing equipments and tools.
- Insufficient testing and inspection.
- Improper packaging.
- Excessive vibration in transport.
- Fluctuation in main supply.
- Poor preventive maintenance.
- Ageing of equipment.

First Look for Troubleshooting

1. Check visually the recorder/player for damage/burn.
2. Check for proper power supply.
3. Supply and drive assembly.


4. Recording and reproduction assembly.
5. Electro-mechanical support assembly.

The general kind of problems associated with the recorder/player are summarised as follows:

S.N.	Functional area	Possible faults
1.	Power supply and drive assembly.	• System is dead • Motor is not working • Lens(CD/DVD) is not moving • Head is not working • Take up and supply wheel not rotating • Rollers and associated parts may not working • Bias voltage is improper.
2.	Recording and reproduction assembly.	• No audio/video output. • Recording/copy not performed. • System is not working. • Noisy sound at the output. • Recording/copy is not uniform on the tape/ player.
3.	Electro - mechanical support assembly	• Take and supply wheel not working. • Belt (tape recorder) may be broken. • System is not working due to damage of mechanical components like clutches, spindle pulleys etc.

Whenever such kind of problems occurs in the system, look into the concerned functional area for the remedy. Test the components in the concerned area for burnt, dry solder, short circuited, open circuited etc. take proper precautions during the component level rectifications. Try to test the circuitry in the proper light and away from the children. Use standard and calibrated tools for testing. Special care should be taken while using ammeters.


Review Questions

1. Briefly explain the principle of analog recording and reproduction process.
2. How digital recording and reproduction process is better than analog. Explain in detail.
3. With neat block diagram explain the disc recording and reproduction system.
4. Discuss the working principle of tape recorder and write down the need of biasing.
5. How optical recording over a tape is accomplished. Discuss the procedure.
6. Explain the manufacturing process of CD. Also write their advantages and disadvantages.
7. Explain the recording and reproduction process of CD/DVD.
8. While troubleshooting, how recording and reproduction system is divided into functional area. Discuss the possible faults associated with each functional area.

UNIT - 4

TV SYSTEM

4.1 UNIT OVERVIEW & DESCRIPTION

- OVERVIEW
- KNOWLEDGE AND SKILL OUTCOMES
- RESOURCE MATERIAL
- DURATION
- ASSESSMENT PLAN

4.2 BLOCK DIAGRAM AND WORKING PRINCIPLE OF TV TRANSMITTER

4.3 BLOCK DIAGRAM AND WORKING PRINCIPLE OF TV RECEIVER

4.4 TV TUNER

4.5 VIDEO IF STAGE

4.6 SOUND STAGE

4.7 SYNCHRONIZATION CIRCUIT

4.8 PICTURE TUBE AND ASSOCIATED CIRCUITS

4.9 VERTICAL DEFLECTION CIRCUIT

4.10 HORIZONTAL DEFLECTION CIRCUIT

4.11 REMOTE CONTROL OF TV RECEIVER

4.12 BANDWIDTH OF THE TV SYSTEM

4.13 BLANKING AND SYNCHRONISING PULSES

4.14 TELEVISION MODULATION SCHEME

4.15 MONOCHROME SYSTEM AND EXTENSION OF COLOUR TRANSMISSION

4.16 CHANNEL AND CABLE TYPE TV SYSTEM

4.17 HEAD END PROCESSOR

4.18 SCRAMBLING


4.1 UNIT OVERVIEW & DESCRIPTION

OVERVIEW

This unit explains in detail the function of TV transmitter and receiver. Brief glimpse of different stages of television system with their simplified circuit diagram are also discussed. Since TV is a medium of communication from the distant. The basic function of TV is to convert sound and picture into electrical signal at the time of transmission and at the receiving mode they are converted back into the original picture and sound information. The function of remote control, the modulation scheme and the bandwidth are explained in a precise manner. Special emphasis is made to describe channel and cable type TV system. Their trunking and cable distribution system are also discussed. LCD, LED, HDTV system are explained in very easy language. Troubleshooting steps are provided for the diagnosis of television system.

Knowledge and Skill Outcomes

The student will be equipped with the fundamental knowledge of the following:

- TV transmitter and receiver system blocks.
- Basic circuit understanding of different stages of TV receiver.
- Principle of cable TV distribution system.
- Technology of LCD, LED TV system.
- HDTV technology.
- Fundamental troubleshooting guide.

Resource Material

1. *Television engineering and video system by R.G.Gupta, TMH publication.*
2. *Television engineering and video system by A.M.Dhake, TMH publication.*
3. *Composite satellite and cable television by R.R.Gulati, New Age publication.*


4. *Consumer electronics by J.S.Chitode, Technical publication.*

5. *www.wikipedia.com*

Duration

14 Hours

Assessment Plan

- Question and answers
- Group discussion
- Mock tests

4.2 BLOCK DIAGRAM AND WORKING PRINCIPLE OF TV TRANSMITTER

The transmission of any information needs source of information, transmitter and transmitting channel. The source of information can be any sound, picture, graphics or combination of all. For the transmission of information at distant location, transmitting device is required. Transmitter requires transmitting channel through which the information travels. TV transmitter is used to transmit the video and audio signals. It consists of video section and audio section as shown in Fig.1. The video section comprises of Mixer, AM modulator, Sweep circuit, Sync generator, High power linear amplifier (HPLA). The audio section comprises of audio amplifier, FM modulator and power amplifier.

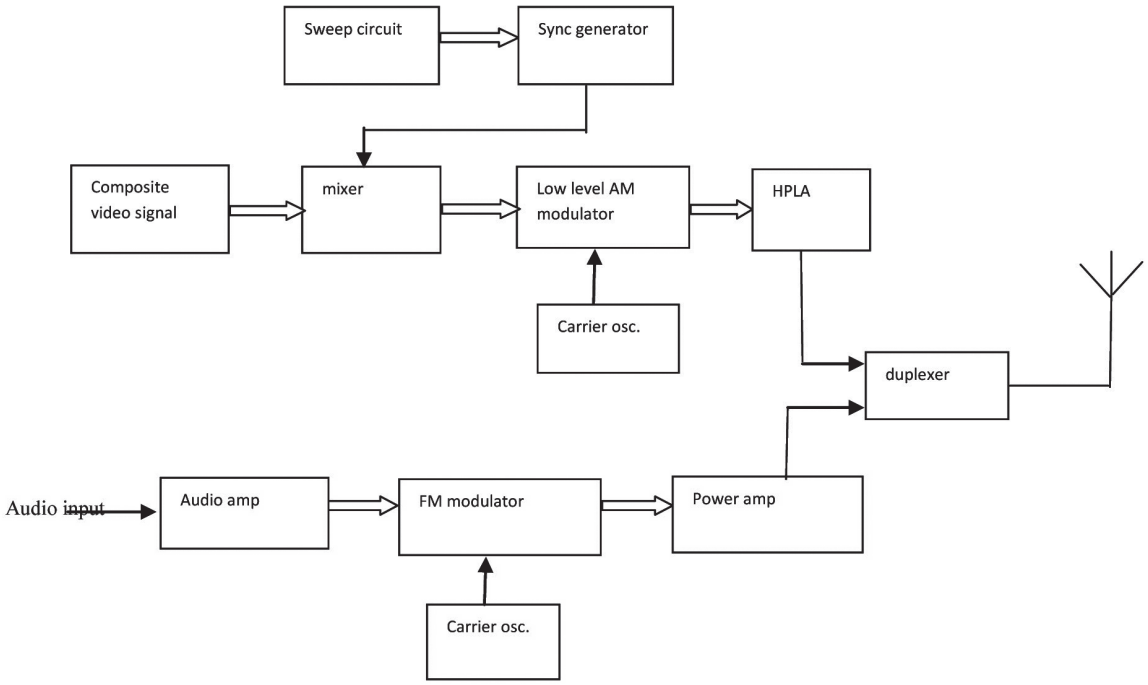


Fig.1 Block diagram of TV transmitter


The images captured by the camera and the captured images are converted into the composite video signal (electrical signal) by the TV transmitter and that is applied to the input of mixer, which adds the sync pulses to the composite video signal. The sync pulses are generated with the help of sweep circuit and sync generator. The sync pulses are used to synchronise the transmitted signal with the receiver. The output signal of the mixer is fed to low level AM modulator. The modulator then modulates the input signal. The RF carrier signal to the modulator is generated by the carrier oscillator. HPLA is used to increase the power level of modulated signal sufficiently higher for long distance transmission of the RF modulated signal.

The sound signal is converted into the electrical audio signal with the help of microphone. It is amplified by the audio amplifier. FM modulator then modulates the amplified audio signal. The audio signal modulates in accordance with the carrier signal which is generated by the carrier oscillator. Power amplifier amplifies the power level of FM modulated signal. The power of the signal is boosted up sufficiently higher for the long distance transmission of the signal. The outputs of video and audio section are combined with the help of duplexer. This signal is transmitted through the transmitting antenna. In this way transmission of information is carried out with the use of transmitter.

4.3 BLOCK DIAGRAM AND WORKING PRINCIPLE OF TV RECEIVER

TV receiver is an electronic device made of complicated circuits that are represented in blocks as shown in Fig.2. The transmitted radio signal is received by the antenna. They receive the entire wave that comes onto their contact and apply these multiple signals to the input of RF amplifier via feeder wire.

RF amplifier is used to amplify the radio signal received by the antenna. The signal received by the antenna is very weak in nature, so amplification for the further processing of the received signal is needed. This amplification is done by the RF amplifier. The signal received by the antenna is contaminated with noise. This stage also reduces the noise of the received radio signal by the antenna. The gain of RF amplifier is maximum in radio frequency range. It has a frequency tuned amplifier whose function is to select a particular band of frequencies and reject rest of other frequencies. The processed signal is fed to the mixer stage.

The mixer is a three port device. Input port of mixer is connected with the RF amplifier and local oscillator. The output port is connected with the IF amplifier. It produces a signal to the IF stage whose frequency is $F_{RF}+F_{LO}$. Where F_{RF} is the frequency of the RF amplifier output and f_{LO} is the frequency of the signal generated by the local oscillator. These two frequencies are mixed in the mixer. An electronic oscillator is used to generate local frequency. This device is called local oscillator. It is used with the mixer to convert the input frequency and output of mixer is input for the IF amplifier stage.

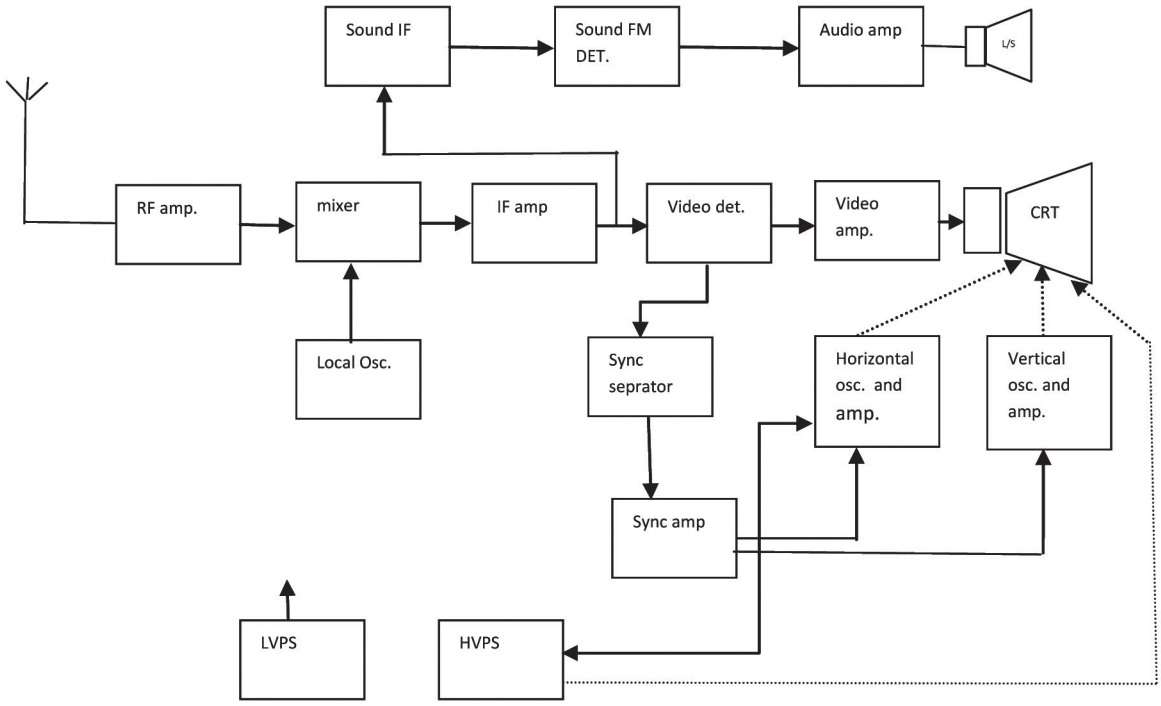


Fig.2 Simplified block diagram of television receiver

IF stands for intermediate frequency amplifier and used as tuned amplifier in television. Their purpose is to provide voltage amplification of the radio signal. IF stage comes before the separation of audio and video signal whose operating frequency is always less than the received frequency and more than audio and video signal frequency.

The output of IF stage is connected with video detector and a separate sound IF stage. The sound IF modulate the carrier frequency and amplifies them. The amplified signal is applied to the FM detector block. This block is composed of phase shift discriminator and a limiter circuit that changes the phase only when the input frequency is changed in proportion to the resonant frequency. The discriminator can detect the signal of amplitude modulation. Further, these signals are processed and amplified and undergoes de-emphasis process to maintain high signal to noise ratio. Finally, the audio amplifier boosts sufficient power to drive the speaker. The loudspeaker is a kind of transducer that converts electrical signal to vibrating sound waves.

The composite signal comes from IF stage that is the input to the video section. The diode detector separates video signal from the composite signal. The video signal is amplified by video amplifier. The amplified signal is high enough to glow phosphor element of the picture tube. The picture tube is designed in such a way that the video signal is converted into pictures. The amplified signal from video amplifier is applied to the neck of the picture tube comprises of grids. The electron beam is strong enough in proportion to the video signal and concentrated at the centre of picture tube. It is the sync separator that separates sync pulses in horizontal and vertical syncs. The deflection


assembly picks up these strong spikes and expand horizontally and vertically on the fluorescent screen of picture tube. Thus, the signal varied in width and height on the screen of the picture tube.

4.4 TV TUNER

Tuner is device used widely in VHF/UHF ranges to select specific range of frequency called channel as shown in the simplified circuit below. The tuner stage comprises of RF amplifier, local oscillator and mixer. The advance receiver uses varactor diode when reverse bias across this diode capacitance is formed. The amount of capacitance can be varied according to the reverse potential. The resonant circuit is connected parallel with varactor diode, so any change in the capacitance of varactor diode causes the change in resonance frequency. The desired channel frequency can be achieved with the variation of varactor diode capacitance. Therefore, the required channel can be tuned.

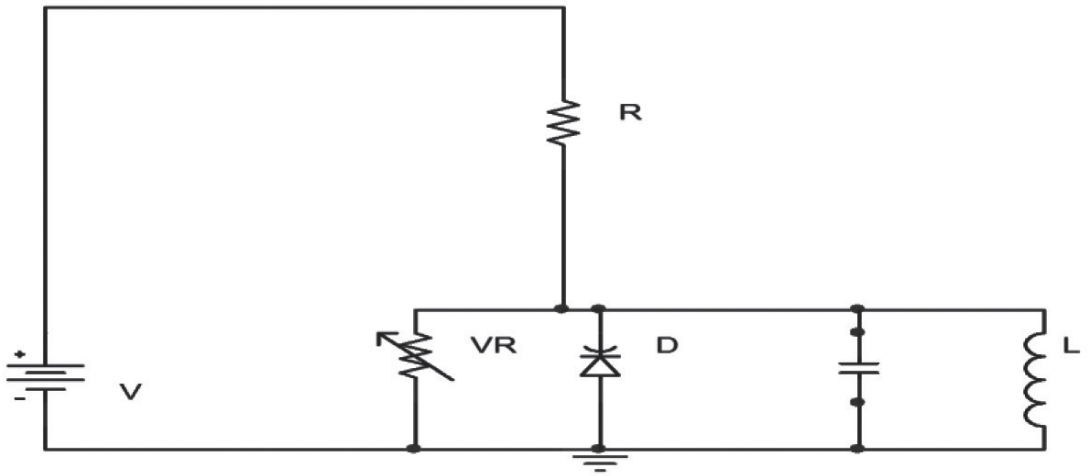


Fig. 3 Simplified circuit diagram of TV tuner

The tuner must have its input impedance equal to the characteristics impedance of the feeder wire. The impedance matching transformer called balun matches input impedance of RF amplifier. The unwanted signals are wiped out by the high pass filter. The output is feed to the RF section that provides better gain to this signal. Therefore in a nut shell tuning is a process of picking desired information and rejecting all unwanted information.

4.5 VIDEO IF STAGE

The output of RF amplifier is the input to the IF stage. The circuit shown in Fig.4 is divided into three stages. The amplifier amplifies video as well as audio signals. This amplifier has high gain and high selectivity. Both the audio and video signals require wide bandwidth for reproducing all the important features. Since single IF circuit have narrow pass band therefore 3-stage circuit are designed that provide better tuning.

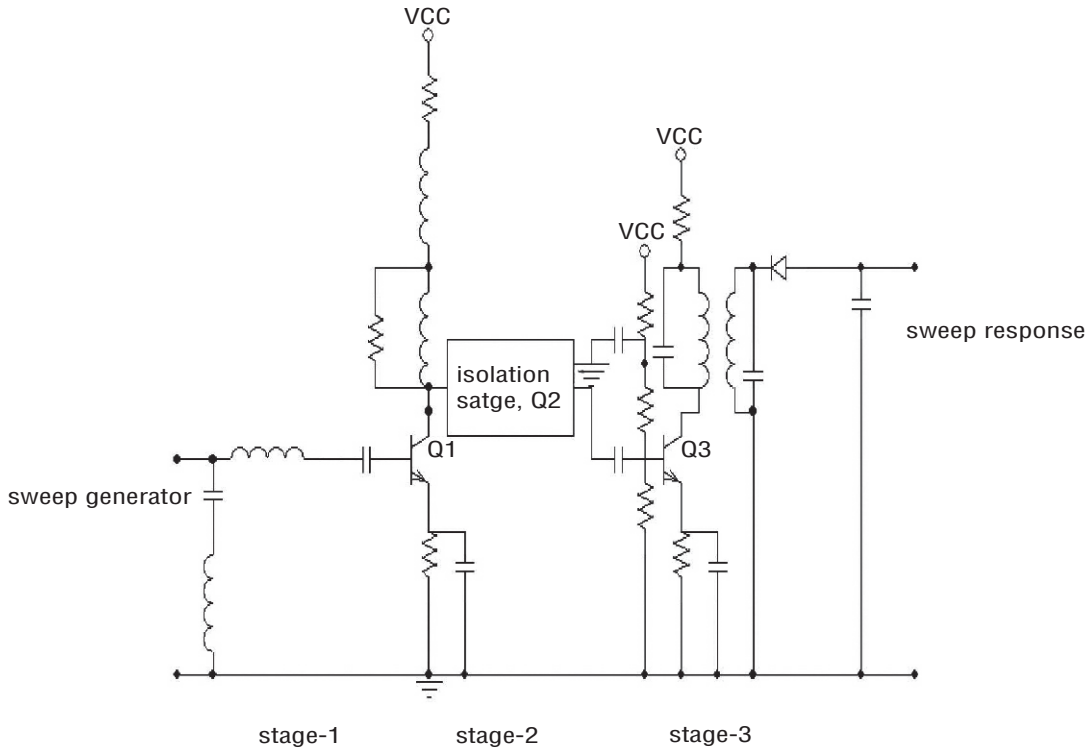


Fig. 4 Simplified circuit diagram of IF amplifier

4.6 SOUND STAGE

The function of sound stage is to provide sufficient audio electrical signal to drive the speaker. The amplifier is used for that purpose. The sound signal posses intermediate frequency of 33.4 MHz which is amplified with the picture signal of 38.9 MHz but the difference between these two (38.9-33.4= 5.5 MHz) is retained by the sound signal. This centre frequency of 5.5 MHz is maintained and does not drift because of local oscillator frequency in the tuner stage tend to increase or decrease. Hence this is the reason both picture and sound IF frequency varies by the same value and maintaining their differences equal to 5.5 MHz.

The simplified circuit of audio transistor amplifier is shown in Fig.5. It takes input from FM detector. It is a power amplifier that enhances the power level of audio signals. It is providing volume control with the use of variable resistance as shown below. Coupling capacitor (Cc) blocks the Dc component and couple the signal from previous stage to next stage. R1, R2, Rc, Re are the biasing resistors. Ce is the bypass capacitor which is used for biasing stability. The detected audio signal undergoes de-emphasis with the help of RC circuit to control volume. Therefore with the application of transistors, resistors and capacitors the original sound wave is reproduced in the television system.

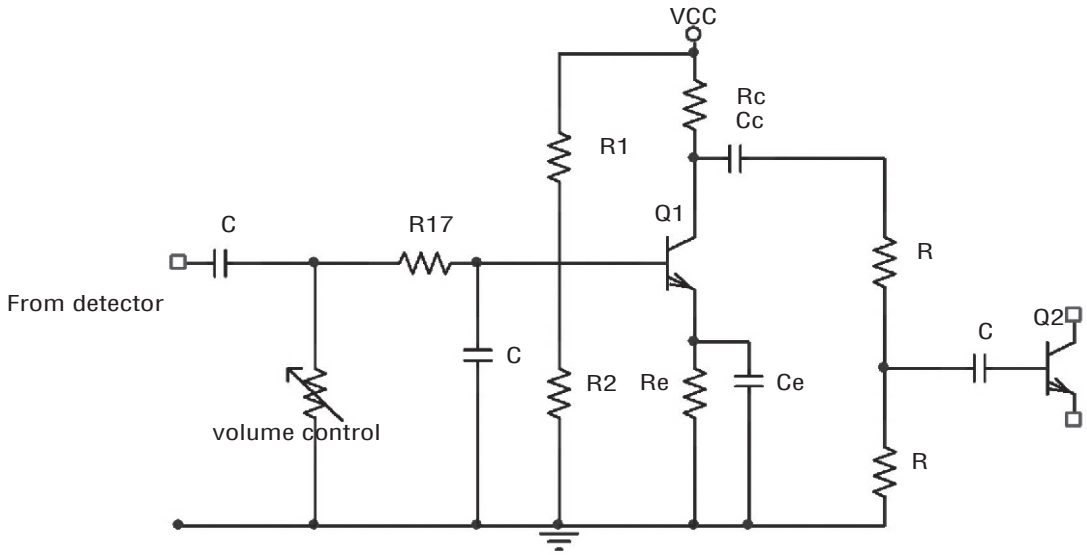



Fig.5 Simplified circuit of sound section

4.7 SYNCHRONIZATION CIRCUIT

The horizontal and vertical sync pulses are separated from the composite signal by using differentiator and integrator circuits. We get horizontal sync pulse at the output of differentiator and vertical sync pulse is obtained at the output of the integrator circuit as shown in Fig.6. Composite signal is fed to transistor Q and at the collector of the transistor integrator and differentiator circuit is used. Composite signal contains the sync pulses at the side of video signal. The amplitude of the sync pulse is much higher than the video signal. So by using amplitude separator, we can get the sync pulses. This can be achieved by the use of input RC network associated with the transistor Q. The charging time period of capacitor is kept very low and the discharging time of capacitor is kept high to get only the sync pulses at the collector of the transistor Q.

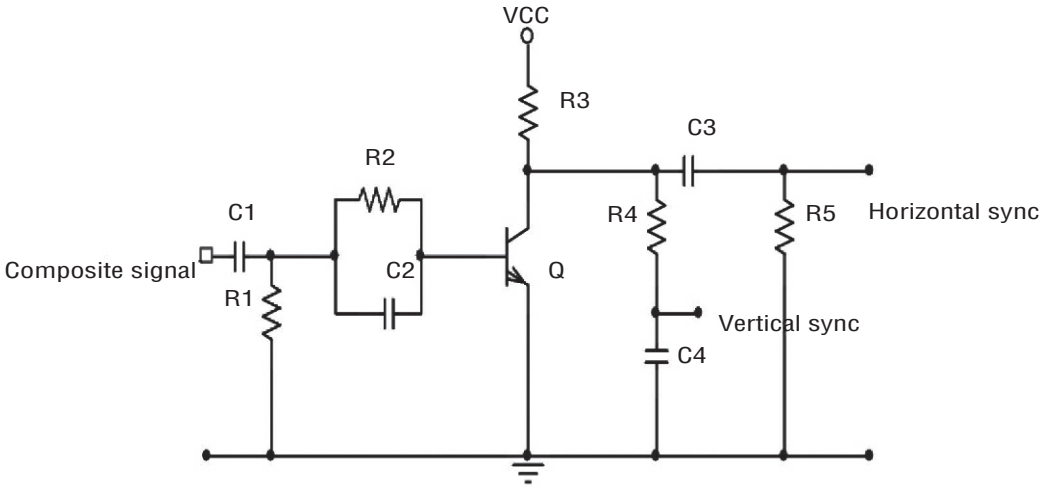


Fig.6 Simplified circuit diagram of horizontal section


4.8 PICTURE TUBE AND ASSOCIATED CIRCUITS

The picture tube is commonly known as cathode ray tube shown in Fig.7. The face plate serves as the screen of the receiver. Monochrome picture tube contains single electron gun but in colour picture tube it is three. The tube is made up of glass with long neck. On the neck of the tube filaments heat the cathode and resulting electrons are emitted. These negatively charged electrons are accelerated by positive bias voltage. The neck assembly of picture tube focuses these electron beams. The control grid is made negative with respect to cathode and hence the beam is accelerated forward with very high voltage.

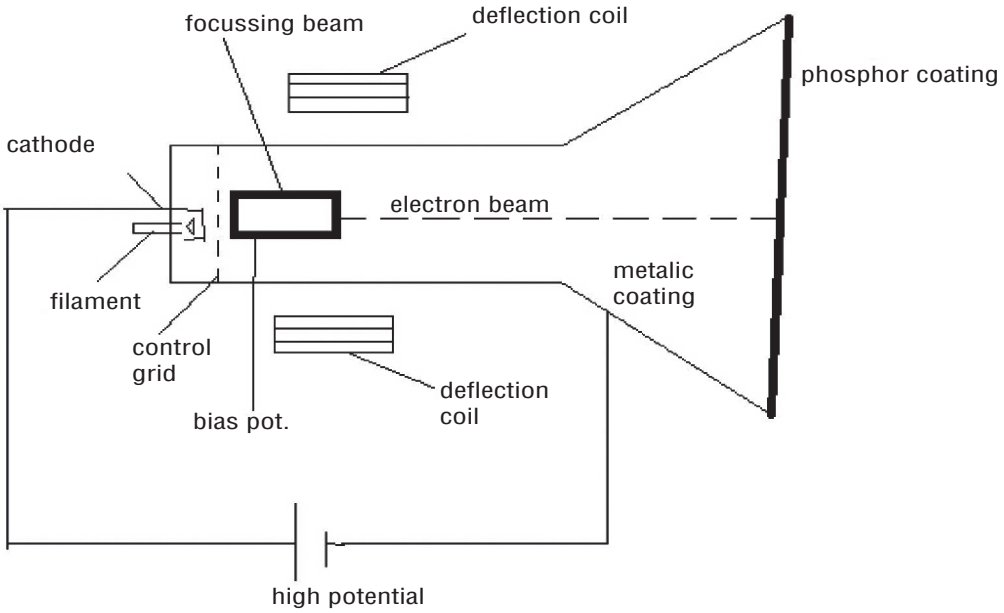


Fig.7 Simplified section of cathode ray tube

The inner coating of CRT is made of phosphor. The material glows when beam strikes over them. The neck assembly comprises of horizontal and vertical current, saw tooth and sync pulses that together generate magnetic field. These magnetic fields are horizontally and vertically deflected by horizontal and vertical coil mounted on the neck. Thus, the beam is swept on the front side of the CRT. There intensity of glow can be varied by varying the grid voltage.

4.9 VERTICAL DEFLECTION CIRCUIT

The input to the vertical deflection circuit consists of vertical sync pulses generated by sweep oscillator and a power amplifier is used to generate sufficient saw tooth current for the vertical deflection. A simplified circuit is shown in the Fig.8. Assume the transistor Q1 initially not working then the capacitor C2 charges through R2 on the application of +Vcc. The charging current can be varied by varying the potentiometer VR2. Charging also depends upon the value of resistor R2. When the capacitor C2 is fully charged that makes base emitter junction of transistor Q1 forward


biased resulting voltage decreases at the collector and transistor starts conducting. Consequently, capacitor C2 discharges through transistor Q1. When capacitor discharges, almost the transistor Q1 again goes under cut off region. Again, capacitor starts charging through Vcc. This process continues again and again. The diode connected across the transformer prohibits the oscillation at the collector of transistor Q1. That will produce a sweep signal and stops vertical rolling of the signal.

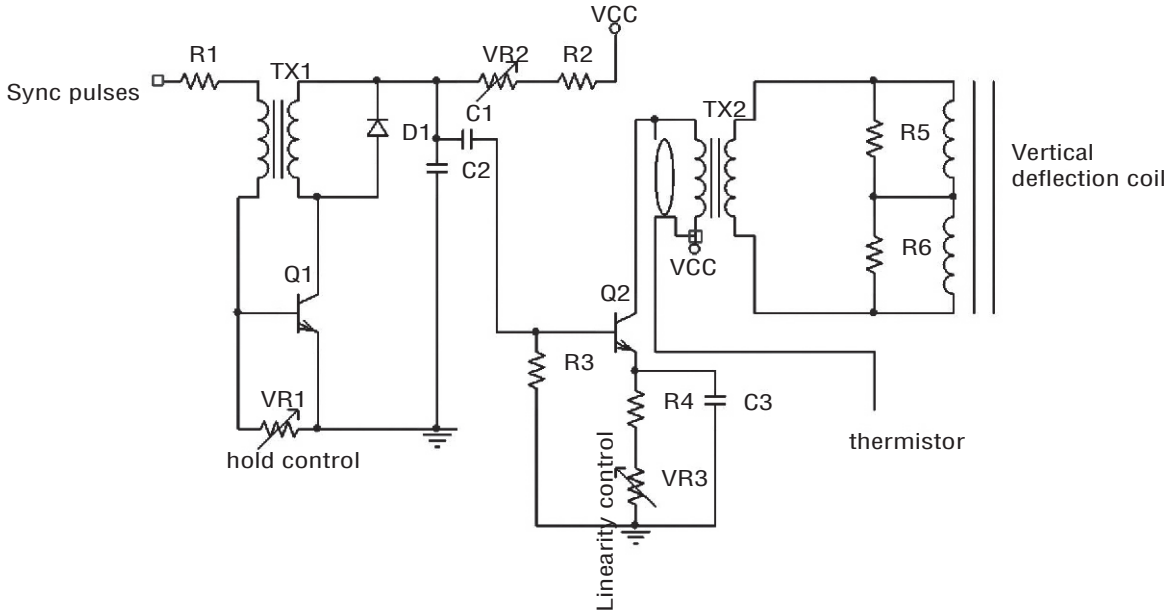


Fig.8 Simplified view of horizontal deflection circuit

The sweep signal going to base of transistor Q2 provides ramp voltage. This signal drives the transistor Q2 accordingly. A vertical sweep signal is produced at the primary of transformer Tx2. The secondary coil of the transformer provides the vertical deflection to the circuit shown in figure. The variable resistance VR3 is varied to adjust the Dc biasing of the transistor Q2. It prevents the transistor going into the nonlinear region. Thermistor at the primary is used for the stability against heating of the transistor. At the output of the transformer, resistances R5 and R6 are used to prevent the ringing oscillation at the output. Thus, we get the vertical deflection in the form of saw tooth wave through the output coil.

4.10 HORIZONTAL DEFLECTION CIRCUIT

The brief description of horizontal deflection circuit is explained in this section. The explanation of the circuit shown in Fig.9 can be divided into two stages. One is for horizontal oscillation and another for driver amplifier. The oscillation of horizontal oscillator is controlled by the AFC signal and the potentiometer VR1. VR1 controls the oscillation when AFC fails to control the oscillation due to excessive deviation in the frequency. It follows by the driver amplifier as shown in figure. It is a buffer amplifier having high input impedance used to provide sustained oscillation.

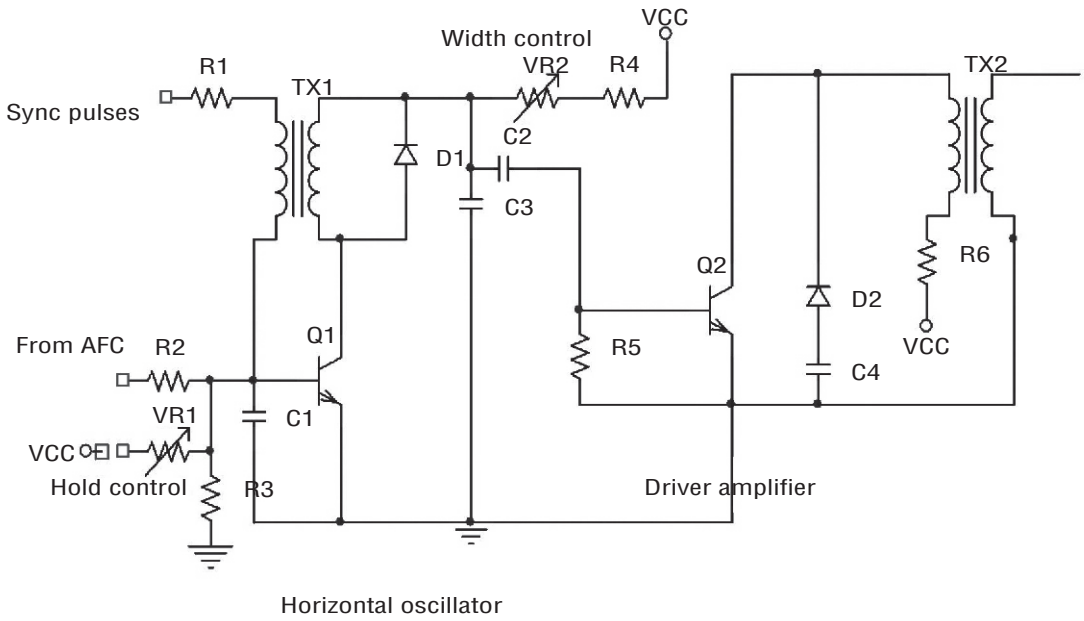


Fig.9 Simplified view of horizontal section

4.11 REMOTE CONTROL OF TV RECEIVER

It is a device used to control the operation of TV receiver from small distance. We may On/Off, Increase/Decrease the volume and subsequently change the channel of our choice. We may also alter the brightness and contrast of the TV receiver as per requirement and convenience. There are two widely used technologies for remote controller-one is the ultrasonic and another one is the infrared.

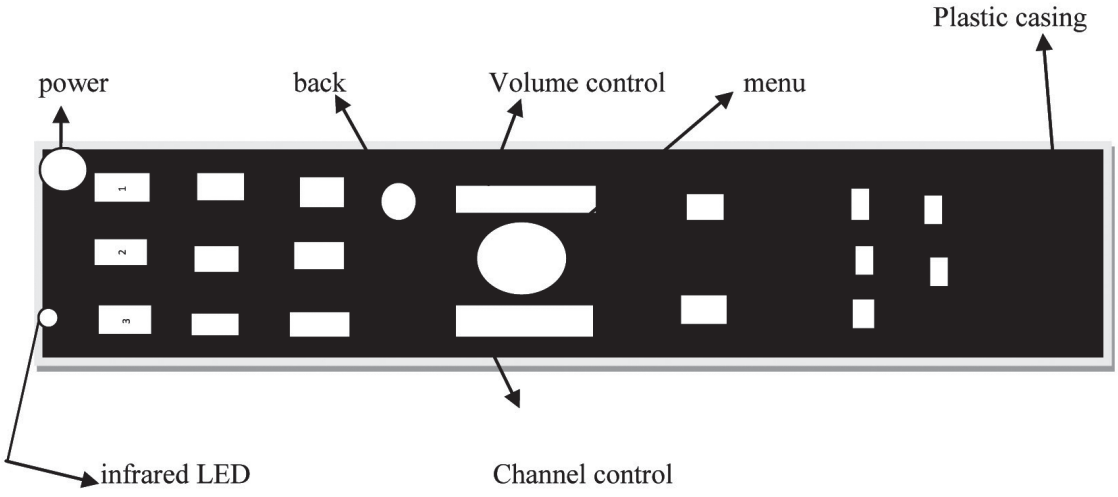


Fig.10 TV remote control


The ultrasonic remote are highly directional and is used for very small distance when some obstacle comes between remote and receiver, they may not control the receiver. On the other hand infrared light emitting diodes are widely used to control the TV receiver. The commands of remote are controlled by infrared light and covers comparatively bigger distance than ultrasonic remote.

Features of remote control

- Used in infra-red/VHF range.
- Covers 10-15 meters of distance.
- Require pencil battery for operation.
- 15-25 Operation buttons are available (varies according to application).
- Controls all the functions of TV receiver.

Note: For proper operation of remote control device change the battery at regular interval.

4.12 BANDWIDTH OF THE TV SYSTEM

The bandwidth of TV signal is shown in Fig.11. It carries one full upper sideband of 5 MHz plus attenuation slope of 0.5 MHz followed by guard band of 0.25 MHz and some portion lower sideband is about 1.25 MHz. Therefore, the total bandwidth required for picture signal transmission is about 7 MHz.

The bandwidth shows there are two carriers, one is for picture carrier and another one is for sound carrier. The picture signal is amplitude modulated and a special class of AM called vestigial sideband modulation is used that utilises full upper sideband with some lower sideband by suppressing major portion of lower sideband. However, sound signal is located in upper portion of the spectrum and the modulation scheme required for sound signal transmission is FM. Note, that the bandwidth required for TV system sound broadcast is comparatively less than standard broadcast.

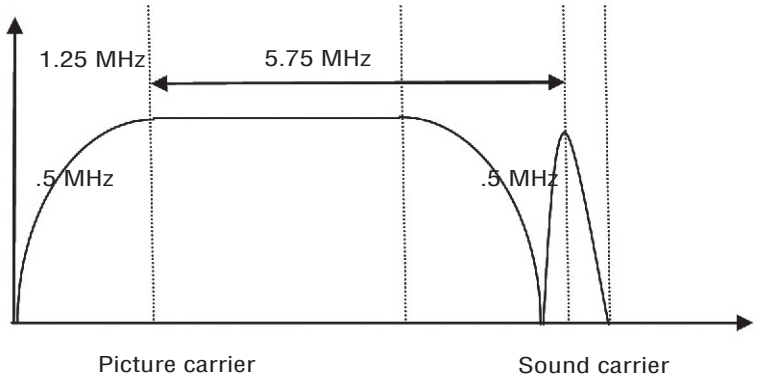


Fig.11 Bandwidth of TV System


4.13 BLANKING AND SYNCHRONIZING PULSES

The frequency of horizontal deflection signal and the fly back signal of a TV receiver is 15625 Hz. The spacing of fly back pulses position is 64 ms and 12 ms in width. That means 64-12 = 52 ms is available duration of video signal on each horizontal line. The time period of vertical deflection signal is 50 ms. These duration of corresponding frequency create the pattern of raster scan.

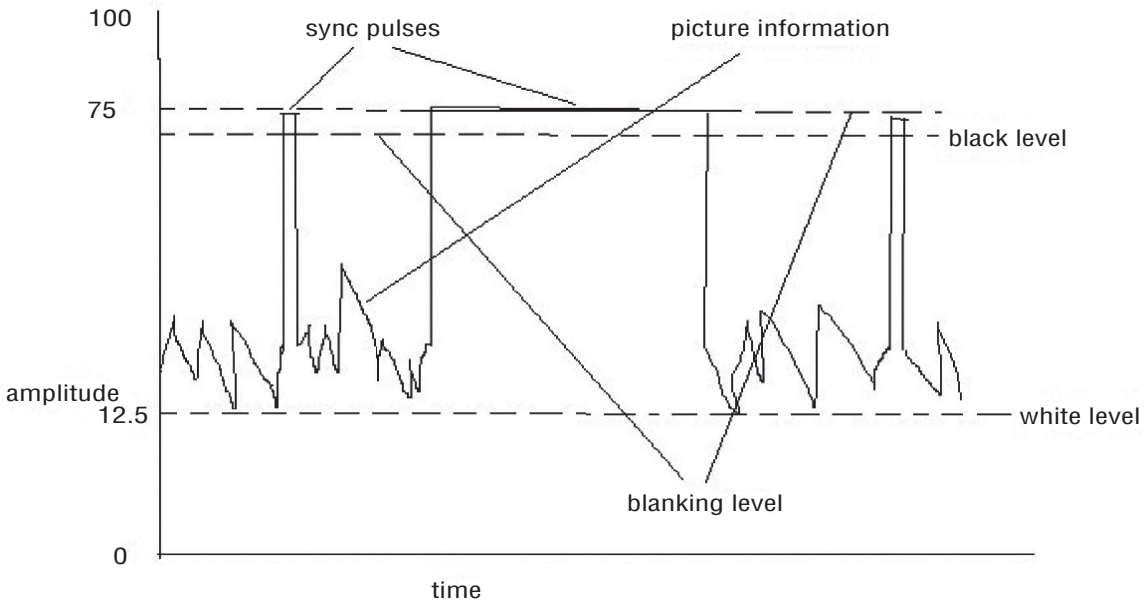


Fig.12 Blanking and Synchronizing Pulse

The nature of sync pulses are shown in the Fig.12. The horizontal sync pulses are narrower; however, vertical sync pulses are broad. Because of this feature, they are easily separated at the receiver. Low pass filter can be employed to separate vertical sync pulses and for separation of horizontal sync pulses, high pass filter is used. The plot of sync signal in time and amplitude indicates 12.5% as white level and 72% as black level. The picture information resides during the blanking period.

4.14 TELEVISION MODULATION SCHEME

Modulation is a process through which the information is modified with the help of locally generated carrier. Since in developing technology information needs to be sent from one location to another distant location, that is why without modification of signal, the information cannot be transmitted because of the following reasons;

- Reduce in height of transmitting antenna.
- Multiplexing of the signal is possible.
- Long distance communication.


- Wireless communication.
- Improved signal to noise ratio.

Therefore, the picture information needs to be modulated either analog modulation scheme or digital modulation scheme is used. For picture transmission, amplitude modulation is used and for sound transmission, frequency modulation is used. The AM is having frequency range in kilohertz and FM is having frequency range in megahertz. So far as efficiencies are concerned, AM is having poor efficiency than FM; although, they are used in different kind of modulation scheme with different kind of information signal.

4.15 MONOCHROME SYSTEM AND EXTENSION OF COLOUR TRANSMISSION

The concept of viewing from distance comes during early 80's. During the initial period, the black and white TV receiver comes into existence. Due to realistic nature of viewing, the technology drastically changed to colour television system from monochrome system. The circuit of colour television system is much more similar to monochrome system except for some additional circuit for colour processing (RGB). In colour system, three video signals are transmitted carrying same inter carrier system as used for black and white transmission. It is a colour TV receiver that separates them and gives it to trigun picture tube. Note, that these colour transmitted signals can be received by monochrome television also. Red, green and blue are three primary colours used for telecasting. By their proper percentage of mixing, the other colour can be reproduced. Characteristics of these colours can be specified as BRIGHTNESS, CONTRAST, HUE, SATURATION and LUMINANCE.

- The BRIGHTNESS represents overall intensity of illusion and can be varied to get optimum results by varying the brightness control knob.
- CONTRAST represents the difference in light intensity for white and black part of the picture. It can also be adjusted by varying the contrast control knob.
- HUE represents actual colour seen by the eye.
- SATURATION represents purity of a colour.
- LUMINANCE represents amount of light intensity.

The following are the three colour system used all over the world:

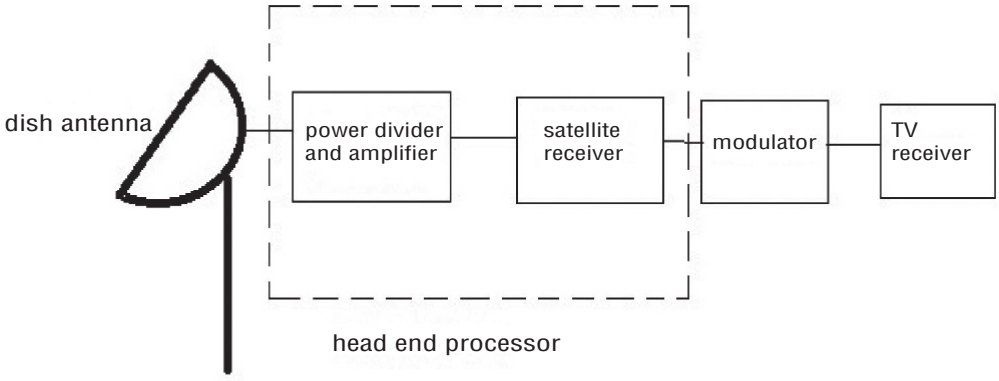
1. **PAL (Phase Alternate by Line) :** PAL system is introduced in early 1960's. It utilises larger channel bandwidth than NTSC, which results in better picture quality. The video bandwidth in this system is 5 MHz. and sound carrier frequency is of 5.5 MHz. It runs on 625 lines per frame standard.


2. **NTSC (National Television System Committee):** It was the first colour TV broadcast system. It was first implemented in US in 1953. It utilises video bandwidth of 4.2 MHz and sound carrier frequency of 4.5 MHz. It runs on 525 lines per frame.

3. **SECAM (Sequential Colour and Memory):** It was first implemented in France. It was introduced in early 1960's. It uses same bandwidth as of PAL system but transmit the colour information sequentially. Its video bandwidth is 5 MHz and sound carrier is of 5.5 MHz.

4.16 CHANNEL AND CABLE TYPE TV SYSTEM

The dish antenna is installed at the proper angular elevation for receiving down spectrum of the satellite channel. Since the signals received are weak, therefore the power levels are enhanced to sufficient level by the power amplifier. The amplified signal is then further processed in the satellite receiver normally available at the operator premises. The satellite receiver select the desired channel out of various signal received. The selected base band signal is fed to the modulator to modify according to the carrier frequency of desired channel. Since various channel can be altered one after another; therefore, the modulation unit not to be adjusted frequently. A TV receiver is connected to the output to check the performance of individual channel. Sometimes, it is desirable to prevent particular channel that can be blocked at the operator premises itself.



Fg.13 Simplified block diagram of cable TV

4.17 HEAD END PROCESSOR

It is a combination of power divider, amplifier and satellite receiver unit. In order to process a number of channels at the same time, equal number of satellite receiver are required. It is used for processing and distribution of the received signal over a cable television. As antenna received microwave signal from the satellite transponder the head end unit amplifies these microwave signals. The indoor unit process to produce video and audio signal by the use of IF amplifier, band pass filter, limiter, demodulator and de-emphasis circuit, then send to TV receiver for reproduction of video and audio signal.


4.18 TRUNK AND CABLE DISTRIBUTION SYSTEM

Cable TV is a modern system for providing TV signal to the subscriber. The service provider of the cable TV picks up all the programme relayed by satellite and route them through coaxial cable/ fibre cable to the subscriber. A special box called set top box are provided by the operator to their user to receive the cable signal. Thus, the TV set at subscriber premises can select desired channel of their choice from the set top box.

The distribution of signal is carried out with either coaxial cables or fiber optics cable. The operator sends all the received signals over these cable lines. The working of cable distribution system can be understood with the following block diagram.

Main station receives TV signal from various satellite then combining network combines these signals over a single line by multiplexer. Signal reaches from multiplexer to distribution amplifier through various amplifiers. The connecting lines of multiplexer and distribution station can either be coaxial cable or fibre optics. The distribution station distributes the signal to different cable boxes geographically located. Amplification is done at various stages. The purpose of amplification is due to the different kind of transmission losses taken place during distribution of the signal. Cable box receives and distributes these signals to the end-user called subscriber.

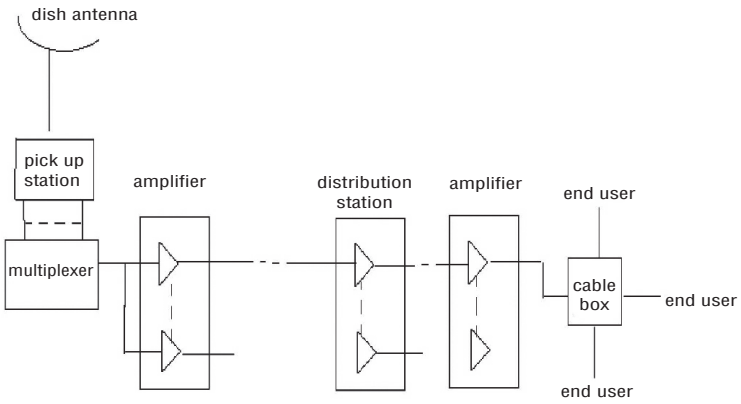


Fig.14 Simplified block diagram of cable TV distribution system

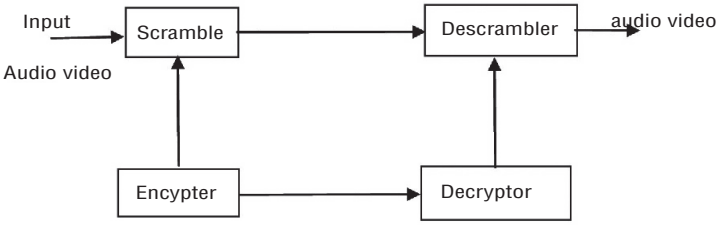
4.19 SCRAMBLING

It is the process in which the reception is restricted. Since in cable TV or in satellite broad casting system a fee based access is granted, so need is to scramble the unauthorised user. This can be achieved by using conditional based reception. A condition access is comprises of two main subsystem- one is scrambler and another is descrambler.

Scrambling and descrambling can be understood with the help of above block diagram. The scrambler restricts the access with an encryption key. This key is used at the receiver end by the descrambler to get the access of audio and video signal received by the receiver. So, the purpose is fulfilled in this way. That is the only way authorised user can received the signal. The following measures are kept in mind while designing the scrambler.

- The code should be complicated, so that it cannot be accessed by unauthorised user.

- It should be difficult for others.
- Do not lose the quality of the audio and video signals.
- Operating cost should not be high.



4.20 ROUTINE MAINTENANCE OF CABLE TV

Cable TV required essential preventive maintenance to for trouble free performance. As cable TV picks signal through dish antenna and LNBC (Low Noise Block Converter). The dish antenna required proper mounting and orientation. The orientation of dish antenna can be changed by the automatic motor assembly to get desired signal from the satellite. The LNBC is a kind of highly voltage sensitive low noise amplifier. Although it is very rugged but need regular check for dc supply to converter unit. It must be protected from rain and moisture. A special cable connects the LNBC to the head end processor that carries all the received signals.

- The cable technician should visit the network sight to check dislocation and break throughout length and distribution points.
- Potential applied across trunk and line amplifiers should be checked for proper value.
- RF signal level should be checked at routine interval.
- When new subscriber is added in particular route resulting signal level to fall, therefore another amplifier may be provided or gain of the existing amplifier may be increased.

TROUBLESHOOTING OF CABLE TV

S.N.	Subsection	Possible associated problems
1.	Dish Antenna	• Weak signal causing poor resolution and poor audio quality. • No sound but picture is received. • No picture but sound is received. • Noisy signal received. • Poor colour resolution.
2.	Head end subsection	• Improper distribution. • Distribution line does not get the desired signal. • Channel missing. • Cable TV software problem.


2.	Distribution line amplifier subsection	• Weak signals at amplifier output. • Improper distribution. • No signal at the output. • Hum in output of any particular channel. • Spikes in picture and noise in sound.
3.	Cable/setup box subsection	• No signal received by the end user. • Desired channel not received by the end user. • Discontinuity in signal flow in the cable system.
4.	End user	• Receiver is not working • No picture. • No sound. • Picture rolling. • Remote controlling device is not working.
5.	Trunking line	• No signal to any particular user. • No signal at a particular distribution route. • No signal at all cable roots. • Ghost image on end user.

4.21 LCD (LIQUID CRYSTAL DISPLAY) TV

Liquid crystal is used as display device in LCD television. A series of cold cathode fluorescent (CCFL) is used at the back of the screen for providing light in LCD television. CCFL is made up of long sealed glass tube having small diameter, inner phosphor coating and are filled with inert gas. A high voltage is applied across the tube. This causes the ionization of gases, which creates ultraviolet (UV) light that excites an inner coating of phosphor to produce visible light. CCFL is an excellent white light source, low cost and have long life.

Fig.16 LCD TV (courtesy Sony Inc.)


Liquid crystal display (LCD) is used now these days everywhere as display device. LCD is clearly replacing the CRT (cathode ray tube), because the size of CRT is bigger and it also draws large amount of power in comparison to LCD. LCD is made up of the liquid crystal. Liquid crystal is the combination of two states of matter- solid and liquid. It possess both the properties of solids and liquids and maintain their respective states with respect to another. The liquid crystal material shows more of a liquid state than that of a solid state. Liquid crystals are more heat sensitive than liquids. A little heat can transform liquid crystal into liquid.

A liquid crystal cell is placed between two glass sheets. These glass sheets contain electrodes. We can form two different kinds of LCDs on the basis of the selection of glass sheets. When one of the glasses is transparent and other is reflective then it is called reflective type. If both the glasses are transparent then it is called transitive type. The LCD does not produce luminance of itself. It entirely depends upon the illumination falling on it for its visual effects.

4.22 LED TV

LED TVs (light-emitting diode televisions) are advanced version of LCD (liquid crystal display) televisions because of their high quality of picture and least power consumption. So far as technologies are concerned both (LED and LCD) are having similar kind of architecture. The only difference is that LED televisions contain light emitting diodes (LED) behind their screen. These LEDs provides sharper graphics and more illuminating effect upon the provision of current. CCFL (Cold cathode fluorescent lamp) used in LCD for the display which contains inert gas inside tube is producing desired light for the visual that is replaced by the LED in the LED television.

Fig.17 LED TV (courtesy Sony Inc.)

Advantages

- Fine display of image.
- Having better resolution and contrast.
- Low power consumption.
- Environmental friendly.
- It is free from the defects of angle viewing which occurs in LCD.


4.23 INTRODUCTION TO HDTV

HDTV stands for high definition TV. It is assumed to be advanced digital broadcast system, which is having high degree of resolution compared to the other TV system so far available. It requires comparatively less bandwidth. It has two key features.

1. Increase in picture resolution 16:9 widescreen.
2. Support multichannel audio.

The standard NTSC and PAL system of broadcast have 525 and 625 horizontal lines. In this system, the real lines used to represent picture are said to be active lines. Both the systems have the feature of interlacing that means each frame is broken into two fields of odd and even lines which are displayed alternatively. The viewer puts them together to create complete image of each frame.

HDTV Format

It has two formats of broadcast, 720p and 1080i. The numeric number shows the resolution of vertical line in each format. The alphabet 'p' and 'i' stands for progressive and interlaced scan that means they are unisum, not been split into fields. In 720p, the image made of horizontal 1280 lines and 720 vertical lines. Therefore, the full image is represented in a single frame.

In 1080i the images are made of 1980x1080 lines and represent as two fields both are interlaced. The quality of these interlaced images is not very smooth in contrast to the progressive one as per the studies carried out. The video bandwidth required five to six times more than that of conventional TV system. E.g. video bandwidth is 5 MHz for 625 lines system and hence relative HDTV bandwidth required will be 30 MHz. Such a large bandwidth decreases number of channels to be transmitted. To overcome this problem band compression technique is used to decrease the bandwidth. The important consideration of HDTV in comparison with television systems are as follows:

- HDTV is having more scanning lines than conventional TV system.
- HDTV aspect ratio is more than conventional TV system.
- HDTV requires more bandwidth than conventional TV system.
- HDTV propose progressive scanning while conventional TV system uses interlaced scanning.

HDTV Receiver

To receive image of broadcast, we need TV set with built-in HDTV receiver, which is capable of receiving HDTV channels. HDTV receiver receives composite video signal. Then it decodes and demodulates to get the transmitted audio and video signals. the composite signal is demultiplexed into audio and video bit streams and then decompressed. Then thereafter these bit streams are


converted into analog form by the application of D/A converter. The analog audio signal drives audio section and the video signal drives video section of the HDTV receiver. In this way HDTV receiver reproduce audio and video information. They are having wide range of applications such as production of motion picture, video theatre, printing and health diagnosis.

4.24 TROUBLESHOOTING OF TV RECEIVER

Troubleshooting is the process finding and rectifying the problem in the TV receiver. So that the optimum performance of can be achieved. If receiver deviates in the performance, the first step is to establish the presence of fault. Then with proper diagnosis pin point the fault location and accordingly rectifying the problem.

Flow Chart for Fault Finding and Rectification

Try to know the previous symptom if any from the user

↓

Inspect visually for physical damage

↓

Look receiver for smell/noise

↓

Look the manual for test point provided by manufacturer

↓

As per instruction find out the sub-section in which fault occur

↓

Check proper dc voltage, current in that sub-section

↓

If found improper replace faulty parts

↓

Test for performance for satisfactory result

↓

If not repeat the procedure


Some General Causes of Failure

Failure of TV receiver refers to its inability to perform the required function. Failures may be partial, may sudden breakdown of required function or complete failure. A sudden failure may be caused by open or short circuit failure in capacitors or in potentiometers. A gradual failure may happens because of poor design, production deficiency, improper storage, transport and the environment of TV receiver in which it is placed. Some of the causes of failures are listed below:

- Wrong choice of components.
- Excessive heat because of lack of cooling.
- Unsuitable storage method.
- Sub-standard manufacturing equipments and tools.
- Insufficient testing and inspection.
- Long storage of TV receiver at production house.
- Improper packaging.
- Excessive vibration in transport.
- Fluctuation in main supply.
- Poor preventive maintenance.
- Ageing of equipment.

First Look for Troubleshooting

1. Check visually the receiver gadget for damage/burn.
2. The orientation of antenna should be properly adjusted since both audio/radio signals are picked up by antenna. A poorly installed/oriented antenna may cause lose/distortion in picture/sound quality.
3. Check for proper supply that may cause the receiver dead.
4. Proper tuning is required to particular band of frequency comprises of information. It may lead to blinking of raster if not properly tuned.
5. Check the battery of remote that may cause defects in the selection of channel, contrast, sound etc.

Repairing of TV Receiver

For deep troubleshooting and diagnosis of the problem of the TV receiver we have to understand the complex circuit named as motherboard mounted on the backside of the picture tube and


picture tube associated circuit. According to their function they are categorised into the following subsection and the problems associated with that subsections are described below.

S.N.	Subsection	Possible associated problems
1.	Antenna subsection	• Weak picture signal and weak sound signal causing poor resolution and poor audio quality. • No sound but picture is received. • No picture but sound is received.
2.	Tuner subsection	• No sound. • No picture. • Normal picture but no sound. • Distorted picture but normal sound. • Noisy sound but normal picture.
2.	Power supply subsection	• Receiver is dead. • No sound no raster. • No sound. • No raster.
3.	Horizontal subsection	• No raster. • Insufficient width of raster. • Picture fold over. • Picture rolling. • Nonlinearity in horizontal direction.
4.	Vertical subsection	• No picture. • No vertical deflection. • Picture rolling. • Bright horizontal line. • Vertical height is distorted.
5.	Video subsection	• No picture. • Negative picture. • Distorted picture.


6.	Audio subsection	• No sound. • Hamming sound. • Distorted sound. • Sound bars.
7.	Picture tube and associated subsection	• Only sharp ray of light on the screen. • Picture rolling. • Picture is not centred. • No ray of light on screen.

If the problem mentioned above is diagnosed then look into the concerned subsection for the fault removal or the removal of faulty component. The component should be checked properly for the problems like burnt component, dry soldering and open circuited, short circuiting. Sometimes problem is due to single faulty subsection and it may be due to fault in multiple subsections.

Review Questions

1. Explain the working principle with the help block diagram of TV transmitter.
2. Draw the neat block diagram of TV receiver. Explain each block in brief.
3. What is the modulation schemes used in TV receiver? Explain.
4. Draw the picture tube circuitry and explain how the picture is formed on the screen.
5. What are the preventive measures observed in a TV receiver?
6. While servicing the following symptoms were observed indicate the faulty section and possible faults.
   a) No picture no sound
   b) Distorted sound at the output
   c) Horizontal bars on the screen
   d) Ghost image
   e) Vertical rolling of picture
7. Explain the following with their circuit diagram:
   i) TV tuner
   ii) IF stage


iii) Picture tube and associated circuit

iv) Synchronization circuit

v) Horizontal and vertical circuit

8. Write down the features of remote control of a TV receiver.

9. Investigate the trunk and cable distribution system of a cable TV.

10. Summarise your answer about channel and cable TV system.

11. Write note on the following:

i) LED TV

ii) LCD TV

iii) HDTV


UNIT - 5

MODERN APPLIANCES

5.1 UNIT OVERVIEW & DESCRIPTION

OVERVIEW

The detail analytical description of the following appliances with their block diagram is discussed in student friendly language:

- Microwave oven
- Telephone
- Fax machine
- Printers
- Scanners

Troubleshooting and preventive maintenance procedures are briefly highlighted.

Knowledge and Skill Outcomes

Student will get the basic understanding of the working principle of microwave oven, telephone, fax machine, printers and scanners. Basic guideline for the repair and maintenance of different over said devises.

Resource Material

1. *http://www.ti.com/solution/scanner*
2. *http://www.explainthatstuff.com/faxmachines.html*
3. *http://www.intechopen.com/books/microwave-heating/microwave-synthesis-a-physical-concept*
4. *http://www.fixyourownprinter.com/forums/laser/64375*
5. *http://h20564.www2.hp.com/hpsc/doc/public/display?docId=emr_na-bpl07726&sp4ts.oid=25475*
6. *http://dl.21ic.com/ebook-992.html*
7. *http://www.threeyem.com/knowledge-base/parts-of-the-toner-cartridge*
8. *http://www.epanorama.net/circuits/teleinterface.html*
9. *http://www.google.com/patents/US5768675*
10. *http://www.manualslib.com/manual/465383/Hp-Laserjet-5000.html*
11. *http://www.barnesandnoble.com/w/subscriber-loop-signaling-and-transmission-handbook-whitham-d-reeve/1000475863?ean=9780879422745*
12. *https://www.scribd.com/doc/2262358/LASERJET-1150-1300-Service-Manual*
13. *http://www.manualslib.com/manual/472617/Hp-5000gn-Laserjet-B-W-Laser-Printer.html*
14. *http://www.researchgate.net/publication/221913895_Microwave_Synthesis_a_Physical_Concept*
15. *http://www.bryair.com/casedetails.php?downMenuID=6&downMenuFields=Brygram&CaseID=45*
16. *http://www.docme.ru/doc/124208/service-manual---hp-laserjet--m1005-mfp*
17. *http://www.google.it/patents/EP0356038A2?cl=en*
18. *http://www.manualslib.com/manual/440749/Hp-Laserjet-4v-Mv.html*
19. *http://yarchive.net/phone/loop_current.html*
20. *Modern Electronic equipment by R.S.Khandpur, TMH publication.*
21. *Consumer electronics by J.S.Chitode, Technical publication.*


Duration

14 Hours

Assessment Plan

- Question and answers
- Group discussion
- Mock tests

5.2 MICROWAVE OVEN

Working Principle of Microwave Oven

Microwave oven works differently from conventional ovens. Conventional oven cooking procedure includes conduction and radiation, in which a lot of energy gets wasted. As we know almost every food contains water and it is a bipolar molecule and when electric field is applied to these water molecules, it gets aligned according to the electric field applied. Inside a microwave oven when electric field due to the microwave radiation is applied to the food, the water molecules in the food gets directed according to the electric field. The change in the direction of electric field causes the change in the alignment of water molecules. These changes cause vibration in water molecules and during this whole process the water molecules collide with each other and with its surroundings. This leads to generation of heat inside the cooking food and in this way we get the food cooked.

Block Diagram of Microwave Oven

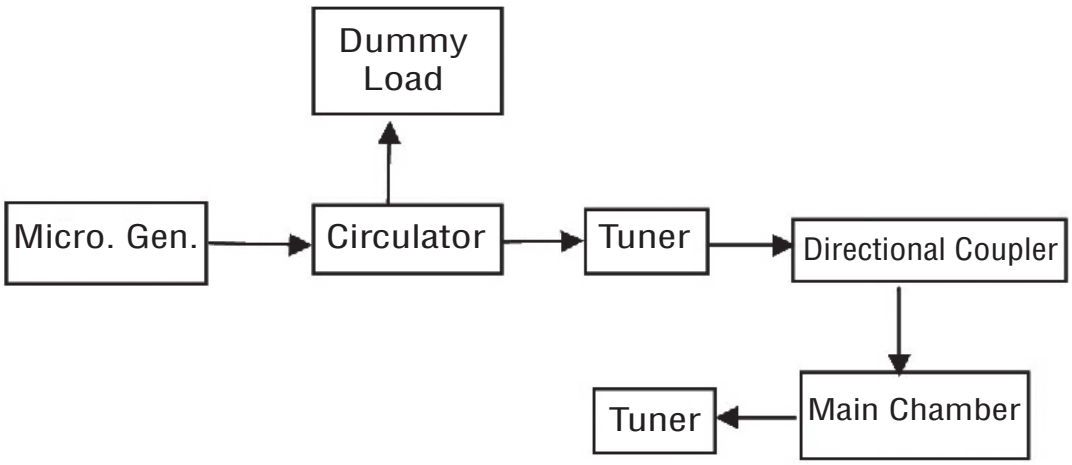


Fig.1 Simplified Block diagram of Microwave oven

Microwave Generator

A magnetron is a diode, usually cylindrical, with a magnetic field parallel to its axis. In modern usage, however, the magnetron implies a diode that, with the aid of a magnetic field, produces short electromagnetic waves. Those magnetrons which produce radiation within the wavelength range of 1 to 30 cm are herein defined as microwave magnetrons. This is one class of tubes sometimes referred to as cavity magnetrons from the fact that, in the usual design, the resonant circuit is a number of closely coupled cavities contained within the evacuated portion of the tube. It is thereby used to generate high power of microwave energy. Microwave power is generated by using Klystrons, Magnetrons, Gyrotrons and Travelling Wave Tubes (TWT). Klystron has precise control in amplitude, frequency and phase. Magnetrons are widely popular in microwave heating due to their easy availability and low cost. Gyrotron provides much higher power output and beam focussing. TWTs provide microwave energy with variable and controlled frequency.

Circulator

A microwave circulator is multiport wave guide. For the simplicity, we have considered four-port microwave circulator which is a combination of two 3dB side-hole directional coupler. A rectangular wave guide with two non-reciprocal phase shifter is as shown in figure below. The operating principle can be analysed with the figure. Each of these two 3dB couplers introduces a phase shift of 90 degree. When a wave is introduced to port-1, consequently the coupler-1 splits into two components. Now, the incident wave arrives at port-2 with a phase change of 180 degree. The second wave propagates through the two couplers are arrived at port-2 with 180 degree phase shift that means these two waves reaching port-2 in same phase.

The wave propagates through the primary guide, phase shifter, coupler-2 are reached at port-4 with the phase shift of 270 degree. The wave passes through coupler-1 and secondary guide and finally it reaches at port-4 with the phase shift of 90 degree. Therefore, these two waves meet port-4 are 180 degree out of phase and hence power transmission from port-1 to port-4 is zero.

Tuner

It is a device used to match power between source and load. Normally, there are two kinds of matching performed by tuner. They are capacitive as well as inductive matching that can be executed with the use of suitable wave guide. There operation can be summarised as when a source is connected with capacitive/inductive load, the waveguides are varied in proportion to the power, so that their impedances are matched.

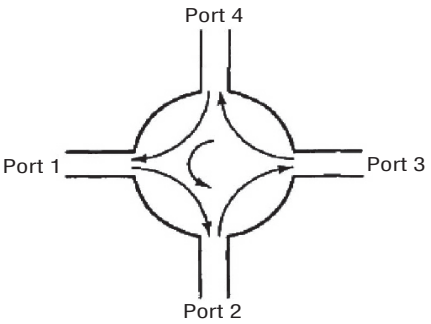


Fig.2 4-port Circulator


Directional Coupler

A four port directional coupler consists of primary waveguide 1-2 and secondary waveguide consists of 3-4. Free transmission of power only happens when all the four ports are terminated to their characteristics impedances. There is no transmission of power between port-1 and port-3 or between port-2 and port-4. Reason being, there is no coupling exists between these two pairs of ports; however, free transmission occurs between port-1 and port-2. The degree of coupling between port-1 and port-4 and between port-2 and port-3 depends on the structure of coupler. There characteristics may be expressed in terms of coupling factor and directivity. In the figure, it is expressed the wave propagating from port-1 to port-2 is in the primary line. The coupling factor and directivity are calculated as

Coupling factor (dB)=$10\log_{10}(P_1/P_4)$

Directivity(dB)= $10\log_{10}(P_4/P_3)$

P_1=Power Input

P_3,P_4=Power output from respective ports

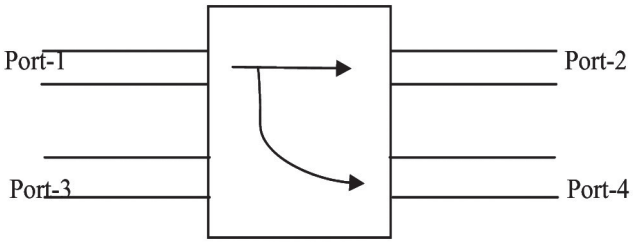


Fig.3 Four port directional coupler

Main Chamber

It is a cavity like place as shown in figure below. This space is solely used to place and process food items. Through the cavity structure microwave power is coupled inside the wall of the chamber. The inner walls are made of metallic reflector that reflects the microwave energy and form standing waves. The rotating base over which food items are placed gets uniform power because of their synchronous rotation.

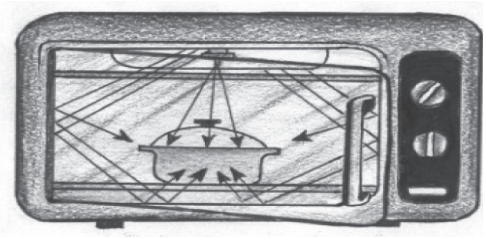


Fig.4 Microwave oven chamber

Microwave Oven Troubleshooting Guide

Microwave ovens are referred to as the most dangerous of consumer product to consumer service due to high voltage and high current. Even after switching off the device, there is energy storage stored that retain dangerous charge for a long duration. So the troubleshooting of the device requires high level of precautions.

Safety Guidelines and Troubleshooting

The following helpful guidelines can prevent you from any fatal shock and also will prevent any form of damage to the device:

- Always use rubber shoes to break completion of current path.
- While removing some circuit board, use insulating material.


- If soldering is required inside the circuit board, first discharge the capacitor with appropriate load resistance.
- Use testing processes always in unplugged state.
- Always troubleshooting work will be done when you feel free from tiredness or fatigue.
- Do not take short-cut for repairing of the device.
- Always use high quality repairing tools.
- Use proper place for any type of repairing purpose.
- A few components of dead microwave can be used in any other device such as interlock switches, magnetrons etc.

5.3 TELEPHONE

The Graham Bell invented the telephone system in March 1876. He realised the communication between two people at distant places can be established by electrical means of transmission. The telephones are categorised as follows,

Simple phone: It is a simplest type of telephone set that primarily consist of hand set, hook switch and a ringer. It is now obsolete.

Dialling type telephone: It consists of handset, mechanical dialling system, hook switch and ringer.

Electronic/Digital phone: It is widely used telephone set in India. It consists of push button key pad. These buttons are in connection with the electronic circuit as and when the buttons are pressed, the circuit transmit pulse or tone to the electronic exchange through the telephone line.

Cordless phone: It is a combination of two units-portable unit and base unit. The base unit is connected with the telephone line. Portable unit is a combination of transmitter and receiver with small antenna. The base unit is also having radio transmitter and radio receiver with a small aerial. The range of communication is the drawback of cordless phone which is very small around 20-30 meter.

Mobile phones: Mobile phone does not require any physical connection between transmitter and receiver. Because of its easy and flexible size and service it covers a very large number of populations throughout the world. The mobile unit consist of transmitter, receiver, dialling pad, antenna, microprocessor chip, display unit, battery etc.

The telephone is a modern electronic device used for voice communication between two people separated at distance. When the communication is established between the two, the exchange sends steady current to both speakers and listeners. The steady nature of currents fluctuates in proportion with the sound pressure of microphone. The resulting air pressure fluctuation causes sound of human voice to be communicated. Block diagram of digital telephone set is shown below.

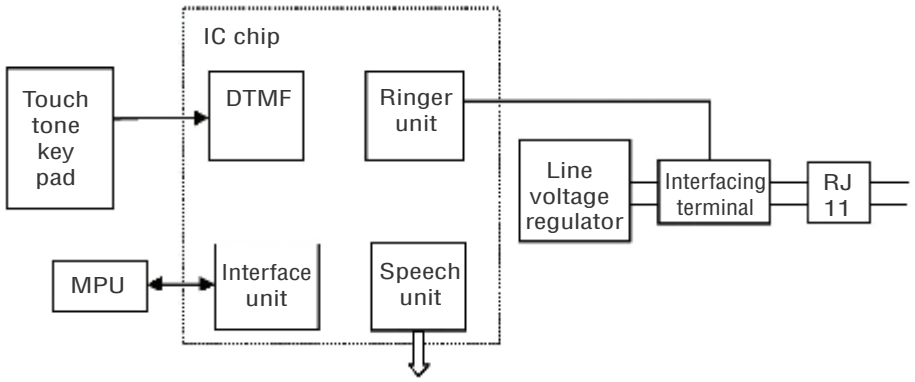



Fig.5 Block diagram of telephone receiver

DTMF

It stands for dual tone multiple frequency and widely used in telephone industry. DTMF audible tone is generated when any key on telephone is pressed. If we press any key namely "1", "2", "3", "*" etc., a particular code is transmitted. This code consists of two frequencies amongst which one is higher frequency and other one is lower frequency. The circuit diagram for the DTMF generation is shown below in figure. The DTMF circuit uses a single contact of key on keyboard at one time and provides rest of the switching function electronically. The circuit operates over the supply voltage range from 3 volts to 15 volts.

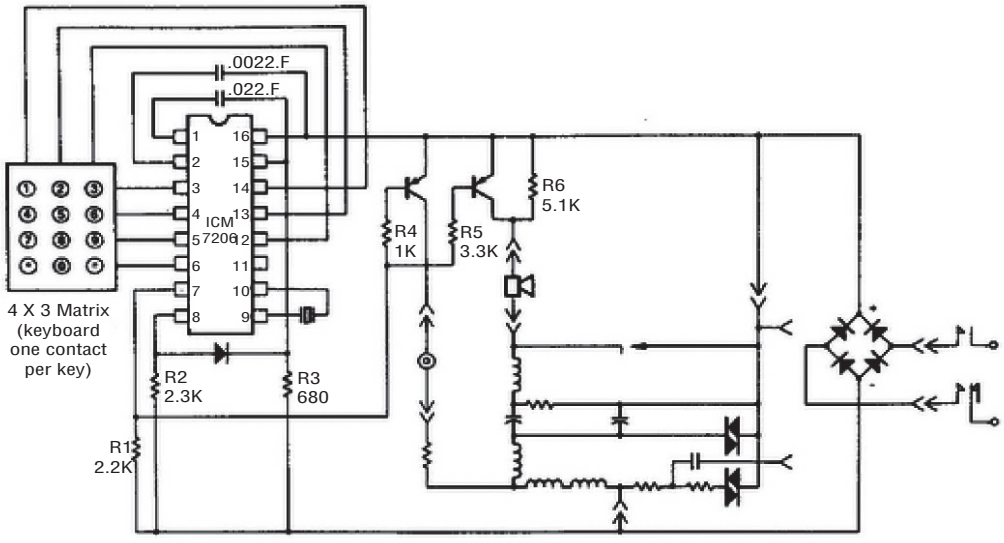


Fig.6 DTMF circuit diagram

(http://www.next.gr/telephone/dtmf-circuits/Telephone-handset-tone-dial-encoderl13028.html)

Tone Ringer Unit

It is an electronic chip and small speaker. The capacitor is used in series with ring IC input to block the DC and passes AC to the ringer chip. Their frequencies range between 16 Hz and 60

Hz. The simplified circuit diagram of tone ringer circuit is shown in figure below. This is a complete telephone ringer circuit having minimum components with Diode Bridge and transient protection on the IC chip.

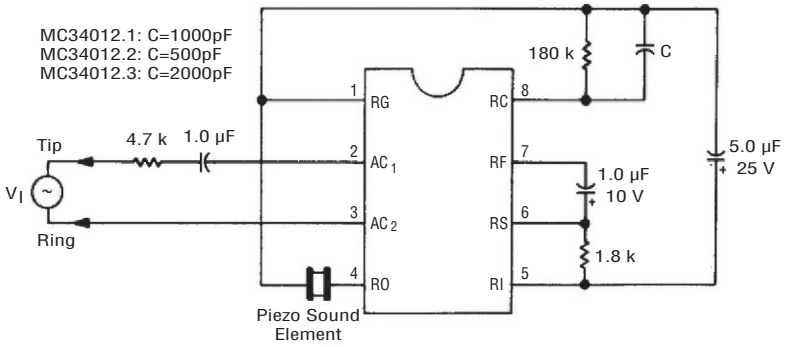


Fig.7 Tone ringer circuit (courtesy http://www.next.gr/telephone/ringers/Telephone-tone-ringer-I13017.html)

MPU and MPU Interface Unit

The microprocessor unit gives all necessary computing power to the system with the help of memory devices and input/output ports. Microprocessors are especially designed control applications. These units are made up of micro chip to interface with different units of the telephone sets. They are providing necessary timing and control signals.

Speech Network

Speech networks carry the basic functions required for handset communications. It amplifies signals from a transmitter and sends them to a telephone line. They also amplify received signals from a telephone line and drive the receiver.

Line Voltage Regulator

The integrated circuit that performs all speech and line interface functions required in an electronic telephone sets. It performs electronic switching between speeches and dialling digits. This regulator circuit can safely convert the base phone signal. During ringing some of the voltage regulator may not handle the AC signal. We can use a diode as shown in figure between phone line and the input pin of the regulator. This will protect the circuit from problems that may caused by reverse polarity.

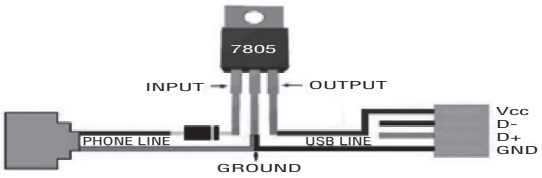


Fig.8 Line voltage regulator (courtesy http://www.k9ham.org/mergencypowerphoneline.htm)

Loop Interface Unit

The loop is a transmission and signalling channel or path between a telephone subscriber's terminal equipment and the serving central office or another piece of terminal equipment. "Transmission" implies transfer of information while "signalling" implies the actions required to control the transmissions.


Terminal equipment includes:

- Telephone set
- Fax machine
- Electronic Private branch exchanges (EPBX)
- Touch pad Key telephone
- Voice mail systems
- Modems
- Computers
- Alarm systems
- Control unit
- Telephone answering machines

RJ11

A telephone plug is a type of connector used to connect a telephone set to the telephone wiring inside a building, establishing a connection to a telephone network. It is inserted into telephone jack, commonly affixed to a wall or baseboard. The standard for telephone plugs varies greatly, though the RJ11 modular connector has become the most common. Detailed pin configuration of RJ11 is shown in figure below.

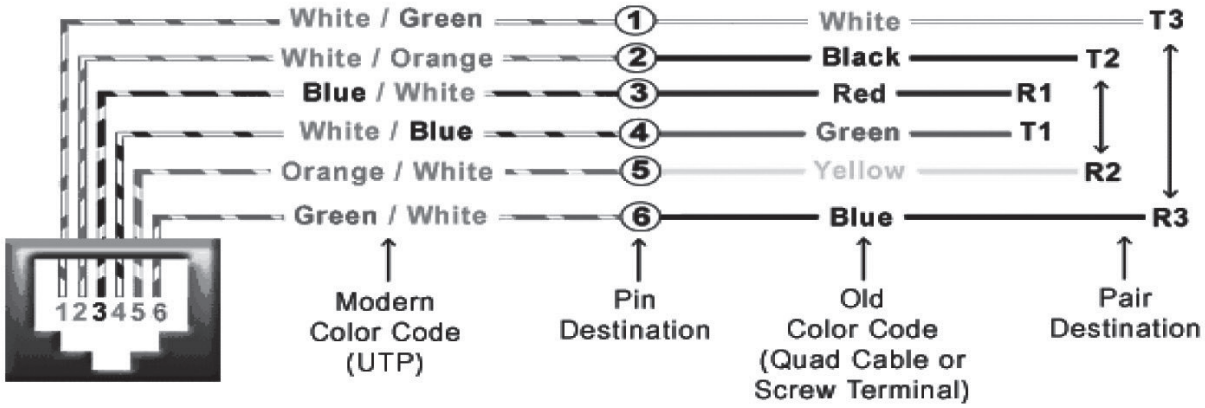


Fig.9 RJ11 pin configuration (courtesy http://cablesupply.com/content/47-telephone-connections-and-rj11)

Touch Tone Pad

The touch tone pad comprises of number of buttons by pushing the buttons connection are made. It generates two tones from 'Row' and 'Column' simultaneously. The keypad touches two contacts


when it will be pressed. The signal encodes a pair of sinusoidal tones. The telephone company knows the number from where it is dialled and it also gets the information by the dialled tone to which it is dialled.

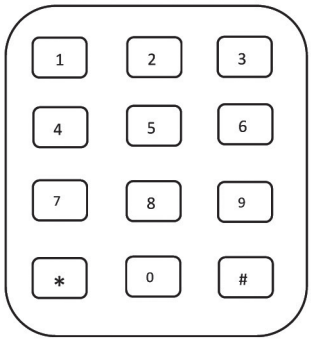


Fig.10 Touchpad

Safety Issues of Telephones

Telephone sets are shield with plastic case. In general, there is no danger of electric shock. The two types of voltages- AC and DC are available in telephone lines. The DC voltage of 48V does not cause any harm, but the AC voltage of 120V may cause a minor shock. Some of the measures the user must remember;

The following devices should not be place either in series or in parallel:

- Batteries
- Polarized capacitors
- Diodes
- Quarter watt resistors

All of the above constitute safety hazard and should be avoided because of the chances of explosion.

5.4 PRINTER

A printer is a peripheral which make a persistent human readable representation of graphics or text on paper or similar physical media. In simple printer is most simple output device which is used to print information on paper. Printers are essential to getting output of any computer based application. They are broadly classified in two categories-impact printer and non impact printer.

The printer that prints the character by striking against the ribbon and on the paper are called impact printer. They may be character type or line type printer. However the non impact printers print the character without striking against the ribbon and onto the paper. They are categorised as LASER printer, inkjet printer and thermal printers.

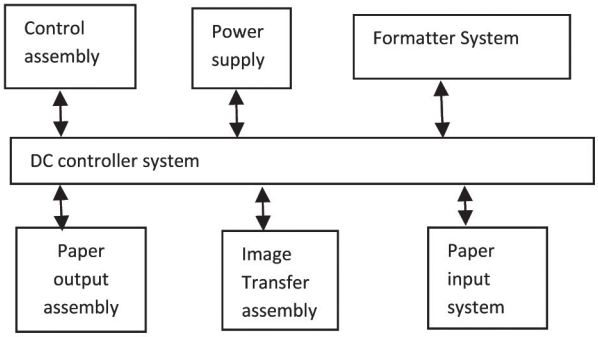


Fig.11 Simplified Block Diagram of printer

Power Supply System

The low voltage power supply (LVPS) contains AC and DC power supply circuit. The high voltage power supply (HVPS) uses DC biased AC voltage that are primarily used for charging roller to


charge the roller in proportion to the image to be transformed over developing unit. The toner section (printing material) is also connected with HVPS.

Formatter Section

The formatter PCA is responsible for the control of the following:

- The power save mode.
- Receiving and processing print data from the various printer interfaces.
- Monitoring control panel inputs and relying printer status information (through the control panel).
- Managing of data placement with print engine.
- Storing font information.
- Communication with the host computer.

Paper Input System

On the basis of information received from formatter section DC controller sends information to the scanner unit to modulate the LASER diode on and off and drive the scanner motor. Once the image is scanned, the paper input sensor activated resulting paper starts moving inside for print process with the help of clutches and input roller.

Controller System

The below mentioned systems and functions are controlled by the DC controller PCA:

- DC power distribution
- Laser and scanner unit.
- Paper movement.
- Clutches (registration, tray pickup, and tray feed)
- Motors (main drive, scanner, and fans)

On the basis of information received from formatter, the controller sends signals to the laser/scanner section to modulate the laser diode ON and OFF and to drive the laser/scanner motor.

Image Transferring Unit

It is a xerographic process that includes electronics, optics and electro photographic for printing operation. The image building process consists of the following:


- Drum Cleaning
- Drum Conditioning
- Image Writing
- Image Developing
- Image Transferring and Media Separation
- Image Fusing

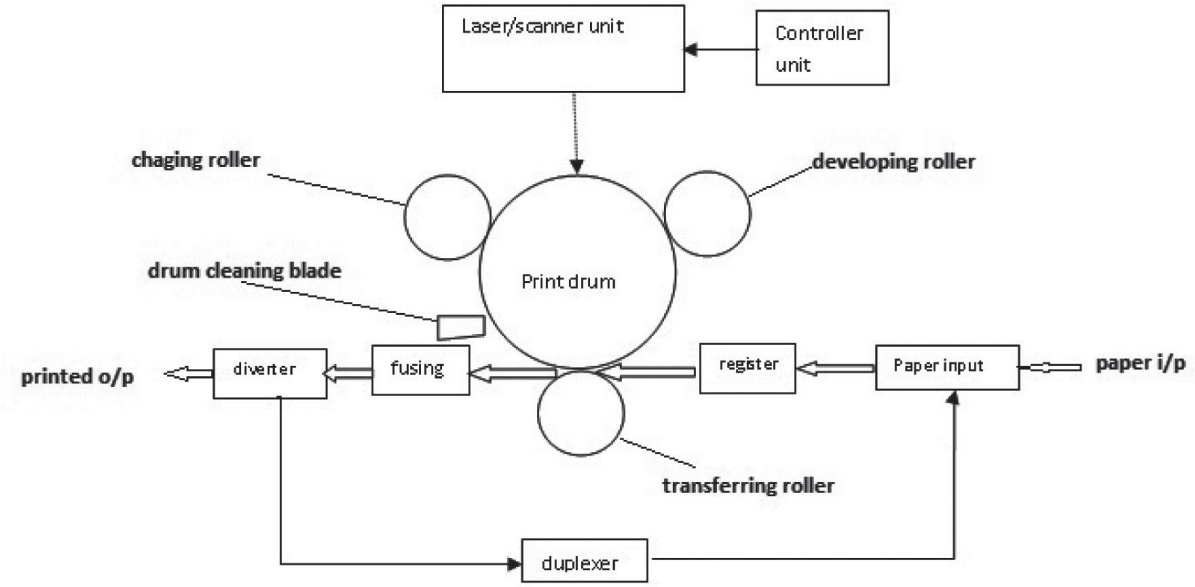


Fig.12 Image Formation Block Diagram

Toner Cartridge

The toner cartridge is referred to be the “heart” of the Image Formation System. It incorporates the cleaning and developing process. The toner unit is composed of the photosensitive drum, primary charging roller, developing station, toner cavity and cleaning station.

The Photosensitive Drum

The image from the scanner after scanning with laser beam is written on the drum surface. The drum is an aluminium cylinder. The aluminium base of the photosensitive drum is connected to ground potential. The outer layer of the cylinder is coated with a thin layer of non-toxic organic-photoconductive (OPC) material. The property of OPC material is electrically conductive when exposed to light. The drum surface is conditioned with negative charge after proper cleaning. When an area on the drum surface is exposed to the laser light beam, the negative charge in that area is conducted to the ground potential of the drum base and thus becomes more positive. The unexposed area is remained negatively charged.

Fig.13 Photosensitive Drum with aluminium base

Image Developing

The developing process transforms positively charged proton to a visible image by depositing negatively charged toner particles on the charged areas of the drum and the drum rotation around fixed magnetic core. The toner is made up of very fine black plastic powdery substance bound to iron particles. These particles get attracted by the magnetic core of the developing cylinder. A rubber blade “brushes” the toner on the developing cylinder to a uniform thickness.

Due to the rubbing of toner particles and developing cylinder, a static negative charge is developed. The negatively charged toner is attracted to the discharged (exposed, more positive) areas of the drum and repelled from the negatively charged (non-exposed) areas.

Image Transferring and Media Separation

The image transferring process is carried out with the transfer of toner image on drum to the print media. The backside of the print media is positively charged by the transfer roller to attract the negatively charged on the drum surface. The stiffness of the paper and the small diameter of the printing drum cause the separation of paper from the printing drum. The fixed eliminator teeth play an important role to separate paper from the printing drum. The fixed eliminator teeth reduce the attractive forces between the negatively charged drum surface and the positively charged paper. Hence that is why the paper does not wrap around the printing drum and we get the printed material on the paper. Now the drum is cleaned so that it is prepared for the printing of next image.

Image Fusing

The fusing unit fixed the toner particles into the media with a hot roller and a soft rubber roller. Both are assembled one above other such that there is no gap in between. The rotation is in such a way that paper rolls out smoothly. The hot roller contains halogen lamps inside that generate heat for the fusing process.


Paper Output Unit

It contains sensors, brushes, solenoid, clutches motor fans and a tray to pick up the printed paper that comes out from fusing unit. Thus, printed material is available at exit tray.

Troubleshooting of Printer

S.N.	Problem	Possible Solution
1	No printing	• Check the power supply • Check power cord • Check line fuse • Check power switch
2	Paper skewing	• Check the feed tray • Check the feed roller and lever
3	Misaligned ink ribbon causing tracking problem	• Check proper installation of ribbon
4	Dirty print quality	• Adjust penetration head
5	Light print quality	• Change the toner cartridge
6	Missing printed letter	• Open the front cover and clean the scanner head with cotton.
7	Straight line on the printed paper	• Check the drum for scratches and if found change the drum
8	Paper jam	• Check the input tray, feed roller, fusing unit, output hot roller, output tray
9	Does not take print commend from computer	• Check for proper driver installation for the printer

5.5 FAX MACHINE

A fax machine is designed to send and receive documents. So it contains a transmitter as well as receiver section. The transmitter section is similar to computer scanner with a charged coupled device. It scans the image line by line. It looks at each line separately, scans the black areas and the white areas, and transmits electric pulse on the phone line to represent it in black and white. The information is transmitted to other side fax through phone line. The receiver side fax machine receives information in the form of electrical pulses. If the receiving fax hears “black”, it draws a tiny black dot on the page, if it hears white, it moves along slightly, leaving a white space. It takes about a minute to transmit a single page of writing. In this way, fax machine works to transmit black and white lines from sending end to receiving end.

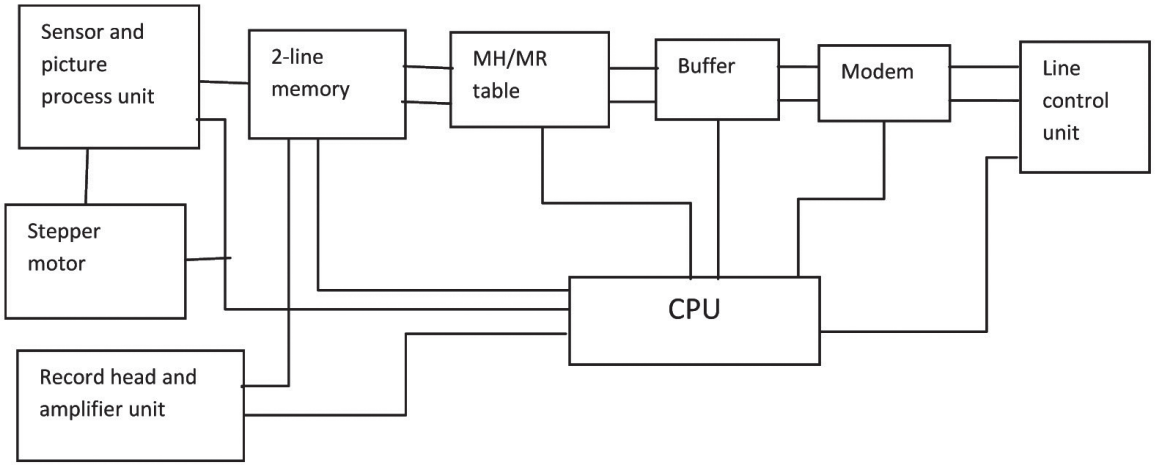



Fig.14 Block diagram of fax machine

Working of Fax Machine

- To send a fax, we put the transmitting image paper into the input slot and it is hence pulled in between several pairs of rollers. Larger fax machines have built-in document feeders that automatically take in multiple pages from a stack, so we don't have to stand at the machine feeding in pages one at a time.
- As the paper moves forward, a bright light strikes onto it. White areas of the page reflect maximum light; black/dark areas reflects very little or none.

Fig.15 Fax machine
(courtesy Panasonic inc.)

- The reflected light off the page falls over the charged coupled device.
- The job of charged coupled device is to transform the analog pattern of black and white areas of the pages into digital pattern and passes the information to the corresponding electronic circuits.
- Now the circuit sends the digital information to the telephone line to the fax machine at the receiving end.
- When we receive a fax, the same circuit takes incoming digital information from the phone line and direct it to a built-in printer.
- In fax machine, paper is pulled from a larger roller inside the machine.
- In the thermal (heat-based) printer, operated by the circuit, reproduces the incoming fax on the paper as it moves past.


- An automatic blade cuts the page and the printed document comes out from the slot.

In the internal structure, we can see that there are two separate machines working together in a fax sending fax and receiving fax. When we use fax machines to photocopies of documents, these two sending and receiving modes are linked together to make photocopies of the original document.

Troubleshooting of Fax Machine

S.N.	Fault	Possible solution
1	Fax machine is dead	• Check the power chord • Check the power supply • Check the power fuse • Check the ON/OFF switch
2	Printed Image is dirty	• Clean the drum section • Clean the scanner head • Clean the fusion section
3	Fax does not received	• Check the telephone line if tone is not available, check the connecting jack
4	Paper jam problem	• Check the input tray and roller • Check the image fusing unit roller • Check the levelling of fax machine • Check the exit tray roller and brush
5	Scanning problem	• Check the lamp • Check the gear, pulley and motor of scanner section

5.6 SCANNER

Scanners are the input peripheral device which is used to transfer images into digital form. These images can be documents, pictures, graphics, photograph etc. The selection of scanner depends on the volume and type of material to be scanned and can be selected as drum scanner, flatbed scanner, sheeted scanner, small hand held scanners etc. The small hand held scanners are

Fig.16 Scanner (courtesy http://www.avrent.co.uk/S/AVRent_IT_Data_Equipment_Scanners-(83).aspx)


widely used with microcomputer. Scanners vary greatly in several basic ways i.e. scan speed, bit resolution and signal-to-noise ratio (SNR). There are tradeoffs to each of these parameters.

Resolution: There is a direct correlation between the bit resolution and the AFE (analog front end). Higher bit resolutions (more digitized bits per pixel) give smoother greys, more natural colour and more "photorealistic" images. The higher bit resolutions also help to give more dynamic range, the difference between the black level and the white level. Dynamic range is particularly important for seeing details in dark or shadowed regions or when an image includes both shadow and sunlit areas.

Scan Speed: There is a direct tradeoff between scan speed and resolution and signal to noise ratio. Slower scanners will tend to be higher resolution and have a higher signal to noise ratio, but these specifications can be improved at higher scan speeds with a faster AFE and processor. Thus the more precise scanner motor should be desired.

Signal-to-Noise Ratio: The signal-to-noise ratio or SNR is dependent upon the entire signal chain, from the image sensors to the AFE. This is important for document scanners if OCR (Optical Character Recognition) or other image processing will be performed. It is important in photo quality scanners to eliminate graininess in images. A higher resolution necessitates a better SNR to maintain quality.

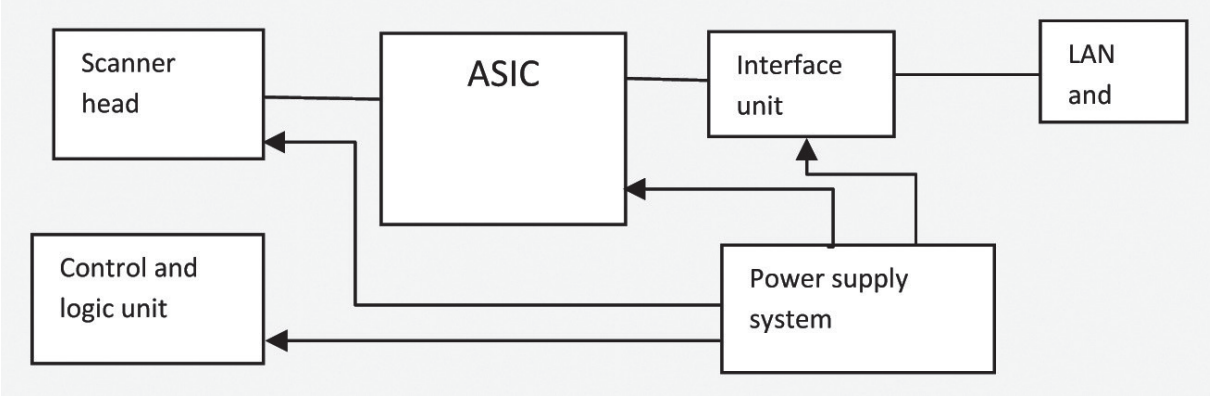


Fig.17 Simplified block diagram of scanner

Depending on the volume and type of the material to be scanned we can use drum scanner, flat bed scanner, sheeted scanner or even small hand held scanner. The small hand held scanners are frequently used with microcomputer. Most of the manufacturer responded to user reluctance to use scanners smaller in size and paper to be scanned at cheaper price. Most of these new devices sit between keyboard and monitor and can be interfaced with fax machine. There purpose is to convert scanned image into numeric digits before storing it into the computer.


Troubleshooting of Scanner

S.N.	Fault	Possible solution
1	Scanner is dead	• Check the power supply • Check the power cord • Check the power fuse • Check the ON/OFF switch of scanner
2	Scanner is not moving	• Check the scanner pulley • Check the motor • Check the gear
3	No scanning image	• Check the lamp if fused replace it
4	Image is not clear	• Clean the lamp • Clean the mirror • Clean the glass
5	Scanner does not work	• Check for the proper software installation

Review Questions

1. Explain the working principle of microwave oven and show how food grains are get heated.
2. Write down the basic principle of telephony with the help of block diagram.
3. How fax machine converts images into electrical signals for transmission of messages?
4. Write down the need of printer. Discuss image transfer unit?
5. What is scanning process? Briefly explain with block diagram?
6. Write down the safety procedure for the following:
   - i) Microwave oven
   - ii) Telephone
   - iii) Fax Machine
   - iv) Printer
   - v) Scanner
7. Write down the various possible faults and their solution for a printer.
8. Write down the various possible faults and their solution for a fax machine.
9. Write down the various possible faults and their solution for a scanner.