ELECTRONICS MECHANIC

TRADE THEORY

NSQF LEVEL - 4.5

HANDBOOK FOR CRAFTS INSTRUCTOR TRAINING SCHEME

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
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A Comprehensive Training Program
under Crafts Instructor Training Scheme (CITS)
for Instructors

HANDBOOK ON TECHNICAL INSTRUCTOR TRAINING MODULES

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सत्यमेव जयते

भारत सरकार
कौशल विकास एवं उद्यमिता मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
AND ENTREPRENEURSHIP

Foreword

In today's rapidly evolving world, the role of skilled craftsmen and women is more crucial than ever. The Craft Instructor Training Scheme (CITS) stands at the forefront of this transformation, shaping the educators who will train the next generation of artisans and technicians. This book aims to provide an in-depth understanding of the subject, exploring its significance, methodologies, and impact on vocational training.

The Craft Instructor Training Scheme was established with the objective of enhancing the quality of instruction in industrial training institutes and other vocational training institutions. By equipping instructors with advanced skills and knowledge, the scheme ensures that they are well-prepared to impart high-quality training to their students. This, in turn, contributes to the creation of a highly skilled workforce capable of meeting the demands of modern industry.

The initial chapters provide the importance of specialized instructor training. Following this, detailed chapters delve into the curriculum covering advanced techniques, safety protocols, and instructional strategies. Each section is designed to offer both theoretical insights and practical applications, ensuring a well-rounded understanding of the subject.

The book offers recommendations for overcoming obstacles and enhancing the effectiveness of the program, with the ultimate goal of producing highly skilled instructors capable of shaping the future workforce.

This book is intended for a diverse audience, including current and aspiring instructors, vocational training administrators, policymakers, and industry stakeholders. It serves as a valuable resource for understanding the intricacies of the subject and its pivotal role in vocational education.

I extend my heartfelt gratitude to all contributors who have shared their experiences and expertise, enriching this book with their valuable insights. Special thanks to the contribution of the development team, reviewers and NIMI that have supported this endeavor, providing essential data and resources.

It is my sincere hope that this book will inspire and guide readers in their efforts to enhance vocational training, ultimately contributing to the development of a skilled and competent workforce.

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DIRECTORATE GENERAL OF TRAINING

FOREWORD

The Craftsmen Training Scheme (CTS) implemented by the Directorate General of Training (DGT) provides skill training to the youth and ensures a steady flow of skilled manpower for the industry. It aims to raise quantitatively and qualitatively the industrial production by systematic training, and to reduce unemployment among the youth by providing them with employable skills.

The Craft Instructor Training Scheme (CITS) is an indispensable part of the Craftsmen Training Scheme (CTS). It offers comprehensive training both in 'skills' and in 'training methodology' to the instructor trainees to make them conversant with techniques of transferring hands-on skills.

I congratulate NIMI for taking the initiative of preparation of the course content for CITS. This will help institutionalize the mechanism for imparting training to the trainers all across the ecosystem. I also extend my gratitude to the Instructors and Officials of National Skill Training Institutes (NSTIs) and the DGT for their invaluable contribution in preparation of the CITS course content.

As we navigate the complexities of a rapidly changing world and the technological disruptions, the significance of CTS and CITS has increased manifold. It not only empowers individuals with practical skills but also lays the foundation for a prosperous future. I am confident that this book will serve as a guiding light to all instructor trainees for skill development and nation-building.

Trishaljit

(Trishaljit Sethi)

PREFACE

The Craft Instructor Training Scheme is an indispensable module of the Craftsmen Training Scheme, which has been an integral part of the Indian skill development industry since its inception. This program aims to equip instructors with the necessary skills and teaching methodology to effectively transfer hands-on skills to trainees and promote a holistic learning experience. The first Craft Instructor Training Institute was established in 1948, followed by six more institutes across India in 1960. Today, these institutes, including the National Skill Training Institute (formerly Central Training Institute for Instructors), offer the CITS course, which is mandated by the Directorate General of Training (DGT).

The Craft Instructor training program is designed to develop skilled manpower for industries. The course aims to offer instructors an opportunity to improve their instructional skills, engage learners effectively, offer impactful mentoring, and make efficient use of resources, leading to a more skilled workforce in various industries. The program emphasizes collaborative and innovative approaches to teaching, resulting in high-quality course delivery. Overall, the Craft Instructor Training Scheme is a pivotal program that helps instructors grow in their careers and make a significant contribution to society. This program is essential for developing skilled manpower and promoting a robust learning environment that benefits both trainees and instructors alike.

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following experts to bring out this Instructional material **(Trade Theory)** for **CITS Electronics Mechanic (NSQF Level - 4.5)** under the **Electronics & Hardware** Sector for **Instructors**.

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NIMI records its appreciation of the Data Entry, CAD, DTP Operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks, the invaluable efforts rendered by all other staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

ABOUT THE TEXT BOOK

The Vocational Instructor Training Program is a comprehensive initiative designed to equip aspiring students with the necessary skills and knowledge to effectively teach in vocational education settings. This program encompasses a range of pedagogical strategies, instructional techniques, and subject-specific content tailored to the diverse vocational fields. Participants engage in coursework that covers curriculum development, assessment methods, classroom management, and the integration of industry-relevant technologies. Practical experience and hands-on training are emphasized, allowing participants to apply theoretical concepts in real-world teaching environments. Through collaborative learning experiences and mentorship opportunities, aspiring vocational instructors develop the confidence and competence to facilitate engaging and impactful learning experiences for their students. This training program aims to cultivate a new generation of educators who are not only proficient in their respective vocational fields but also adept at fostering the success and employability of their students in today's competitive workforce.

This text book covers communication, self-management, information and communication technology, entrepreneurial and green skills. It has been developed as per the learning outcome-based curriculum.

G C Rama Murthy,
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CONTENT

CONTENT

MODULE 1: Safety & maintenance of tools and equipments

LESSON 1 - 4 : Importance of Safety

Objectives

At the end of this lesson you shall be able to:

- state the imporatnce of safety & first aid
- practice safety precautions in work area.

Importance of Safety

Safety is of paramount importance in various aspects of life, including:--

1 **Personal Safety:** Ensuring personal safety involves taking precautions to protect oneself from harm or danger, such as following traffic rules, using safety gear when engaging in risky activities, and being cautious in unfamiliar environments.

2 **Workplace Safety:** Employers must prioritize the safety of their employees by providing a safe working environment, training on safety protocols, and implementing measures to prevent accidents and injuries.

3 **Public Safety:** Governments and organizations focus on public safety by implementing laws and regulations, maintaining infrastructure like roads and bridges, and providing emergency services to ensure the well-being of citizens.

4 **Health and Well-being:** Safety plays a crucial role in maintaining good health and well-being. This includes practicing safe habits like proper hygiene, following medical guidelines, and creating a safe home environment.

5 **Environmental Safety:** Protecting the environment is essential for sustainable living. Safety measures such as waste management, pollution control, and conservation efforts help safeguard ecosystems and natural resources.

Overall, safety is essential for preserving life, preventing injuries and accidents, promoting well-being, and creating a secure and sustainable future.

Safety Precautions & First Aid

Safety and precaution are essential aspects of everyday life, ensuring the well-being and protection of individuals from potential harm or danger. They encompass various practices and measures aimed at minimizing risks and promoting a secure environment. Some common safety and precautionary measures include:

1 **Personal Safety:** Be aware of your surroundings, trust your instincts, and avoid risky situations whenever possible.

2 **Traffic Safety:** Follow traffic rules, wear seatbelts while driving or riding in a vehicle, and use appropriate safety gear for cycling or motorcycling.

3 **Fire Safety:** Install smoke detectors in your home, have fire extinguishers readily available, and have an emergency evacuation plan in place.

4 **Health Precautions:** Practice good hygiene, get regular check-ups, maintain a healthy diet, exercise regularly, and follow guidelines for preventing the spread of illnesses, especially during outbreaks or pandemics.

5 **Workplace Safety:** Follow safety protocols and use protective equipment as required in your workplace. Report any hazards or unsafe conditions to the appropriate authorities.

6 **Online Safety:** Use strong passwords, be cautious of phishing attempts and suspicious websites, keep your software and antivirus programs updated, and avoid sharing sensitive information online.

7 **Emergency Preparedness:** Have emergency kits stocked with essentials like food, water, first aid supplies, and important documents. Familiarize yourself with emergency procedures for different scenarios.

These are just a few examples, and specific safety measures may vary depending on the context and environment. It's important to stay informed, be proactive, and prioritize safety in all aspects of life.

First AID

First aid refers to the immediate assistance or treatment given to someone who has been injured or has suddenly fallen ill. It aims to preserve life, prevent the condition from worsening, and promote recovery. First aid can include actions like CPR, bandaging wounds, administering medications like epinephrine for allergic reactions, and providing emotional support to the person in distress. It is crucial to have basic first aid knowledge and skills to be able to respond effectively in emergencies until professional medical help arrives.

Golden rule's of first aid

First Aid
Golden Rules

- Calm and Composed
- Your Own Safety First
- Emergency Response System
- Comfort of the Injured Person
- Stopping Any Bleeding
- Immobilizing a Person with Neck, Head or Back Pain
- Keeping a First Aid Kit

The golden rule of first aid is "Do no further harm." This principle emphasizes the importance of taking actions that will not worsen the condition or injury of the person receiving first aid. It guides first responders to prioritize safety and cautiousness while providing assistance.

First Aid

1 Use a systematic approach in all medical emergencies.

2 Identify and avoid risks to yourself, the person affected and third parties.

3 Request support early (first aiders, AED, emergency number 144).

4 Be "suspicious" and primarily assume it is something serious.

5 Deal quickly with any chaos and cope with the situation.

6 Position the patien so that they feel comfortable (except in the event of a suspected spinal injury).

7 Only let one person talk to the patient.

8 Get professional support much quicker in case of emergencies with children.

9 Ensure there is leadership: one person must always take the lead.

10 Only transport patients by ambulance or taxi.

Concept of 5s and 7QC Tools

5S

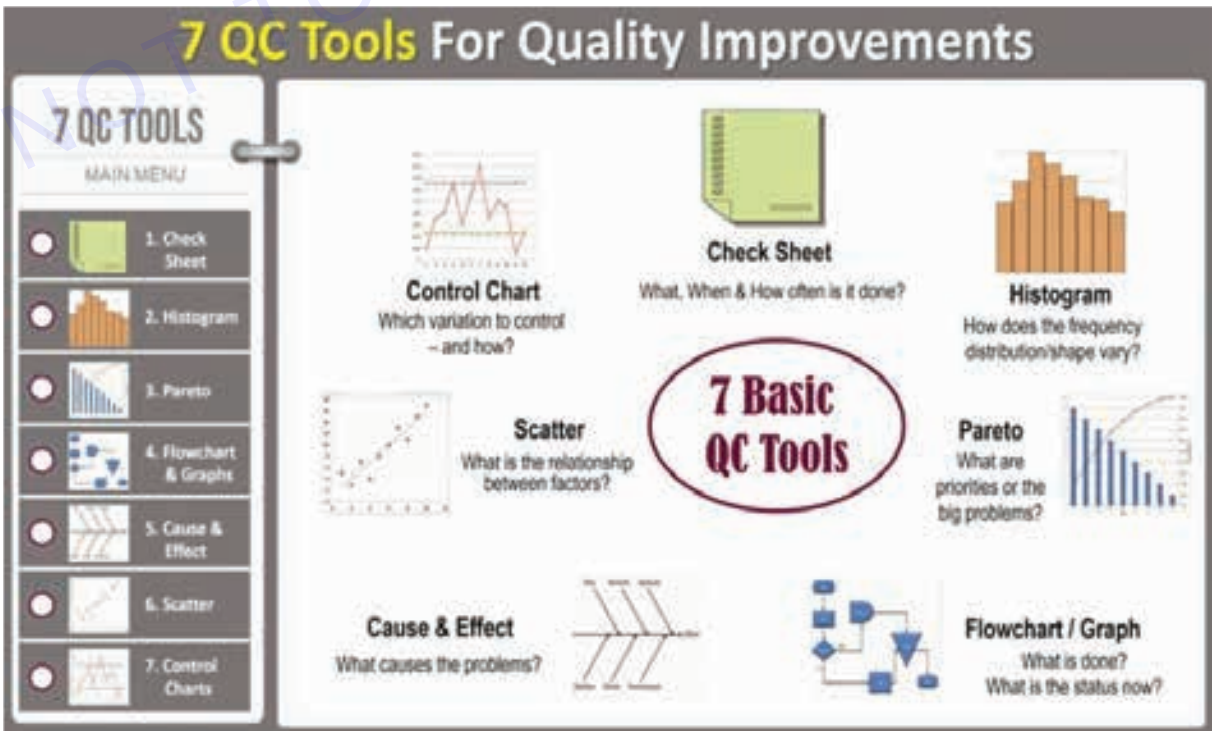
The concepts of “5S” and “7 QC (Quality Control) Tools” are widely used in various industries, including manufacturing, healthcare, and service sectors, to improve efficiency, productivity, and quality. Here’s an overview of each concept:

- **Sort:** Eliminate unnecessary items and keep only what is essential for the work area.
- **Set in Order (Straighten):** Organize items and tools in a structured and accessible manner to promote efficiency and reduce waste.
- **Shine (Clean):** Keep the work area clean and well-maintained to ensure a safe and productive environment.
- **Standardize:** Establish standardized procedures and practices for maintaining the first three S’s consistently.
- **Sustain:**Continuously maintain and improve the 5S practices through regular monitoring, training, and employee involvement.

The 5S methodology aims to create a systematic and organized workplace that enhances safety, productivity, and quality while reducing waste and errors.

7 QC (Quality Control) Tools

- **Check Sheet:** A simple data collection tool used to gather and organize data for analysis.
- **Pareto Chart:** A bar graph that helps identify and prioritize the most significant factors contributing to a problem.
- **Cause and Effect Diagram (Ishikawa or Fishbone Diagram):*** A visual tool for identifying and categorizing potential causes of a problem to facilitate root cause analysis.
- **Histogram:** A graphical representation of data distribution to understand variations and identify trends or patterns.
- **Scatter Diagram:** A graph that shows the relationship between two variables to identify potential correlations.
- **Control Chart:** A statistical tool used to monitor processes over time, detect variations, and determine if a process is within control limits.
- **Quality Function Deployment (QFD):** A systematic approach for translating customer requirements into specific product or service features to ensure customer satisfaction.



These tools are used in quality management and improvement initiatives to analyze data, identify issues, make informed decisions, and continuously enhance processes and products/services.

Tools and Equipment:

The various tools and equipment used by an electrical or electronic technician while working with electrical circuits are explained below:

a **Screw Driver:** It is used to turn, tighten or remove screws.

b **Ratchet:** It is used to allow rotary motion in only one direction and preventing the motion in opposite direction. It is used to tighten nuts of various sizes.

c **Spanner:** It is used to provide grip to apply torque for turning objects such as nut or a bolt. A spanner is available with variable diameter to tighten nuts and bolts of various sizes.

d **Wrench:** It is a hand tool used for tightening and loosening of the nuts and bolts. These tools hold slippery or small nuts and bolts for loosening or tightening it.

e **Wire cutter and Plier:** A wire cutter is used for striping and cutting wires whereas a plier is used to hold objects like nuts and bolts firmly also used for cutting metal wires.

f **Tester:** It is used to verify the presence of electric voltage in electrical equipment.

g **Hammer:** It is used to fix nails in walls and wood, fit parts, or forge metal and breaking different materials.

h **Ladder:** It is used to climb upwards to reach higher places (6 to 7 feet) in tall units of a control panel.

i **Utility Knife:** It is used to cut various objects, such as wires, cords, tapes and so on.

j **Soldering or Desoldering Iron:** It is used to embed/ remove the components on/from the panel.

k **Soldering or Desoldering Station:** It is used to hold the hot iron when it is not in use and adjust the temperature of the tip .

l **Crimping Tool:** It is used to cut various objects such as wires, cords, tapes and so on. It is also used to join wires with metal or plastic objects

m **Voltmeter:** It is used to measure potential difference between two points in the electric circuit

n **Ammeter:** It is used to measure current flow in a circuit

o **Watt meter:** It is used to measure electrical power of any given circuit (in watts).

p **Megohmmeter or Megger:** It is used to measure leakage in wires and earth resistance.

q **Multimeter:** It is used to measure various electricalquantities like resistance, voltage, current, etc.

Application and Safety to be observed while handling Handtools, Special tools, Equipments & Machineries

1 Carry all sharp tools in sheath or holsters.

2 Tag worn, damaged or defective tools “Out of Service” and do not use them.

3 Do not use a tool if the handle surface has splinters, burrs, cracks or splits .

4 When handing a tool to another person, direct sharp points and cutting edges away from yourself and the other person.

5 Do not carry sharp or pointed hand tools such as probes or knives in your pocket unless the tool or your pocket is sheathed.

6 Do not perform “make-shift” repairs to tools.

7 Do not throw tools from one location to another or from one employee to another.

8 Transport hand tools only in tool boxes or tool belts.

Hammer Safety

1 Use a claw hammer for pulling nails and for driving nails.

2 Do not strike nails or other objects with the “cheek” of the hammer.

3 Do not strike one hammer against another hammer.

4 Do not use a hammer, screwdriver, file, etc., if your hands are oily, greasy or wet.

Power Drill Safety:

1 Use brushes or vacuum machinery to remove metal chips, shavings and other debris from the drill table. Do not use your bare hands.

2 Do not use dull, cracked or bent drill bits.

Power Saw Safety:

1 Keep control of saws by releasing downward pressure at the end of the stroke.

2 Do not use a saw that has a dull blade.

3 Oil saw blades after each use of the saw.

4 Keep your hands and fingers away from the saw blade while you are using the saw.

5 Do not carry a saw by the blade.

Hand Files & Rasp Safety:

1 Do not use a file as a pry bar, hammer, screwdriver or chisel.

2 When using a file or a rasp, grasp the handle in one hand and the toe of the file in the other.

3 Do not hammer on a file.

Chisel Safety:

1 Use a chisel that has been sharpened; do not use a chisel that has a dull cutting edge.

2 Hold a chisel by using a tool holder if possible.

3 Clamp small work pieces in the vise and chip towards the stationary jaw when you are working with a chisel.

Tool Boxes, Tool Chests & Cabinets:

1 Use the handle when opening and closing a drawer or door of a tool box, chest, or cabinet.

2 Tape over or file off sharp edges on tool boxes, chests or cabinets.

3 Do not stand on tool boxes, chests or cabinets to gain extra height.

4 Lock the wheels on large tool boxes, chests or cabinets to prevent them from rolling.

5 Push large chests, cabinets and tool boxes; do not pull them.

6 Do not open more than one drawer of a tool box at a time.

7 Close and lock all drawers and doors before moving the tool chest to a new location.

8 Do not use a tool box or chest as a workbench.

9 Do not move a tool box, chest or cabinet if it has loose tools or parts on the top.

Importance and Types of Maintenance of Vehicles/Engines

Engines are the heart of your vehicle. Without a good engine, your vehicle is an expensive metal box. Understanding engines and how they work is vital to care for your vehicle.

Engine Does

Engines come in all shapes and sizes, but they all have the same primary function: converting fuel into energy that powers your vehicle. A well-maintained engine is essential for your vehicle's longevity and efficiency. Regular engine maintenance includes oil changes, fluid checks, and spark plug replacements. Neglecting engine maintenance can lead to costly repairs or total engine failure.

Benefits of Maintaining Your Engine

One of the primary benefits of a well-maintained engine is improved fuel efficiency. A properly tuned engine burns fuel more efficiently, saving you money on gas over time. Additionally, a well-maintained engine produces fewer harmful emissions, making it better for the environment.

There are different types of engines available in the market. The internal combustion engine is a complex machine that uses fuel, air, and spark to create an explosion within the engine. Other types of engines include electric engines and hybrid engines.

Signs of Engine Damage

If you notice any warning signs, such as strange noises, vibrations, or a decreased performance, get your engine checked by an auto repair professional. These warning signs can indicate more extensive issues that require immediate attention. Ignoring these signs can lead to more expensive repairs in the future.

Keep Your Engine In Great Condition

Engines are the heart and soul of your vehicle. A well-maintained engine provides improved fuel efficiency, fewer harmful emissions, and a longer lifespan for your vehicle. Take care of your engine by following regular maintenance schedules and addressing issues as they arise. You'll have a safer, more reliable car, saving money in the long run.

Types of maintenance

There are four types of vehicle maintenance namely :

1 Preventive maintenance

2 Break maintenance

3 Periodic maintenance or schedule maintenance

4 Operation Maintenance

1 Preventive maintenance

Prevention without breakdown or without giving trouble on road some attention or maintenance taken to the vehicle is called as preventive maintenance. It intends to reduce or totally eliminate breakdown and accidents due to mechanical failure and reduces repair cost. This type of maintenance is done to prevent problems from occurring in the future. It involves routine checks, adjustments, and replacements of various components and fluids, such as oil changes, tire rotations, and brake inspections.

A Good preventive maintenance program lead to following advantages:

A Reduce the breakdown of vehicle.

B Increase safety due to reduced breakdown.

C Less expenses on repairs.

D Good control on inventory of spare parts.

E Lesser number of equipment are require.

2 Breakdown maintenance

Break down maintenance is a attention which is to be provided when the motor vehicle becomes immobilized due to fault created during running. These fault are started difficulties, puncture, electrical fault, carburetor and fuel supply fault, overheating, fan belting, breakage and accident etc.

3 Periodic maintenance

Periodic maintenance or operatives maintenance is attentions provided attention provide to motor vehicles after in operation for a specified time or covered distance.

Various types of maintenance in automobiles, highlighting their significance and benefits:

1 Preventive Maintenance

Preventive maintenance involves scheduled inspections, adjustments, and replacements to prevent potential issues before they escalate. By adhering to manufacturer recommendations and conducting routine check-ups, vehicle owners can identify and address problems proactively, minimizing the risk of major failures.

2 Predictive Maintenance

Predictive maintenance relies on advanced technologies and data analysis to predict when maintenance is required. It utilizes sensors, diagnostics, and machine learning algorithms to monitor vehicle conditions, identify patterns, and forecast potential failures. By predicting maintenance needs, vehicle owners can optimize repair schedules and minimize downtime.

3 Corrective Maintenance

Corrective maintenance refers to repairs performed after a failure has occurred. This type of maintenance aims to restore the vehicle to its normal operational state. While corrective maintenance can be unplanned and costly, it is essential for addressing unexpected breakdowns and malfunctions.

4 Condition-Based Maintenance

Condition-based maintenance involves monitoring the condition of specific vehicle components to determine when maintenance is required. It relies on real-time data collection and analysis, allowing for targeted repairs based on the actual condition of the vehicle. Condition-based maintenance optimizes maintenance efforts by focusing on components that show signs of degradation or wear.

5 Scheduled Maintenance

Scheduled maintenance follows a predetermined maintenance schedule provided by the manufacturer. It includes routine tasks such as oil changes, filter replacements, and inspections. By adhering to scheduled maintenance, vehicle owners can ensure the optimal performance and longevity of their vehicles.

6 Routine Maintenance

Routine maintenance encompasses regular tasks that need to be performed at specific intervals. This includes checking fluid levels, tire pressure, and battery health. Routine maintenance helps in identifying minor issues early on and prevents them from escalating into major problems.

7 Emergency Maintenance

Emergency maintenance refers to repairs done in urgent situations, typically when a breakdown or malfunction occurs unexpectedly. It involves immediate actions to restore the vehicle's operability and ensure safety. Emergency maintenance focuses on addressing the immediate issue to get the vehicle back on the road quickly.

8 Periodic Maintenance

Periodic maintenance involves servicing a vehicle at regular intervals based on time or mileage. It includes tasks such as replacing timing belts, spark plugs, and other components that have a limited lifespan. Periodic maintenance helps in preventing sudden failures and extends the overall lifespan of the vehicle.

9 Breakdown Maintenance

Breakdown maintenance is performed when a vehicle experiences a sudden failure or breakdown. It involves immediate repairs to restore the vehicle's functionality. While breakdown maintenance is reactive in nature, it is crucial for getting the vehicle back on track promptly.

10 Shutdown Maintenance

Shutdown maintenance refers to maintenance activities performed during scheduled downtime or when a vehicle is not in operation. It includes extensive inspections, overhauls, and repairs that require significant time and resources. Shutdown maintenance helps in optimizing the vehicle's performance and address long-term maintenance needs.

11 Overhaul Maintenance

Overhaul maintenance involves a comprehensive examination and restoration of a vehicle's major components. It includes disassembling, repairing, and replacing worn-out parts to ensure the vehicle's efficiency and reliability. Overhaul maintenance is typically performed after a specified service life or when major issues are detected.

12 Seasonal Maintenance

Seasonal maintenance focuses on preparing a vehicle for specific weather conditions. It includes tasks such as changing tires, checking heating systems, and inspecting cooling systems. Seasonal maintenance ensures that the vehicle is equipped to handle the challenges posed by different seasons.

13 Proactive Maintenance

Proactive maintenance aims to prevent potential issues by analyzing data and identifying patterns of failure. It involves proactive inspections, data analysis, and continuous monitoring to detect and address early signs of degradation or wear. Proactive maintenance helps in avoiding unexpected failures and prolongs the life of vehicle components.

14 Reactive Maintenance

Reactive maintenance is performed in response to unexpected failures or breakdowns. It involves immediate repairs to restore the vehicle's functionality. While reactive maintenance can be costly and disruptive, it is essential for addressing unforeseen issues promptly.

15 Predictable Maintenance

Predictable maintenance involves planned repairs and replacements based on the expected service life of vehicle components. It relies on historical data, manufacturer recommendations, and industry standards to schedule maintenance tasks. Predictable maintenance ensures that components are replaced before they reach a critical state, minimizing the risk of failures.

Safely handling of Hazardous Materials

Assess the risks that exist in the workplace: Know which materials in the workplace represent hazards.

Provide employees adequate training and information about the hazardous materials in your workplace: As mentioned, federal training is a prerequisite, but often stipulates only a minimum obligation. Don't be afraid to expand safety consultation and procedures beyond those required by law and encourage established procedures on employees.

Consider potential hazards and plan ahead: Have arrangements and procedures in place to handle emergency circumstances that may arise from hazmat spills or exposure. This means making sure employees understand emergency procedures, including evacuation, cleanup or what to do in case of fire. Make sure emergency equipment such as eye wash and shower stations are accessible, kept clean and are tested routinely. Train employees on first-aid skills and how to respond to co-workers who may be injured or experience chemical exposure.

Always use the proper personal protection equipment (PPE): Old or damaged PPE should be replaced, and the PPE should be inspected prior to each use. Proper control measures like ventilation hoods should always be used and routinely inspected.

Ensure all hazardous materials are properly marked: Make sure all hazmat containers are adequately labeled and that all chemicals are stored in the appropriate containers.

Keep all hazardous materials stored properly: Keep chemicals in dry, cool and ventilated areas, and separate incompatible materials. Always keep lids closed – meaning leak-proof and vapor-tight – on all hazmat containers. Make sure these storage areas are free from items that might cause trips, falls or spills, and free from materials that might encourage pests or rodents. Always keep work areas clean. Not just of clutter, but clean work surfaces frequently to minimize risk of contamination or exposure.

Only use hazardous materials for their intended purposes.

Never eat or drink while handling hazardous materials, and always wash hands after using, handling or transporting hazardous chemicals.

Employees handling hazardous materials should always read the labels to understand what they're working with and have the safety data sheet (SDS) accessible prior to using any materials in order to understand how to handle a spill or exposure to that chemical.

Report any concerns about damaged containers or potential leaks or spills. Even if a suspicion turns out to be incorrect, as the saying goes, it's always better to be safe than sorry.

MODULE 2 : Digital electronics & simulation software

LESSON 5 - 8 : Basic gates

Objectives

At the end of this lesson you shall be able to

- identify the occupational safety devices.
- interpret the different types of safety devices.

Electronic systems usually deal with information. Representation of information is called asignal. Signal in electronics is generally in form of voltage or current.

There are two types of signals

Analog Signals

Digital Signals

Analogsignal: Signals that are continuous in time and continuous in value are called analog signal.

Digitalsignal: Signals that are discrete intime and discrete in values are called digital signals. Digital presenting values only eight different values can be represented. Thus a continuous value signal has to be quantized and converted to discrete value signal.

Comparison of Analog and Digital Systems:

	Analog systems	Digital systems
1	Analog systems operate on continuous time and continuous value signals.	Digital systems operate on discrete time and discrete value signals generally Represented in binary.
2	Analog systems are difficult to design.	Digital systems are easy to design as most of the components are in form of Integrated Circuits(IC).
3	Analog systems are mostly custom made and lack flexibility.	Digital systems have high degree of flexibility.
4	Less efficient in storage of information.	More efficient in storage of information.
5	Analog signal processed by these systems are affected by noise very easily.	Digital signal are more noise-immune compared to analog signals.
6	Relatively costly compared to digital system	Low cost due to mass production of components.
7	Analog systems are more sensitive to parameter variation.	Digital systems are less sensitive to parameter variation
8	No conversion of input signals are required before processing	Input signals are converted from analog to digital form before it is processed
9	As no conversion of input signal is required there is no loss of information.	Due to process of sampling and quantization there is loss of information.
10	Analog systems are more efficient for real time processing	Digital systems may offer limitations for real time processing

Advantages of Digital Systems:

Digital systems are easier to design

Information storage is easy

Accuracy and precision are greater

Digital systems are more versatile

Digital circuits areless affected by noise

More digital circuitry can be fabricated on IC chips

Logic gates

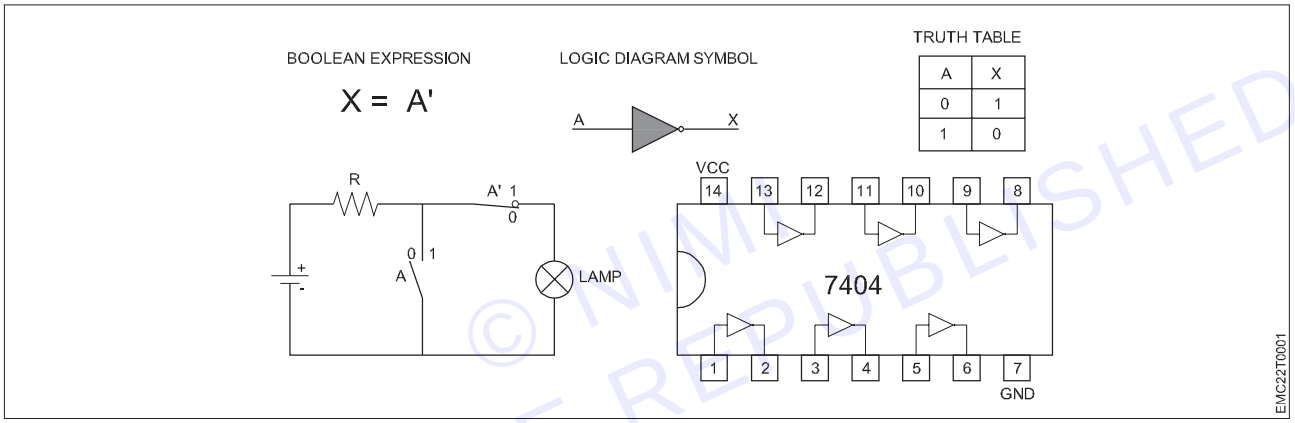
Logic gates are the fundamental building blocks of digital systems. They are the physical devices that performs the basic Boolean operations of AND,OR and NOT.

There are total seven logic gates in which three are basic logic gates (AND,OR,NOT) and two are Universal logic gates (NAND,NOR).

Various basic gates are discussed as follows;

Not Gate

NOT gate has one inputs and one output. The output becomes logic 1 when input is at logic 0 andoutput becomes logic 0 when the input is at logic 1. Thus it inverts or complements the logic available at input and hence called and inverter or complement. NOTgate and its truth table are shown in fig.



NOTgate

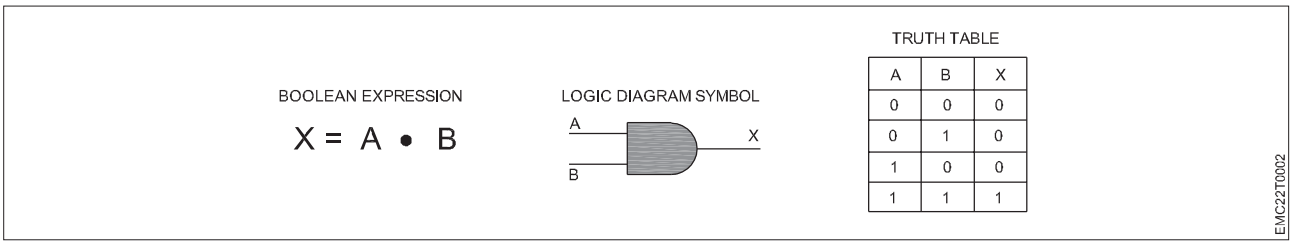
AND Gate

AND gate means all or nothing logic

AND gate has two or more inputs and one output.The output becomes logic1only when each one of its input is at logic1. For all other input combinations it gives output logic 0. It is represented by a symbol•.

Thus,for example, X=A·B (also written simply as X=AB) is read as “X is equal to AANDB”.

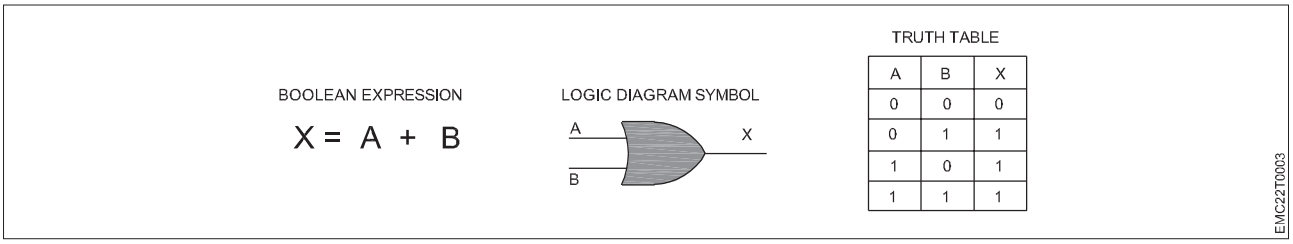
Two input AND gate and its truth table is shown below :



OR Gate:

OR gate means any or all logic

OR gate has two or more inputs and one output. The output becomes logic1 when atleast (minimum) one of the inputs is at logic1. It is represented by a symbol+. Thus, for example, X=A+B is read as “X is equal to A OR B”.

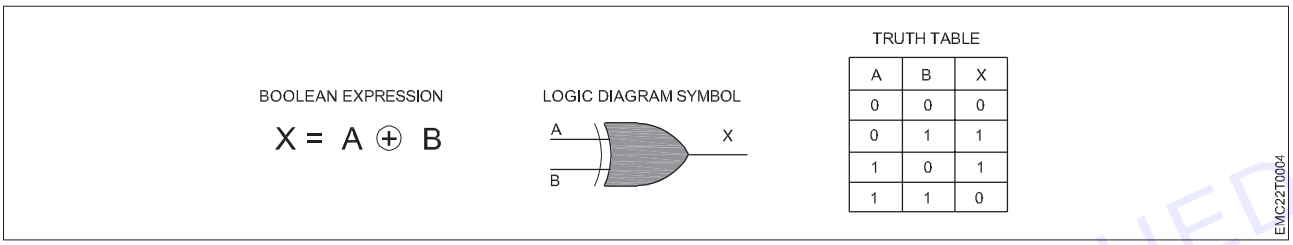


Exclusive OR Gate (EX-OR)

It also means In equality detector because it gives output high when both inputs are different.

Exclusive OR gate give output equal to1when the two inputs are exclusively different. This is there as on why it is also known as in equality gate.

The schematic symbol and truth table of the gate is shown below :



Equal to AX OR B."The logic expression this gate in terms of AND, OR and NOT operation is

X= Ax or B=A'B+AB'.

Exclusive NOR Gate (EX-NOR)

It also means equality detector because it gives output high when both inputs are same.

Exclusive NOR gate is XOR gate followed by inverter. Thus it is complement of XOR gate. This is there as on why it is also known as equality gate.

The logic symbol, logic expression, schematic symbol, truth table of the gate is shown below :

X=AB+A'B'

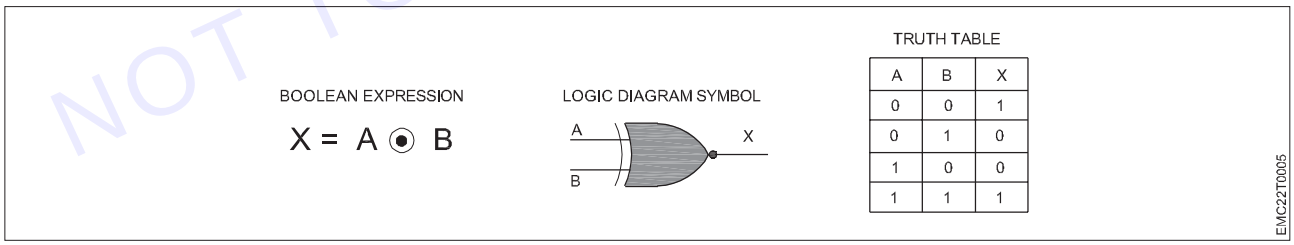
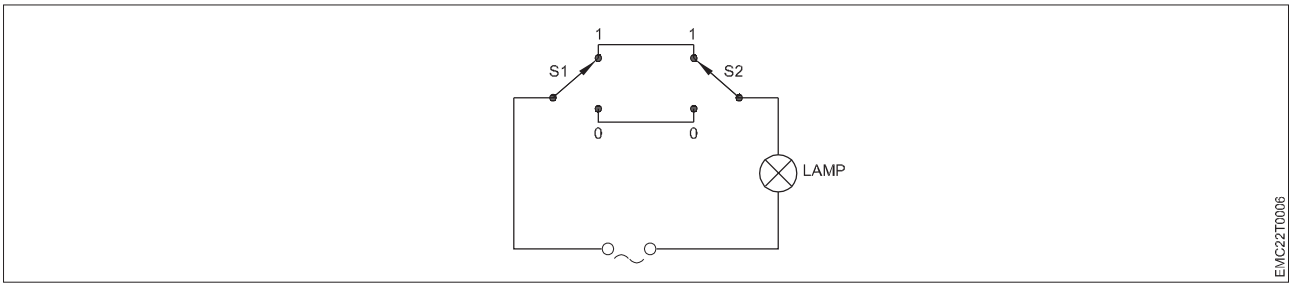


Illustration of EX-NOR gate



Universal Gates

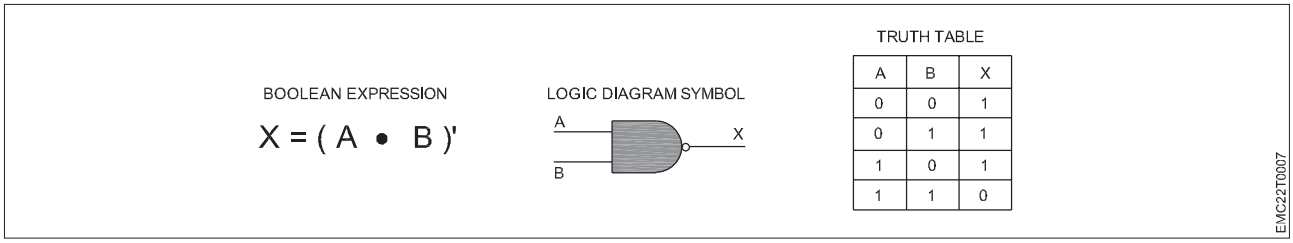
NAND and NOR gates are known as a universal gates because from this two gates all other gates can be constructed.

1. NAND Gate:

NAND gate represents combination of AND gate followed by NOT gate. It represents complement of AND operation.

Schematic symbol of NAND gate and its truth table ares hown below :

The logic Expression is given as X= orX= (A·B)2



NAND gateas Universal gate

1 Implementing NOT gate

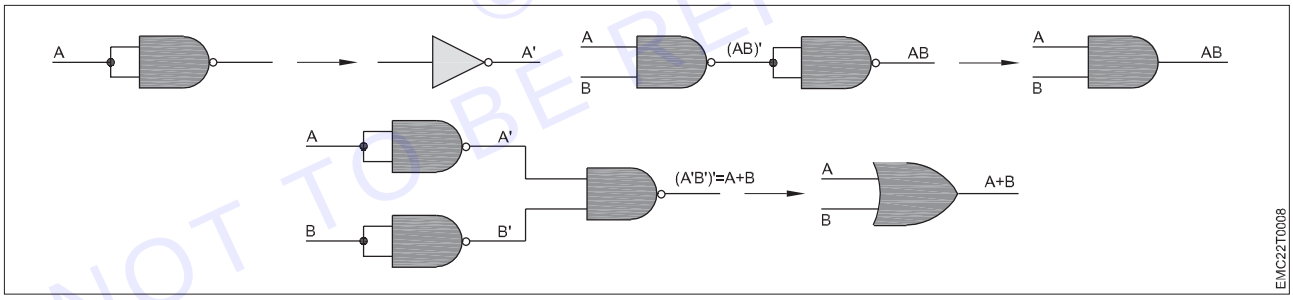
All NAND input pins connect to the input signal A gives an output A'.

2 Implementing AND gate

The AND is replaced by a NAND gate with its output complemented by a NAND gate inverter

3 Implementing OR gate

The OR gate is replaced by a NAND gate with all its inputs complemented by NAND gate inverters.



7 NOR Gate

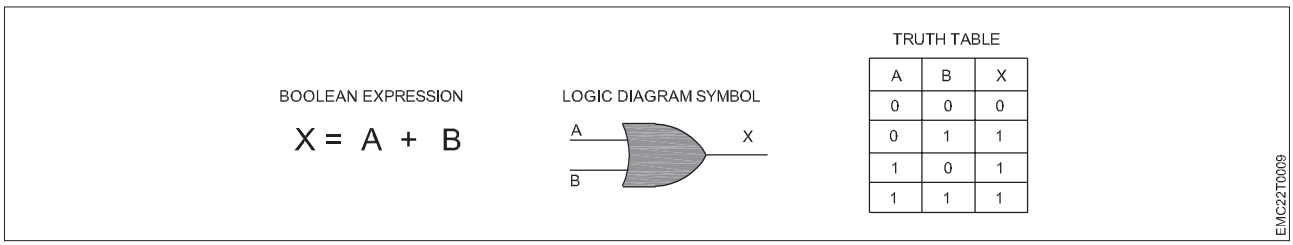
NOR gate represents combination of OR gatefollowed by NOT gate.It represents complement of ORoperation. Schematic symbol of NOR gate and its truth table are shown below.

The logic expression is given as X=(AnorB) orX =(A+B)'.

NOR gate as Universal gate.

1 Implementing NOT gate

All NOR input pins connect to the input signal A gives an output A`.

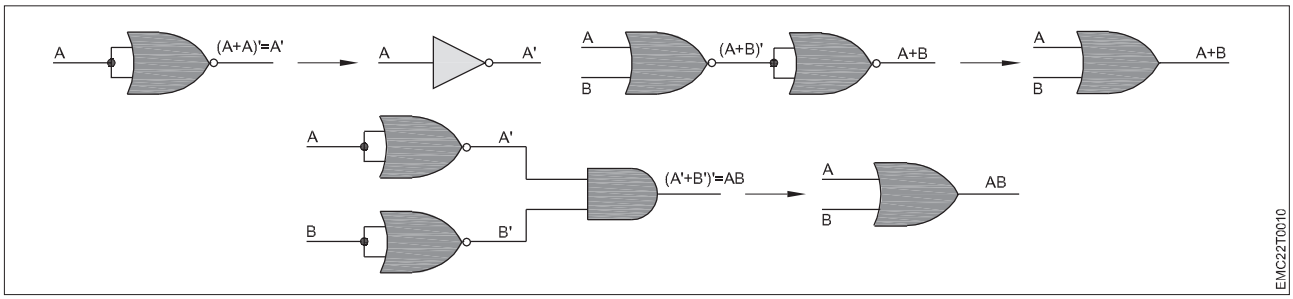


2 Implementing AND gate

The AND gate is replaced by a NOR gate with all its inputs complemented by NOR gate inverters

3 Implementing OR gate

The OR is replaced by a NOR gate with its output complemented by a NOR gate inverter.



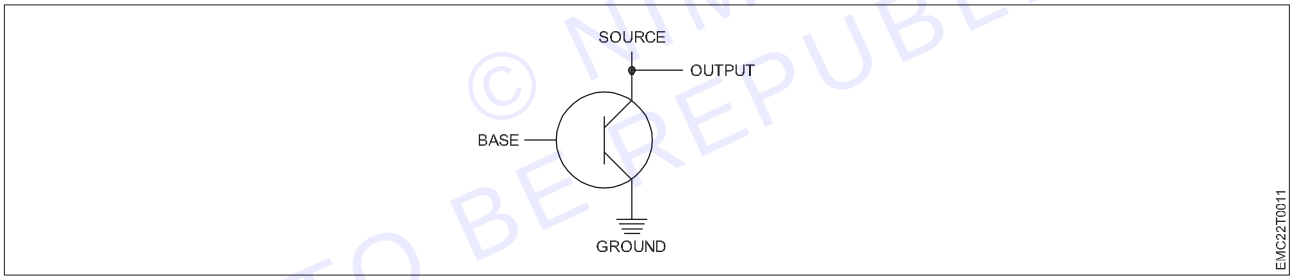
Constructing Gates by using Transistor

A transistor is adevice that acts, depending on the voltage level of an input signal, either asa wire that conducts electricity or as a resistor that blocks the flow of electricity

A transistor has no moving parts, yet acts like a switch.

It is made of a semi conductor material, which is neither a particularly good conductor of electricity, such as copper, nor a particularly good insulator, such as rubber.

A transistor is shown below :



Transistor

A transistor has three terminals

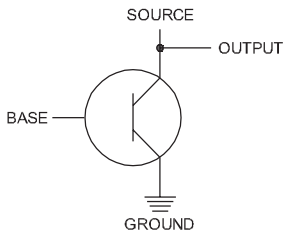
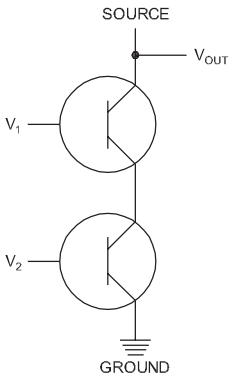
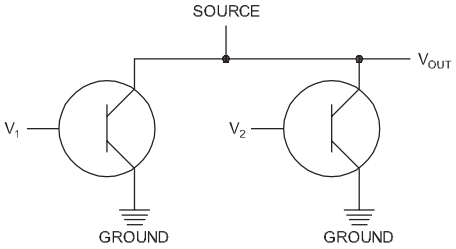
1 A source

2 A base and

3 An emitter – typically connected to a ground wire

If the electrical signal is grounded, it is allowed to flow through an alternative route to the ground (literally) where it can do no harm.

It turns out that, because the way a transistor works, the easiest gates to create are the NOT, NAND and NOR gates shown below :

NOT GATE	NAND GATE	NOR GATE
		

Logic gates using transistor

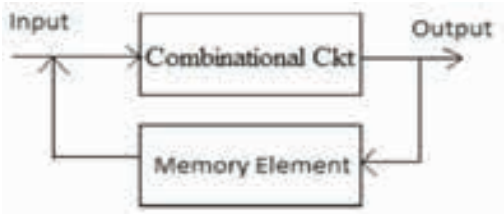
Types of logic circuit

There are two types of logic circuit;

Sequential circuit

Combinational circuit

Difference between combinational & sequential circuit

Combinational Circuit	Sequential Circuit
Output is dependent only on the input at the same instant of time	Output is dependent on present input and past output.
It does not contains memory elements. 	It contains memory element. 
Its behaviour is described by these to output function.	Its behavior is described by the set of next state function and these to output function.
No feedback is available.	Feedback is available.
It does not contains periodic clock signal.	It contains clock signals.
Faster than sequential circuit.	Slower than combinational circuit.
e.g. half adder, full adder,etc.	e.g. Flipflop,counter,etc.

Laws of boolean algebra:

Complementation Laws

The term complements imply means to invert,i.e. to change 0's to1's and 1's to 0's.

Law 1:0'=1

Law 2: 1'=0

Commutative Laws:

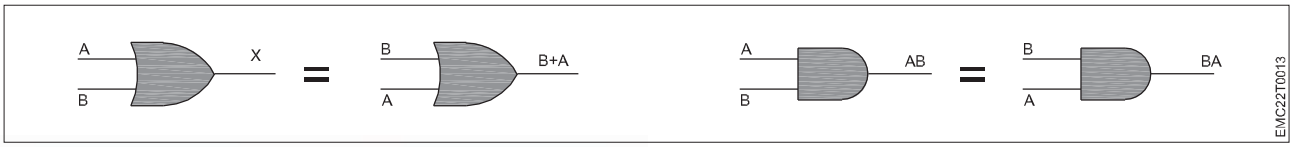
Commutative laws allow change in position of AND or OR variables.

Law1:A+ B=B+ A

Proof:

This law can be extended to any numbers of variables fo re.g.

A+B +C= B+A+C= C+B+A=C+A+B



A	B	A + B
0	0	0
0	1	1
1	0	1
1	1	1

=

B	A	B + A
0	0	0
0	1	1
1	0	1
1	1	1

A	B	A · B
0	0	0
0	1	0
1	0	0
1	1	1

=

B	A	B · A
0	0	0
0	1	0
1	0	0
1	1	1

This law can be extended to any numbers of variables for e.g.

A·B· C=B · A·C= C·B·A= C·A·B

Associative Laws

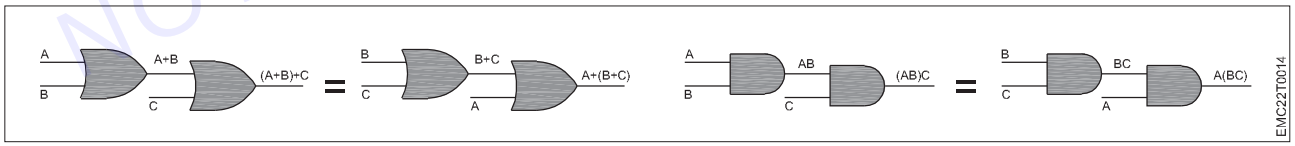
The associative laws allow grouping of variables.

Law1: (A+ B)+ C=A+ (B+ C)

Proof:

This law can be extended to any no.of variables for e.g.

A+(B+ C+D) = (A+B +C) + D= (A+ B)+(C+D)



A	B	C	A + B	(A + B) + C
0	0	0	0	0
0	0	1	0	1
0	1	0	1	1
0	1	1	1	1
1	0	0	1	1
1	0	1	1	1
1	1	0	1	1
1	1	1	1	1

=

A	B	C	B + C	A + (B + C)
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	1
1	0	0	0	1
1	0	1	1	1
1	1	0	1	1
1	1	1	1	1

A	B	C	AB	(AB)C
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	0
1	0	0	0	0
1	0	1	0	0
1	1	0	1	0
1	1	1	1	1

=

A	B	C	BC	A(BC)
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	1	0
1	0	0	0	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

This law can be extended to any no.of variables for e.g.

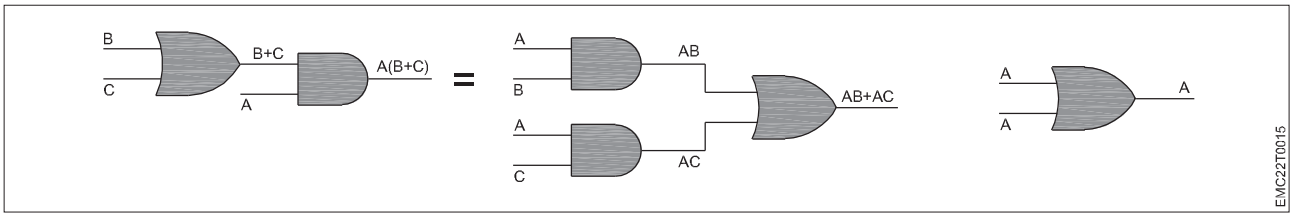
A·(B· C · D) =(A·B ·C)·D= (A·B) ·(C·D)

Distributive Laws

The distributive laws allow factoring or multiplying out of expressions.

Law1:A (B+ C)= AB +AC

Proof:



A	B	C	B + C	A(B + C)
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	1	0
1	0	0	0	0
1	0	1	1	1
1	1	0	1	1
1	1	1	1	1

=

A	B	C	AB	AC	AB + AC
0	0	0	0	0	0
0	0	1	0	0	0
0	1	0	0	0	0
0	1	1	0	0	0
1	0	0	0	0	0
1	0	1	0	1	1
1	1	0	1	0	1
1	1	1	1	1	1

Complementation Law /Negation Law:

Law1: A·A'=0

Proof:

Case1: If A=0óA'= 1 So, A·A'=0·1=0

Case2: If A =1óA'= 0 So, A·A'=1·0=0

Double Negation Law:

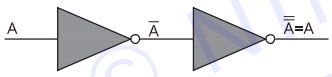
This law states that double negation of a variables is equal to the variable itself.

Law1: A"=A

Proof:

Case1: If A= 0óA"= 0"= 1'= A

Case 2: If A = 1óA" =1"=0'=A



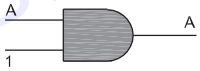
Any odd no.of inversion is equivalent to single inversion.

Any even no.of inversion is equivalent to no inversion at all.

Identity Law:

Case1 : If A=1óA·1=1·1=1=A

Case2 : If A=0óA·0=0·0=0=A

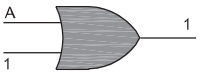


Law2 : A+ 1 = 1

Proof:

Case 1: If A=1óA+1=1+1=1=A

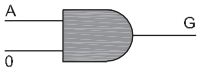
Case 2: If A=0óA+0=0+0=0=A



Null Law:

Case1: If A=1óA·0=1·0=0=0

Case2: If A=0óA·0=0·0=0=0

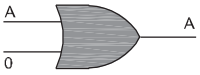


Law 2: A+ 0 = A

Proof:

Case 1: IfA=1óA+0=1+0=1=A

Case 2 : IfA=0óA+0=0+0=0=A



Absorption Law:

Law1: A+AB = A

Consensus Theorem:

Theorem1:

A·B +

A'C+ BC =

AB + A'C Proof: L.H.S.=AB+ A'C +BC

=AB +A'C+ BC(A+A')

=AB +A'C+ BCA+BCA'

=AB(1 +C)+ A'C(1 +B)

=AB +A'C

=R.H.S.

This theorem can be extended as,

AB+A'C+BCD= AB+A'C

Theorem 2:(A+ B)(A'+C)(B+ C) =(A+ B)(A'+C)

Proof : L.H.S.=(A+B)(A'+ C)(B +C)

=(AA'+AC+A'B+BC) (B+C)

=(0+ AC+A'B+ BC)(B +C)

=ACB +ACC+A'BB +A'BC+BCB +BCC

=ABC+AC+ A'B+A'BC+ BC+BC

=ABC+AC+A'B+A'BC+BC

=AC(1 + B)+A'B(1+ C) +BC

= AC+ A'B+BC (1)

R.H.S.=(A+B)(A'+C)

= AA'+AC+ BA'+BC

=0 +AC+BA'+BC

= AC+ A'B+BC (2)

Equation (1) = Equation (2)So.

L.H.S = R.H.S.

This theorem can be extended to any no.of variables.

(A+ B)(A'+C) (B +C+ D)=(A+B)(A'+C)

Transposition theorem:

Theorem:

AB +A'C=

(A+ C)(A'+B) Proof: R.H.S.=(A+C)(A'+B)

=AA'+ AB+CA'+CB

=0+AB+CA'+CB

=AB+CA'+CB

=AB+A'C (B'cz of AB+A'C+BC= AB+A'C)

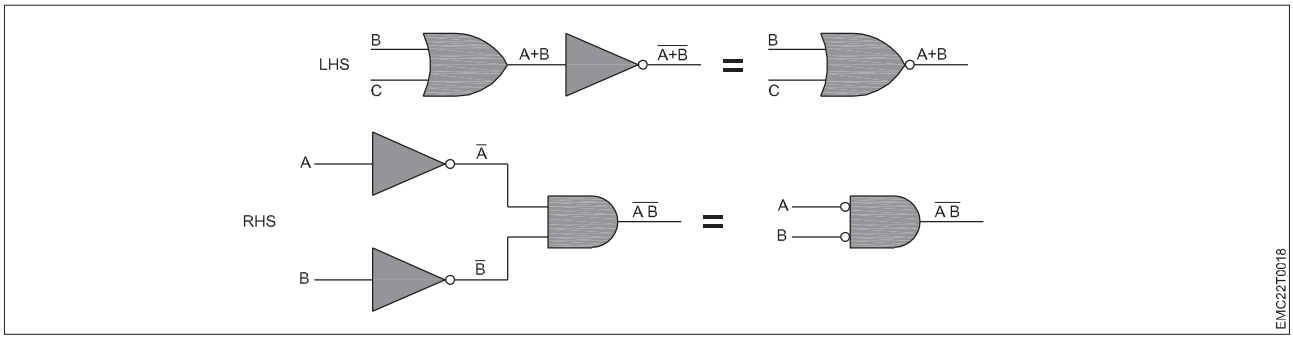
=L.H.S.

DeMorgan'sTheorem:

Law1: (A+ B)'=A'· B'

Proof:

Law2: (A· B)'=A'+B'



A	B	A+B	$\overline{A+B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

=

A	B	$\overline{A}$	$\overline{B}$	$\overline{A} \cdot \overline{B}$
0	0	1	1	1
0	1	1	0	0
1	0	0	1	0
1	1	0	0	0

Duality Theorem:

Duality theorem arises as a result of presence of two logic system i.e. positive & negative logic system.

This theorem helps to convert from one logic system to another.

From changing one logic system to another following steps are taken:

0 becomes 1, 1 becomes 0.

AND becomes OR, OR becomes AND.

'+' becomes '·', '·' becomes '+'.

Variables are not complemented in the process.

Given Expression	*Dual*
1. $\overline{0} = 1$	$\overline{1} = 0$
2. $0 \cdot 1 = 0$	$1 + 0 = 1$
3. $0 \cdot 0 = 0$	$1 + 1 = 1$
4. $1 \cdot 1 = 1$	$0 + 0 = 0$
5. $A \cdot 0 = 0$	$A + 1 = 1$
6. $A \cdot 1 = A$	$A + 0 = A$
7. $A \cdot A = A$	$A + A = A$
8. $A \cdot \overline{A} = 0$	$A + \overline{A} = 1$
9. $A \cdot B = B \cdot A$	$A + B = B + A$
10. $A \cdot (B \cdot C) = (A \cdot B) \cdot C$	$A + (B + C) = (A + B) + C$
11. $A \cdot (B + C) = AB + AC$	$A + BC = (A + B)(A + C)$
12. $A(A + B) = A$	$A + AB = A$
13. $A \cdot (A \cdot B) = A \cdot B$	$A + A + B = A + B$
14. $\overline{AB} = \overline{A} + \overline{B}$	$\overline{A + B} = \overline{A}\ \overline{B}$

LESSON 9 - 29 : Combinational Logic Circuit

Objectives

At the end of this lesson you shall be able to

- state various logic circuits such as half adder, full adder, encoducer etc.
- state different types of flipflop and their application
- explain about careless & their types.

Binary Addition Circuits

The operation of adding two binary numbers is one of the fundamental tasks performed by a digital computer. The four basic addition operations are 0 + 0 = 0, 1 + 0 = 1, 0 + 1 = 1 and 1 + 1 = 10. In the first three operations, each binary addition gives sum as one bit, i.e., either 0 or 1.

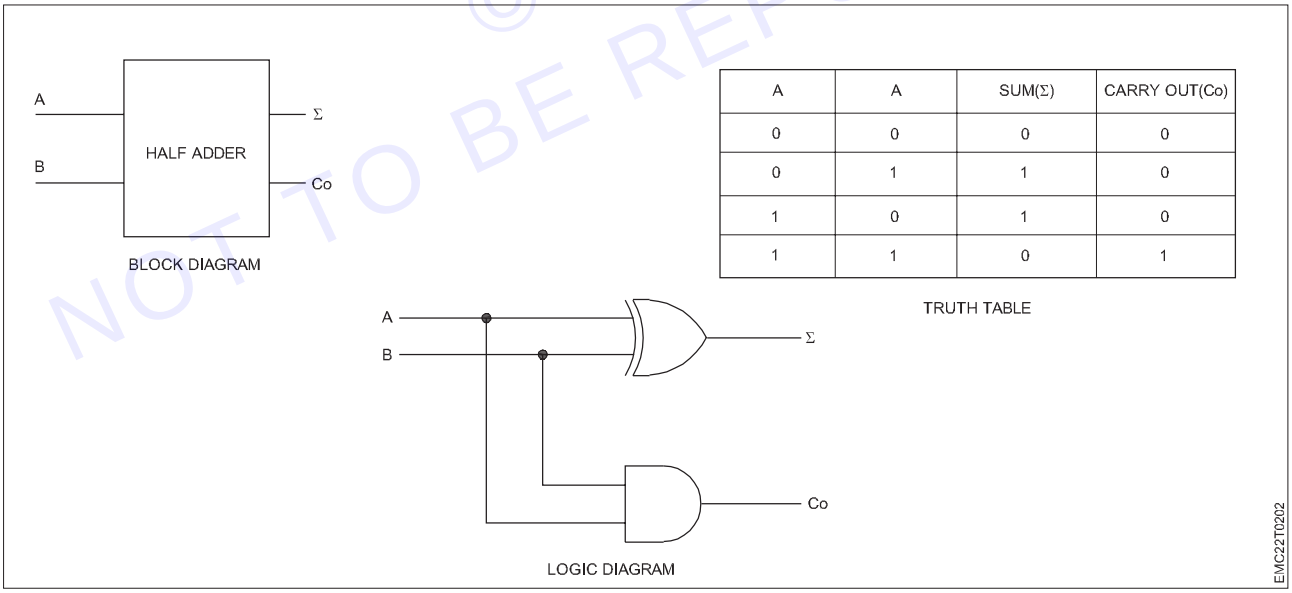
But the fourth addition operation gives a sum that consists of two binary digits. In such result of the addition, lower significant bit is called as the sum bit, whereas the higher significant bit is called as the carry bit. The logic circuits which are designed to perform the addition of two binary numbers are called as binary adder circuits.

Half Adder

A logic circuit block used for adding two one bit numbers or simply two bits is called as a half adder circuit. This circuit has two inputs which accept the two bits and two outputs, with one producing sum output and other produce carry output.

To accomplish the binary addition with Ex-OR gate, there is need of additional circuitry to perform the carry operation. Hence, a half adder is formed by connecting AND gate to the input terminals of the Ex-OR gate so as to produce the carry as shown in below.

Half adder has Application especially multiedition must be added along.



A	A	SUM(Σ)	CARRY OUT(Co)
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

TRUTH TABLE

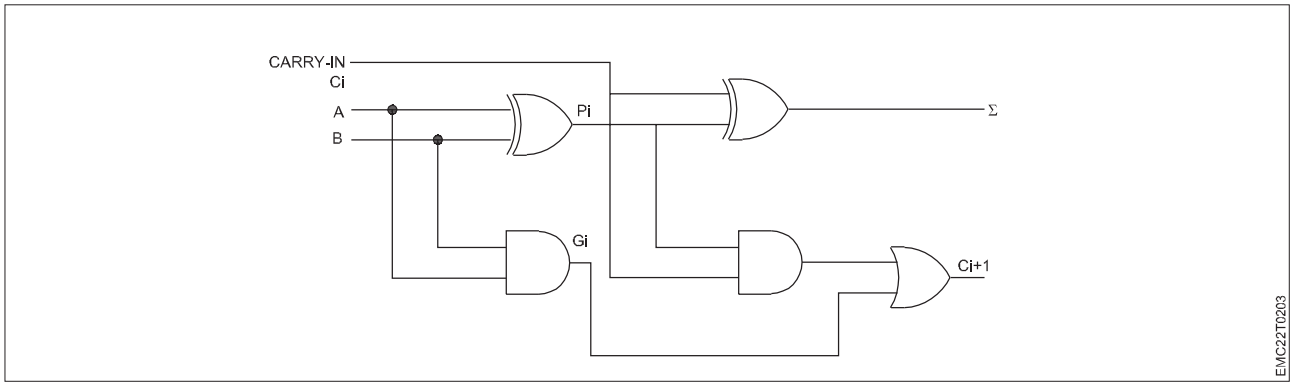
Full Adder

A binary full adder is a multiple output combinational logic network that perform the arithmetic sum of three input bits. As the half adder cannot respond to the three inputs and hence the full adder is used to add three digits at a time.

It consists of three inputs, in which two are input variables represent the two significant bits to be added, labeled as A and B, whereas the third input terminal is the carry from the previous lower significant position and labeled as Cin. The two outputs are a sum and a carry outputs which are labeled as ∑ and Cout respectively.

Full adder can be formed by combining two half adders and an OR gate as shown in above where

output and carry-in of the first adder becomes the input to the second half adder that produce the total sum output. The total carry out is produced by ORing the two half adder carry outs as shown in figure(above).



Truth Table

Inputs			Outputs	
A	B	C_{in}	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Binary substraction circuits

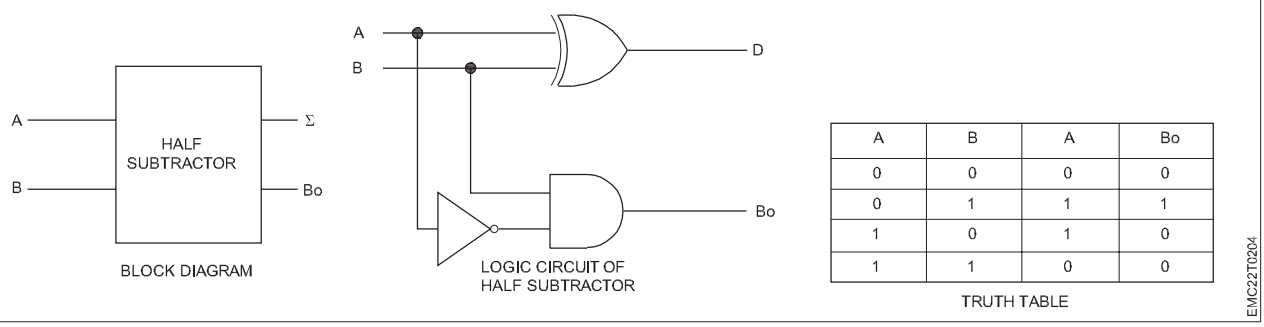
Substraction is a mathematical operation in which one integer number is deducted from another to obtain the equivalent quantity. The number from which other number is to be deducted is called as minuend and the number subtracted from the minuend is called subtrahend.

Half Subtractors

A half subtractor is a multiple output combinational logic network that does the subtraction of two bits of binary data. It has input variables and two output variables. Two inputs are corresponding to two input bits and two output variables corresponds to the difference bit and borrow bit.

The binary subtraction is also performed by the Ex-OR gate with additional circuitry to perform the borrow operation. Thus, a half subtractor is designed by an Ex-OR gate including AND gate with A input complemented before fed to the gate.

In case of multi-digit subtraction, subtraction between the two digits must be performed along with borrow of the previous digit subtraction, and hence a subtractor needs to have three inputs. Therefore, a half subtractor has limited applications and strictly it is not used in practice.



A	B	A	Bo
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

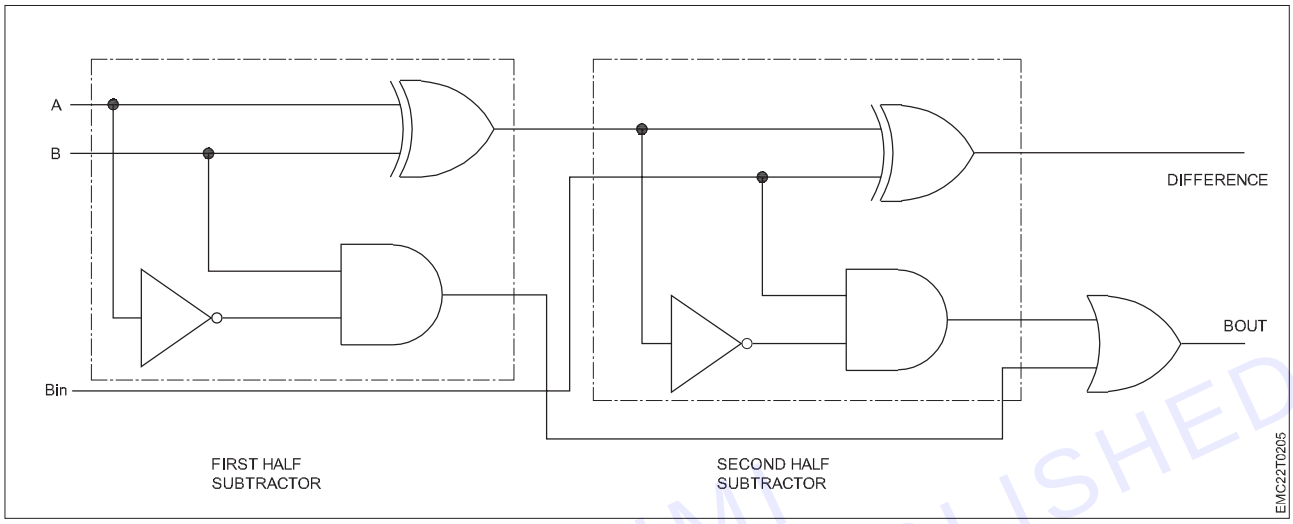
TRUTH TABLE

Full Subtractor

A combinational logic circuit performs a subtraction between the two binary bits by considering borrow of the lower significant stage is called as the full subtractor. In this, subtraction of the two digits is performed by taking into consideration whether a 1 has already borrowed by the previous adjacent lower minuend bit or not.

It has three input terminals in which two terminals corresponds to the two bits to be subtracted (minuend A and subtrahend B), and a borrow bit Bi corresponds to the borrow operation. There are two outputs, one corresponds to the difference D output and other borrow output Bo as shown in figure along with truth table.

Block Diagram of Full Subtractor



Truth Table

Inputs			Outputs	
A	B	C_{in}	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

By comparing the adder and subtractor circuits or truth tables, one can observe that the output D in the full subtractor is exactly same as the output S of the full adder. And the only difference is that input variable A is complemented in the full subtractor.

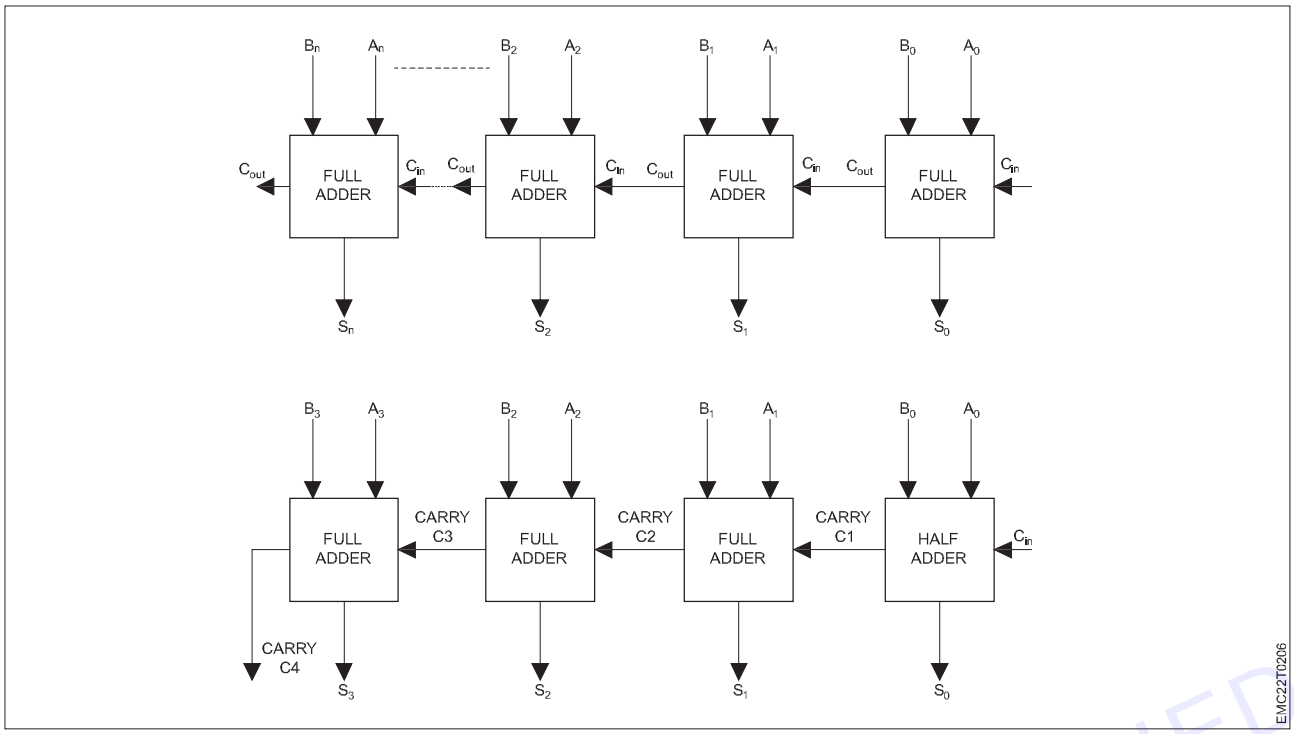
Therefore, it is possible to convert the full adder circuit into full subtractor by simply complementing the input A before it is applied to the gates to produce the final borrow bit output Bo.

Parallel Binary Adders

As we discussed that a single full adder performs the addition of two one bit numbers and an input carry. For performing the addition of binary numbers with more than one bit, more than one full adder is required depends on the number bits. Thus, a parallel adder is used for adding all bits of the two numbers simultaneously.

By connecting a number of full adders in parallel, n-bit parallel adder is constructed. From the below figure, it is to be noted that there is no carry at the least significant position, hence we can use either a half adder or made the carry input of full adder to zero at this position.

The figure below shows a parallel 4 bit binary adder which has three full adders and one half-adder. The two binary numbers to be added are A3A2A1A0 and B3B2B1B0 which are applied to the corresponding inputs of full adders. This parallel adder produces their sum as C4S3S2S1S0 where C4 is the final carry.



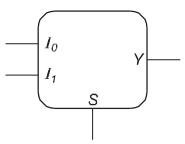
In the 4 bit adder, first block is a half-adder that has two inputs as A0B0 and produces their sum S0 and a carry bit C1. Next block should be full adder as there are three inputs applied to it. Hence this full adder produces their sum S1 and a carry C2. This will be followed by other two full adders and thus the final sum is C4S3S2S1S0.

Most commonly Full adders designed in dual in-line package integrated circuits. A typical 74LS283 is 4 bit full adder.

Multiplexer

- Multiplexer is a special type of combinational circuit.
- The figure below shows the n x 1 multiplexer and its equivalent circuit representation.
- There are 'n' data inputs, 1 output and 'm' select lines, i.e.$2^{m=n}$.
- A multiplexer is a digital circuit which selects one of the n data inputs and routes it to the output. The selection of one of the n inputs is done by the select inputs
- To select 'n' inputs, 'm' select lines such that $2^{m=n}$.
- Depending on the digital code applied at the select inputs, one out of 'n' data sources is elected and transmitted to the single output.
- As shown in the figure, the multiplexer acts like a digitally controlled single pole, multiple way switch.
- The output gets connected to only one of the 'n' data inputs at given instant of time.
- It is also called DATASELECTOR.
- Different types of multiplexers are available viz. 2 to 1, 4 to 1, 8 to 1, 16 to 1 andonwards.
- Multiplexers are needed in most of electronics systems, where the digital data is available on more than one lines, and it becomes necessary to route this data over a single line.
- Many logical functions can be implemented using Multiplexer.

2x1 Multiplexer



BLOCK DIAGRAM

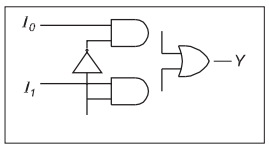
It has two data inputs I0 and I1, one select input S, and one output Y.

Truth table of 2 X 1 multiplexer

SELECT LINE S	OUTPUT Y
0	I_0
0	I_1

2 X 1 MULTIPLEXER

Boolean Equation : $Y = S'I_0 + SI_1$



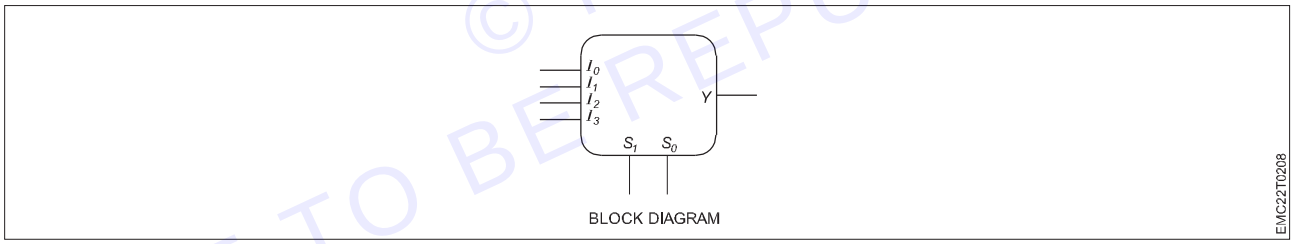
CIRCUIT DIAGRAM

Working

- When S=0,the upper AND GATE will turn ON and lower AND GATE will turn OFF, and so the input I 0 appears in the output.
- When S=1, the upper AND gate will turn OFF and lower AND gate will turn ON, and so the inputI1 appears in the output.

4 X 1 Multiplexer

- It has four data inputs I3, I2, I1 and I0, two select inputs S1 & S0, and one output Y.
- Here $2^{n=4}$ inputs, i.e. n=2 select lines and m = 1output



BLOCK DIAGRAM

Truth Table

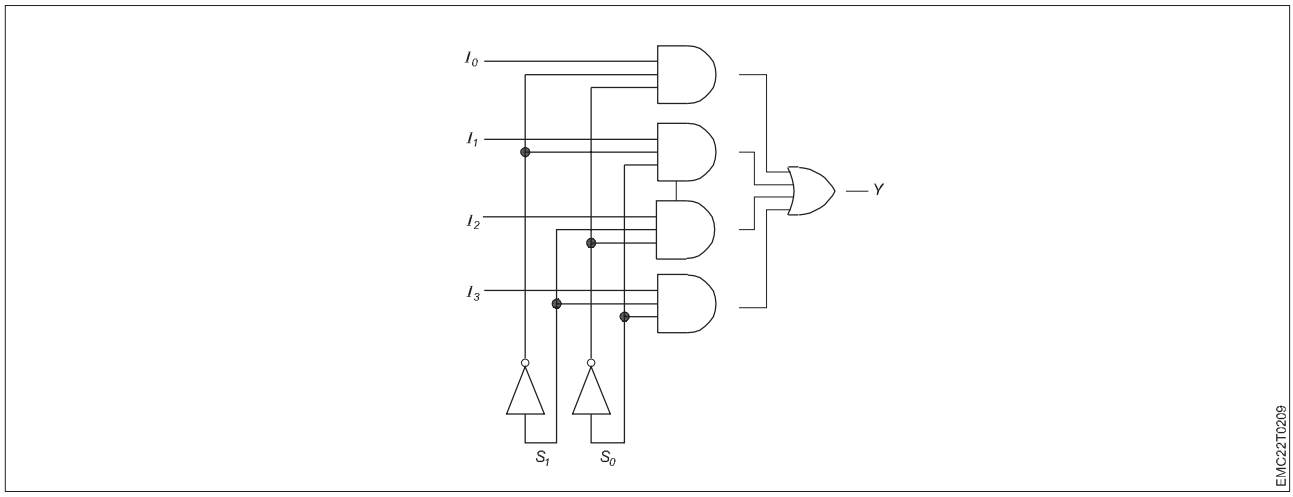
Select Line		Output Y
S1	S0	
0	0	0
0	1	1
1	0	12
1	1	13

Working

- According to the truth table, when S1 S0=00, the input I0 is selected and routed to the output.
- When S1 S0=01, the input I1 is selected and routed to the output.
- Similarly, when S1 S0=10, then Y=I2 & when S1 S0=11, then Y=I3.

Boolean Equation

Y = S1'S0'I0 + S1'S0I1 + S1S0'I2 + S1S0I3



Demultiplexer

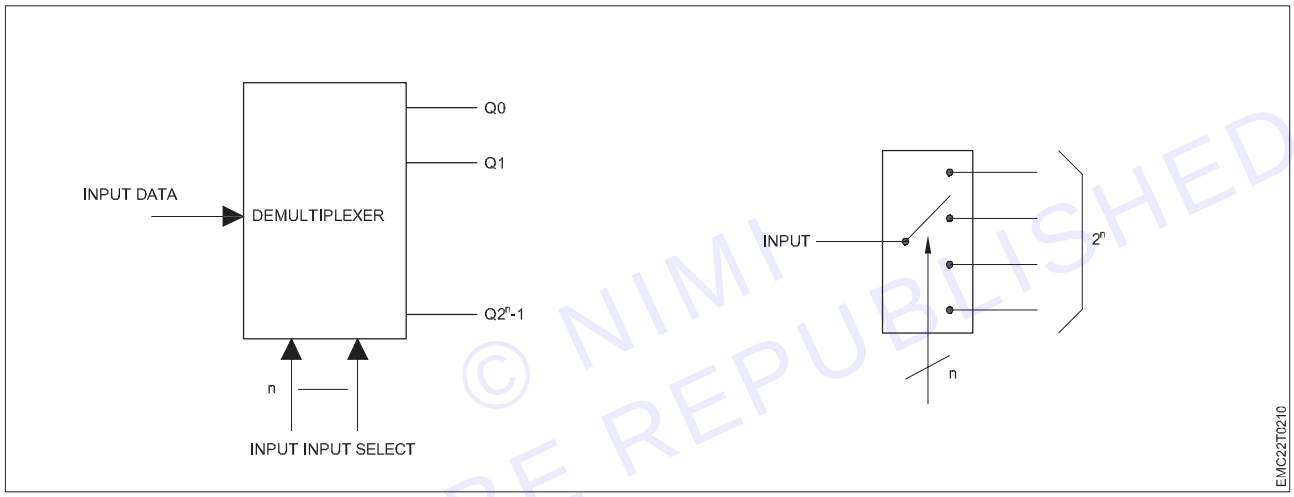


Illustration of demultiplexer

- It has one input common data, 'n' select lines and 'm' output lines.
- A demultiplexer performs the reverse operation of a multiplexer i.e. it receives one input and distributes it over several outputs.
- At a time only one output line is selected by the select lines and the input is transmitted to the selected output line.
- Relation between 'n' output lines and m select lines is as follows:

$$n = 2^m$$

1 X 4 Demultiplexer

- 1 to 4 Demultiplexer has one data input F; select line inputs a,b and four outputs A, B, C &D.
- The select lines control the data to be routed. It helps in selecting the output on which the data will be routed.

Switch Representation

Based on the switch control, the input is routed to particularoutput.

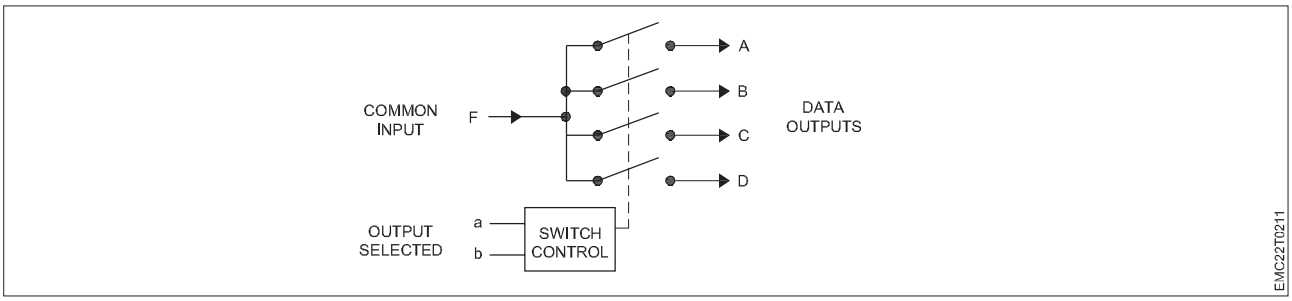
Truth table of 1 X 4 demultiplexer

Boolean Equation

A= Fb′a′; B = Fb′a; C= ba′; D=Fba

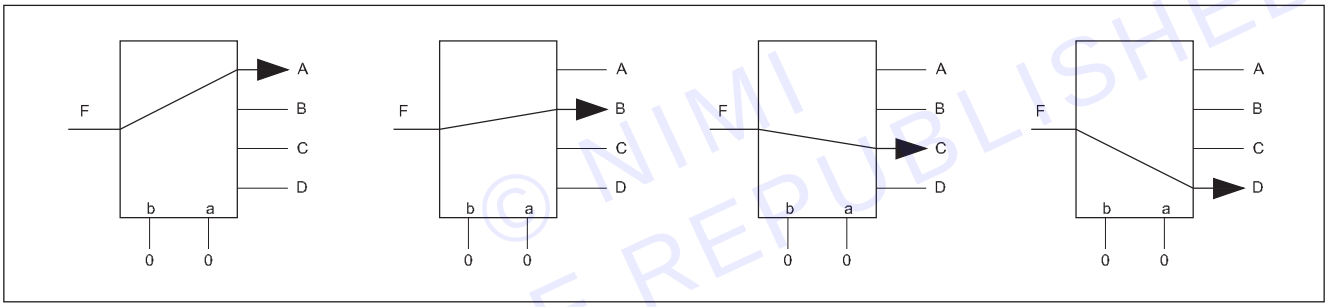
Working

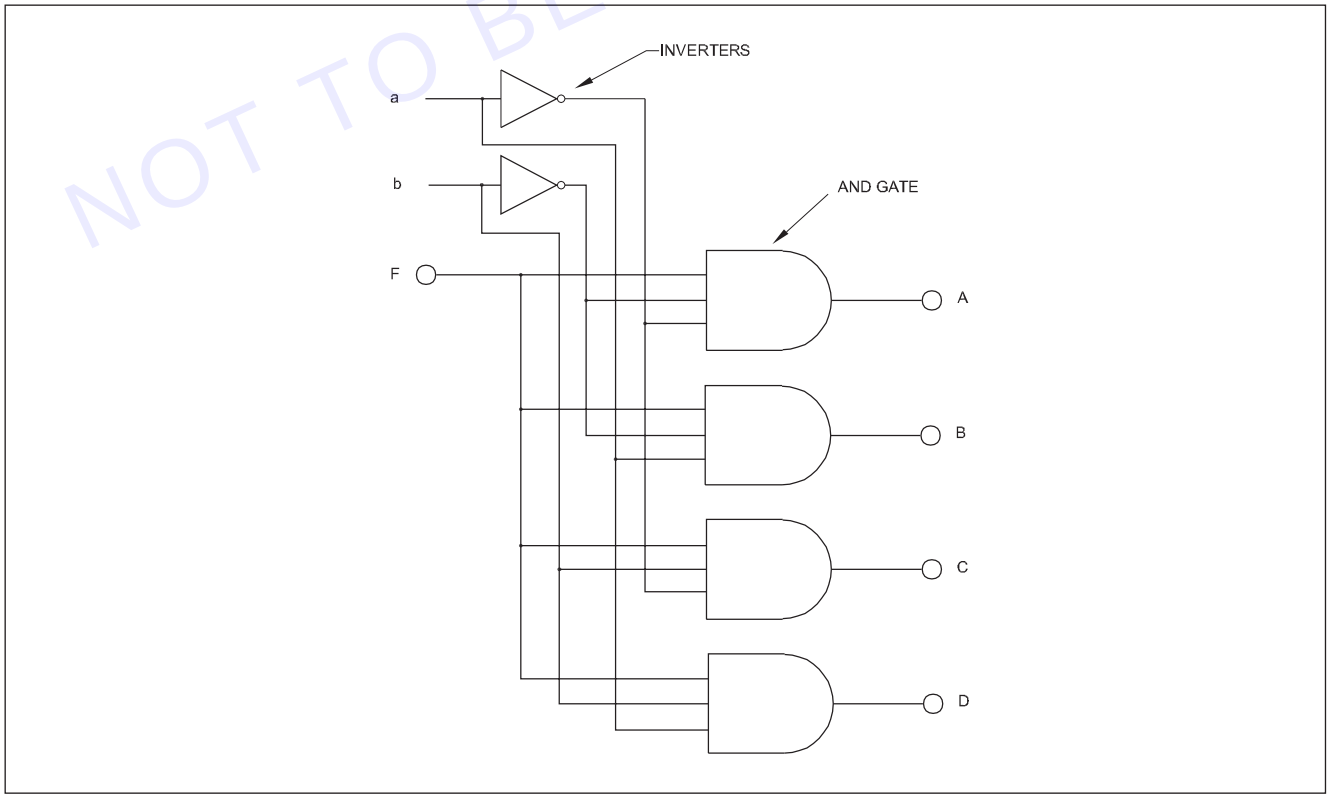
- When ab="00", the input data F is routed to the output A



Select Line		Output Line
b	A	
0	0	A
0	1	B
1	0	C
1	1	D

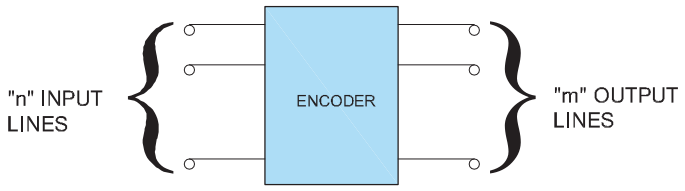
- When ab=”01”, the input data F is routed to the output B
- When ab=”10”, the input data F is routed to the output C
- When ab=”11”, the input data F is routed to the output D





Encoder

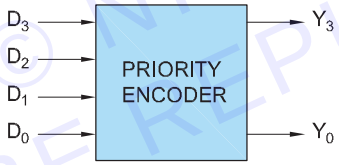
- It is a combinational circuit.
- It has 'n' input lines & 'm' output lines.
- An encoder produces an 'm' bit binary code corresponding to the digital input number of 'n'bits.
- Many types of Encoders – Octal to Binary (8 to 3), Decimal to BCD (10 to 4)etc.
- The block diagram is as shown below,



ENCODER

Priority Encoder

- This is special type of encoder.
- Priorities are given to the input lines.
- Iftwoormoreinputlinesare'1'at the same time, then the input line with highest priority will be considered.
- The block diagram is shown below



PRIORITY ENCODER

- The truth table of priority encoder is as given below,
- There are four inputs, D0 through D3 and outputs Y1 and Y0. Out of the four inputs D3 has the highest priority and D0 has the lowest priority.
- That means if D3 = 1 then Y1Y0 = 11 irrespective of the other inputs. Similarly if D3 = 0 and D2 = 1 then Y1Y0 = 10 irrespective of other inputs

Truth Table

Inputs				Outputs	
D_3	D_2	D_1	D_0	Y_1	Y_0
0	0	0	0	X	X
0	0	0	1	0	0
0	0	1	X	0	1
0	1	X	X	1	0
1	X	X	X	1	1

D_1D_0 / D_3D_2	00	01	11	10
00	X	0	1	1
01	0	0	0	0
11	1	1	1	1
10	1	1	1	1

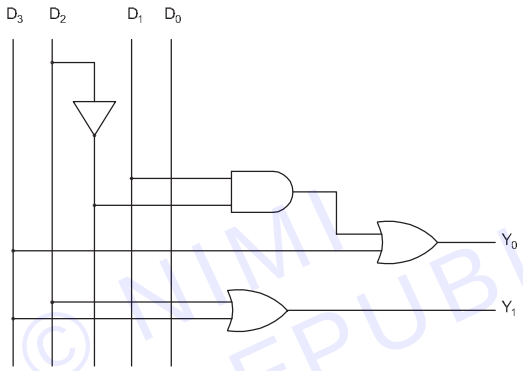
K-map representation of priority encoder

Boolean expression

Y1 = D3+D2

Y0 = D3 + D2'D1

- Circuit diagram of Priority Encoder



CIRCUIT DIAGRAM OF PRIORITY ENCODER

Octal to Binary (8 to 3) Encoder

Truth table of octal to binary encoder

Input								Output		
D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	Q_2	Q_1	Q_0
1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	1	0	0	1	0	1
0	0	0	0	0	0	1	0	1	1	0
0	0	0	0	0	0	0	1	1	1	1

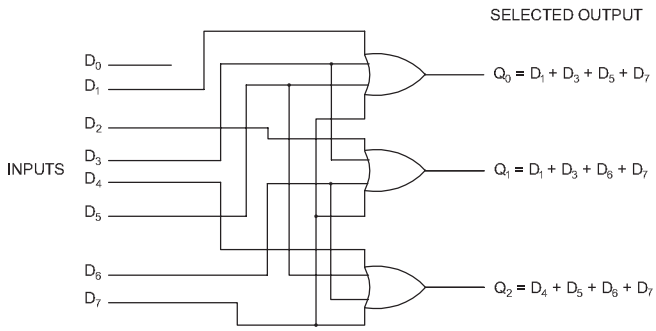
- It has 8 input lines & 3 output lines.
- Corresponding to the eight input octal numbers we get three bit binaryoutput.
- In encoders only one input will have a one value at any given time.

Boolean Equation

Q0 = D1 + D3 + D5 + D7

Q1 = D2 + D3 + D6 + D7

Q2 = D4 + D5 + D6 + D7



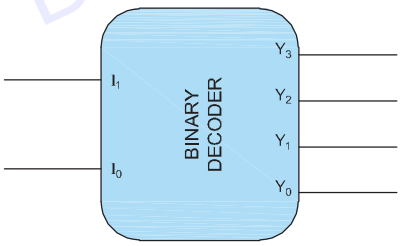
CIRCUIT DIAGRAM

Decoder

- Decoder is a device which does the reverse operation of Encoder. It is a combinational circuit that converts binary information from 'n' input lines to a maximum of '2n' unique output lines.
- Decoder is identical to a demultiplexer without any data input.
- E.g.: 2 to 4 Decoder, 3 to 8 Decoder, BCD to Seven Segment Decoder

2 to 4 Line Decoder

- I0 & I1 are two inputs whereas y3, y2, y1 & y0 are four outputs.
- The truth table shows that each output is '1' for only a specific combination of inputs.



BLOCK DIAGRAM

Boolen Equation

$y0 = \overline{I}\,1\overline{I}\,0;$

y1= I1I0;

$y2 = I1\overline{I}\,0;$

y3= I1I0

Truth Table

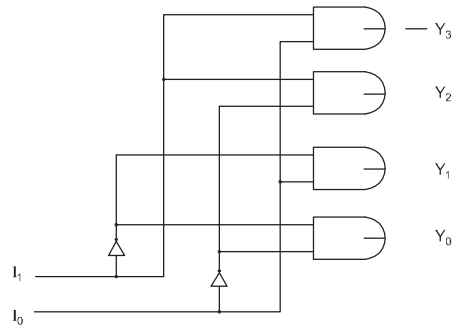
Working

- According to the truth table, when I1I0=00, the output Y0 is set to '1', others are'0'
- When I1I0=01, the output Y1 is set to '1', others are'0'

INPUTS		OUTPUT			
I_1	I_0	y_0	y_1	y_2	y_3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

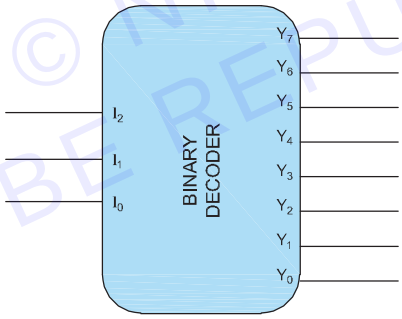
TRUTH TABLE

- Similarly, for other input combinations, particular output is set to '1' & others are'0
- **3 to 8 Decoder**



CIRCUIT DIAGRAM

Block diagram of 3 to 8 decoder



BLOCK DIAGRAM

Truth Table

Inputs			Output							
I_2	I_1	I_0	Y_0	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

Working

- According to the truth table, when I2I1I0=000, the output Y0 is set to '1', others are'0'
- When I2I1I0=001, the output Y1 is set to '1', others are'0'
- Similarly, for other input combinations, particular output is set to '1' & others are'0'

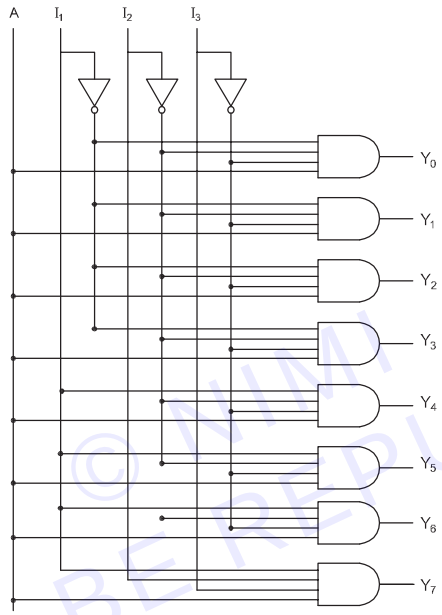
Boolean Equation:

$Y0=\overline{I2}\,\overline{I1}\,\overline{I0}$; $Y1=\overline{2}\,\overline{I}1I0$;

$Y2=\overline{I2}I1I\overline{0}$; $Y3=\overline{I2}I1I0$

$Y4=I2\overline{I1}\,\overline{I0}$; $Y5=I2\overline{I1}I0$;

$Y6=I2I1\overline{I0}$; $Y7=I2I1I0$



CIRCUIT DIAGRAM

Sequential Logic circuits

There are two types of sequential circuits. Their classification depends on the timing of their signals

- Synchronous sequential circuits
- Asynchronous sequential circuits

Asynchronous sequential circuit

This is a system whose outputs depend upon the order in which its input variables change and can be affected at any instant of time.

Synchronous sequential circuits

This type of system uses storage elements called flip-flops that are employed to change their binary value only at discrete instants of time.

Synchronous sequential circuits use logic gates and flip-flop storage devices. Sequential circuits have a clock signal as one of their inputs. All state transitions in such circuits occur only when the clock value is either O or 1 or happen at the rising or falling edges of the clock depending on the type of memory elements used in the circuit. Synchronization is achieved by a timing device called a clock pulse generator. Clock pulses are distributed throughout the system in such a way that the flip-flops are affected only with the arrival of the synchronization pulse. Synchronous sequential circuits that use clock pulses in the inputs are called clocked-sequential circuits.

Here is the difference between synchronous and asynchronous sequential circuits

Synchronous Sequential Circuit: Output changes at discrete interval of time. It is a circuit based on an equal state time or a state time defined by external means such as clock. Examples of synchronous sequential circuit are Flip Flops, Synchronous Counter.

Asynchronous Sequential Circuit: Output can be changed at any instant of time by changing the input. It is a circuit whose state time depends solely upon the internal logic circuit delays. Example of asynchronous sequential circuit is Asynchronous Counter.

Basic Flip Flops

A circuit that changes from 1 to O or from O to 1 when current is applied. It is one bit storage location.

Flip flops are actually an application of logic gates. When a certain input value is given to them, they will be remembered and executed, if the logic gates are designed correctly. A higher application of flip flops is helpful in designing better electronic circuits.

The most commonly used application of flip flops is in the implementation of a feedback circuit. As a memory relies on the feedback concept, flip flops can be used to design it.

Latches and flip-flops are the basic elements for storing information. One latch or flip flop can store one bit of information. The main difference between latches and flip-flops is that for latches, their outputs are constantly affected by their inputs as long as the enable signal is asserted. In other words, when they are enabled, their content changes immediately when their inputs change. Flip-flops, on the other hand, have their content change only either at the rising or falling edge of the enable signal. This enable signal is usually the controlling clock signal. After the rising or falling edge of the clock, the flip-flop content remains constant even if the input changes.

There are basically four main types of latches and flip-flops: SR, D, JK, and T. The major differences in these flip-flop types are the number of inputs they have and how they change state. For each type, there are also different variations that enhance their operations.

RS Latch

- RS latch have two inputs, S and R. S is called set and R is called reset.
- The S input is used to produce HIGH on Q (i.e. store binary 1 in flip-flop).
- The R input is used to produce LOW on Q (i.e. store binary O in flip-flop).
- Q' is Q complementary output, so it always holds the opposite value of Q.
- The output of the S-R latch depends on current as well as previous inputs or state, and its state (value stored) can change as soon as its inputs change.

There are mainly four types of flip flops that are used in electronic circuits

1 The basic Flip Flop or S-R Flip Flop

2 Delay Flip Flop [D Flip Flop]

3 J-K Flip Flop

4 T Flip Flop

1 SR Flip Flop

The SET-RESET flip flop is not designed with the help of two NOR gates and also two NAND gates. These flip flops are also called S-R Latch.

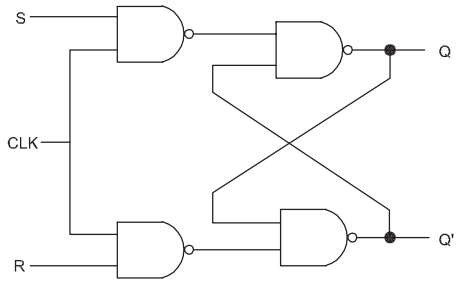
S-R Flip Flop using NOR Gate

The design of such a flip flop includes two inputs, called the SET [S] and RESET [R].

There are also two outputs, Q and Q'. The diagram and truth table is shown below.

The operation has to be analyzed with the 4 inputs combinations together with the 2 possible previous states.

From the diagram it is evident that the flip flop has mainly four states. They are



S	R	Q	Q_{+1}	STATE
0	0	0	X	INVALID
0	0	1	X	
0	1	0	1	SET
0	1	1	1	
1	0	0	0	RESET
1	0	1	0	
1	1	0	0	NO CHANGE
1	1	1	1	

EMC22T0219

1 When S=1, R=0 the output becomes Q=1, Q'=0

This SR flip flop function table is constructed based on the XOR gate. In XOR gate if any of the input is 1 the output becomes 1.

In this state when S=1 and R=0 the output Q becomes set (1). So this state is also called the SET state.

2 When S=0, R=1, the output becomes Q=0, Q'=1

In this state When R=1 it resets the output. So this state is known as the RESET state.

In both the states you can see that the outputs are just compliments of each other and that the value of Q follows the value of S.

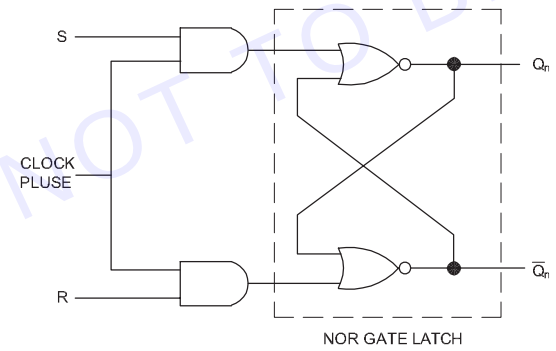
3 When S=0, R=0 the output is Q & Q' = Remember (memory)

If both the values of S and R are switched to 0, then the circuit remembers the value of S and R in their previous state.

4 When S=1, R=1 the output Q=0, Q'=0 [Invalid]

This is an invalid state because the values of both Q and Q' are 0. They are supposed to be compliments of each other. Normally, this state must be avoided.

S-R Flip Flop using NAND Gate



S	R	Q	Q_{+1}	STATE
0	0	0	X	INVALID
0	0	1	X	
0	1	0	1	SET
0	1	1	1	
1	0	0	0	RESET
1	0	1	0	
1	1	0	0	NO CHANGE
1	1	1	1	

EMC22T0220

Like the NOR Gate S-R flip flop, this one also has four states. They are

1 S=1, R=0, Q=0,Q'=1

This state is also called the SET state.

2 S=0, R=1,Q=1,Q'=0

This state is known as the RESET state.

In both the states you can see that the outputs are just compliments of each other and that the value of Q follows the compliment value of S.

3 S=0, R=0, Q=1, & Q' =1 [Invalid]

If both the values of S and R are switched to O it is an invalid state because the values of both Q and Q' are 1.

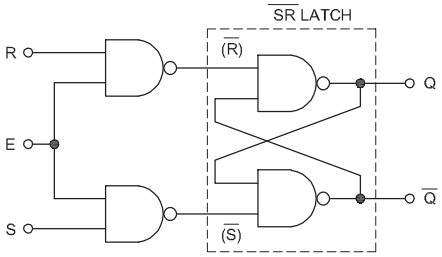
They are supposed to be compliments of each other. Normally, this state must be avoided.

4 S=1, R=1,Q & Q'= Remember

If both the values of S and Rare switched to 1, then the circuit remembers the value of S and R in their previous state.

Clocked S-R Flip Flop

- It is also called a Gated S-R flip flop.
- The problems with S-R flip flops using NOR and NAND gate is the invalid state.
- This problem can be overcome by using a bistable SR flip-flop that can change outputs when certain invalid states are met, regardless of the condition of either the Set or the Reset inputs.
- For this, a clocked S-R flip flop is designed by adding two AND neither gates to a basic NOR Gate flip flop.
- The circuit diagram and truth table is shown below.

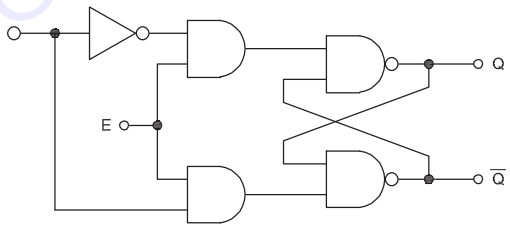


INPUTS			OUTPUT	STATE
CLK	S	R	Q	
X	0	0	NO CHANGE	PREVIOUS
↑	0	1	0	RESET
↑	1	0	1	SET
↑	1	1	-	FORBIDDEN

EMC22T0221

- A clock pulse [CP] is given to the inputs of the AND Gate.
- When the value of the clock pulse is 'O', the outputs of both the AND Gates remain 'O'.
- As soon as a pulse is given the value of CP turns 'I '.
- This makes the values at S and R to pass through the NOR Gate flip flop. But when the values of both S and R values turn 'I ', the HIGH value of CP causes both of them to turn to 'O' for a short moment.
- As soon as the pulse is removed, the flip flop state becomes intermediate.
- Thus either of the two states may be caused, and it depends on whether the set or reset input of the flip-flop remains a' l' longer than the transition to 'O' at the end of the pulse. Thus the invalid states can be eliminated.

D Flip Flop



D	S	R	Q	STATE
	0	0	PREVIOUS STATE	NO CHANGE
0	0	1	0	RESET
1	1	0	1	SET
	1	1	?	FORBIDDEN

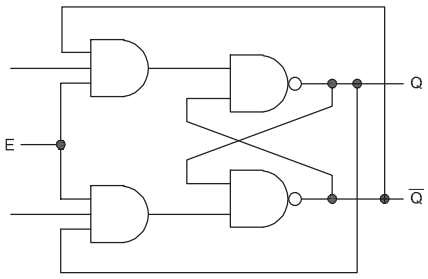
SR & D FLIP FLOP TRUTHTABLE

EMC22T0222

- D flip flop is actually a slight modification of the above explained clocked SR flip-flop. From the figure you can see that the D input is connected to the S input and the complement of the D input is connected to the R input.
- The D input is passed on to the flip flop when the value of CP is 'I '.
- When CP is HIGH, the flip flop moves to the SET state. If it is '0', the flip flop switches to the CLEAR state.
- As long as the clock input C = 0, the SR latch has both inputs equal to O and it can't change its state regardless of the value of D
- When C is 1, the latch is placed in the set or reset state based on the value of D. If D = 1, the Q output goes to 1.

If D = 0, the Q output goes to 0.

K Flip Flop

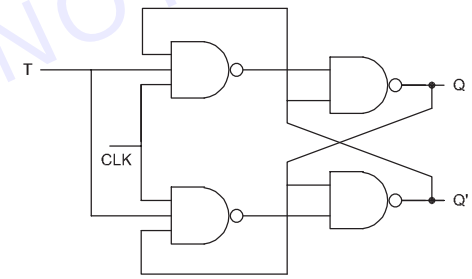


	CLOCK	INPUT		OUTPUT		DESCRIPTION
	CIK	J	K	Q	Q'	
SAME AS FOR SR LATCH	X	0	0	1	0	MEMORY NO CHANGE
	X	0	0	0	1	
	↓	0	1	1	0	RESET Q>>0
	X	0	1	0	1	
	↓	1	0	0	1	SET Q>>1
	X	1	0	1	0	
TOGGLE ACTION	↓	1	1	0	1	TOGGLE
	↓	1	1	1	0	

EMC22T0223

- A J-K flip flop can also be defined as a modification of the S-R flip flop. The only difference is that the intermediate state is more refined and precise than that of a S-R flip flop.
- The behavior of inputs J and K is same as the S and R inputs of the S-R flip flop. The letter J stands for SET and the letter K stands for CLEAR.
- When both the inputs J and K have a HIGH state, the flip-flop switches to the complement state. So, for a value of Q = 1, it switches to Q=0 and for a value of Q = 0, it switches to Q=l.
- The circuit includes two 3-input AND gates. The output Q of the flip flop is returned back as a feedback to the input of the AND along with other inputs like K and clock pulse [CP].
- So, if the value of CP is 'l ', the flip flop gets a CLEAR signal and with the condition that the value of Q was earlier 1.
- Similarly output Q' of the flip flop is given as a feedback to the input of the AND along with other inputs like J and clock pulse [CP].
- So the output becomes SET when the value of CP is 1 only if the value of Q' was earlier 1.
- The output may be repeated in transitions once they have been complimented for J=K=l because of the feedback connection in the JK flip-flop.
- This can be avoided by setting a time duration lesser than the propagation delay through the flip-flop.

T Flip Flop



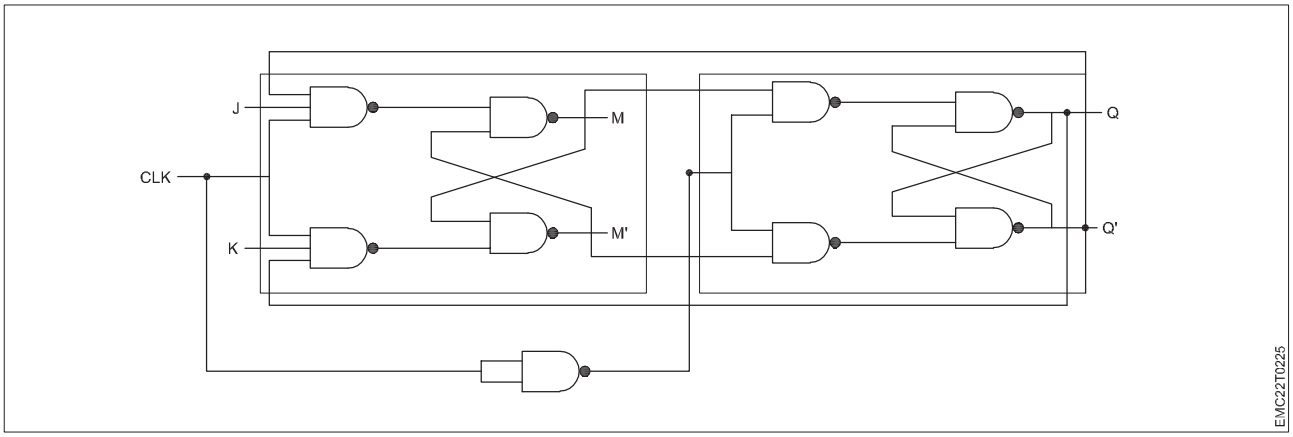
TRUTH TABLE

T	Q_N	Q_{N+1}
0	0	0
0	1	1
1	0	1
1	1	0

EMC22T0224

- This is a much simpler version of the J-K flip flop.
- Both the J and K inputs are connected together and thus are also called a single input J-K flip flop.
- When clock pulse is given to the flip flop, the output begins to toggle.
- Here also the restriction on the pulse width can be eliminated with a master-slave or edge• triggered construction. Take a look at the circuit and truth table below.

Master-Slave Flip Flop Circuit



- Before knowing more about the master-slave flip flop you have to know more on the basics of a J-K flip flop and S-R flip flop. To know more about the flip flops, click on the link below.
- Master-slave flip flop is designed using two separate flip flops. Out of these, one acts as the master and the other as a slave. The figure of a master-slave J-K flip flop is shown below.
- From the below figure you can see that both the J-K flip flops are presented in a series connection. The output of the master J-K flip flop is fed to the input of the slave J-K flip flop. The output of the slave J-K flip flop is given as a feedback to the input of the master J-K flip flop. The clock pulse [Clk] is given to the master J-K flip flop and it is sent through a NOT Gate and thus inverted before passing it to the slave J-K flip flop.

Case	Inputs			Outputs		Remarks
	CLK	J	K	Q_{n+1}	$\overline{Q}_{n+1}$	
I	X	0	0	Q_n	$\overline{Q}_n$	No change
II	(1)	0	1	Q_n	$\overline{Q}_n$	No change
III	(1)	0	1	0	1	Reset
IV	(1)	1	0	1	0	Set
V	(1)	1	1	$\overline{Q}_n$	Q_n	Toggle

Counters

A Counter is a device which stores (and sometimes displays) the number of times a particular event or process has occurred, often in relationship to a clock signal. Counters are used in digital electronics for counting purpose, they can count specific event happening in the circuit. For example, in UP counter a counter increases count for every rising edge of clock. Not only counting, a counter can follow the certain sequence based on our design like any random sequence 0,1,3,2… .They can also be designed with the help of flip flops. They are used as frequency dividers where the frequency of given pulse waveform is divided. Counters are sequential circuit that count the number of pulses can be either in binary code or BCD form. The main properties of a counter are timing , sequencing , and counting.

Counter works in two modes

- Up counter
- Down counter

Counter Classification

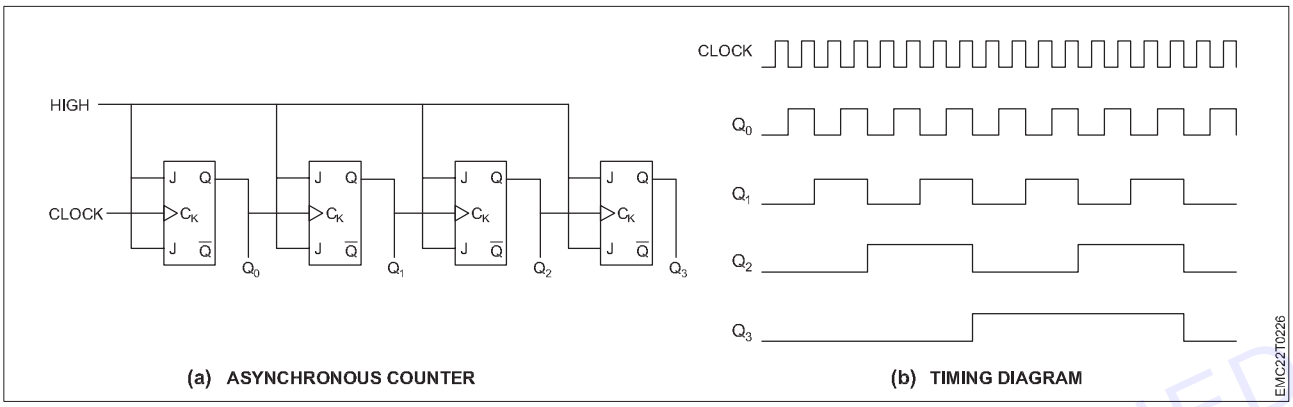
Counters are broadly divided into two categories

1 Asynchronous counter

2 Synchronous counter

Asynchronous Counter

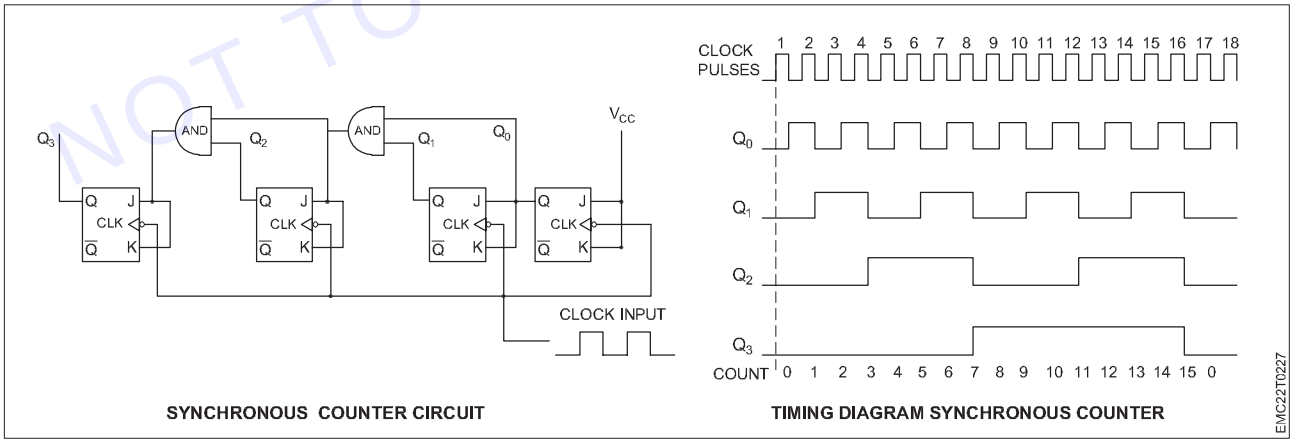
In asynchronous counter we don't use universal clock, only first flip flop is driven by main clock and the clock input of rest of the following flip flop is driven by output of previous flip flops. We can understand it by following diagram



It is evident from timing diagram that Q0 is changing as soon as the rising edge of clock pulse is encountered, Q1 is changing when rising edge of Q0 is encountered(because Q0 is like clock pulse for second flip flop) and so on. In this way ripples are generated through Q0,Q1,Q2,Q3 hence it is also called RIPPLE counter and serial counter. A ripple counter is a cascaded arrangement of flip flops where the output of one flip flop drives the clock input of the following flip flop.

Synchronous Counter

Unlike the asynchronous counter, synchronous counter has one global clock which drives each flip flop so output changes in parallel. The one advantage of synchronous counter over asynchronous counter is, it can operate on higher frequency than asynchronous counter as it does not have cumulative delay because of same clock is given to each flip flop. It is also called as parallel counter.



From circuit diagram we see that Q0 bit gives response to each falling edge of clock while Q1 is dependent on Q0, Q2 is dependent on Q1 and Q0 , Q3 is dependent on Q2,Q1 and Q0.

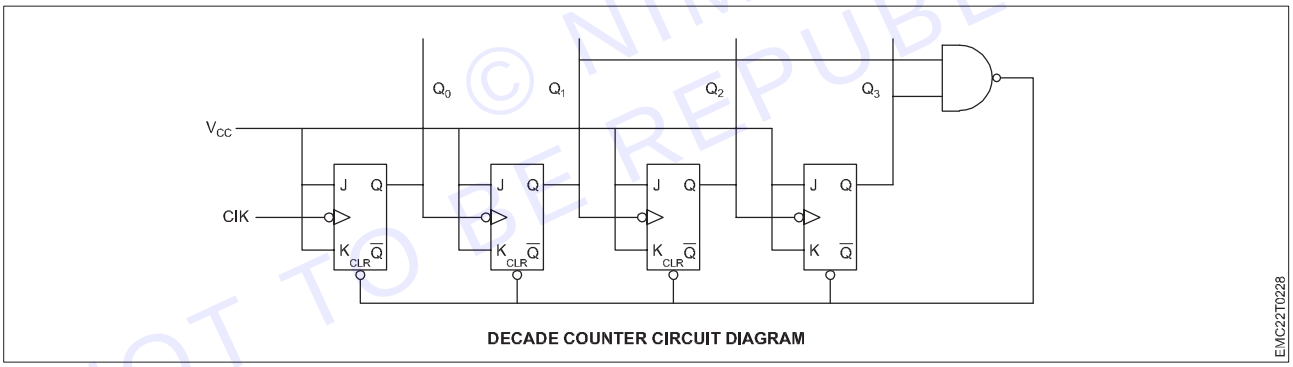
Decade Counter

A decade counter counts ten different states and then reset to its initial states. A simple decade counter will count from 0 to 9 but we can also make the decade counters which can go through any ten states between 0 to 15(for 4 bit counter).

Truth table for simple decade counter

Clock pulse	Q3	Q2	Q1	Q0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	1
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	0	0	0	0

Decade counter circuit diagram

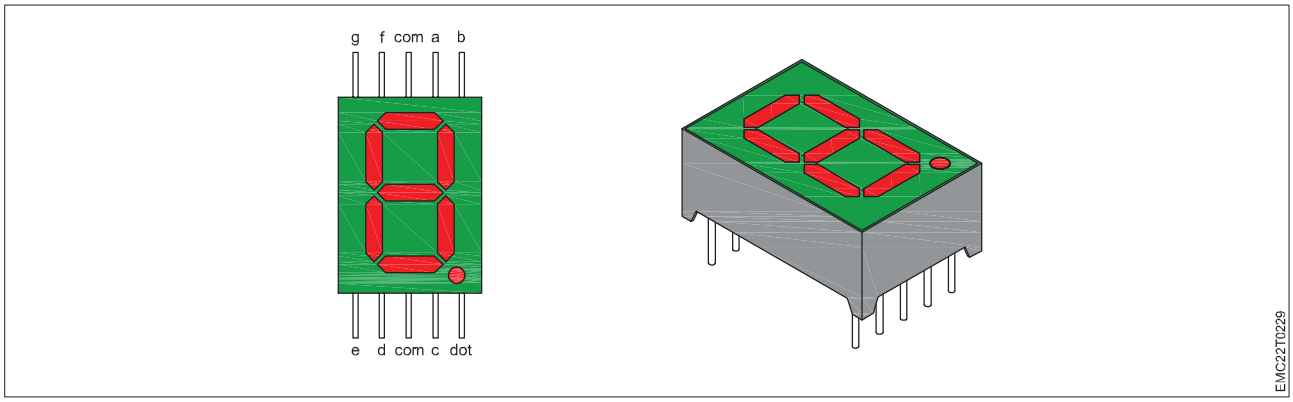


DECADE COUNTER CIRCUIT DIAGRAM

We see from circuit diagram that we have used nand gate for Q3 and Q1 and feeding this to clear input line because binary representation of 10 is 1010

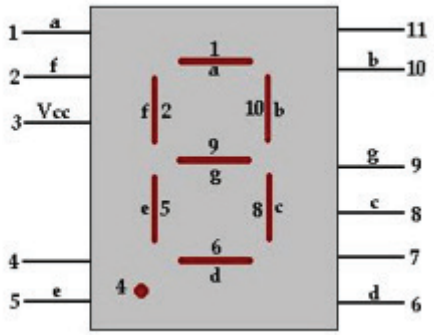
And we see Q3 and Q1 are 1 here, if we give NAND of these two bits to clear input then counter will be clear at 10 and again start from beginning.

Important point: Number of flip flops used in counter are always greater than equal to (log2 n) where n=number of states in counter.



Seven segment displays

Seven segment displays are the output display devices that provide a way to display information in the form of image or text. For displaying the images or text in a proper manner, some types of displays can show only alpha-numeric characters and digits. But, some displays can also show characters and images. Most commonly used displays along with the microcontrollers are LCD, LEDs and seven segment displays, etc.



The seven segment display is the most common display device used in many gadgets, and electronic appliances like digital meters, digital clocks, microwave oven and electric stove, etc. These displays consist of seven segments of light emitting diodes (LEDs) and that is assembled into a structure like numeral 8. Actually seven segment displays contain about 8-segments wherein an extra 8th segment is used to display dot. This segment is useful while displaying non integer number. Seven segments are indicated as A-G and the eighth segment is indicated as H. These segments are arranged in the form of 8 which is shown in the seven segment display circuit diagram.

A seven segment displays are generally available in ten pin package. In that 8 pins relate to the 8 LEDs, the remaining pins at middle are internally shorted. These segments come in two outlines they are common cathode and common anode. In common cathode configuration, the negative terminals are connected to the common pins and the common is connected to the ground. When the corresponding pin is given high,then particular LED glows. In a common anode arrangement, the common pin is given to a logic high and the pins of the LED are given low to display a number.

Seven Segment Display Working

When the power is given to all the segments, then the number 8 will be displayed. If you disconnect the power for segment G (that means 7) then that will result number 0. The circuit of the seven segment display is designed in such a way that the voltage at different pins can be applied at the same time. In the same way, you can form the combinations to display numerals from 0 to 9. Practically, seven segment displays are available with two structures, both the type of displays consists of 10 pins.

The numeric seven segment displays can also display other characters. But generally A-G and L, T, O, S and others are also available. Some problems may occur with the H, X, 2, and Z. Anyways the common seven segment display is numeric only. Alphanumeric displays are also available but cost is little more. These types of displays still have a real purpose due to its high illumination and 7 segment displays are used in dark areas like railway stations. Even 7 segment display based countdown display is used in NASA, which can be read easily even in sunlight.

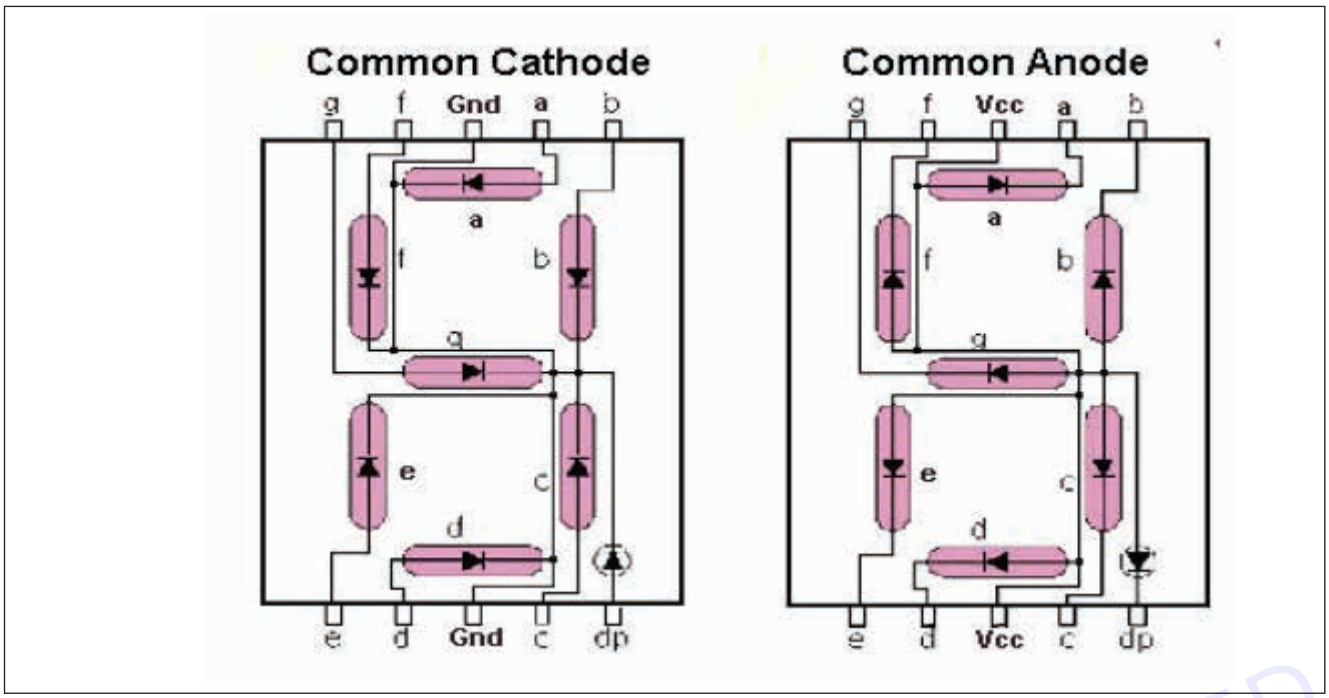
Types of 7-Segment Displays

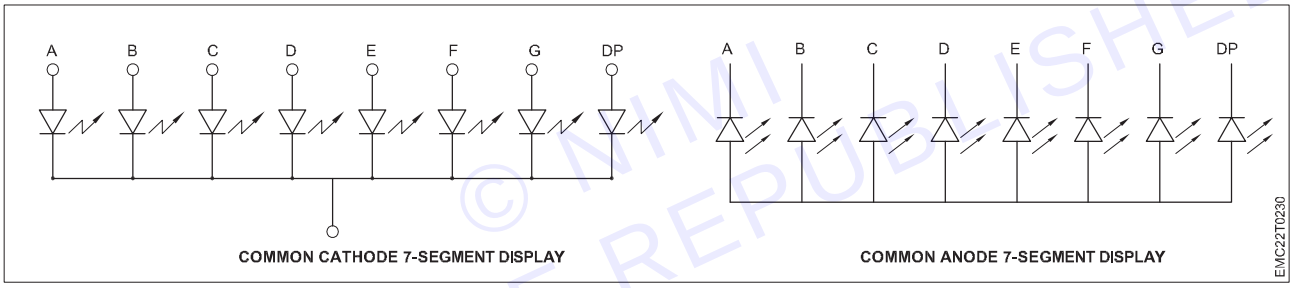
There are two types of seven segment displays available in the market. According to the type of application, these displays can be used. The two configurations of seven segment displays are discussed below.

- Common Anode Display
- Common Cathode Display

Common Cathode 7-segment Display

In this type of display, all the cathode connections of the LED segments are connected together to logic 0 or ground. The separate segments are lightened by applying the logic 1 or HIGH signal through a current limiting resistor to forward bias the individual anode terminals a to g.





Common Anode 7-segment Display

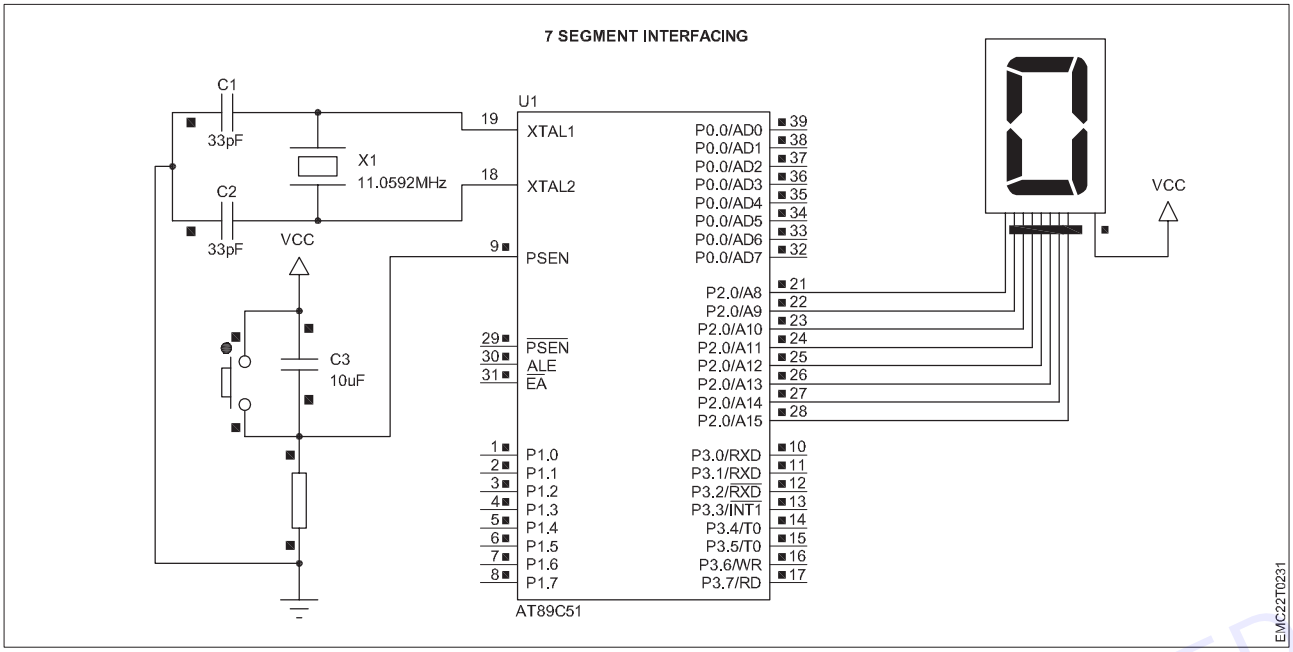
In this type of display, all the anode connections of the LED segments are connected together to logic 1. The separate segments are lightened by applying of the logic 0 or LOW signal through a current limiting resistor to the cathode of the particular segment a to g.

Therefore, common anode seven segment displays are very popular as many logic circuits can sink more current than they can source. These displays are not a direct replacement in a circuit for a common anode display, as it is the same as connecting the LEDs in reverse, and hence the light emission will not take place. Depending upon the decimal number displayed, the particular set of LEDs is forward biased. For instance, to display the numerical number 0, we need to light up remaining segments corresponding to a, b, c, d, e and f. Then the digits from 0 through 9 can be displayed using a seven segment display.

Seven Segment Display Controlling Ways

There are different types of controlling techniques that are implemented by interfacing these seven segment displays with the external controlling devices. Seven segment displays must be controlled by other external devices. Different types of microcontrollers are very useful to communicate with external devices like keypads, memory, switches, etc. There are numerous interfacing techniques that have been developed to solve the complex problems to communicate with displays.

Interfacing 7-Segment Display Circuit Diagram



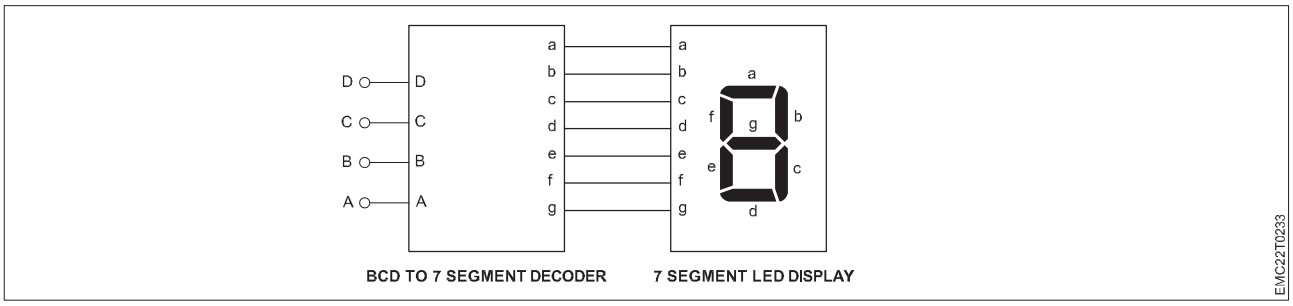
BCD to 7 Segment Decoder

Prerequisite – Number System and base conversions, BCD(8421). In Binary Coded Decimal (BCD) encoding scheme each of the decimal numbers(0-9) is represented by its equivalent binary pattern(which is generally of 4-bits). Whereas, Seven segment display is an electronic device which consists of seven Light Emitting Diodes (LEDs) arranged in a some definite pattern (common cathode or common anode type), which is used to display Hexadecimal numerals(in this case decimal numbers,as input is BCD i.e., 0-9). Two types of seven segment LED display.

1 **Common Cathode Type:** In this type of display all cathodes of the seven LEDs are connected together to the ground or -Vcc(hence, common cathode) and LED displays digits when some 'HIGH' signal is supplied to the individual anodes.

2 **Common Anode Type:** In this type of display all the anodes of the seven LEDs are connected to battery or +Vcc and LED displays digits when some 'LOW' signal is supplied to the individual cathodes.

But, seven segment display does not work by directly supplying voltage to different segments of LEDs. First, our decimal number is changed to its BCD equivalent signal then BCD to seven segment decoder converts that signals to the form which is fed to seven segment display. This BCD to seven segment decoder has four input lines (A, B, C and D) and 7 output lines (a, b, c, d, e, f and g), this output is given to seven segment LED display which displays the decimal number depending upon inputs.



Truth Table for common cathode type BCD to seven segment decoder

A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	1	1	1	1	1	0	1	1

Note

- **For Common Anode type seven segment LED display, we only have to interchange all '0s' and '1s' in the output side i.e., (for a, b, c, d, e, f, and g replace all '1' by '0' and vice versa) and solve using K-map.**
- **Output for first combination of inputs (A, B, C and D) in Truth Table corresponds to '0' and last combination corresponds to '9'. Similarly rest corresponds from 2 to 8 from top to bottom.**
- **BCD numbers only range from 0 to 9,thus rest inputs from 10-F are invalid inputs.**

Registers

Flip flops can be used to store a single bit of binary data (1 or 0). However, in order to store multiple bits of data, we need multiple flip-flops. N flip flops are to be connected in order to store n bits of data. A Register is a device that is used to store such information. It is a group of flip-flops connected in series used to store multiple bits of data. The information stored within these registers can be transferred with the help of shift registers.

Shift Register is a group of flip flops used to store multiple bits of data. The bits stored in such registers can be made to move within the registers and in/out of the registers by applying clock pulses. An n-bit shift register can be formed by connecting n flip-flops where each flip-flop stores a single bit of data. The registers which will shift the bits to the left are called "Shift left registers". The registers which will shift the bits to the right are called "Shift right registers". Shift registers are basically of following types.

Types of Shift Registers

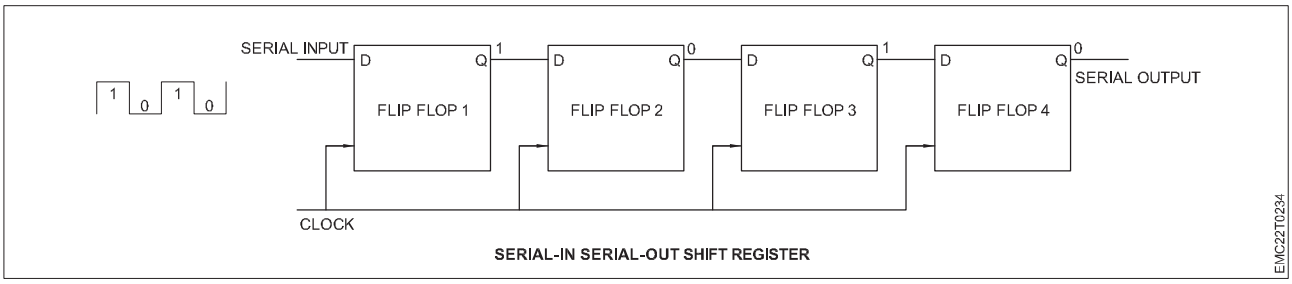
- Serial In Serial Out shift register
- Serial In parallel Out shift register
- Parallel In Serial Out shift register
- Parallel In parallel Out shift register
- Shift Register Counter

Serial-In Serial-Out Shift Register (SISO)

The shift register, which allows serial input (one bit after the other through a single data line) and produces a serial output is known as a Serial-In Serial-Out shift register. Since there is only one output, the data leaves the shift register one bit at a time in a serial pattern, thus the name Serial-In Serial-Out Shift Register. The logic circuit given below shows a serial-in serial-out shift register. The circuit consists of four D flip-flops which are connected in a serial manner. All these flip-flops are synchronous with each other since the same clock signal is applied to each flip-flop.

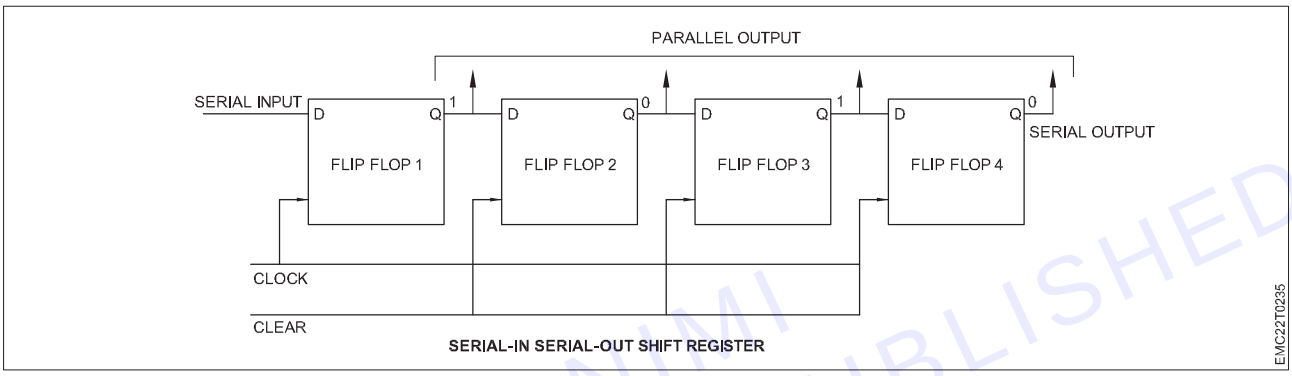
The above circuit is an example of a shift right register, taking the serial data input from the left side of the flip flop. The main use of a SISO is to act as a delay element.

Serial-In Parallel-Out Shift Register (SIPO)



SERIAL-IN SERIAL-OUT SHIFT REGISTER

The shift register, which allows serial input (one bit after the other through a single data line) and produces a parallel output is known as the Serial-In Parallel-Out shift register. The logic circuit given below shows a serial-in-parallel-out shift register. The circuit consists of four D flip-flops which are connected. The clear (CLR) signal is connected in addition to the clock signal to all 4 flip flops in order to RESET them. The output of the first flip-flop is connected to the input of the next flip flop and so on. All these flip-flops are synchronous with each other since the same clock signal is applied to each flip-flop.

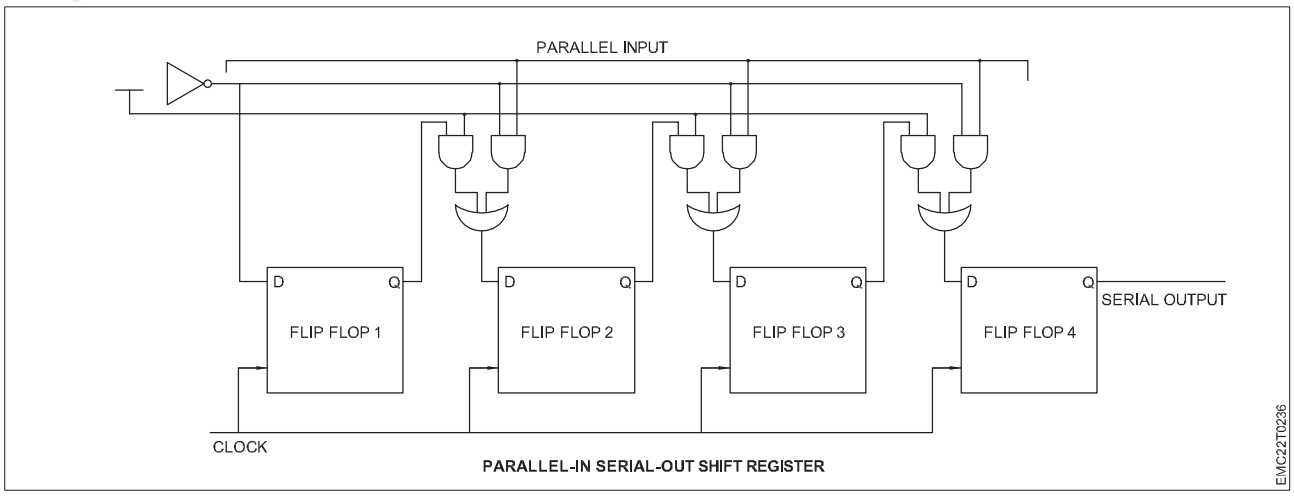


SERIAL-IN SERIAL-OUT SHIFT REGISTER

The above circuit is an example of a shift right register, taking the serial data input from the left side of the flip-flop and producing a parallel output. They are used in communication lines where demultiplexing of a data line into several parallel lines is required because the main use of the SIPO register is to convert serial data into parallel data.

Parallel-In Serial-Out Shift Register (PISO)

The shift register, which allows parallel input (data is given separately to each flip flop and in a simultaneous manner) and produces a serial output is known as a Parallel-In Serial-Out shift register. The logic circuit given below shows a parallel-in-serial-out shift register. The circuit consists of four D flip-flops which are connected. The clock input is directly connected to all the flip-flops but the input data is connected individually to each flip-flop through a multiplexer at the input of every flip-flop. The output of the previous flip-flop and parallel data input are connected to the input of the MUX and the output of MUX is connected to the next flip-flop. All these flip-flops are synchronous with each other since the same clock signal is applied to each flip-flop.

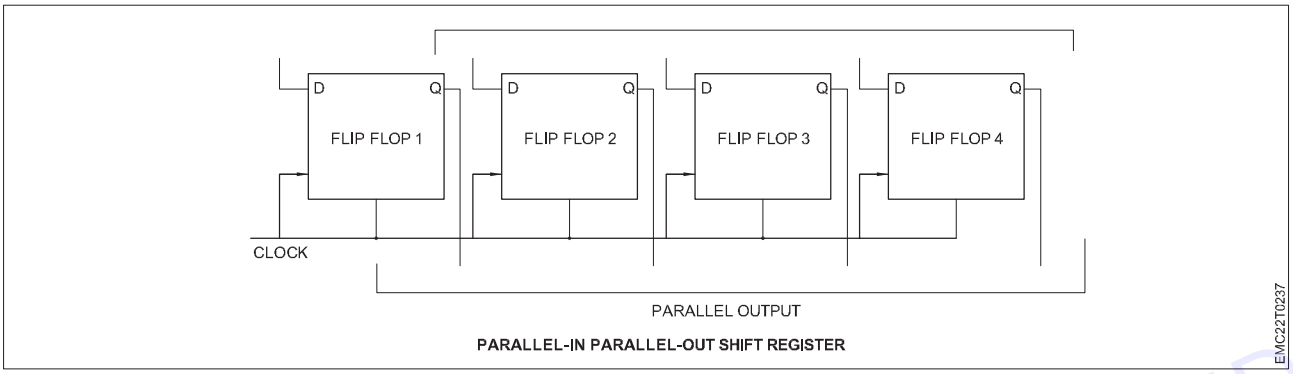


PARALLEL-IN SERIAL-OUT SHIFT REGISTER

A parallel in serial Out (PISO) shift register is used to convert parallel data to serail data.

Parallel-In Parallel-Out Shift Register (PIPO)

The shift register, which allows parallel input (data is given separately to each flip flop and in a simultaneous manner) and also produces a parallel output is known as Parallel-In parallel-Out shift register. The logic circuit given below shows a parallel-in-parallel-out shift register. The circuit consists of four D flip-flops which are connected. The clear (CLR) signal and clock signals are connected to all 4 flip-flops. In this type of register, there are no interconnections between the individual flip-flops since no serial shifting of the data is required. Data is given as input separately for each flip flop and in the same way, output is also collected individually from each flip flop.



PARALLEL-IN PARALLEL-OUT SHIFT REGISTER

A Parallel in Parallel out (PIPO) shift register is used as a temporary storage device and like SISO Shift register it acts as a delay element.

Shift Register Counter

Shift Register Counters are the shift registers in which the outputs are connected back to the inputs in order to produce particular sequences. There are basically two types:

- Ring Counter
- Johnson Counter

Ring Counter

A ring counter is basically a shift register counter in which the output of the first flip-flop is connected to the next flip-flop and so on and the output of the last flip-flop is again fed back to the input of the first flip-flop, thus the name ring counter. The data pattern within the shift register will circulate as long as clock pulses are applied. The logic circuit given below shows a Ring Counter.

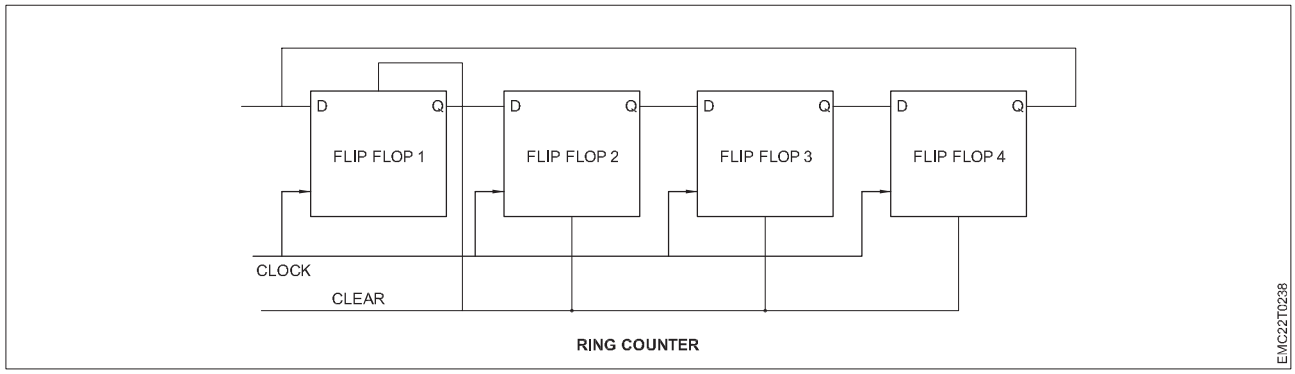
Ring Counter Truth Table

Clock pulse	Q1	Q2	Q3	Q4
0	1	0	0	1
1	1	1	0	0
2	0	1	1	0
3	0	0	1	1

The circuit consists of four D flip-flops which are connected. Since the circuit consists of four flip-flops the data pattern will repeat after every four clock pulses as shown in the truth table. A Ring counter is generally used because it is self-decoding. No extra decoding circuit is needed to determine what. State the counter is in.

Johnson Counter

A Johnson counter is basically a shift register counter in which the output of the first flip flop is connected to the next flip flop and so on and the inverted output of the last flip flop is again fed back to the input of the first flip flop.



RING COUNTER

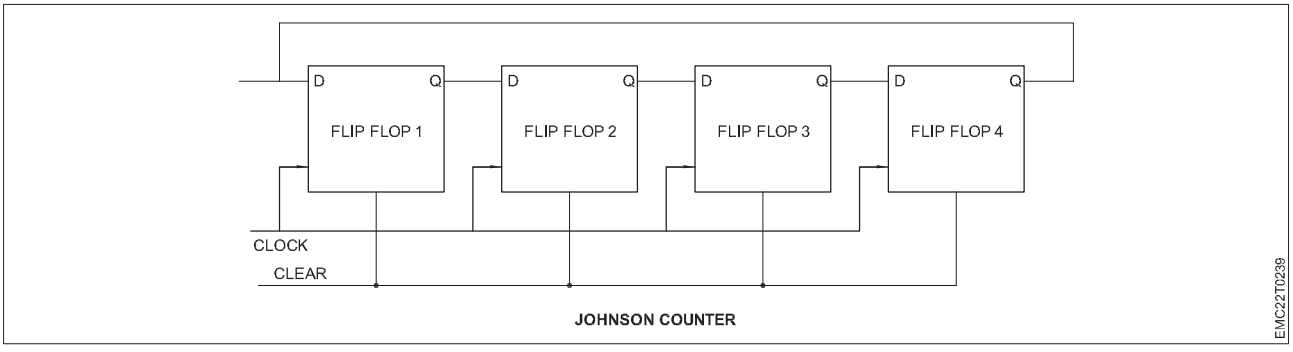
They are also known as twisted ring counters. The logic circuit given below shows a Johnson Counter. The circuit consists of four D flip-flops which are connected.

Clock pulse	Q1	Q2	Q3	Q4
0	0	0	0	1
1	0	0	0	0
2	1	0	0	0
3	1	1	0	0
4	1	1	1	0
5	1	1	1	1
6	0	1	1	1
7	0	0	1	1

Applications of Shift Registers

- The shift registers are used for temporary data storage.
- The shift registers are also used for data transfer and data manipulation.
- The serial-in serial-out and parallel-in parallel-out shift registers are used to produce time delay to digital circuits.
- The serial-in parallel-out shift register is used to convert serial data into parallel data thus they are used in communication lines where demultiplexing of a data line into several parallel lines is required.
- A Parallel in Serial out shift register is used to convert parallel data to serial data.

An n-stage Johnson counter yields a count sequence of 2n different states, thus also known as a mod-2n counter. Since the circuit consists of four flip-flops the data pattern will repeat every eight clock pulses as shown in the truth table. The main advantage of the Johnson counter is that it only needs n number of flip-flops compared to the ring counter to circulate a given data to generate a sequence of 2n states.



JOHNSON COUNTER

LESSON 30 - 33 : Electronics Circuit Simulation

Objectives

At the end of this lesson you shall be able to

- state the literally components available in the circuit
- simulation software.

Electronic Circuit simulation is a process in which a model of an electronic circuit is created and analyzed using various software algorithms, which predict and verify the behavior and performance of the circuit. Since fabrication of electronic circuits, especially integrated circuits (ICs), is expensive and time-consuming, it is faster and more cost-effective to verify the behavior and performance of the circuit using a circuit simulator before fabrication.

There are different types of circuit simulators catering to varied needs across the accuracy-performance/capacity spectrum. At one end of the spectrum are analog simulators that solve accurate representations of electronic circuits. They offer high accuracy and are commonly used to simulate small circuits. At the other end of the spectrum are digital simulators that use functional representations of electronic circuits, typically described using hardware description languages (HDL). These offer the highest performance and capacity, but at relatively lower levels of accuracy. Digital simulators are commonly used to simulate very large circuits.

Types of Electronics Circuit Simulation

There are three basic types of circuit simulation: analog, digital, and mixed mode.

Analog circuit simulation involves the use of highly accurate models (i.e., representations) of the electronic circuit to achieve high accuracy. The models include non-linear, linear, and simpler table-based representations of the various electronic devices in the circuit. Analog simulation can run in different modes. These include AC (frequency domain), DC (non-linear quiescent), and transient (time-domain). All analog simulators employ algorithms to mathematically analyze the behavior of the electronic circuit in these different modes. They all share the quality of solving matrices to predict the performance of the electronic circuit. Signals are propagated as continuously varying values.

There are two primary types of analog circuit simulators

SPICE and Fast SPICE

SPICE simulators use highly accurate non-linear and linear models of electronic devices to analyze the behavior of the circuit. SPICE simulators employ many different integration methods, such as Forward Euler, Backward Euler, and Newton-Raphson as well as matrix decomposition techniques to compute the response of the entire circuit (i.e., mathematical representation) at every single time point in the simulation period of interest.

By contrast, Fast SPICE simulators use simpler table-model representations of electronic devices to analyze circuit behavior. They employ sophisticated algorithms to reduce the complexity of the circuit and partition the circuit based on various criteria, essentially creating a simpler and more modular circuit representation. This representation is then selectively evaluated at a given time point in the simulation period of interest, a process that greatly improves the performance and capacity of the simulation. Fast SPICE simulators offer various simulation knobs to help balance the tradeoffs between simulation accuracy and performance.

Digital circuit simulation involves the use of simpler models of electronic circuits. These models are typically created using HDL. In digital simulation, rather than propagating continuously varying signals, a few discrete voltage levels (primarily logic 0 and logic 1) are propagated. The methods to propagate these signals have varying degrees of accuracy regarding the propagation delay of the logic levels through the circuit. This method of simulation allows much larger circuits to be simulated in less time with fewer computer resources when compared to analog simulation.

Mixed-mode circuit simulation combines the analog and digital simulation approaches. The circuit is partitioned between the two regimes to support the correct level of analysis detail for each part of the circuit. Analog simulators (SPICE and Fast SPICE) are used for the analog analyses and a digital simulator is used for the digital analyses. This method of simulation allows for much larger circuits to be simulated in less time with fewer computer resources when compared to analog simulation.

Benefits of Electronics Circuit Simulation

Circuit simulation provides a critical view into the behavior of electronic circuits. Given the expense and time involved in fabricating electronic circuits, especially ICs, it's much more practical to validate circuit behavior and performance via circuit simulation prior to manufacturing.

Some of the specific area of validation include

Memory Performance: The read and write access times and latency of memory devices are built from analog circuit simulation of the bit cells and read/write paths inside these memories.

Overall Digital Simulation Accuracy: Digital circuit simulators model the propagation of voltage for logic level 1 and logic level 0. Analog circuit simulation is used to determine the time it takes for a circuit to transition between these voltage levels. This forms the basis for the overall accuracy of the digital circuit simulator.

Noise and Crosstalk: Higher level models for noise and crosstalk are developed based on the detailed circuit level analysis of these parasitic effects from analog circuit simulations.

Optimization of High-Frequency and High-Power Circuits: These types of circuits must undergo detailed continuous time analysis to determine their behavior and performance criteria. Analog circuit simulation delivers these important analyses.

The overall performance and behavior of complex digital circuits (core processors and AI accelerators are examples) are verified with digital circuit simulation.

Introduction

So far, we have designed all our circuits by studying basic electronic subcircuit building blocks and then constructing larger circuits from these. We have designed our circuits by calculating their steady state behavior, as well as their response to small AC (sine wave) signal deviations from the quiescent state. While this method is useful for coming up with the overall design of a circuit, it is a slow and limited method for predicting the ideal theoretical behavior of a circuit under all experimental conditions.

Computer based analog circuit simulator

Computer software circuit simulators are very good at calculating ideal theoretical behavior from Kirchhoff's Laws. While circuit simulators will not help you come up with the insight or the creativity to design a good circuit, they are very useful for helping to elucidate quickly the benefits and disadvantages of one circuit design against another. Generally, you can simulate a circuit much more quickly than you can build and test it on a breadboard (after a little practice, of course). The circuit simulator also allows you to try out many variations on a circuit relatively quickly.

The industry standard analog circuit simulation software is SPICE (Simulation Program with Integrated Circuit Emphasis), which was originally developed at UC Berkeley during the 1970's and early 1980's. SPICE (v2G.6) is the basis for many commercial computer software programs. These programs provide the GUI (Graphical User Interface) but use the SPICE (or Win SPICE) simulation engine to perform all the circuit calculations.

SPICE does not simulate the electromagnetic fields in a circuit since these depend explicitly on the layout of the circuit. The results of SPICE can be trusted up to the low MHz range but should be treated with suspicion for higher frequencies.

B Computer-based circuit layout editor

In the electronics labs, you have designed the layout of your breadboard circuits on the fly. In a professional setting, the layout of a circuit determines its compactness, ease of use (and debugging), cost, longevity, and its performance (especially at high frequencies). Several programs exist to help with circuit layout. In fact, in industry, most electronics engineers will design an abstract circuit with a circuit simulator and then use a software package to layout the actual circuit on a PCB (Printed Circuit Board). The PCB layout design is then turned into an industry standard Gerber file which is sent to a PCB production company. A prototype will be assembled and tested at the engineering company from a PCB board and electronics components, and once it is tested the entire production is usually contracted out to a third company.

In a physics research lab, the production is done in house, generally. The use of professionally made PCBs is relatively common, since it generally results in a reproducible circuit, which is likely to work better at high frequencies than one put together with wires or prototyping boards.

Microprocessor

A microprocessor is a computerprocessor for which the data processing logic and control is included on a single integrated circuit (IC), or a small number of ICs. It is a programmable device that takes in input, performs some arithmetic and logical operations over it and produces the desired output. In simple words, a Microprocessor is a digital device on a chip that can fetch instructions from memory, decode and execute them and give results.

Basics of Microprocessor

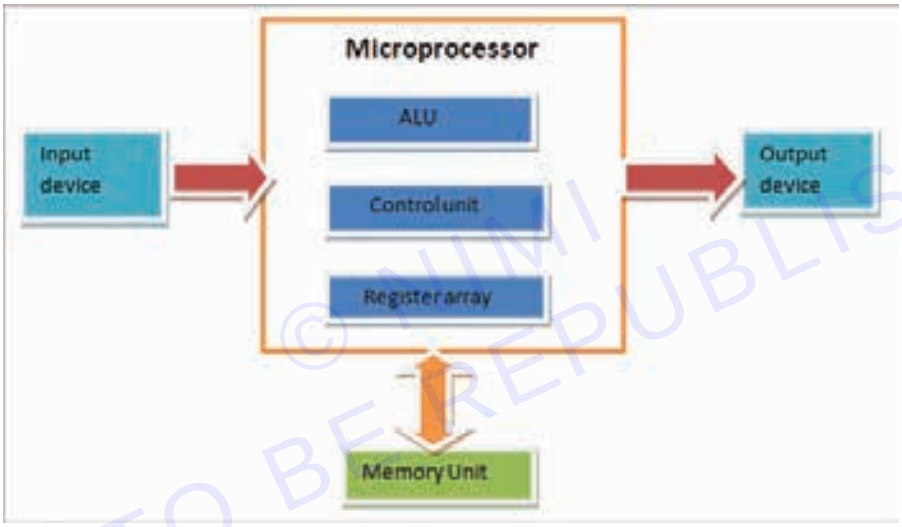
A Microprocessor takes a bunch of instructions in machine language and executes them, telling the processor what it must do. Microprocessor performs three basic things while executing the instruction:

It performs some basic operations like addition, subtraction, multiplication, division, and some logical operations using its Arithmetic and Logical Unit (ALU). New Microprocessors also perform operations on floating-point numbers also.

Data in microprocessors can move from one location to another.

It has a Program Counter (PC) register that stores the address of the next instruction based on the value of the PC, Microprocessor jumps from one location to another and takes decisions.

Block Diagram of a Microcomputer



The basic building blocks of this processor are an ALU, register array, and the main control processing unit. The function of the arithmetic logical unit (ALU) is to perform mathematical and logical operations based on the data fetched from the input units or the memory device.

The register array is a combination of register and accumulator. The control unit handles the overall processing and flow of data in the computer.

MODULE 3 : Microcontroller (8051)

LESSON 34 - 42 : Microcontroller

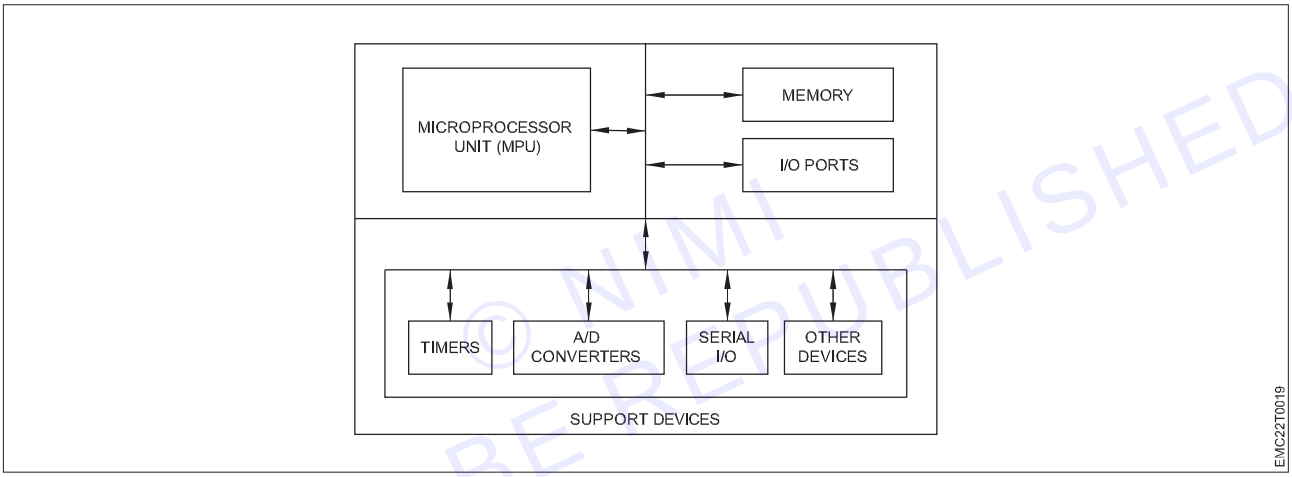
Objectives

At the end of this lesson you shall be able to

- state about the microcontroller
- explain about the types, features of microcontroller.

A microcontroller is a small and low-cost microcomputer, which is designed to perform the Specific tasks of embedded systems like displaying microwave's information, receiving remote signals, etc. The general microcontroller consists of the processor, the memory (RAM, ROM, and EPROM), Serial ports, peripherals (timers, counters), etc.

Block Diagram of a Microcontroller



Types of Microcontrollers

Microcontrollers are divided into various categories based on memory, architecture, bits and instruction sets.

Following is the list of their types −

Bit

Based on bit configuration, the microcontroller is further divided into three categories.

8-bit microcontroller− This type of microcontroller is used to execute arithmetic and logical operations like addition, subtraction, multiplication division, etc. For example, Intel 8031 and 8051 are 8 bits microcontroller.

16-bit microcontroller− This type of microcontroller is used to perform arithmetic and logical operations where higher accuracy and performance is required. For example, Intel 8096 is a 16-bit microcontroller.

32-bit microcontroller − This type of microcontroller is generally used in automatically controlled appliances like automatic operational machines, medical appliances, etc.

Memory

Based on the memory configuration, the microcontroller is further divided into two categories.

External memory microcontroller − This type of microcontroller is designed in such a way that they do not have a program memory on the chip. Hence, it is named as external memory microcontroller. For example: Intel 8031 microcontroller.

Embedded memory microcontroller – This type of microcontroller is designed in such a way that the microcontroller has all programs and data memory, counters and timers, interrupts, I/O ports are embedded on the chip. For example: Intel 8051 microcontroller.

Instruction Set

Based on the instruction set configuration, the microcontroller is further divided into two categories.

CISC – CISC stands for complex instruction set computer. It allows the user to insert a single instruction as an alternative to many simple instructions.

RISC – RISC stands for Reduced Instruction Set Computers. It reduces the operational time by shortening the clock cycle per instruction.

Difference between Microprocessor and Microcontroller

The following table highlights all the important differences between microprocessors and microcontrollers

Parameter	Microprocessor	Microcontroller
Definition	Microprocessors can be understood as the heart of a computer system	Microcontrollers can be understood as the heart of an embedded system
What is it?	A microprocessor is a processor where the memory and I/O component are connected externally	A microcontroller is a controlling device wherein the memory and I/O output component are present internally
Circuit complexity	The circuit is complex due to external connection	Microcontrollers are present on chip memory. The circuit is less complex
Memory and I/O components	The memory and I/O components are to be connected externally	The memory and I/O components are available
Compact system compatibility	Microprocessors can't be used in compact systems	Microcontrollers can be used with a compact system
Efficiency	Microprocessors are not efficient	Microcontrollers are efficient
Zero status flag	Microprocessors have a zero-status flag	Microcontroller doesn't have a zero-status flag
Zero status flag	Microprocessors have a smaller number of registers	Microcontrollers have a greater number of registers
Applications	Microprocessors are generally used in personal computers	Microcontrollers are generally used in washing machines, and air conditioners wing

Introduction to 8051 Microcontroller

8051 microcontroller is designed by Intel in 1981. It is an 8-bit microcontroller. It is built with 40 pins DIP (dual inline package), 4kb of ROM storage and 128 bytes of RAM storage, 2 16-bit timers. It consists of four parallel 8-bit ports, which are programmable as well as addressable as per the requirement. An on-chip crystal oscillator is integrated in the microcontroller having crystal frequency of 12 MHz.

Features of 8051 MC

The main features of the 8051-microcontroller architecture include the following.

8-bit CPU through two Registers A & B.

8K Bytes – Internal ROM and it is a flash memory that supports while programming the system.

256 Bytes – Internal RAM where the first RAM with 128 Bytes from 00H to 7FH is once more separated into four banks through 8 registers in every bank, addressable registers -16 bit & general-purpose registers – 80.

The remaining 128 bytes of the RAM from 80H to FFH include Special Function Registers (SFRs). These registers control various peripherals such as Serial Port, Timers, all I/O Ports, etc.

Interrupts like External-2 & Internal-3

Oscillator & CLK Circuit.

Control Registers like PCON, SCON, TMOD, TCON, IE, and IP.

16-bit Timers or Counters -2 like T0 & T1.

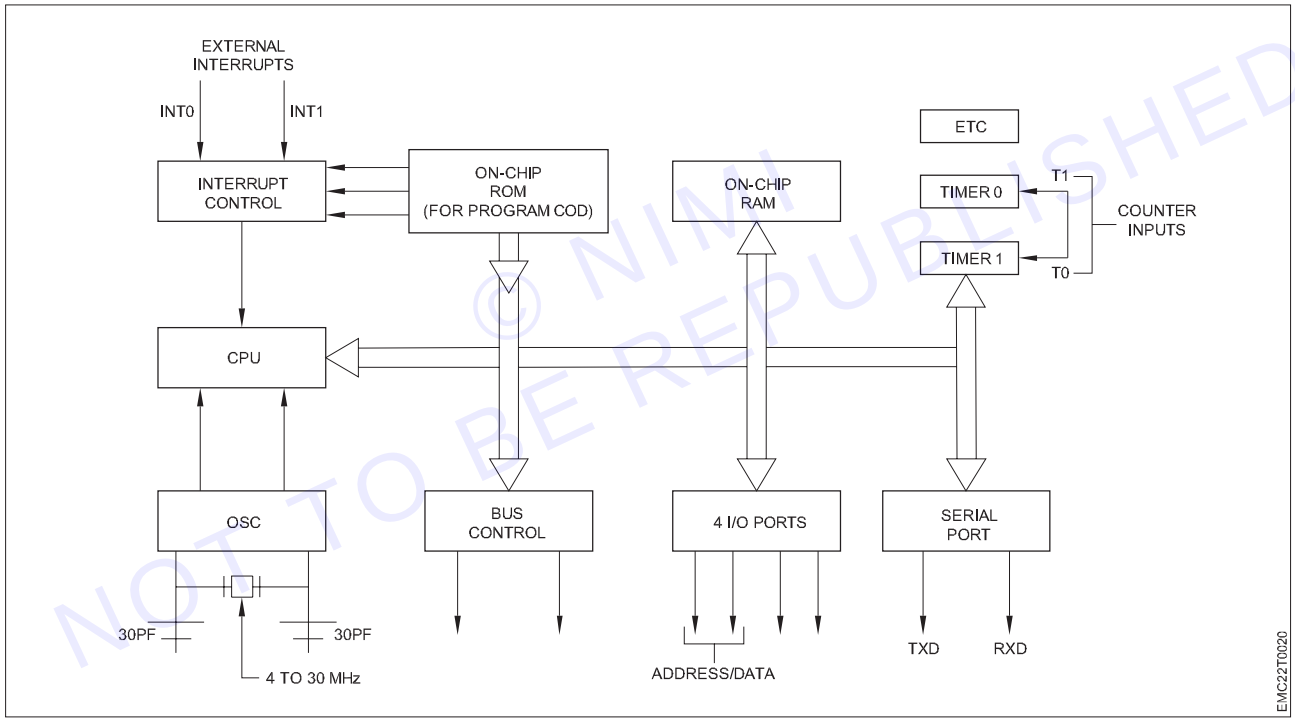
Program Counter – 16 bit & DPRT (Data Pointer).

I/O Pins – 32 which are arranged like four ports such as P0, P1, P2 & P3.

Stack Pointer (SP) – 8bit & PSW (Processor Status Word).

Serial Data Tx & Rx for Full-Duplex Operation.

8051 Microcontroller Architecture



8051-microcontroller architecture is shown below. Let's have a closer look at the features of the 8051-microcontroller design

CPU (Central Processor Unit)

As you may be familiar that the Central Processor Unit or CPU is the mind of any processing machine. It scrutinizes and manages all processes that are carried out in the Microcontroller. The user has no power over the functioning of the CPU. It interprets the program printed in storage space (ROM) and carries out all of them and does the projected duty. CPU manages different types of registers in the 8051 microcontrollers.

Interrupts

As the heading put forward, Interrupt is a subroutine call that reads the Microcontroller's key function or job and helps it to perform some other program which is extra important then. The characteristic of 8051 Interrupt is extremely constructive as it aids in emergency cases. Interrupts provide us a method to postpone or delay the current process, carry out a sub-routine task and then all over again restart standard program implementation.

The Micro-controller 8051 can be assembled in such a manner that it momentarily stops or breaks the core program at the time of the interruption. When the sub-routine task is finished then the implementation of the core program initiates automatically as usual. There are 5 interrupt supplies in the 8051 Microcontroller, two out of five are peripheral interrupts, two are timer interrupts and one is serial port interrupt.

Memory

The micro-controller needs a program that is a set of commands. This program enlightens the Microcontroller to perform precise tasks. These programs need a storage space on which they can be accumulated and interpreted by the Microcontroller to act upon any specific process. The memory which is brought into play to accumulate the program of the Microcontroller is recognized as Program memory or code memory. In common language, it's also known as Read-Only Memory or ROM.

The microcontroller also needs memory to amass data or operands for the short term. The storage space which is employed to momentarily data storage for functioning is acknowledged as Data Memory and we employ Random Access Memory or RAM for this principal reason. Microcontroller 8051 contains code memory or program memory 4K, so which has 4KB Rom and it also comprises data memory (RAM) of 128 bytes.

Bus

Fundamentally Bus is a group of wires which function as a communication canal or means for the transfer of Data. These buses comprise 8, 16, or more cables. As a result, a bus can bear 8 bits, 16 bits altogether. There are two types of buses

1 **Address Bus:** Microcontroller 8051 consists of a 16-bit address bus. It is brought into play to address memory positions. It is also utilized to transmit the address from the Central Processing Unit to Memory.

2 **Data Bus:** Microcontroller 8051 comprises of 8 bits data bus. It is employed to cart data.

Oscillator

As we all make out the Microcontroller is a digital circuit piece of equipment, thus it needs a timer for its function. For this function, Microcontroller 8051 consists of an on-chip oscillator that toils as a time source for the CPU (Central Processing Unit). As the productivity thumps of the oscillator are steady as a result, it facilitates harmonized employment of all pieces of the 8051 Microcontroller. Input/Output Port: As we are acquainted with that Microcontroller is employed in embedded systems to manage the functions of devices.

Thus, to gather it to other machinery, gadgets or peripherals we need I/O (input/output) interfacing ports in Micro-controller. For this function Micro-controller 8051 consists of 4 input/output ports to unite it to other peripherals.

Timers/Counters

Micro-controller 8051 is incorporated with two 16 bit counters & timers. The counters are separated into 8-bit registers. The timers are utilized for measuring the intervals, to find out pulse width, etc.

Types of Interrupts

The interrupts of the 8051 microcontrollers have the following sources

TF0 (Timer 0 Overflow Interrupt)

TF1 (Timer 1 Overflow Interrupt)

INT0 (External Hardware Interrupt)

INT1 (External Hardware Interrupt)

RI/TI (Serial Communication Interrupt)

Memory

The memories of the 8051-microcontroller architecture include a program memory and data memory.

The instructions of the CPU are stored in the Program Memory. It is usually implemented as Read-Only Memory or ROM, where the Program written into it will be retained even when the power is down, or the system is reset.

Data Memory in a Microcontroller is responsible for storing values of variables, temporary data, intermediate results, and other data for the proper operation of the program.

Timer and Control Unit

The main function of a timer is to make a delay otherwise time gap between two events. This microcontroller includes two timers where each timer is 16-bit where the system can generate two delays concurrently to produce the suitable delay. Generally, every microcontroller uses hardware delays where a physical device can be used through the processor to generate the particular delay which is called a timer.

The delay can be generated through the timer based on the requirement of the processor & transmits the signal to the processor whenever the delay gets generated.

By using this processor, we can also produce a delay based on the requirement of the system. However, this will guide the processor to remain active all the time because it will not perform any other task in that specific period. As a result, the existence of a timer within the microcontroller permits the processor to be free for performing other operations.

The microcontroller also includes a program counter, data pointer, stack & stack pointer, instruction registers including latches, temporary registers & buffers for the I/O ports.

Registers

Registers in microcontrollers are mainly used to store data and short-term instructions which are mainly used to process addresses to fetch data. This microcontroller includes 8-bit registers which have 8-bit start from D0 to D7. Here, D0 to D7 is LSB (least significant bit) and D7 is the most significant bit (MSB).

To make the data process better than 8-bit, then it must be separated into eight different bit parts. It includes several registers however general-purpose type registers are frequently available to programmers. They are classified into two types like General purpose & Special purpose. So, most of the general-purpose registers are listed below.

An accumulator is mainly used to execute arithmetic & logic instructions.

Registers like B, R0 toR7 are used for storing instruction addresses & data.

Data Pointers or DPTR is used to allow & process data in dissimilar addressing modes. This register includes DPH (high byte) & a DPL (low byte) which is mainly used to hold a 16-bit address. So, it can be used as a base register with no direct jumps, lookup table instructions & external data transfer.

Program counter or PC is a 16-bit register used to store the next instruction's address to be performed

These registers are 8-bits other than program counter & data pointer registers.

Data Types

This microcontroller includes simply one 8-bit data type where the size of each register is 8-bit. If the data is better than 8-bit, then the programmer is accountable to separate data into 8-bit parts before processing. For assemblers, the most widely used data directive is the DB directive in assembly language.

PSW Register

The term PSW stands for Program status word, and it is one kind of register in the microcontroller. It is also called a flag register, used to demonstrate the position of arithmetic logic instructions such as zero carry bit, carry bit, etc. PSW or flag register is an 8-bit register where 6-bits are used. This register includes 8-flags where these flags are known as conditional flags. These flags will perform instructions simply if the condition is satisfied.

These conditional flags are overflow, parity, auxiliary carry & carry. The Program status word registers bit numbers like 3 & 4 are used to alter the bank registers whereas 1 & 5 are not used but they can be used by the programmer for executing a specific task.

Register Banks

For stacks & register banks, Ram with 32 Bytes is used and these are separated into four types of banks. So, every back includes 8-registers which range from R0 to R7. Here, R0 & R7 denotes the locations of RAM like zero location and seventh location. The second bank register begins from location 8 & ends at 05H. The third bank register begins from 10H & completed at the 17H location. The final bank can be placed among the 18H-1FH.

Stack

The part of RAM like Stack is mainly used through the processor for data storage otherwise address momentarily. In a microprocessor, it is a very significant part because there are extremely restricted numbers of registers for storing addresses and data.

In the 8051 microcontrollers, the stack is 8-bit wide, and it can hold data from 00 – FFH. The stack pointer can be used through the CPU to allow the stack. This microcontroller includes an 8-bit stack pointer that means it can allow values from 00H to FFH. Once it is activated, then the stack pointer includes the 07 value.

Organization of Memory

The microcontroller has complex memory organization, and it includes a separate address bus that is used for program memory, external RAM & data memory. It depends on Harvard architecture that is developed through Harvard in the year 1944.

Addressing Modes

Microprocessors get data in different methods. Generally, the data stored within memory, register & can be used from instant value. So, these different methods for accessing data are known as addressing modes. Different types of microcontrollers include different addressing modes which depend on the plan of manufacturers. The addressing modes of this microcontroller includes the following.

Register

Register indirect

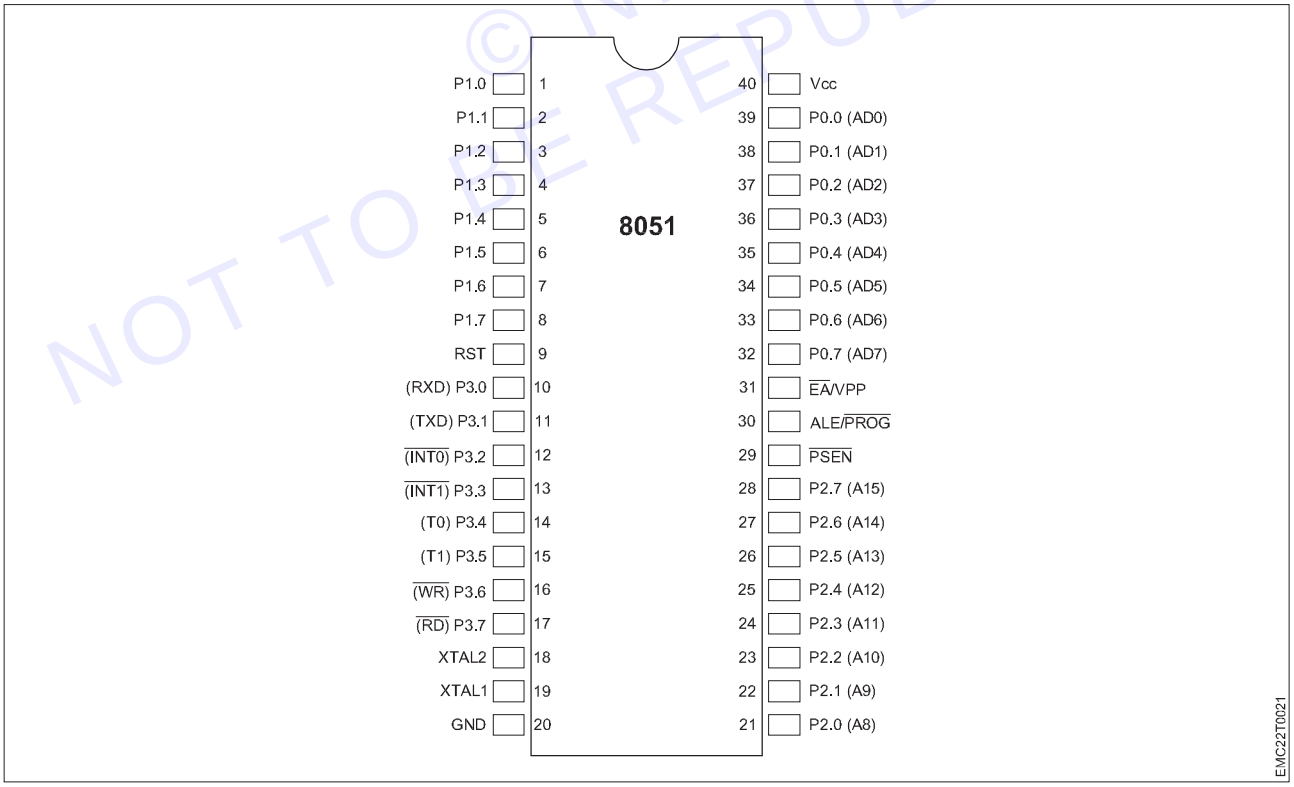
Immediate

Indexed

Direct

Pin Diagram Of Microcontroller 8051

The pin diagram of 8051 microcontroller looks as follows:



The 8051-microcontroller pin diagram is comprised of 40 pins, as may be seen below. Four Ports named P0, P1, P2, and P3 are used to store a total of 32 pins. Where each port has eight pins. The pin diagram and description for microcontroller 8051 are therefore provided in this article.

Pins 1 to 8

It is also known as PORT 1. The 8-bit bidirectional input and output ports with inbuilt pull-up resistors make up PORT 1 Pins. Older 8051 microcontrollers only have an 8-bit I/O port on port 1. This port doesn't serve any additional purposes, unlike other ports.

Pin 9

It is an active HIGH pin, meaning the microcontroller will be reset if the RST Pin (Pin 9) is HIGH for at least two machine cycles. So, it is the RESET pin used to reset it to its default values when operating or at the beginning of an application.

Pins 10 to 17

It is also known as PORT 3. Interrupts, timer input, control signals, serial communication signals Receive Data (RXD) and Transmit Data (TXD), and other operations are served by this port.

Pin 3.0 - This pin is known as the serial input pin and its function is to receive data during serial communication.

Pin 3.1 - This pin is known as the serial output pin and its function is to transmit data during serial communication.

Pin 3.2 - This pin is used as an external trigger for interrupt 0.

Pin 3.3 - This pin is used as an external trigger for interrupt 1.

Pin 3.4 - This pin is for external input for Timer 0.

Pin 3.5 - This pin is for external input for Timer 1.

Pin 3.6 - This pin is used for writing data to the external memory.

Pin 3.7 - This pin is used for reading data from the external memory.

Pins 18 and 19

The pins connecting an external oscillator are 18 and 19, or XTAL 2 and XTAL 1, respectively. A Quartz Crystal Oscillator is often attached here.

Pin 20

The ground pin on an 8051 microcontroller is pin 20, or GND. It connects to the power supply's negative terminal (0V), representing 0V.

Pins- 21-28

The PORT 2 Pins on the 8051 Microcontroller are Pins 21 through 28. The PORT 2 pins function as either inputs or outputs because it is a bidirectional port. Additionally, PORT 2 pins work as the higher-order address byte when external memory is interfaced.

Pin 29

Program Store Enable, often known as PSEN, is used to interpret signals from external program memory.

Pin 30

This pin is linked to VCC (Voltage Common Collector) to drag it high if there is no requirement for external memory.

Pin 31

It is also known as Address Latch Enable or ALE and is used to demultiplex the port 0 address data indication (for external memory interfacing).

Pins 32 to 39

Pins 32 to 39 are known as Port 0 (P0.0 to P0.7), and they are multiplexed with low-order data/address bus signals to act as input/output ports (to provide the use of outer memory interfacing).

Pin 40 (VCC)

The circuit receives power supply voltage, or +5 Volts, from this pin, VCC (Voltage Common Collector).

The pin diagram of the 8051 microcontroller is as follows:

1 **VCC -** This pin provides +5V power supply to the circuit.

2 **GND -** This pin is connected to the negative terminal of the device to provide 0V supply.

3 **XTAL1andXTAL2 -** These pins are connected to the external oscillator to provide clock frequency.

4 **Reset -** This pin is used to reset the microcontroller.

5 **Port 1 -** This port is a collection of 8 bidirectional pins used for simple input/output operations. These do not serve any additional purpose.

6 **Port 2 -** This port is a collection of 8 bidirectional pins used for simple input/output operations. These do not serve any additional purpose.

7 **Port 3 -** This is a collection of 8 bidirectional Pins. These act as higher-order address bytes whenever an additional external memory is interfaced with the 8051 microcontrollers.

8 **Port 4 -** This port is a collection of 8 bidirectional pins. These pins are used to provide functionality like Interrupts, Timer input, control signals and serial communication.

9 **INT0 -** This pin is used as a trigger to Interrupt External 0.

10 **INT1 -** This pin is used as a trigger for external interrupt 1.

11 **T0 -** This pin is used as external Timer 0.

12 **T1 -** This pin is used as external Timer 1.

13 **WR -** This pin gives the write signal for external memory.

14 **RD -** This pin gives the read signal for external memory.

15 **ALE -** This pin gives the signal to enable the latch to get the address for the external memory.

16 **PSEN -** This pin is used to give the signal for accessing the program memory.

17 **17-24 -** Address bus - These pins transmit address from the microcontroller to the external memory.

18 **25-32. Data bus -** These pins transmit data from the microcontroller to the internal memory.

19 **RST -** This pin gives the signal that the microcontroller is being reset.

20 **EA -** This pin is used for selecting the program memory.

21 **VPP -** This pin is used in programming and configuration of the microcontroller.

22 **36-39. XTAL -** These pins are connected to the oscillator to provide clock frequency.

23 **P1.0 (AD0) –** P1.7 (AD7) - These pins are used to interface external devices with the microcontroller.

8051 Memory Organization

The 8051 microcontroller's memory is divided into Program Memory and Data Memory. Program Memory (ROM) is used for permanent saving program being executed, while Data Memory (RAM) is used for temporarily storing and keeping intermediate results and variables.

Program Memory (ROM)

Program Memory (ROM) is used for permanent saving program (CODE) being executed. The memory is read only. Depending on the settings made in compiler, program memory may also be used to store a constant variable. The 8051 executes programs stored in program memory only. code memory type specifier is used to refer to program memory.

8051 memory organization allows external program memory to be added.

How does the microcontroller handle external memory depends on the pin EA logical state.

Internal Data Memory

Up to 256 bytes of internal data memory are available depending on the 8051 derivatives. Locations available to the user occupy addressing space from 0 to 7Fh, i.e. first 128 registers and this part of RAM is divided into several

blocks. The first 128 bytes of internal data memory are both directly and indirectly addressable. The upper 128 bytes of data memory (from 0x80 to 0xFF) can be addressed only indirectly.

Since internal data memory is used for CALL stack also and there are only 256 bytes splinted over a few different memory areas, fine utilizing of this memory is crucial for fast and compact code. See types efficiency also.

Memory block in the range of 20h to 2Fh is bit-addressable, which means that each bit being there has its own address from 0 to 7Fh. Since there are 16 such registers, this block contains a total of 128 bits with separate addresses (Bit 0 of byte 20h has the bit address 0, and bit 7 of byte 2Fh has the bit address 7Fh).

Three memory type specifiers can be used to refer to the internal data memory: data, idata, and bdata.

External Data Memory

Access to external memory is slower than access to internal data memory. There may be up to 64K Bytes of external data memory. Several 8051 devices provide on-chip XRAM space that is accessed with the same instructions as the traditional external data space. This XRAM space is typically enabled via proper setting of SFR register and overlaps the external memory space. The setting of that register must be manually done in code, before any access to external memory or XRAM space is made.

The micro-PRO for 8051 has two memory type specifiers that refers to external memory space: xdata and pdata.

8051 Microcontroller Hardware

The 8051 architecture consists of these specific features:

Eight-bit CPU with:

Register A (the Accumulator)

Register B

Instruction set

Sixteen-bit program counter (PC) and data pointer (DPTR)

Eight-bit program status (PSW)

Eight-bit stack pointer (SP)

Internal ROM or EPROM (8751) of 0(8031) to 4K (8051)

Internal RAM of 128 bytes:

Four register banks, each containing eight registers

Sixteen bits, which may be addressed at the bit level:

128 addressable bits

Eighty bytes of general-purpose data memory

Thirty-two input/output pins arranged as four 8-bit ports: P0-P3

Two 16-bit timer/counters: T0 and T1

Full duplex serial data receiver/transmitter: SBUF

Control registers:

TCON

TMOD

SCON

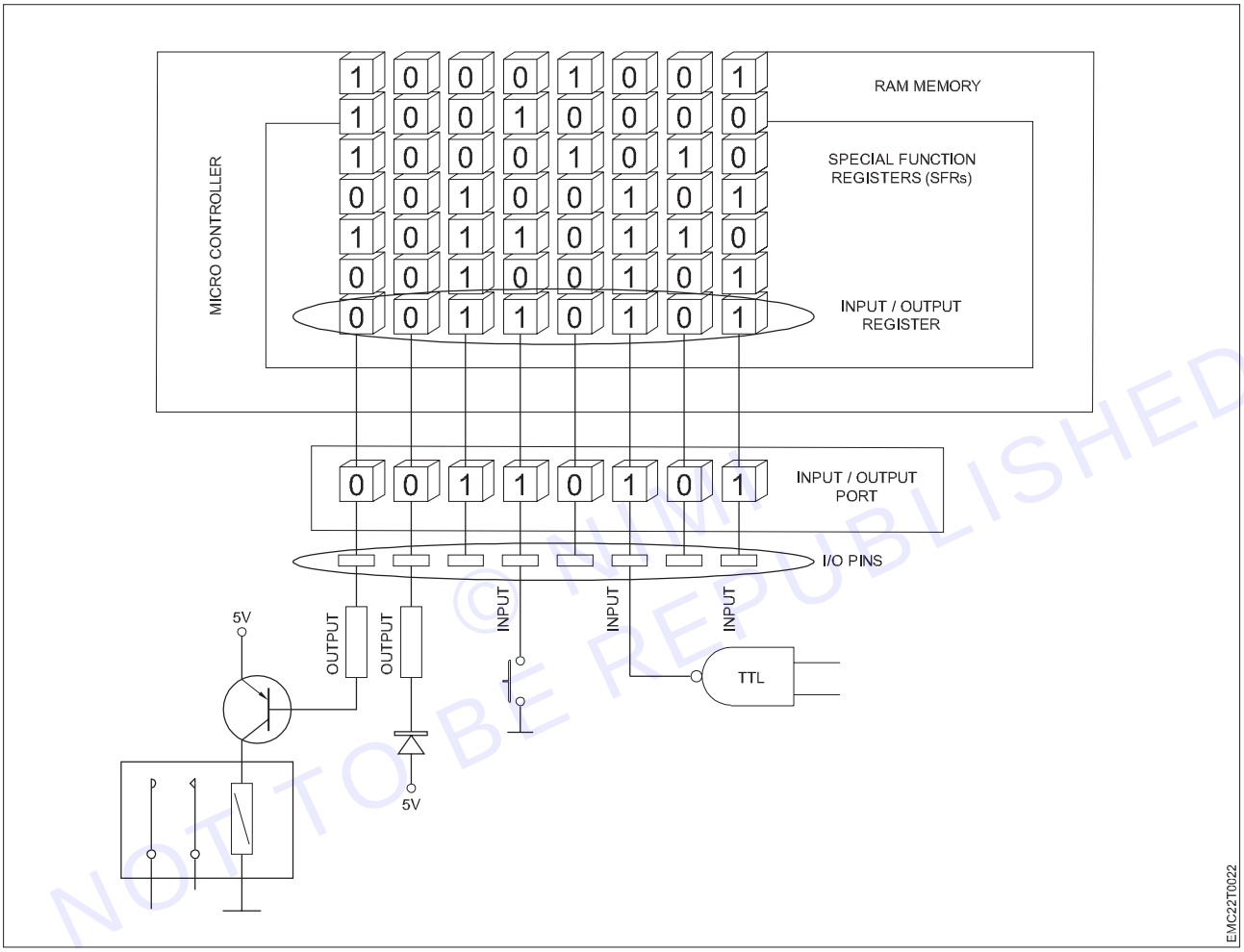
PCON

IP

IE

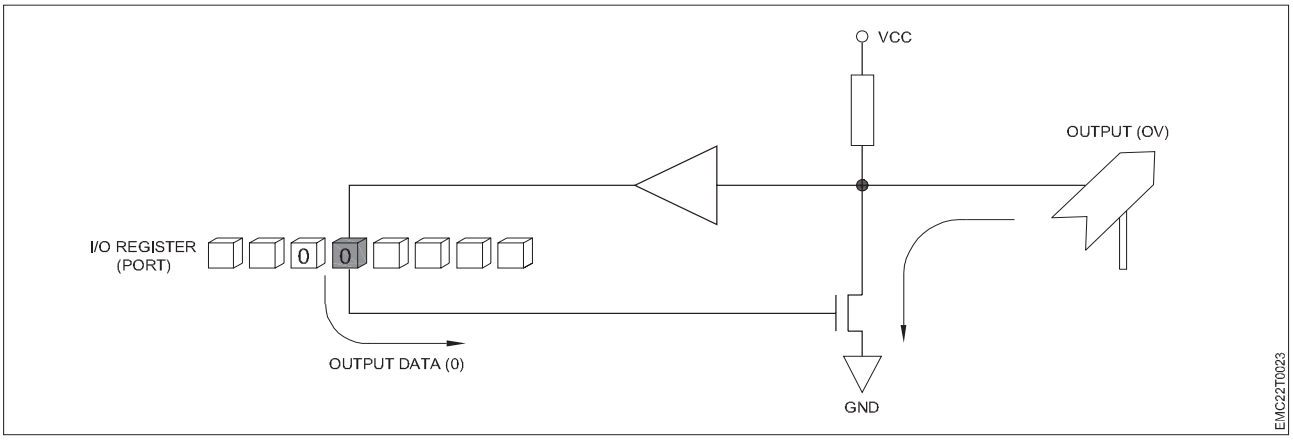
Input/Output Ports (I/O Ports)

All 8051 microcontrollers have 4 I/O ports each comprising 8 bits which can be configured as inputs or outputs. Accordingly, in total 32 input/output pins enabling the microcontroller to be connected to peripheral devices are available for use. Pin configuration, i.e. whether it is to be configured as an input (1) or an output (0), depends on its logic state. To configure a microcontroller pin as an output, it is necessary to apply a logic zero (0) to appropriate I/O port bit. In this case, the voltage level on the appropriate pin will be 0. Similarly, to configure a microcontroller pin as an input, it is necessary to apply a logic one (1) to appropriate port. In this case, the voltage level on the appropriate pin will be 5V (as is the case with any TTL input). This may seem confusing but don't lose your patience. It all becomes clear after studying simple electronic circuits connected to an I/O pin.



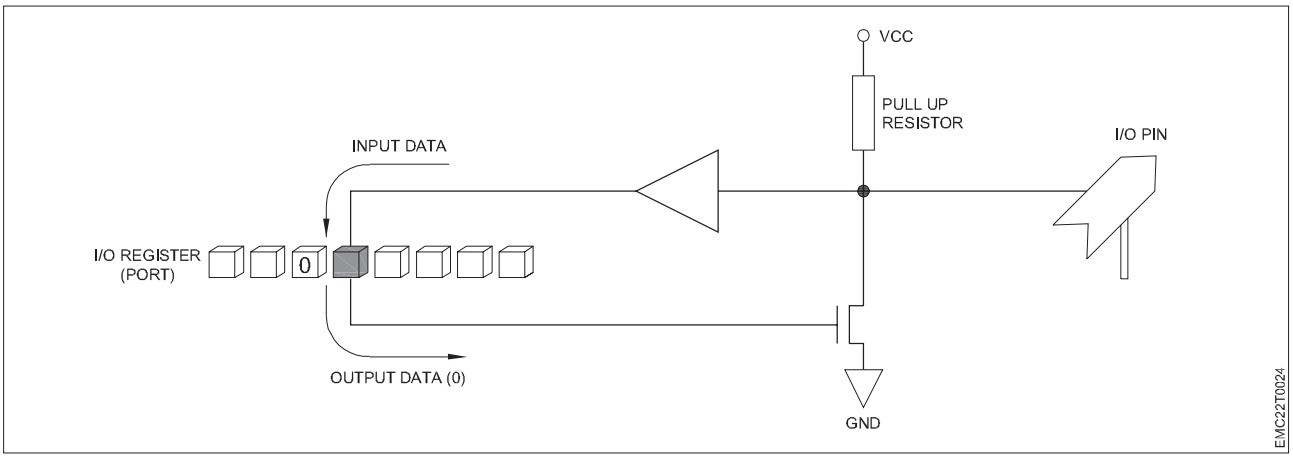
Input/Output (I/O) pin

Figure above illustrates a simplified schematic of all circuits within the microcontroller connected to one of its pins. It refers to all the pins except those of the P0 port which do not have pull-up resistors built in.



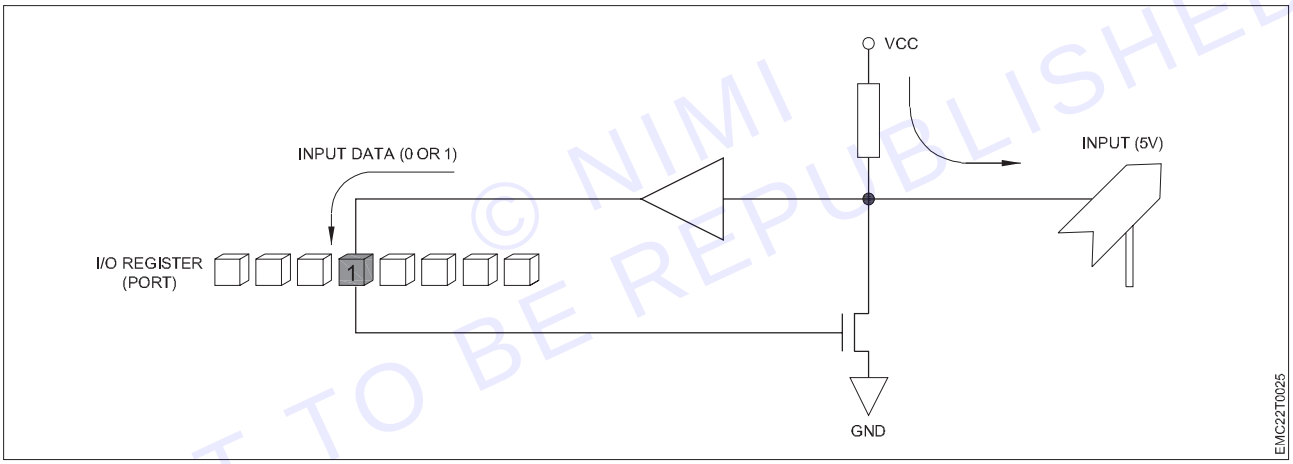
Output pin

A logic zero (0) is applied to a bit of the P register. The output FE transistor is turned on, thus connecting the appropriate pin to ground.



Input pin

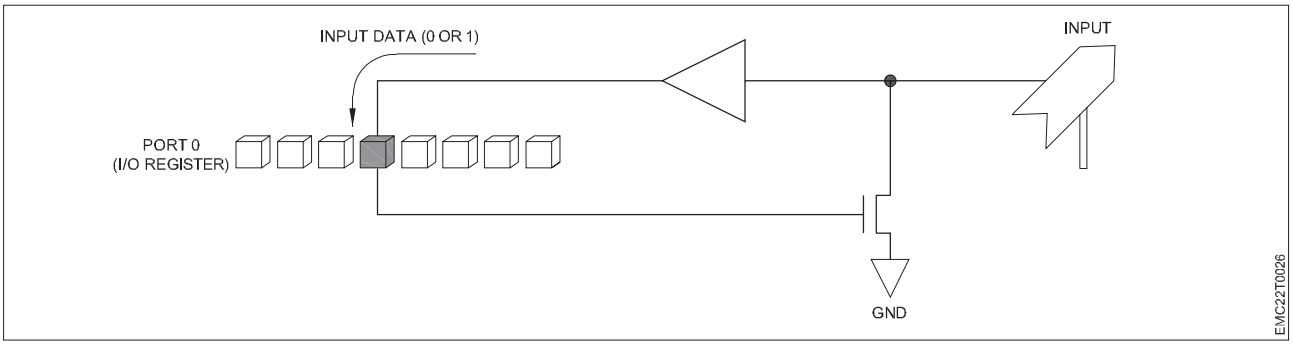
A logic one (1) is applied to a bit of the P register. The output FE transistor is turned off and the appropriate pin remains connected to the power supply voltage over a pull-up resistor of high resistance.



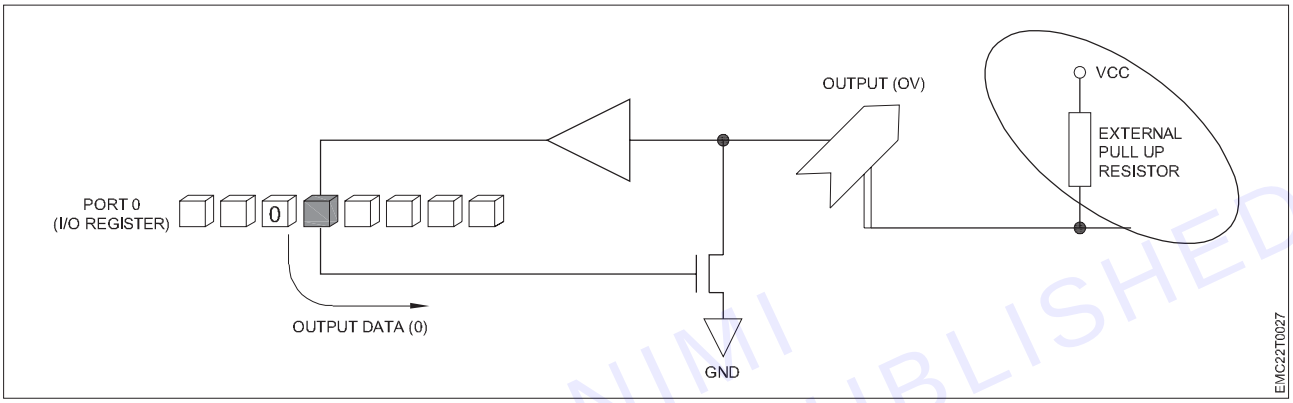
In short, the logic state (voltage) of any pin can be changed or read at any moment. A logic zero (0) and logic one (1) are not equal. A logic one (0) represents a short circuit to ground. Such a pin acts as an output. A logic one (1) is “loosely” connected to the power supply voltage over a resistor of high resistance. Since this voltage can be easily “reduced” by an external signal, such a pin acts as an input.

Port 0

The P0 port is characterized by two functions. If external memory is used, then the lower address byte (addresses A0-A7) is applied on it. Otherwise, all bits of this port are configured as inputs/outputs. The other function is expressed when it is configured as an output. Unlike other ports consisting of pins with built-in pull-up resistor connected by its end to 5 V power supply, pins of this port have this resistor left out. This apparently small difference has its consequences: Input Configuration If any pin of this port is configured as an input, then it acts as if its “floats”. Such an input has unlimited input resistance and indetermined potential.



Output Configuration: When the pin is configured as an output, it acts as an "open drain". By applying logic 0 to a port bit, the appropriate pin will be connected to ground (0V). By applying logic 1, the external output will keep on "floating". To apply logic 1 (5V) on this output pin, it is necessary to build in an external pull-up resistor.



Note: Only in case P0 is used for addressing external memory, the microcontroller will provide internal power supply source to supply its pins with logic one. There is no need to add external pull-up resistors.

Port 1

P1 is a true I/O port, because it doesn't have any alternative functions as is the case with P0 but can be configured as general I/O only. It has a pull-up resistor built-in and is completely compatible with TTL circuits.

Port 2

P2 acts similarly to P0 when external memory is used. Pins of this port occupy addresses intended for external memory chips. This time it is about the higher address byte with addresses A8-A15. When no memory is added, this port can be used as a general input/output port showing features like P1.

Port 3

All port pins can be used as general I/O, but they also have an alternative function. To use these alternative functions, a logical one (1) must be applied to the appropriate bit of the P3 register. In terms of hardware, this port is like P0, with the difference that its pins have a pull-up resistor built in.

Pin's Current limitations

When configured as outputs (logic zero (0)), single port pins can receive a current of 10mA. If all 8 bits of a port are active, the total current must be limited to 15mA (port P0: 26mA). If all ports (32 bits) are active, total maximum current must be limited to 71mA. When these pins are configured as inputs (logic 1), built-in pull-up resistors provide very weak current, but strong enough to activate up to 4 TTL inputs of LS series.

In Short: As seen from description of some ports, even though all of them have similar architecture, it is necessary to pay attention to which of them is to be used for what and how. For example, if they shall be used as outputs with high voltage level (5V), then P0 should be avoided because its pins do not have pull-up resistors, thus giving low logic level only. When using other ports, one should bear in mind that pull-up resistors have a relatively high resistance, so that their pins can give a current of several hundred Microampere only.

Different Variants of 8051 and their Resources

Features of 8051 made it extremely popular in the market. Because of its popularity and high demand Intel allowed other manufacturers to fabricate and market different variants of 8051 with a condition that all these variants should be code compatible with 8051.

This resulted in a lot of variants of 8051 in market, among which 8052 and 8031 are the most popular ones. Therefore, 8052 and 8031 are considered as the family members of 8051.

8052 – 8052 is the super set of 8051 as it has all the features of 8051 with an extra timer and an extra RAM of 128 bytes. Therefore, 8052 has a total of 256 bytes of RAM and 3 timers in all. Also, all the programs written for 8051 will run on 8052 as 8052 is super set of 8051, but it's reverse is not true.

8031 – 8031 is referred to as ROM-less microcontroller chip because it has 0 K byes of on-chip ROM. For its operation, 8031 requires external ROM which aids it in fetch and execute operations. Apart from this, it shares almost all the features of 8051.

80C31/80C52: The 80C31 and 80C52 are enhanced versions of the 8031 and 8052, respectively. They have additional features such as an on-chip oscillator, an expanded interrupt structure, and a power-down mode. These microcontrollers are also compatible with the 8051 in terms of pinout and instruction set.

AT89C51/52: The AT89C51 and AT89C52 are popular derivatives of the 8051 developed by Atmel Corporation. They have additional features such as an on-chip flash memory, an expanded interrupt structure, and a power-down mode. These microcontrollers are also compatible with the 8051 in terms of pinout and instruction set, making it easy to migrate code between them.

STC89C5x: The STC89C5x series of microcontrollers are based on the 8051 architectures but have additional features such as an on-chip flash memory, an expanded interrupt structure, and a power-down mode. They also have higher clock speeds and more I/O pins than the 8051. However, they are not fully compatible with the 8051 in terms of pinout and instruction set, so code migration between them requires some modifications.

P89V51RD2: The P89V51RD2 is a derivative of the 8051 developed by NXP Semiconductors. It has additional features such as an on-chip flash memory, an expanded interrupt structure, and a power-down mode. It also has a dual-data pointer and a programmable counter array. Like the STC89C5x, it is not fully compatible with the 8051 in terms of pinout and instruction set.

Comparison of 8051 with its other family members

Following table highlights the main characteristics of distinction between 8051, 8052 and 8031

Characteristic	8051	8052	8031
RAM	128 bytes	256 bytes	128 bytes
ROM (on-chip)	4 KB	8 KB	0 KB
Number of Timer	2	3	2
Interrupt Sources	6	8	6
Serial Port	1	1	1
Number of I/O Ports	32	32	32

Uses of Comparison of 8051 with its other family members

Here are some specific uses of this comparison

1 **Selecting the appropriate microcontroller:** By comparing the features of the 8051 with its derivatives, engineers can choose the most suitable microcontroller for their application. They can evaluate the additional features and capabilities of each family member and determine which one best meets their requirements.

2 **Code migration:** By understanding the similarities and differences between the 8051 and its family members, engineers can migrate code from one microcontroller to another. This can save time and effort in software development and testing.

3 **Upgrading existing systems:** If an existing system is based on the 8051, engineers can compare it with the features of the newer family members and determine whether an upgrade is necessary. They can evaluate the additional features and benefits of the newer microcontrollers and decide whether an upgrade would improve the performance or functionality of the system.

4 **Learning about microcontroller architecture:** By comparing the 8051 with its family members, students and hobbyists can learn about microcontroller architecture and understand the tradeoffs between different features and capabilities. This can help them make informed decisions when selecting a microcontroller for their own projects.

5 **Developing new applications:** By understanding the additional features and capabilities of the 8051 family members, engineers can develop new applications that require specific features such as an on-chip flash memory, expanded interrupt structure, or power-down mode. This can lead to the development of more advanced and sophisticated embedded systems.

Issues in Comparison of 8051 with its other family members

There are also some potential issues that should be considered:

1 **Compatibility:** While many of the family members are compatible with the 8051 in terms of instruction set and pinout, there may still be some differences that could affect code migration. Engineers should carefully evaluate the compatibility of the microcontrollers before attempting to migrate code.

2 **Development tools:** Different microcontrollers may require different development tools, such as compilers, debuggers, and programmers. Engineers should ensure that the necessary tools are available and compatible with the microcontroller they select.

3 **Availability:** Some family members may be more readily available than others, depending on the region or market. Engineers should consider the availability of the microcontroller when selecting a suitable option.

4 **Cost:** The cost of the microcontroller may vary depending on its features and capabilities. Engineers should evaluate the cost-benefit of selecting a particular microcontroller based on the requirements of the application.

5 **Training and support:** The availability of training and support resources may vary depending on the microcontroller. Engineers should consider the availability and quality of training and support when selecting a microcontroller.

6 **Power consumption:** While the 8051 family members are generally known for their low power consumption, some microcontrollers may consume more power than others due to their additional features and capabilities. Engineers should evaluate the power consumption of the microcontroller to ensure that it meets the requirements of the application.

Register banks & their functioning

SFRs & their configuration for different applications

Registers are temporary storage locations inside any processor and a microcontroller that provide a fast way to store data and address of the memory location where the data is to be stored.

If you want to manipulate data within CPU of microcontroller by performing addition, subtraction, and so on, we cannot do that directly in the memory, but to do it you need some registers to process and store the data.

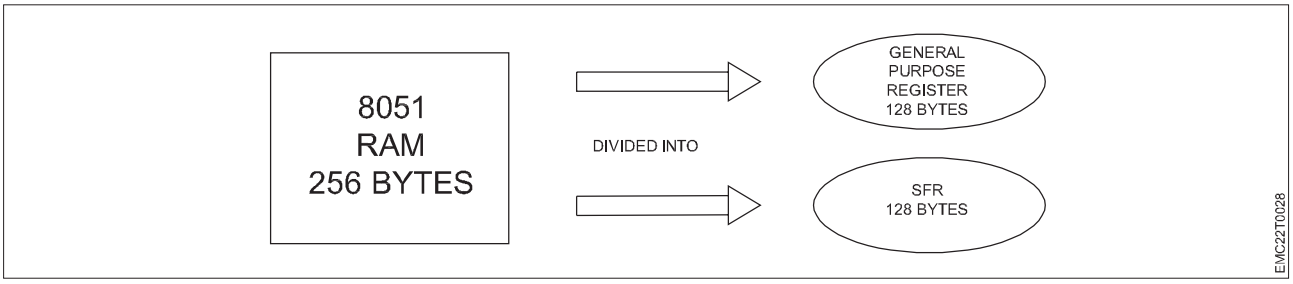
Microcontrollers contain several types of registers that can be classified according to their content or instructions that operate in them.

Types of Registers In 8051 Microcontroller

8051 microcontrollers mainly contain two types of registers

1 General-purpose registers (Byte addressable registers)

2 Special function registers (Bit addressable registers)



Microcontrollers basically consist of 256 bytes of RAM (Random Access Memory), which is divided into two parts, first part contain 128 bytes for general purpose Register these are byte addressable registers and second part contain 128 bytes for special function registers (SFR) memory these are bit addressable registers.

The part of memory which is used for general purpose is called as RAM, and the memory used for Special Function Register (SFR) contains all the peripheral related registers like Accumulator, 'B' register, Timers or Counters, and interrupt related registers.

General Purpose Registers

We know that a register is a storage element that can store bits of information.

8051 microcontrollers have 4 registers bank. These are B0, B1, B2, and B3 stand for Bank0, Bank1, Bank2, Bank3 respectively and each bank contains eight general purpose registers ranging from 'R0' to 'R7'.

These are 32 general purpose registers address from 00h to 1Fh.

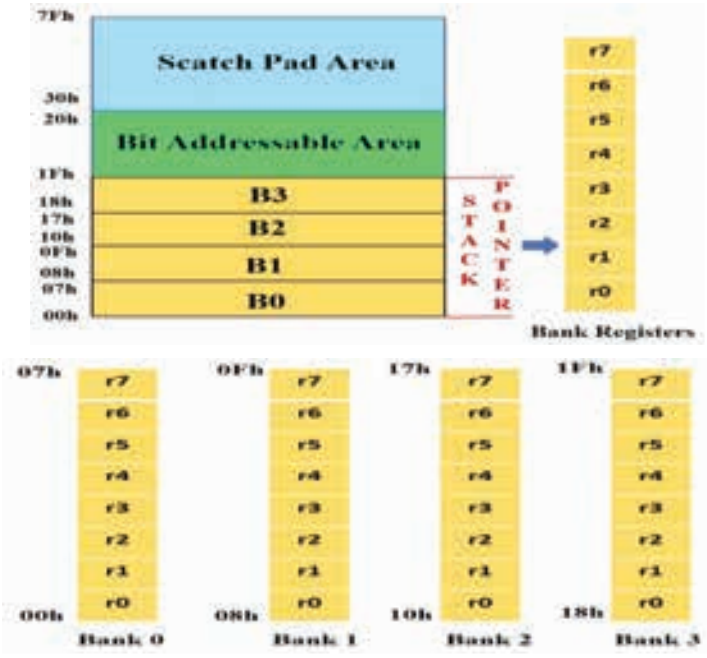
The address range of Register Bank 0 (00 h to 07 h)

The address range of Register Bank 1 (08 h to F h)

The address range of Register Bank 2 (10 h to 17 h)

The address range of Register Bank 3 (18 h to 1F h)

These Register Banks are selected with the help of PSW (Program Status Word) Register bits i.e. RS0, RS1.



Special Function Registers (SFR's)

In 8051 micro controller there are 21 Special function registers (SFR), and this includes Register A, Register B, Processor Status Word (PSW), PCON etc. There are 21 unique locations for these 21 special function registers and each of these registers is of 1 byte size.

The 21 SFR of 8051 Microcontroller are categorized into seven groups these are:

Math or CPU Registers: A and B Register

Status Register: PSW (Program Status Word) Register

Pointer Registers: DPTR (Data Pointer – DPL, DPH) and SP (Stack Pointer) Registers

I/O Port Latches: P0 (Port 0), P1 (Port 1), P2 (Port 2) and P3 (Port 3) Registers

Peripheral Control Registers: PCON, SCON, TCON, TMOD, IE and IP Registers

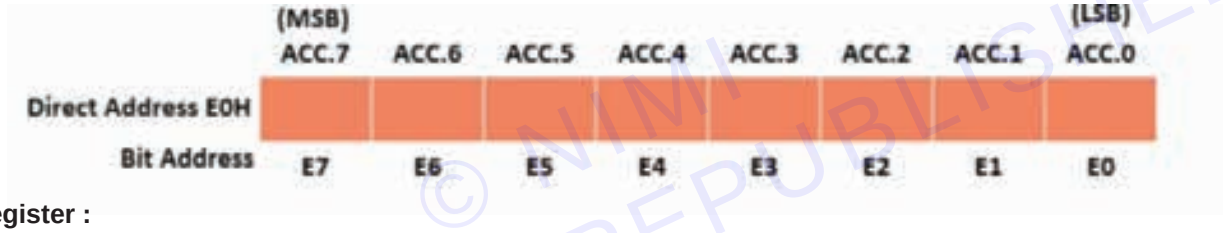
Peripheral Data Registers: TL0, TH0, TL1, TH1 and SBUF Registers.

Accumulator (A register)

It is an 8-bit register.

It holds data and receives the result of the arithmetic instructions.

ACC is usually accessed by direct addressing and its physical address is E0H. The accumulator is both byte and bit addressable. If you want to access the second bit (i.e. bit 1), you may use E1H and for third bit E2H and so on.



B Register :

It is an 8-bit register.

It is a bit and byte-addressable register.

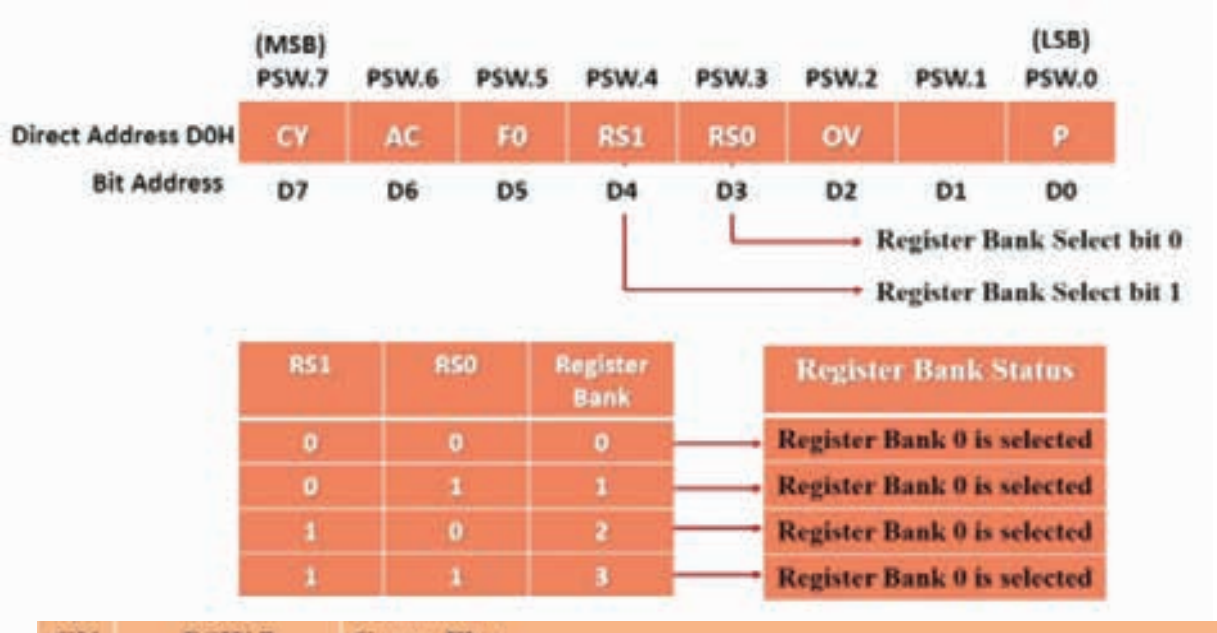
You can access 1-bit or all 8-bits by a physical address F0h. Supposed to access a bit 1, we must use f1.

The B register is only used for multiplication and division arithmetic operations.

PSW (Program Status Word) Register

The PSW (Program Status Word) Register is also called Flag Register. It is one of the important SFRs in 8051 microcontrollers. It is also an 8-bit register. It consists of Flag Bits or status bits that reflect the current state of the CPU. This will help the programmer in checking the condition of the result and making decisions.

PSW flag register is both bit and byte addressable. The physical address of PSW starts from D0H. The individual bits are accessed by using bit address D1, D2 … D7. The two unused bits are user-defined flags. Four of the flags are called conditional flags, which means that they indicate a condition which results after an instruction is executed. These four are CY (Carry), AC (auxiliary carry), P (parity), and OV (overflow).



RS1	RS0	Register Bank	Register Bank Status
0	0	0	Register Bank 0 is selected
0	1	1	Register Bank 0 is selected
1	0	2	Register Bank 0 is selected
1	1	3	Register Bank 0 is selected

CY	PSW.7	Carry Flag
AC	PSW.6	Auxiliary Carry Flag
F0	PSW.5	Flag 0 available to user for general purpose.
RS1	PSW.4	Register Bank selector bit 1
RS0	PSW.3	Register Bank selector bit 0
OV	PSW.2	Overflow Flag
-	PSW.1	User definable FLAG
P	PSW.0	Parity FLAG. Set/ cleared by hardware during instruction cycle to indicate even/odd number of 1 bit in accumulator.

Timer/Counter Registers

The 8051 has two 16-bit Programmable timers / counters (Timer 0 – Timer 1).

Which can be used either as timer to generate a time delay or as counter to count events happening outside the microcontroller.

The Counters and Timers in 8051 microcontrollers contain two special function registers: TMOD (Timer Mode Register) and TCON (Timer Control Register).

TMODE Registers

TMODE register is an 8-bit register

Gate: when Gate control is set. The Timer/counter is enabled only while the IN TX pin is high and the TRX control pin is set. When it is cleared, the timer is enabled whenever the TRX control bit is set.

C/T: The Timer or counter selection. When cleared for timer operation (input from internal system clock). Set for counter operation (input from Tx input pin).

Mode selects bits of TMODE register: The M1 and M0 are mode select bits, which are used to select the timer operations. There are four modes to operate the timers.

M1	M0	Mode of operation
0	0	Mode 0 (13-bit timer mode)
0	1	Mode 1 (16-bit timer mode)
1	0	Mode 2 (8-bit Auto Reload mode)
1	1	Mode 3 (Split timer mode)

TCON Registers

It is Timer control Register.

It is an 8-bit register.

SP (Stack Pointer)

The stack is a portion of RAM Used by the CPU to store data or memory address on temporary basis.

The stack pointer register is used to access the stack known as SP register. The stack pointer register is 8-bits wide. It can take a value of 00 to FFH. The RAM memory location 08H is the first location used for the stack. When the 8051 microcontroller is initialized, the SP register contains the value 07H.

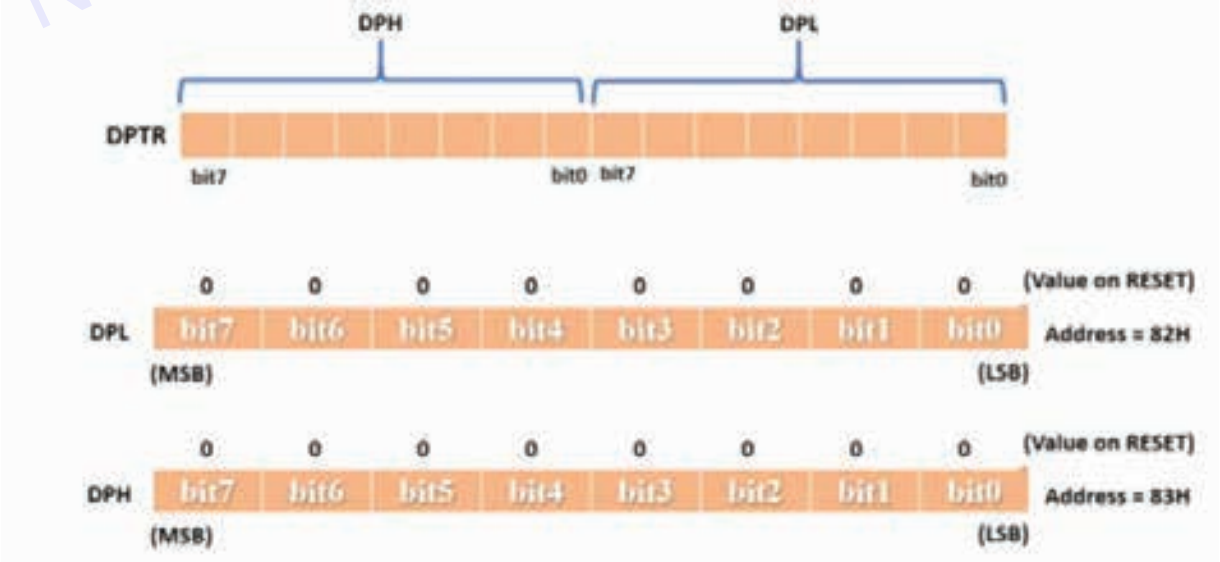
If we want to store CPU register data into the stack this is known as PUSH operation and if we are getting the data from stack back into a CPU register this is known as a POP operation.

DP (Data pointer register)

The data pointer is a 16-bit register used to hold the 16-bit address of data memory. This can also be used as two 8-bit registers namely DPH and DPL. Data Pointer can be used as a single 16-bit register (as DPTR) or two 8-bit registers (as DPL and DPH).

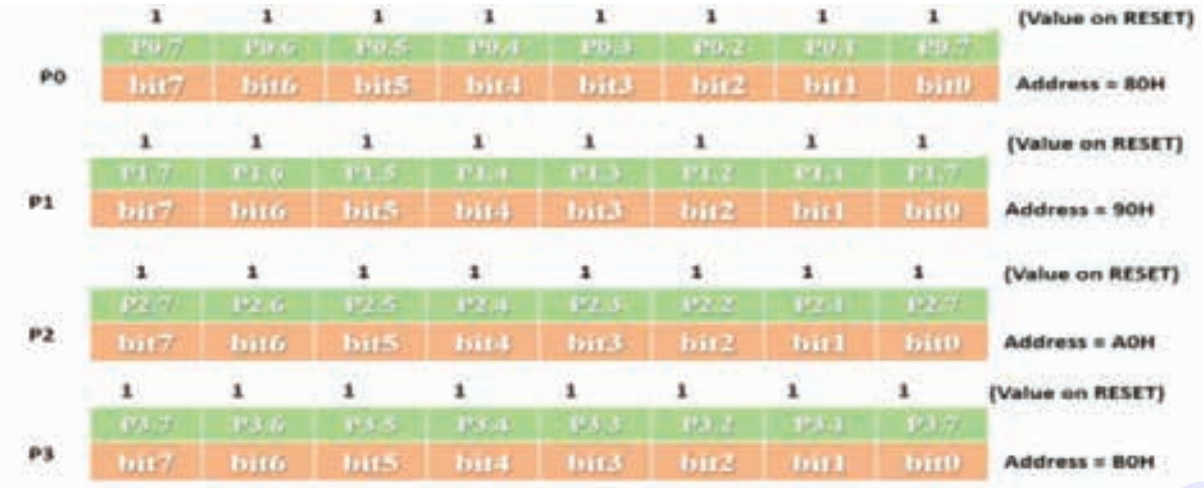
The 8-bit data pointers are used for accessing internal RAM and SFR. The 16-bit data pointer is used for accessing external data memory.

The contents of data pointer are programmable using instructions. It is used by the 8051 to access external memory using the address indicated by DPTR.



Port Registers

8051 microcontrollers have 4 bidirectional I/O ports. Port 0, Port 1, Port 2 and Port 3 (P0, P1, P2 and P3). Which can work as input or output port. Each port has 8-bits. Hence, a total of 32 input/output pins allows the microcontroller to communicate with the outside world, which means this port allows it to relate to the peripheral devices.



PC (Program Counter)

It is a 16-bit register. It is used to hold the address of the memory location from where the next instruction is to be fetched.

When 8051 initializes PC starts at 0000h and it is automatically is incremented every time after an instruction is executed. (So, in this way PC maintains the sequence of program execution).

Comparison between 8051 and 8052

Characteristic	8051	8052
RAM	128 bytes	256 bytes
ROM (on-chip)	4 KB	8 KB
Number of Timer	2	3
Interrupt Sources	6	8
Serial Port ce	1	1
Number of I/O Ports	32	32

MODULE 4 : Sensors, Transducers and Applications

LESSON 43 - 47 : Sensors, Transducers and Applications

Objectives

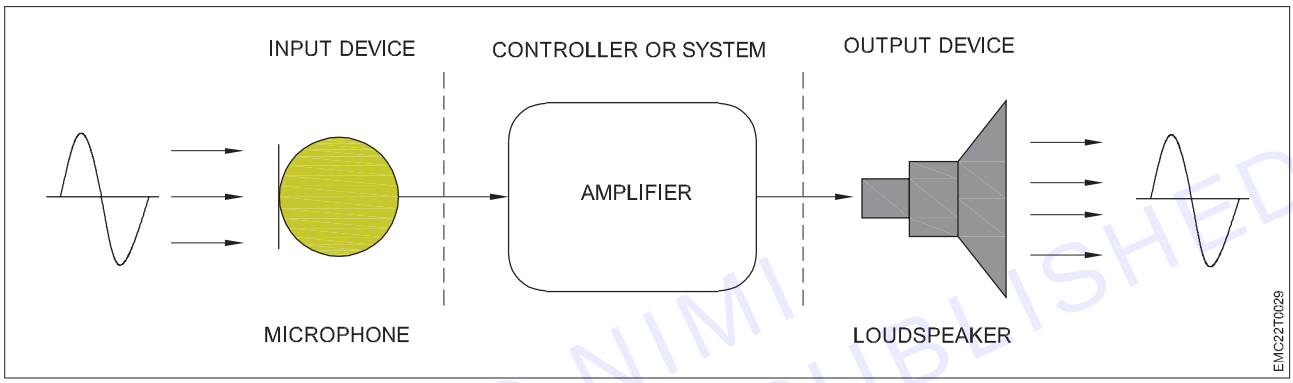
At the end of this lesson you shall be able to:

- state the classification, principles application of sensors & transducers

Sensors, Transducers and Applications

Transducer

A transducer is an electronic device that converts energy from one form to another. Common examples include microphones, loudspeakers, thermometers, position and pressure sensors, and antenna.



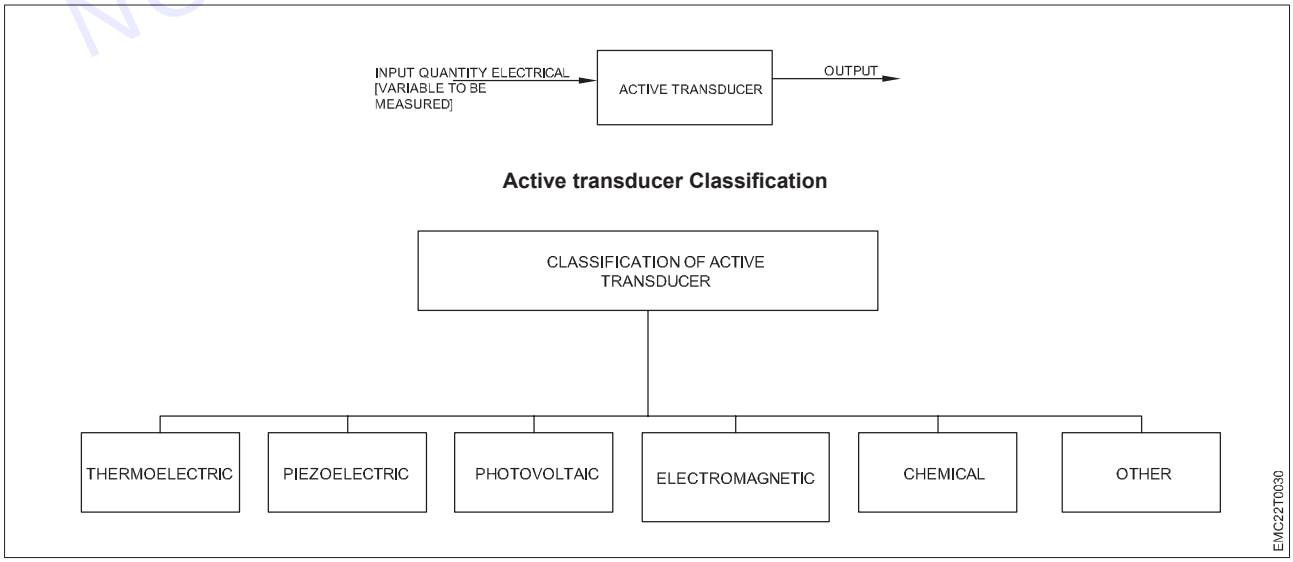
Classification based on Source of Energy requirement-

- Active Transducer
- Passive Transducer

Active Transducer

Active transducer is defined as transducer that does not requires an external energy source. In this type of transducer, the non-electrical quantity which is to be measured is converted to electrical output without any external source. As it does not require any external source this type of transducer is also known as a self-generating transducer.

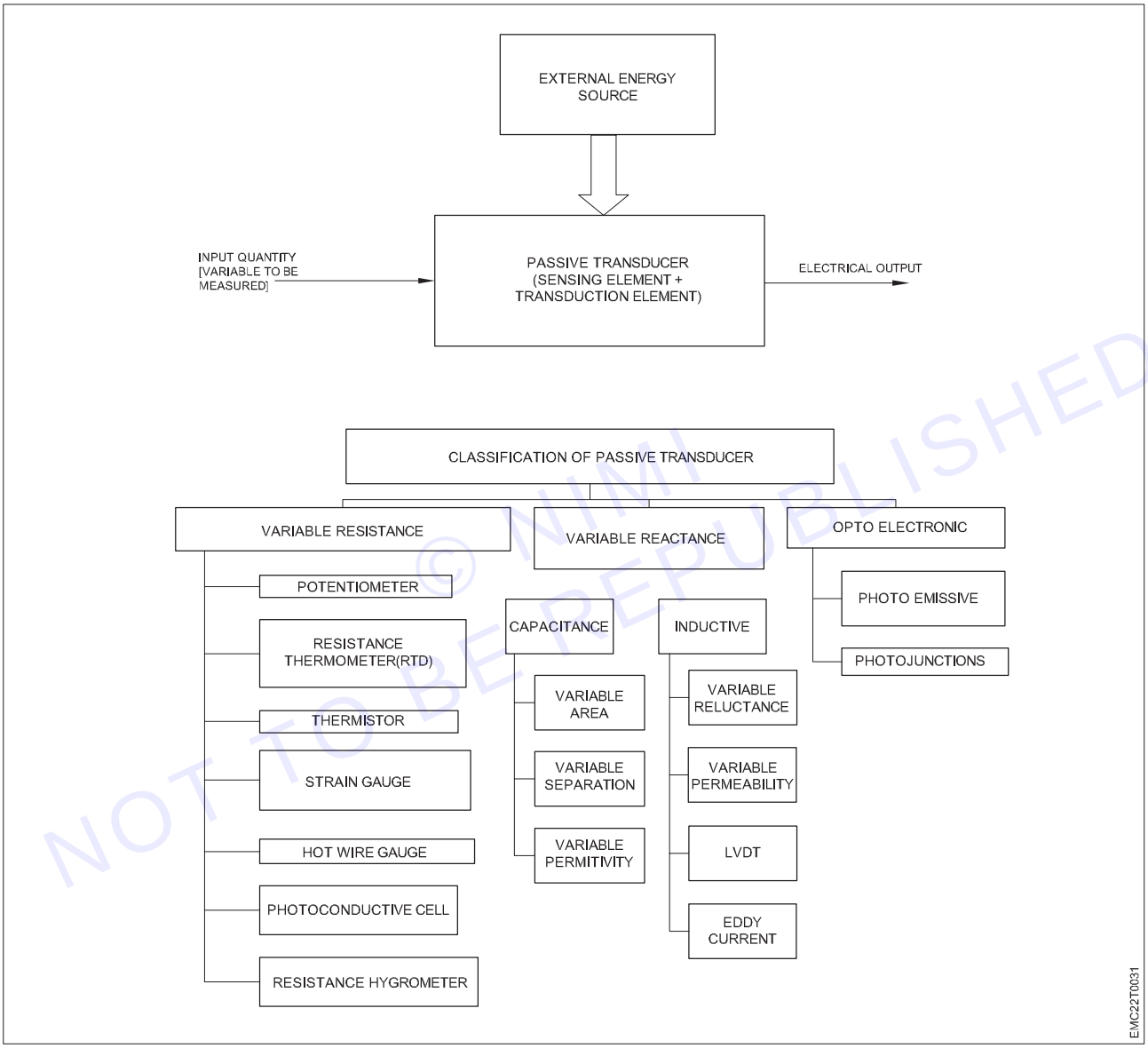
Examples of an Active Transducer: Thermocouple, Piezoelectric Pick up & Photovoltaic.



Passive Transducer

The transducer which requires external energy to produce its output is called a passive transducer. This transducer requires external energy to process the output from the sensing element to produce respective electric output. The electrical parameters in a passive transducer are resistance, inductance, and capacitance which require external energy for conversion.

Examples of Passive Transducer: Potentiometric Transducer, RTD, Thermistor, Capacitor microphone, LVDT etc.,



Selection Transducer

Factors to consider while selecting a transducer Transducers should have high input impedance and low output impedance to avoid the loading effect. A transducer should be highly sensitive to desired signals and insensitive to unwanted signals. Transducers should be able to work in corrosive environments.

Operating range : The range of transducer should be appropriate for measurement to get a good resolution.

Operating Principle : The transducers are selected on the basis of operating principle it may be resistive, inductive, capacitive, optical etc.

Accuracy : The accuracy should be as high as possible or as per the measurement.

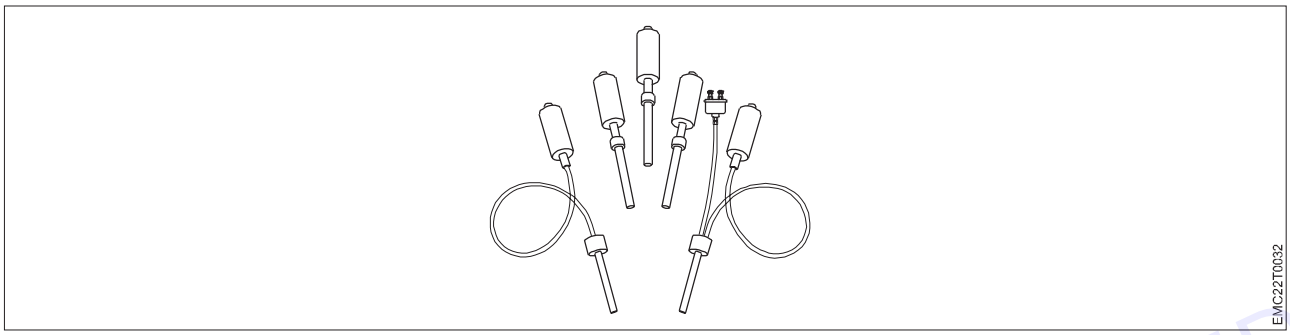
Range : The transducer can give good result within its specified range, so select transducer as per the operating range.

Sensitivity : The transducer should be more sensitive to produce the output or sensitivity should be as per requirement.

Environmental compatibility : The transducer should maintain input and output characteristic for the selected environmental condition.

Loading effect: The transducer's input impedance should be high and output impedance should be low to avoid loading effect.

Errors : The error produced by the transducer should be low as possible



Transducer Characteristics

The characteristics of the transducer are given below that are determined by examining the output response of a transducer to a variety of input signals. The method of computational and standard statistical can be applied to the test data.

1 **Accuracy:** It is defined as the closeness which the reading approaches an accepted standard value or ideal value or true value, of the variable being measured.

2 **Noise:** All transducers have some random noise in their output. So the small signals are largely affected by noise in comparison to larger signals.

3 **Linearity:** The output of the transducer should be linearity proportional to the input quantity under measurement. It should have linear input-output characteristics.

4 **Sensitivity:** The electrical transducer is defined as the electrical output obtained per unit in the physical parameter of the input quantity called sensitivity of the transducer.

5 **Hysteresis:** This property wherein a transducer output is dependent not only on the present input but also on the previous inputs.

6 **Size:** The transducer should have the smallest possible size and shape with minimal weight and volume. This will make the measurement system very compact.

7 **Repeatability:** A transducer ability to produce identical output upon stimulation by the same input in termed as repeatability.

8 **Speed:** It is rapidity with which the transducer responds to changes in the measured quantity. The speed of the response of the transducer should be as high as practicable.

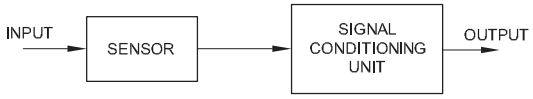
9 **Ruggedness:** The transducer should be mechanically rugged to withstand overloads. it should have overload protection.

10 **High output:** The Transducer should give reasonably high output signal so that it can be easily processed and measured. The output must be much larger than noise. Nowadays digital output is preferred in many applications.

11 **Dynamic range:** For a transducer, the operating range should be wide so that it can be used over a wide range of measurement conditions.

Sensor & IOT

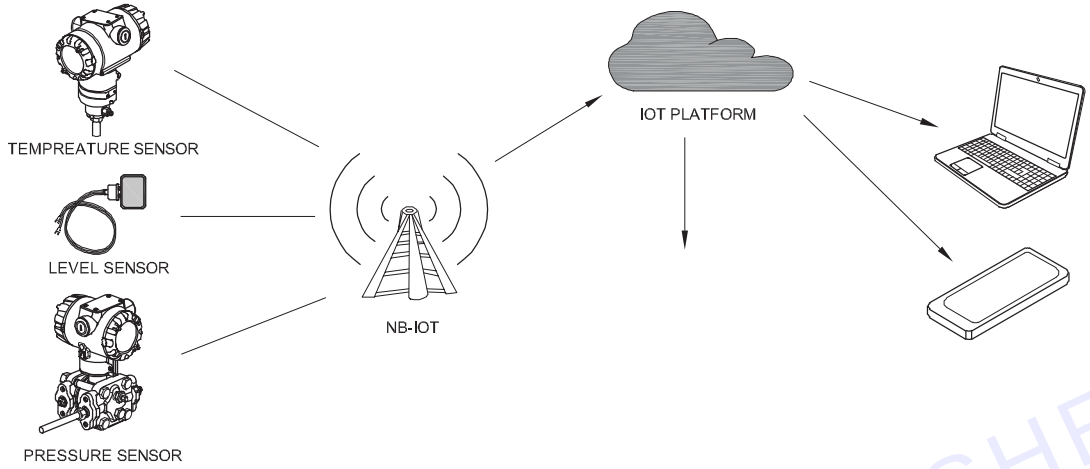
A sensor is a device that detects the change in the environment and responds to some output on the other system. A sensor converts a physical phenomenon into a measurable analog voltage (or sometimes a digital signal) converted into a human-readable display or transmitted for reading or further processing.



IOT: The Internet of Things (IOT) is revolutionizing the way we live and work by connecting everyday objects to the internet.

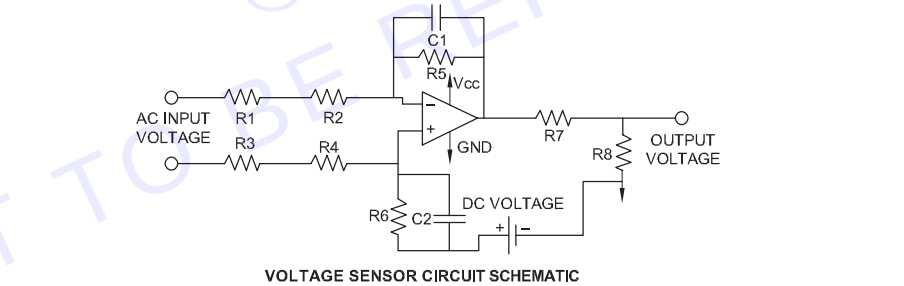
This connectivity allows for the collection and analysis of data in real-time, enabling us to make informed decisions and automate processes.

One of the key components of IOT is sensors, which play a crucial role in the collection and transmission of data.



Sensor Voltage And Current

Sensor Voltage: A voltage sensor is a device that measures voltage. Voltage sensors can measure the voltage in various ways, from measuring high voltages to detecting low current levels. These devices are essential for many applications, including industrial controls and power systems.



VOLTAGE SENSOR CIRCUIT SCHEMATIC

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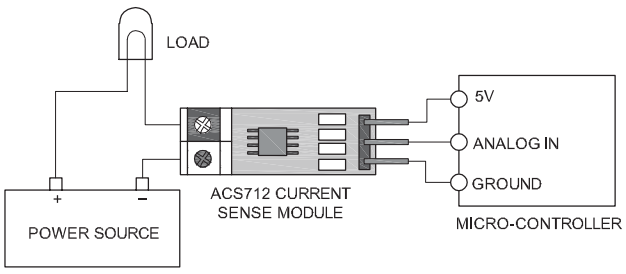
Sensor Current: A current sensor detects and measures the electric current passing through a conductor. It turns the current into a quantifiable output, such as a voltage, current, or digital signal, which may be utilised in a variety of applications for monitoring, control, or protection.



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Thermistor

A thermistor is a resistance thermometer, or a resistor whose resistance is dependent on temperature. The term is a combination of “thermal” and “resistor”. It is made of metallic oxides, pressed into a bead, disk, or cylindrical shape and then encapsulated with an impermeable material such as epoxy or glass.

Thermocouple

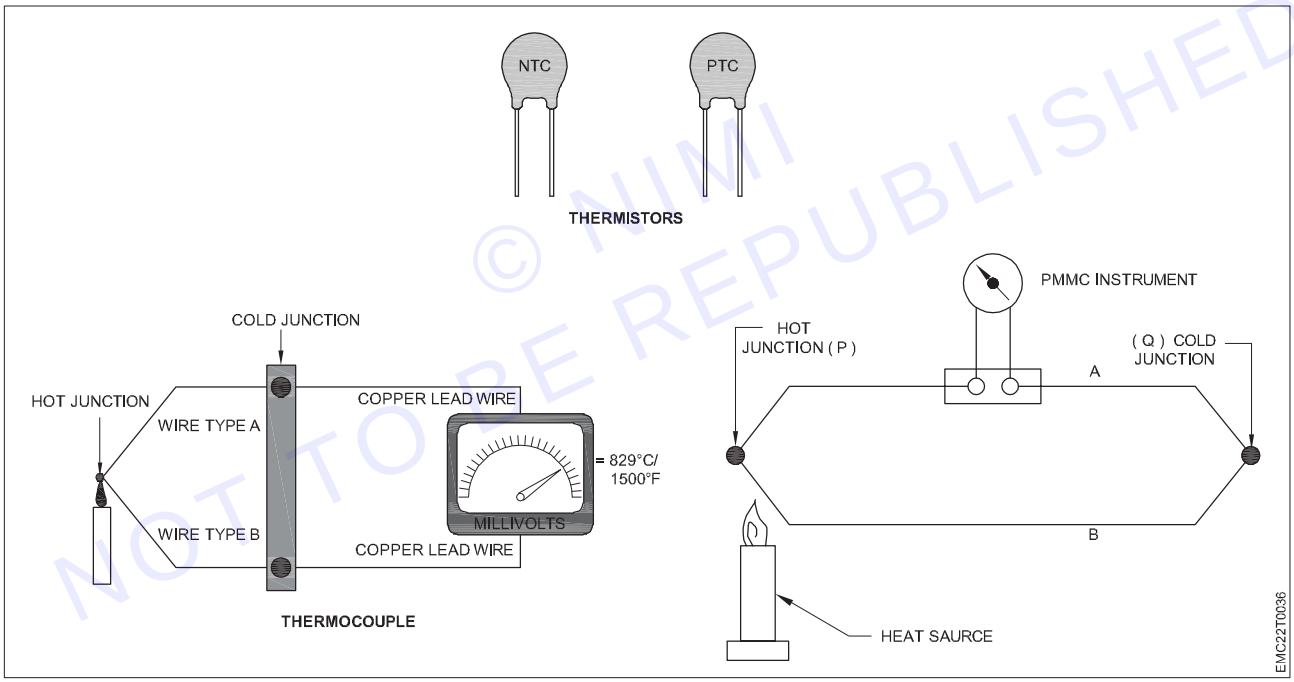
A thermocouple is a sensor that measures temperature. It consists of two different types of metals, joined together at one end. When the junction of the two metals is heated or cooled, a voltage is created that can be correlated back to the temperature.

Principal Of Thermocouple

The thermocouple working principle is based on the See back Effect. This effect states that when a closed circuit is formed by jointing two dissimilar metals at two junctions, and junctions are maintained at different temperatures then an electromotive force (e.m.f.) is induced in this closed circuit.

Working Of Thermocouple

A typical circuit diagram of a thermocouple is shown in Figure. In the Figure, two dissimilar metals ‘A’ and ‘B’ are joined at the two junctions ‘P’ and ‘Q’. Here the ‘P’ junction is measuring junction or hot junction whereas the junction ‘Q’ is the reference junction or cold junction. And a PMMC instrument is connected in this arrangement as shown in Figure.



When these junctions are kept at different temperatures, generally cold junction is kept at 0oC and measuring junction is kept at an unknown temperature which we want to measure (i.e. the temperature of the junction is raised by heating it). An e.m.f. will be generated in this circuit due to the temperature difference of the junctions.

These are used to measure the temperature up to 1400oC. There are different combinations of metals which are used in thermocouples. Different combinations generate different e.m.f

Types of Thermocouple

T-Type Thermocouple

Positive wire — Cu Negative wire — Constantan It can be used up to 350oC. It is very stable and inexpensive. Generally, it is used for very low-temperature applications.

E – Type Thermocouple

Positive wire — Chromel Negative wire — Constantan It can be used up to 850oC. It is most sensitive thermocouple. It generates a high output voltage.

J – Type Thermocouple

Positive wire — Iron Negative wire — Constantan It can be used up to 1000oC. It is a very common type of thermocouple. Its stability is high.

K — Type Thermocouple

Positive wire — Chromel Negative wire — Alumel It can be used up to 1200oC. It is a widely used type of thermocouple. It is a cheaper type as compared to other types.

S – Type Thermocouple

Positive wire — Platinum 10% Rohodium Negative wire — Platinum It can be used up to 1400oC. It has very high precision thus used for very high accuracy requirements.

The current will flow from + ve marked lead to the – ve marked lead. In thermocouples, negative lead is generally a red colored wire. The color of positive lead will be according to its type.

Advantages:

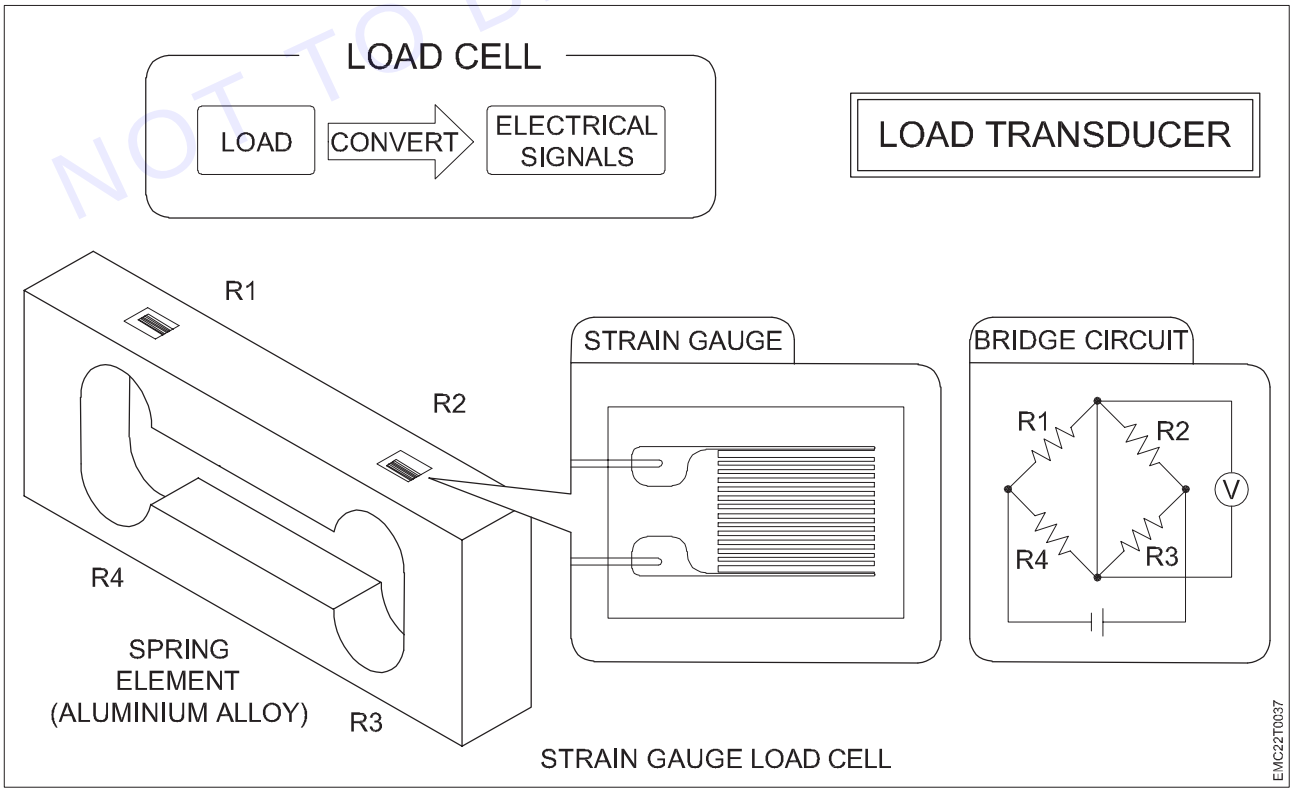
They follow the temperature changes with a small time-lag.So it can be used in the applications where very rapid changes in temperature take places.It responds to those changes very quickly.These are very convenient for measuring the temperature at one particular point in any apparatus or setup.

Disadvantages:

They have very low accuracy. So they cannot be used for very high precision measurement.They have to protect against contamination to ensure long life.They are placed at a very large distance from the measuring device. This increases errors in the result.

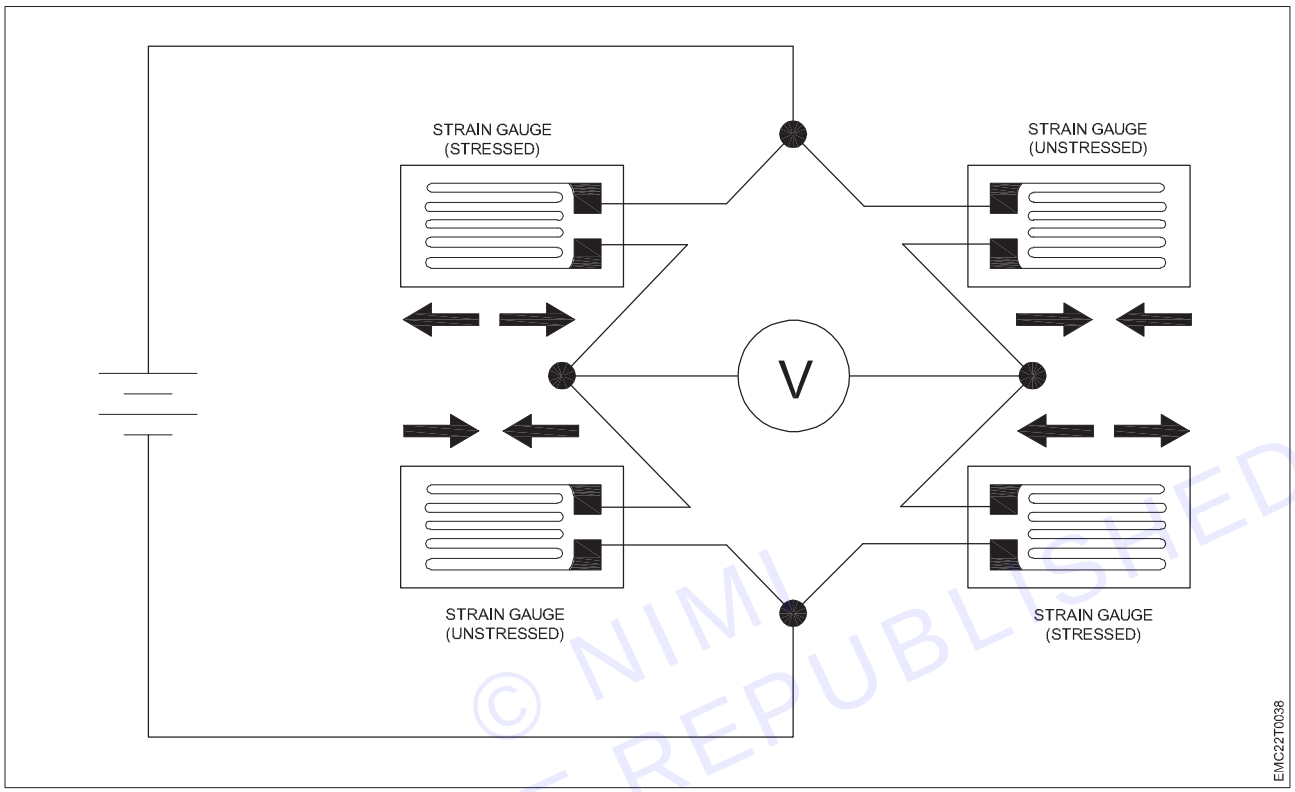
Strain Gauge/Load Cell

Strain gauges and load cells Load cells are blocks of metal that have been machined in such a way that specific areas are put under high strain when weight is applied to them. These areas have strain gauges attached to them with a high strength adhesive. The materials used to manufacture load cells are Aluminum, Steel Alloy, and Stainless steel. Strain gauges themselves consist of thin foil elements that are glued to the load cell body. Strain gauges are cunningly shaped so that even very small movements or “stretching” of the gauge results in comparatively large changes in resistance. The relationship between strain and change in resistance is almost perfectly linear. Accuracies between ±0.01% and ±0.02% are not uncommon for a high accuracy load cell.



Strain Gauge Working Principle

Strain gauge working principle is based on the concept of electrical resistance variation due to mechanical strain. The strain gauge consists of a fine wire or foil, typically made of a highly conductive material like copper or constantan, which is attached to a flexible backing material. When a mechanical strain is applied to the strain gauge, the wire or foil undergoes deformation, resulting in a change in its length and cross-sectional area. This alteration in dimensions causes a corresponding change in the electrical resistance of the wire or foil.



Gauge Factor: The characteristics of the strain gauges are described in terms of its sensitivity (gauge factor). Gauge factor is defined as unit change in resistance for per unit change in length of strain gauge wire given as

G.F. = (ΔR/RG)/ε Where,

ΔR - the change in resistance caused by strain,

RG - is the resistance of the undeformed gauge,

ε – Strain

Types of Strain Gauge:

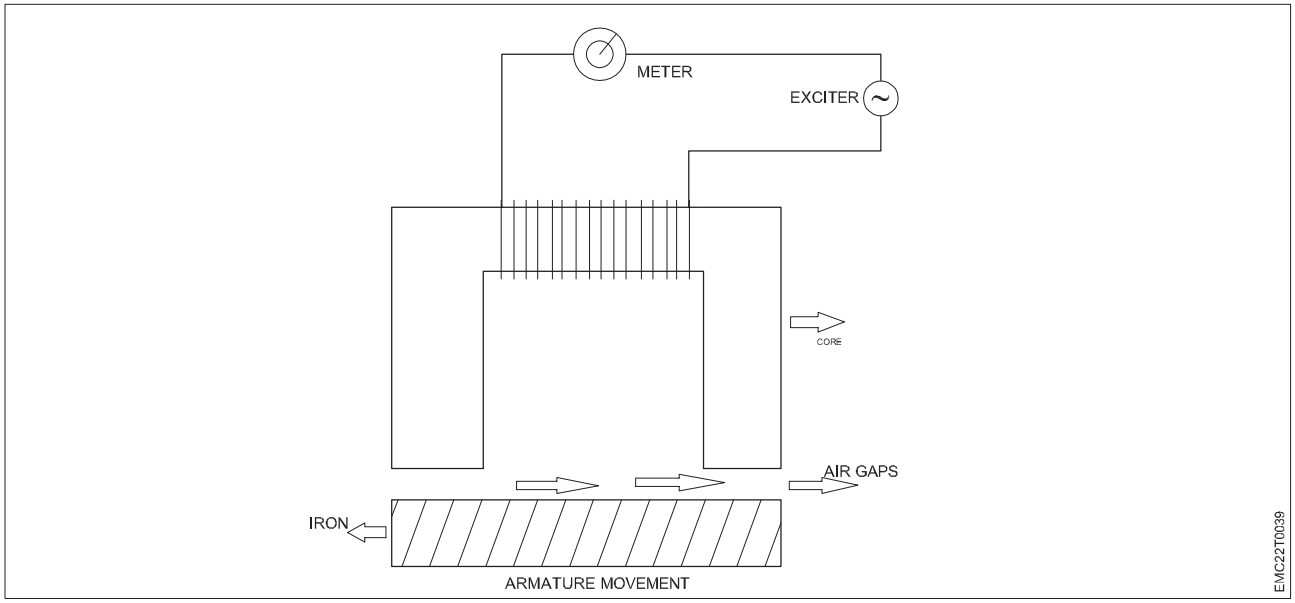
- Mechanical strain gauge
- Optical strain gauge
- Electrical strain gauge

Mechanical strain gauge: In these gauge change in lenth is magnified mechanically using gears or levers .These gauge are generally large in size .

Optical strain gauge: These are similar to mechanical gauges the difference being that magnification of change in dimension is achieved with multiple reflectors using mirrors .

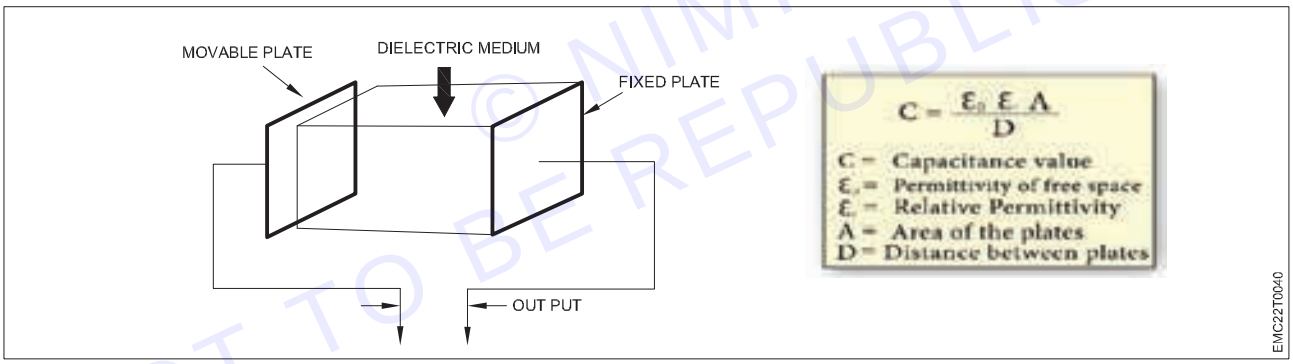
Electrical strain gauge: These are based on measurement of change in resistance or inductance or capacitance. Strain gauges based on change in resistance is most commonly use.

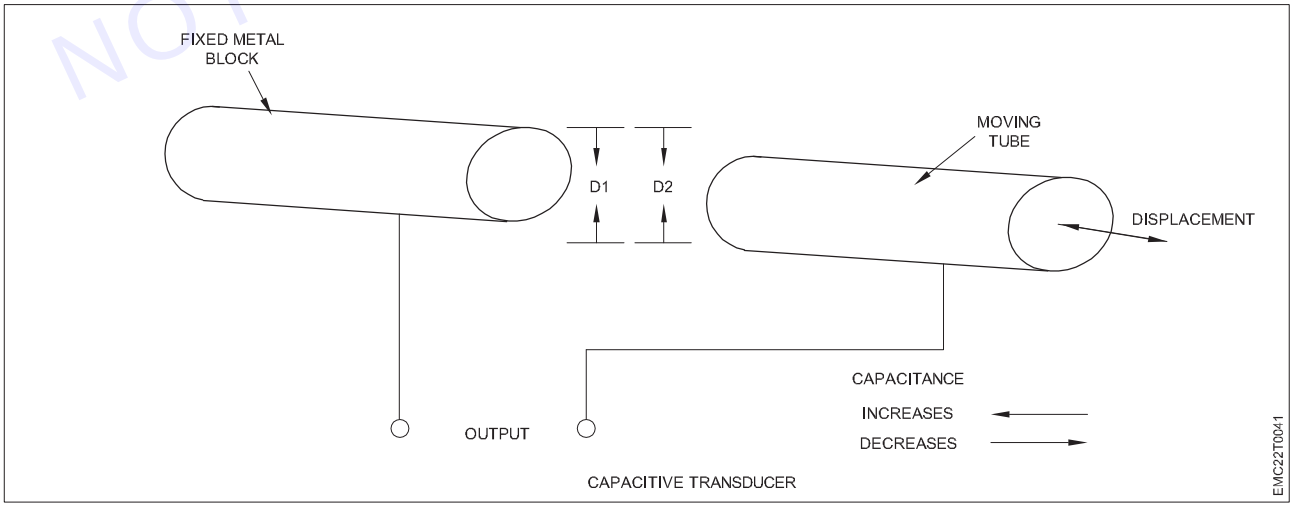
Inductive Transducer: Inductive transducer work on the principle of inductance change due to any appreciable change in the quantity to be measured i.e. measured .For example .LVDT a kind of inductive transducers. Measures displacement in terms of voltage difference between its two secondary voltages.



Working Principle: Generally inductive transducers works on the principle of change in self-inductance of one coil, change in mutual inductance of two –coils and eddy current production .The voltage difference and change in inductance result due to the change in flux in the coils secondary of primary coils.

Capacitive Transducer: The capacitive transducer is used measuring the displacement, pressure and other physical quantities .It is a passive transducer that means it requires external power for operation.





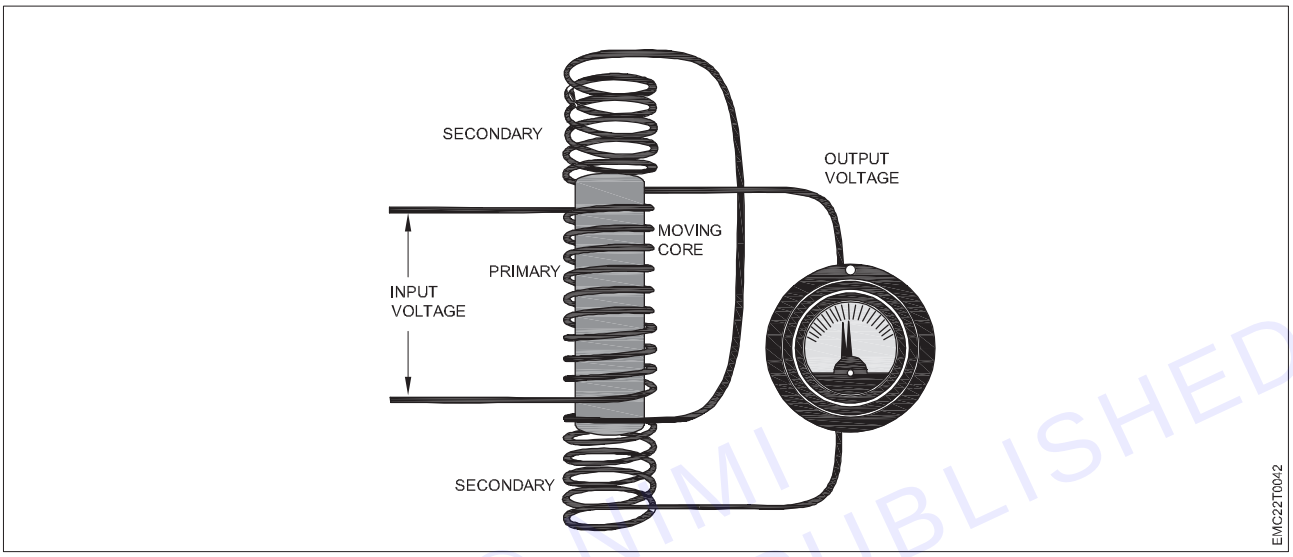
Working Principle: The capacitive transducer work on the principle variable capacitances. The capacitive transducer changes because of many reasons like of plates, change in distance between the plates and dielectric constant.

Advantages: The sensitivity of capacitive transducer high.The capacitive transducer is useful for small system. It has good frequency response.It requires small power to operate.

Disadvantages: The capacitive transducer temperature sensitive.It gives non-linear behaviour.The output impedance depends upon the frequency used.

Linear Variable Differential Transformer (LVDT)

LVDT The term LVDT stands for the Linear Variable Differential Transformer. It is the most widely used inductive transducer that converts the linear motion into the electrical signal. The output across secondary of this transformer is the differential thus it is called so. It is very accurate inductive transducer as compared to other inductive transducers.

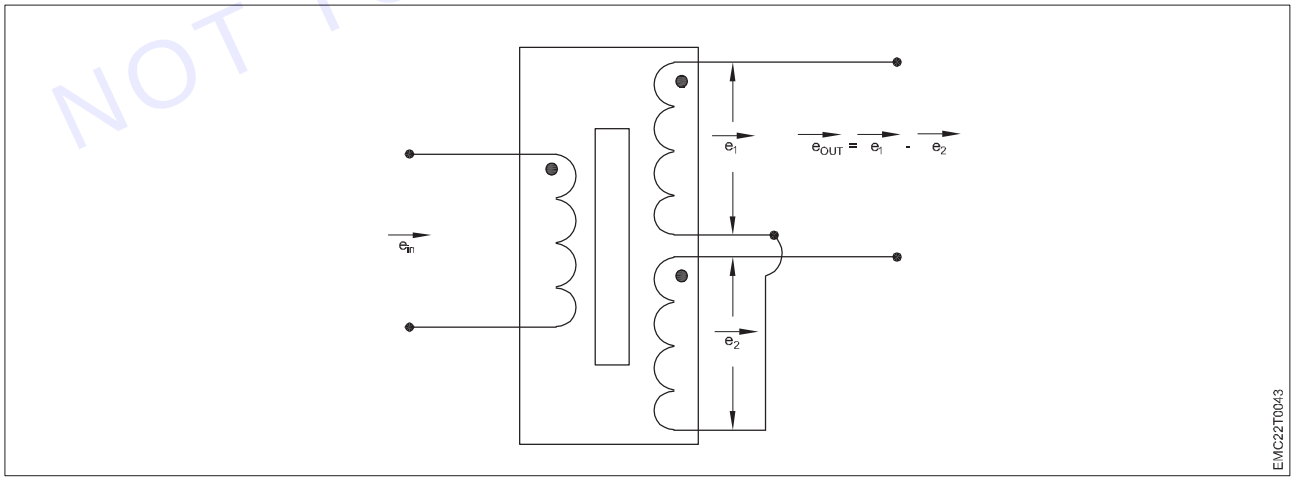


Principle of Operation and Working

As the primary is connected to an AC source so alternating current and voltage are produced in the secondary of the LVDT. The output in secondary S1 is E_1 and in the secondary S2 is E_2 so the differential output is,

$out=E_1-E_2$

This equation explains principle of operation of LVDT.



Now there case arise according to the location of core which explains the working of LVDT are discussed below as,

Case I when the core is at null position (for no displacement) When the core is at null position then the flex linking with both the windings.

Case II when the core is moved to upward of null position. (For displacement to the upward of reference point)

Case III when the core is moved to downward of null position (for displacement to the downward of the reference point)

The amount of change in voltage either amount of movement of core and indicates amount of linear motion.

The output voltage of an LVDT is linear function of core displacement .

Advantages of LVDT:

High range- The LVDTs have a very high range for measurement of displacement .They can used for measurement of displacement s ranging for 1.25mm to 250mm

High input and high sensitivity-The output of LVDT is so high that it does not need any amplification .The transducer possesses a high sensitivity which is typically about 40v/mm.

Low power consumption -The power is about 1w which is very as compared to other transducers.

Disadvantages of LVDT

LVDT is sensitive to stray magnetic fields so it always requires a setup to protect them from stray magnetic fields.

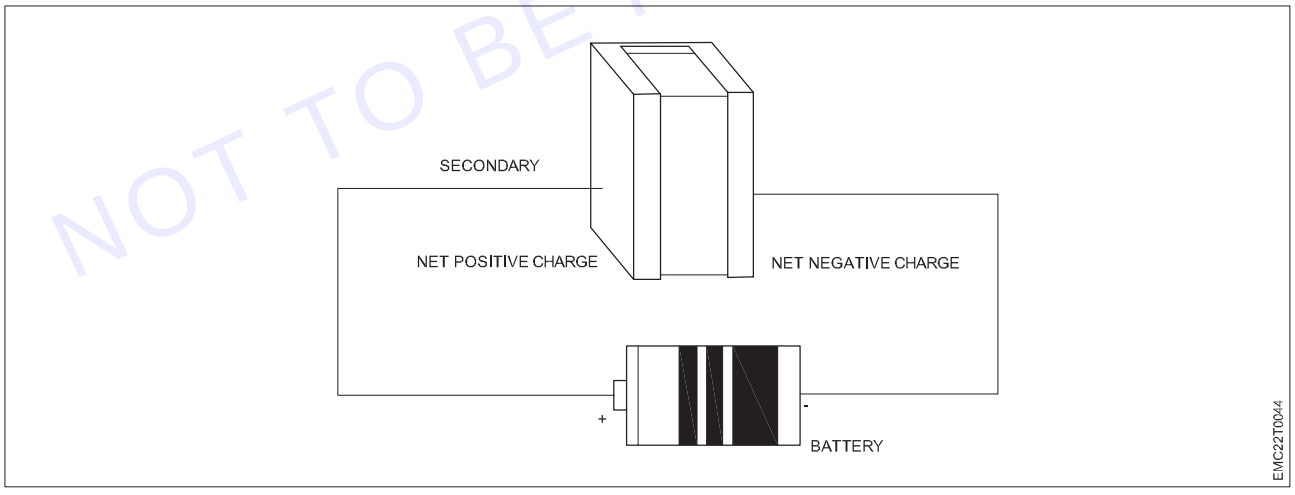
LVDT gets affected by vibrations and temperature.

Proximity Sensor

"Proximity Sensor" includes all sensors that perform non-contact detection in comparison to sensors, such as limit switches, that detect objects by physically contacting them. Proximity Sensors convert information on the movement or presence of an object into an electrical signal.

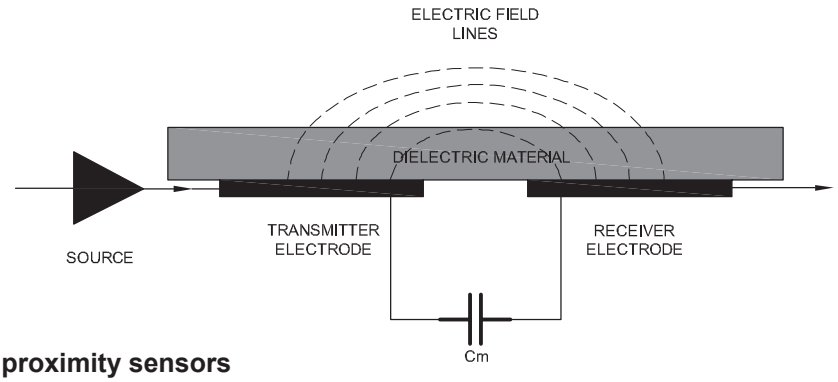
Working Principle of Inductive Proximity Sensors

Inductive Proximity Sensors detect magnetic loss due to eddy currents that are generated on a conductive surface by an external magnetic field. An AC magnetic field is generated on the detection coil, and changes in the impedance due to eddy currents generated on a metallic object are detected. Other methods include Aluminum-detecting Sensors, which detect the phase component of the frequency, and All-metal Sensors, which use a working coil to detect only the changed component of the impedance. There are also Pulse response Sensors, which generate an eddy current in pulses and detect the time change in the eddy current with the voltage induced in the coil. The sensing object and Sensor form what appears to be a transformer-like relationship

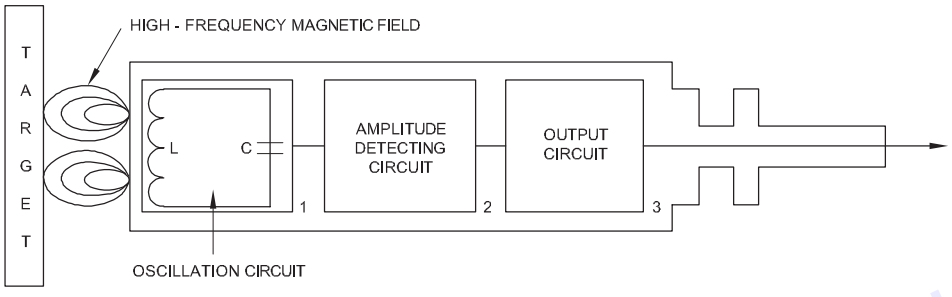


Working Principle of Capacitive Proximity Sensors

Capacitive Proximity Sensors detect changes in the capacitance between the sensing object and the Sensor. The amount of capacitance varies depending on the size and distance of the sensing object. An ordinary Capacitive Proximity Sensor is similar to a capacitor with two parallel plates, where the capacity of the two plates is detected. One of the plates is the object being measured (with an imaginary ground), and the other is the Sensor's sensing surface. The changes in the capacity generated between these two poles are detected. The objects that can be detected depend on their dielectric constant, but they include resin and water in addition to metals.



Eddy current proximity sensors



EDDY CURRENT PROXIMITY SENSORS

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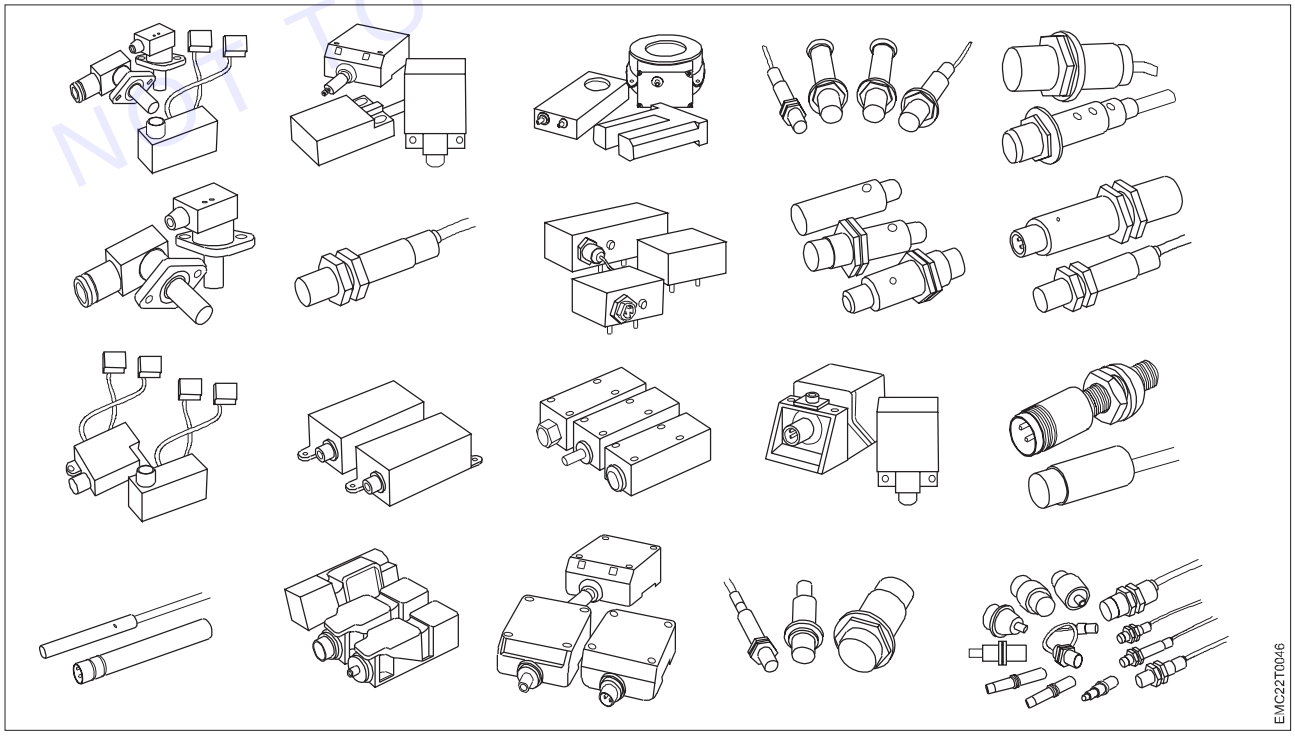
Eddy current proximity sensors are used to detect non-magnetic but conductive materials.

Applications

- Proximity sensors are also used in machine vibration monitoring to measure the variation in distance between a shaft and its support bearing.
- This is common in large steam turbines, compressors and motors that use sleeve-type bearing.
- Use with smartphones and tablet computers.
- Parking sensors.
- Food processing industry.
- Security usages.



EMC22T0046

MODULE 5 : SMPS,Inverter and Uninterrupted power supply(UPS)

LESSON 48-55 : SMPS and inverter

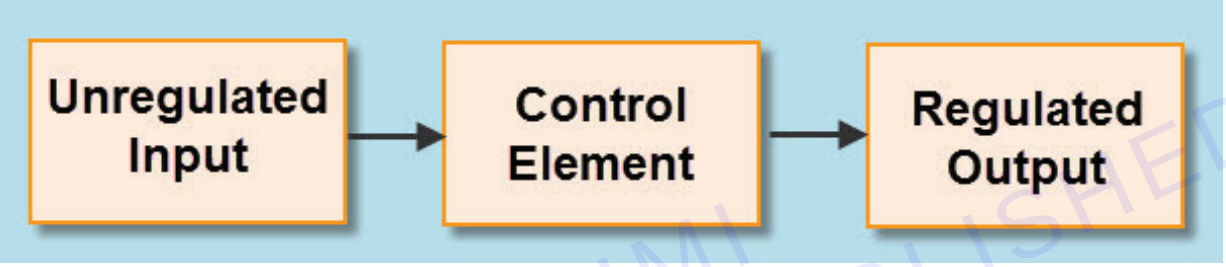
Objectives

At the end of this lesson you shall be able to:

- explain the operative principles of BMPS & Inverter

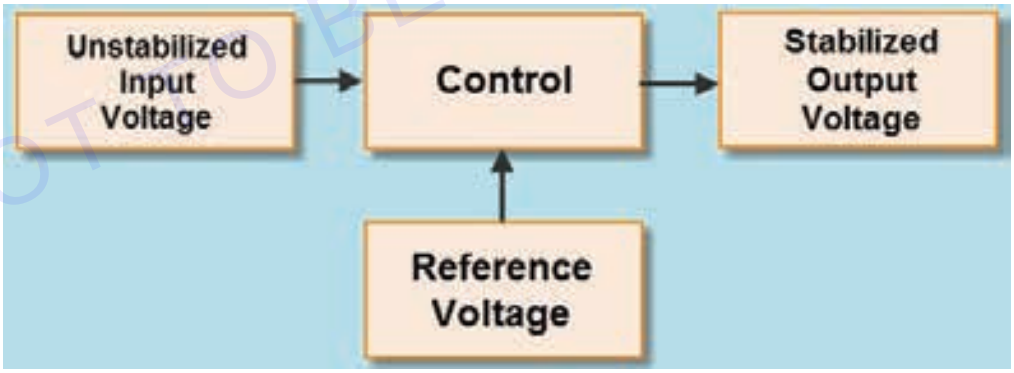
Stabilizer:

A Stabilizer is a thing or device used to maintain something or a quantity steady or stable. There are different types of stabilizers based on the quantity they are used for maintaining stability. For example, a stabilizer used for maintaining the voltage quantity stable in a power system is called as voltage stabilizer.



Voltage Stabilizer

Voltage stabilizer is designed for maintaining the stable voltage level to provide a constant supply in spite of any fluctuations or changes in supply in order to protect the home appliances. Generally voltage regulators are used to maintain constant voltage and these voltage regulators which are used to provide constant voltage to the home appliances are called as Voltage Stabilizers.



There are different types of voltage regulators such as electronic voltage regulators, electromechanical voltage regulators, automatic voltage regulators and active regulators. Similarly, there are different types of voltage stabilizers such as servo voltage stabilizers, automatic voltage stabilizers, AC voltage stabilizers and DC voltage stabilizers.

Voltage Stabilizer Working

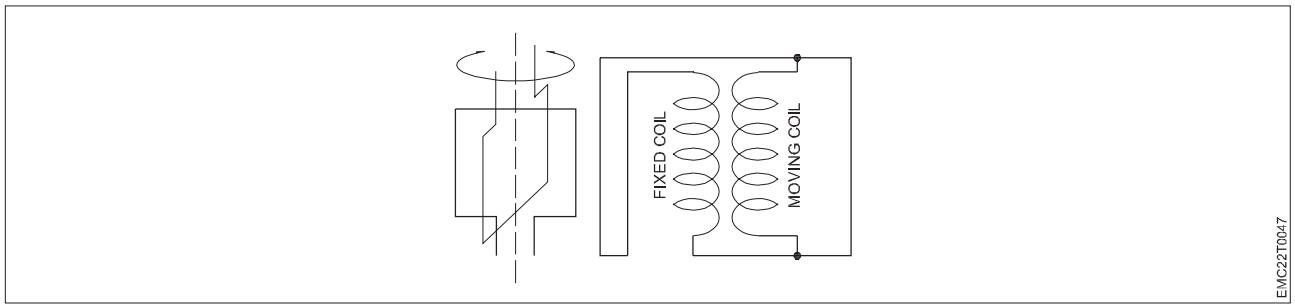
The working of the voltage stabilizer can be studied by considering the different types of voltage stabilizers, such as:

AC Voltage Stabilizers

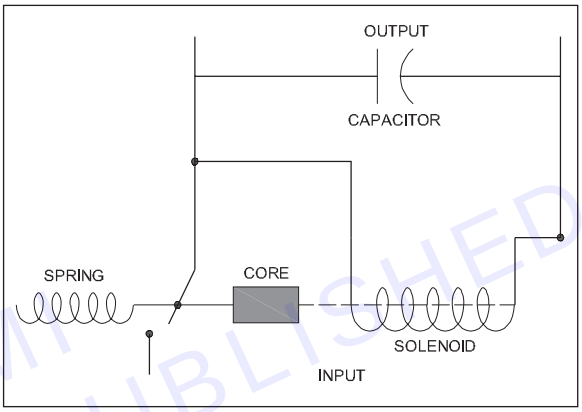
These AC voltage stabilizers are classified into different types such as Coil rotation AC voltage regulators, Electromechanical regulators and Constant-voltage transformer.

1 Coil Rotation AC Voltage Regulators

It is an older type of voltage regulator which was used in 1920s. It works on the principle similar to the variocoupler. It consists of two field coils: one coil is fixed and the other can be rotated on an axis which is parallel with the fixed coil.



A constant voltage can be obtained by balancing the magnetic forces acting on the movable coil which is achieved by positioning the movable coil perpendicular to the fixed coil. The voltage in the secondary coil can be increased or decreased by rotating the coil in one or the other direction from center position.



A Servo control mechanism can be used to advance the movable coil position for increasing or decreasing the voltage; with this coil rotation, the AC voltage regulators can be used as automatic voltage stabilizers.

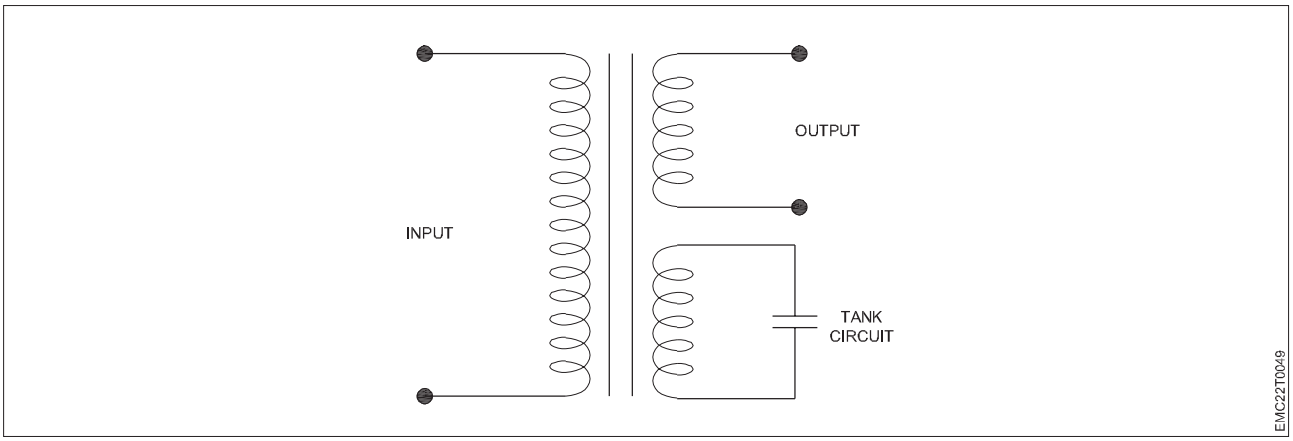
2 Electromechanical Regulators

Electromechanical voltage regulators that are used for regulating the voltage on AC power distribution lines, also called as voltage stabilizers or tap-changers. To select an appropriate tap from multiple taps of an autotransformer, these voltage stabilizers utilize the servomechanism operation.

If the output voltage is not in the range of intended value, then the servomechanism is used for switching the tap. Thus, by changing the turns ratio of the transformer, the secondary voltage can be changed to obtain the acceptable values of the output voltage. The hunting, which can be defined as the failure of the controller to constantly adjust the voltage; it can be observed in the dead band wherein the controller do not operate.

3 Constant Voltage Transformer

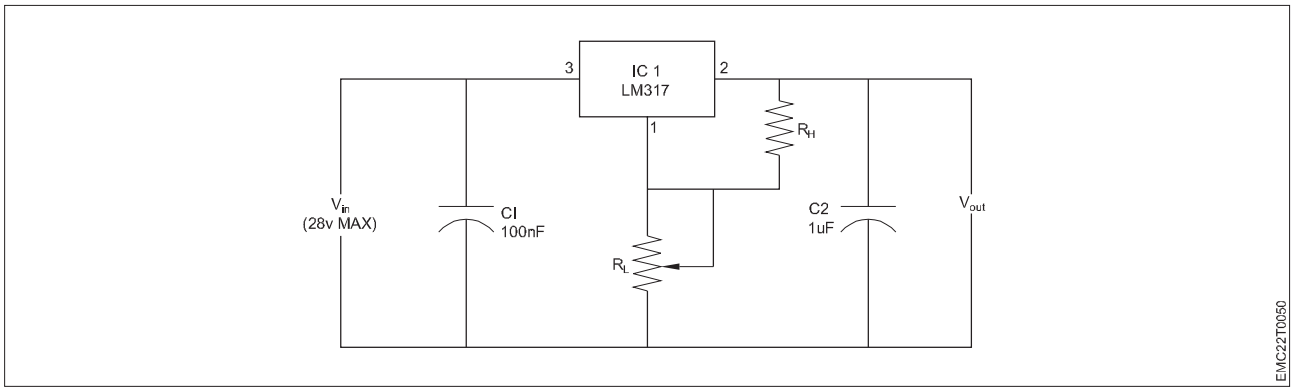
It is a type of saturating transformer which is used as a voltage stabilizer; it is also called as ferroresonant transformer or ferroresonant regulator. These voltage stabilizers use a tank circuit composed of a capacitor for generating nearly constant average output voltage with varying input current and a high-voltage resonant winding. By the magnetic saturation, the section around secondary is used for regulating the voltage.



A simple, rugged method is used for stabilizing an AC power supply which can be provided by saturating transformers. Due to lack of active components, ferroresonant approach is an attractive method that relies on square-loop saturation characteristics of the tank circuit for absorbing changes in the input voltage.

DC Voltage Stabilizers:

Series or Shunt regulators are frequently used for regulating the voltage of the DC power supplies. A reference voltage is applied using a shunt regulator like Zener diode or Voltage regulator tube. These voltage stabilizing devices start conduction at a specified voltage and they will conduct maximum current to hold the specified terminal voltage. Excess current is diverted to ground often using a low-value resistor for dissipating the energy. The figure shows the DC-adjustable-voltage stabilizer using IC LM317.

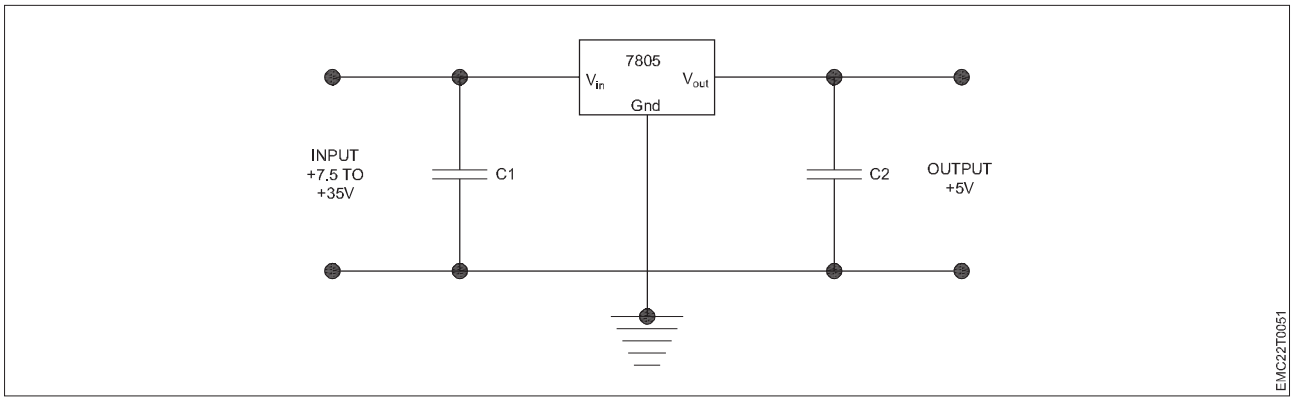


The shunt regulator output is used only for providing the standard reference voltage to the electronic device called as voltage stabilizer, which is capable of delivering much larger currents based on the demand.

Automatic Voltage Stabilizers:

These voltage stabilizers are used on generator sets, emergency power supply, oil rigs, and so on. It is an electronic power device used for providing variable voltage and, this can be done without changing the power factor or phase shift. Large sized voltage stabilizers are fixed permanently on the distributed lines and small voltage stabilizers are used for protection of the home appliances from the voltage fluctuations. If the voltage of the power supply is less than the required range, then a step up transformer is used for stepping up the voltage levels and similarly if the voltage is greater than the required range, then it is stepped-down using a step-down transformer.

Practical example of automatic voltage stabilizer can be observed in power supply circuits used to provide supplies to the electronic and electronic circuits. Frequently 7805 regulator is used for providing supply to the microcontroller based project kits as the microcontrollers operate at 5v. In this 7805 voltage stabilizer, the first two digits represent the positive series and the last two digits represents the output voltage value of the voltage regulator.



Switch Mode Power Supply (SMPS):

A switching regulator is integrated into an electronic power supply called a switch mode power supply (SMPS), which is sometimes referred to as a switcher, switched power supply, switching-mode power supply, and simply switcher. This power supply effectively converts electrical power. An SMPS, like other kinds of power supplies, converts current and voltage characteristics while transferring power from an AC or DC source (often mains power; see AC adapter) into DC loads, like a personal computer. Switched-mode energy sources can also be significantly lighter and more compact than linear power supplies since their transformers can be considerably smaller. This is due to the fact that, in contrast with the 50 to 60 Hz mains frequency, it works at a high rate of switching that extends from a few kHz to several MHz. The power supply architecture and the need for EMI (electromagnetic interference) suppression in commercial systems lead to a typically significantly higher component count and accompanying circuit complexity despite the smaller transformer.

Switch Mode Power Supply :

A switching regulator is included in an electronic power supply called a switched-mode power supply (SMPS) to facilitate effective electrical power conversion. An SMPS converts voltage and current while transferring power to DC loads via a DC or AC source, just like other suppliers.

Working Principle of SMPS

Switching regulators are employed in SMPS devices to maintain & regulate the output voltage by turning on or off the load current. The mean value between on and off is the appropriate power output for a system. The SMPS reduces depletion strength because, in contrast to the linear power supply, it carries transistor switches between low dissipation, full-on as well as full-off phases and spends significantly fewer seconds in high dissipation cycles.

Switch Mode Power Supply

In the initial stage, a rectifier and filter are used to process the AC power that comes in into DC.

Because the SMPS operates at high frequencies, the DC signal is processed by a high-frequency switch to produce a medium-frequency pulsating DC signal.

A power transformer reduces the high-voltage DC output to the proper level of DC signal.

Reversing and filtering the stepped-down DC signal results in a constant steady DV output.

To guarantee a constant output stream of the intended voltage, the control circuitry continuously monitors the generated voltage and modifies the high-frequency switch.

AC-DC Converter SMPS Working

The input supply in this sort of SMPS is AC, and the output is DC. This AC power is converted to DC using rectifiers and filters. This erratic DC voltage is applied to the impacted circuits for power factor correction. This is due to a low current pulse that occurs near the voltage peak inside the rectifier.

DC-DC Converter SMPS Working

This power source's input supply comes straight from a DC power source, which provides high-voltage DC power. Next, the frequency of this high-voltage DC power supply is lowered to 15KHz–5KHz. A 50 Hz steps-down transformer unit receives it after that. This transformer's output serves as the rectifier's input, and the rectifier's output provides the power that loads are drawn from. A closed-loop regulation is created when the oscillator is regulated on time. The transformer transfers its maximum power when its duty cycle is 50%. If its duty cycle is lowered, the transformer's power is likewise decreased by lowering the interruption.

Fly-Back Converter Type SMPS Working

A fly-back converters SMPS is any SMPS with an output power of less than 100W. The circuit for these SMPS is easy to understand and less complicated than that of other SMPS. Low power consumption is the purpose of this kind of SMPS. Using a MOSFET, the unregulated voltage that is input of constant intensity switches at a frequency of about 100 kHz to the desired output voltage. A transformer is used to achieve voltage separation. A workable fly-back converter can be operated while the switch is controlled via PWM. Unlike a typical transformer, the fly-back transformer exhibits unique qualities. The two windings that make up the fly-back transformer function as magnetically coupled inductors. To improve filtering, capacitors and diodes are used to spread the transformer's output.

Forward Converter Type SMPS Working

This kind of SMPS shares nearly the same design as the SMS flyback converter type. In order to control such SMPS, the switch is linked to the secondary winding that powers the transformer's output. The circuitry for filtering and correction is more intricate than that of a flyback converter. These SMPS, commonly referred to as DC-DC buck converters, are employed in transformer isolation and scaling applications.

Types of SMPS

For end users, these are some of the most well-known and widely utilized Switched Mode Power Supplies.

DC-DC Conversion

High-voltage DC power that is received from the AC mains has been rectified and filtered. After that, the high DC voltage is switched and sent to the primary side step-down transformer. The rectified & filtered output is gathered at the step-down transformer's secondary side before being supplied as the output into the power supply.

Converting Ahead

The choke in the forward converter transfers the current whether or not the transistor is conducting. To maintain the energy flow across the load during the transistor's off-time, the diode within the device conducts the current. Part of the electrical power is passed to the resultant load and stored by the choke during the On phase.

Flyback Converter

With a flyback converter, the inductor's magnetic field saves energy when the switch is turned on. Energy is released into the resulting voltage circuit when the toggle switch stays in the open position. The output voltage in a flyback converter determines its Duty cycle.

Flyback converter with self-oscillation

It is predicated on the Flyback theory. A current across the transformer primary begins to ramp up linear with the slope Vin/Lp during conduction. The quick recovery rectifier begins to function in reverse biassed and holds the conducting transistors ON as a result of the voltage that is induced in the secondary winding and feedback winding. When the current hits its maximum value, the core starts to saturate. As a result, the fixed base motor supported by input windings is unable to withstand a sudden increase in current. As a result, the switching starts to emerge from saturation.

Advantages and Disadvantages of SMPS:

Given below the Advantages and Disadvantages of SMPS :

Advantages of SMPS

The SMPS weighs relatively little.

The production spectrum of SMPS is broad.

The switch-mode power supply has a compact size.

Strongly anti-interference.

It is recommended to use SMPS power consumption, which is normally between 60 – 70 percent.

Disadvantages of SMPS

The SMPS has a very high level of complexity.

There is only one voltage output in an SMPS.

SMPS control is poorer and its output ripple is higher.

In the case of SMPS, the production reflect is substantial and its control is inadequate.

SMPS usage is limited to step-down regulation.

Applications of SMPS:

Their main applications are in power stations, refrigerators, ovens, and personal computers.

A frequency converter can be used to convert D.C. voltages to D.C. and A.C. voltages to A.C.

They are utilized to supply variable power and voltages in factories and manufacturing facilities.

They are also utilized in power plants, servers, airports, railroads, security systems, and railroads.

These are found in contemporary smartphones.

Uncontrolled DV input voltage balancing is another application for the SMPS.

They are employed in electrical machinery.

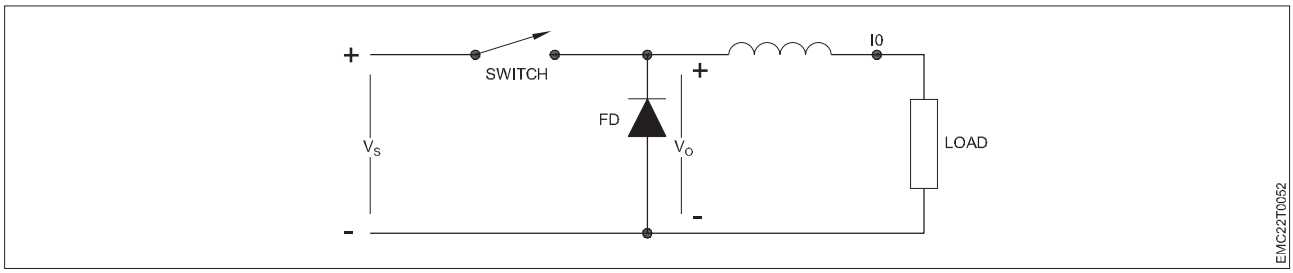
The auto industry also makes use of SMPS devices.

The purpose of the SMPS is to balance the excess current and stabilize the electric current.

They are compatible with electromagnetic fields.

Chopper Circuit:

Chopper circuits are known as DC to DC converters. Similar to the transformers of the AC circuit, choppers are used to step up and step down the DC power. They change the fixed DC power to variable DC power. Using these, DC power supplied to the devices can be adjusted to the required amount.



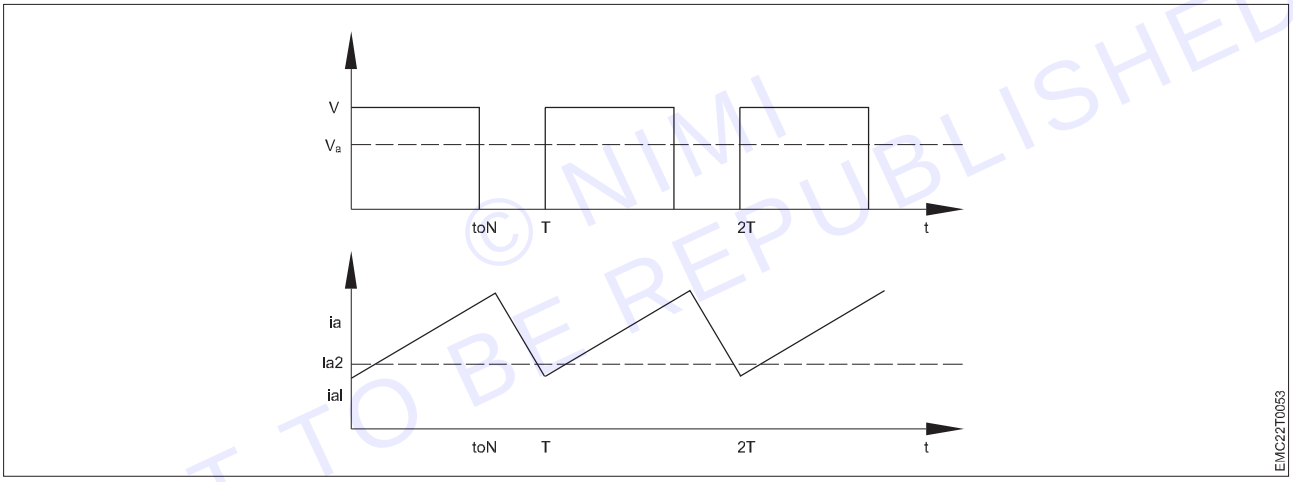
Principle of Operation:

The principle of operation of chopper can be understood from the circuit diagram below. The circuit consists of a semiconductor diode, resistor, and a load. For all type of chopper circuit, the output voltage value is controlled by periodic closing and opening of the switches used in the circuit.

The chopper can be viewed as an ON/OFF switch that can rapidly connect or disconnect the source to load connection. Continuous DC is given as source to the chopper as Vs and chopped DC is obtained across the load as V0.

Output Voltage and Current Waveforms

Above are the output voltage and current waveforms of a chopper circuit. From the voltage waveform, it can be seen that during the period of TON the load voltage V0 is equal to the source voltage Vs. But when the interval TOFF occurs, the DC voltage step downs to zero, thus making the load short-circuited.



In the current waveform, it can be seen that during the interval TON the load current rises to the maximum value. During the interval TOFF, the load current decays. In TOFF condition the chopper is off so, the load voltage becomes zero. But load current flows through the diode FD, making the load short-circuited.

Thus, the chopped DC voltage is produced at the load. The current waveform is continuous which rises during TON state and decays during TOFF state.

Classification of Chopper:

Based on their operation principle and type of source voltage chopper are of various types. The main classification of the chopper is DC chopper and AC Link chopper. Based on the commutation process they are classified as a natural commutated chopper and forced commutated chopper.

Forced commutated chopper is further classified as Jones chopper, Morgan chopper. Based on output voltage values choppers are classified as a step down the chopper, step up chopper, step-up/down chopper. Based on the power loss occurred at switching time choppers are classified as Hard switched and soft switched.

1 AC Link Chopper

In this classification of the chopper, the voltage inversion takes place. Here the DC voltage is converted into AC with the help of an inverter. Now this AC is passed through a step-down or step-up transformers. The output from the transformers is again converted into DC by a rectifier. AC link choppers are very bulky and occupy a large amount of space.

2 DC Chopper

DC chopper works on DC voltage. They work as a step up and step down transformers on DC voltage. They can convert the steady constant DC voltage to a higher value or lower value based on their type.

DC choppers are more efficient, speed and optimized devices. These can be incorporated on electronic chips. They provide smooth control over the DC voltage.

Different Types of Chopper Circuits:

The main element based on which choppers are categorized is the semiconductor used in the chopper circuit. Based on the positioning of this semiconductor, choppers can be made to work in any of the four quadrant conditions. Depending on the quadrant of operation choppers are categorized as Type A, B, C, D, and E

Type A chopper works in the first quadrant. In this chopper, the voltage and current both are positive and flows in the same direction. Power from source to load and the average output voltage is less than input DC voltage.

Type B chopper works in the second quadrant. Here the load voltage is positive and current is negative. Power flows from load to source. This chopper is also known as a step-up chopper.

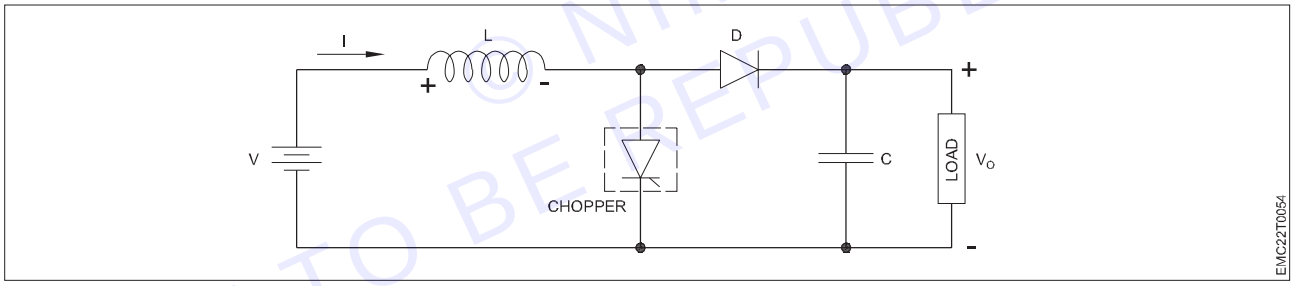
Type C chopper is formed by parallel connection of Type A and Type B choppers.

Type D chopper is the two quadrant type B chopper and Type E chopper is the fourth gradient chopper.

Step Up Chopper

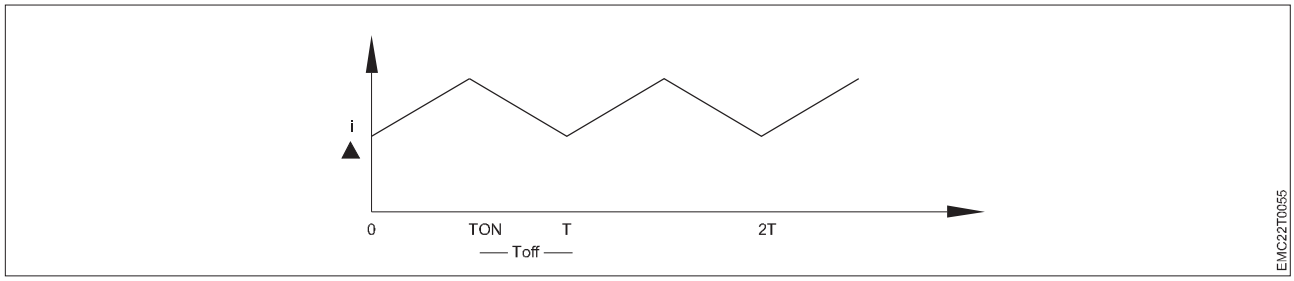
Step-up chopper works as a step-up transformer on DC current. This chopper is used when the output DC voltage has to be made higher than the input voltage.

The working principle of a step up chopper can be explained from the above diagram. In the circuit, a large inductor L is connected in series to the supply voltage. Capacitor maintains the continuous output voltage to the load. The diode prevents the flow of current from load to source.



When the chopper is ON, supply voltage VS is applied to the load .i.e. V0 = VS and inductor starts storing energy. At this condition load current raises from Imin to Imax.

When the chopper is switched OFF, the supply voltage takes the path from L – D – Load – VS. During this period the inductor discharges the stored e.m.f through diode D to the load. Thus the total voltage at the load V0 = VS + Ldi/dt which s greater than the input voltage. Current changes from Imax to Imin.



Where ΔI is the change in current, TON is is the duration, then

$$L\frac{di}{dt} = V_S, \quad \frac{\Delta I}{T_{ON}} = \frac{V_S}{L}$$

$$\Delta I = \frac{V_S}{L} T_{ON} \quad \text{------1}$$

During T_{OFF} condition…

$$\Delta I = \frac{V_0 - V_S}{L} T_{OFF} \quad \text{----- 2}$$

from 1 and 2 Average output voltage is given as $V_0 = \frac{V_S}{T - T_{ON}/T}$

Step –up chopper is also known as Boost choppers. Applications of the step up choppers include battery charging and as a voltage booster.

Applications of Chopper :

DC to DC converters are applied for many applications such as in

Switched Mode Power Supply System.

in DC motors as speed controllers.

DC voltage boosters.

Battery chargers.

Railway systems.

Electric cars etc…

Choppers are used in signal processing systems also. In choppers, the output voltage can be controlled using many different techniques such as Pulse width modulation, Frequency modulation, Variable frequency, variable pulse width, CLC control, etc.

INVERTER

In India and other countries, the main system of electric supply is single and three-phase AC supply but sometimes shutdown or failure of electric supply may occur so an alternative system is become very much necessary at that particular time. This type of alternative system is called emergency electric supply system.

Generators are the best example of this system but it is very much expensive due to high price of its fuel and its smoke is very harmful for environment as well as human health. So due to this, there is a need generated for such systems which are free from these lacks. Hence, the development of inverter and uninterrupted power supply have given us a silent and almost pollution free system of emergency supply.

In inverter, 12V/24V battery supply (DC supply) is converted into 230 V, 50 Hz AC supply. A battery charging circuit is also incorporated in the inverter to recharge the battery many times, when needed. In order to emergency power supply, there is one more power system which is very much used by computer system, is Uninterrupted Power Supply (UPS).

Because as interruption of even millisecond can cause a loss of data, damage to hardware as well as software and interruption of works. So all these things increase the financial loss. A UPS provides at least 10-15 min backup time in case of desktop PC and 1 to 2 hours in case of laptops Therefore, the study of inverter and UPS and their installation becomes necessary for an electronic mechanic.

An inverter is used to produce an uninterrupted 220 V or 110 V AC (depending on the line voltage of a particular country) supply to the device connected as the load at the output socket.

The inverter gives constant AC voltage at its output socket when the AC mains power supply is not available.

Working of Inverter

The working of an inverter can be considered in the following conditions.

1 When the AC mains power supply is available.

2 When the AC mains power supply is not available.

i When the AC Mains Power Supply is Available When the AC mains supply is available, the AC mains sensor senses it and the supply goes to the relay and battery charging sections of the inverter. AC main sensor activates a relay and this relay will directly pass the AC mains supply to the output socket. The load will be driven by the line voltage in this situation.

Also the line voltage is given to the battery charging section where the line voltage is converted to a DC voltage (12 V DC or 24 V DC usually), then regulated and battery is charged, using it.

There are special circuits for sensing the battery voltage and when the battery is fully charged the charging is stopped. In some inverters, there will be a trickle charging circuit which keeps the battery constantly at full charge.

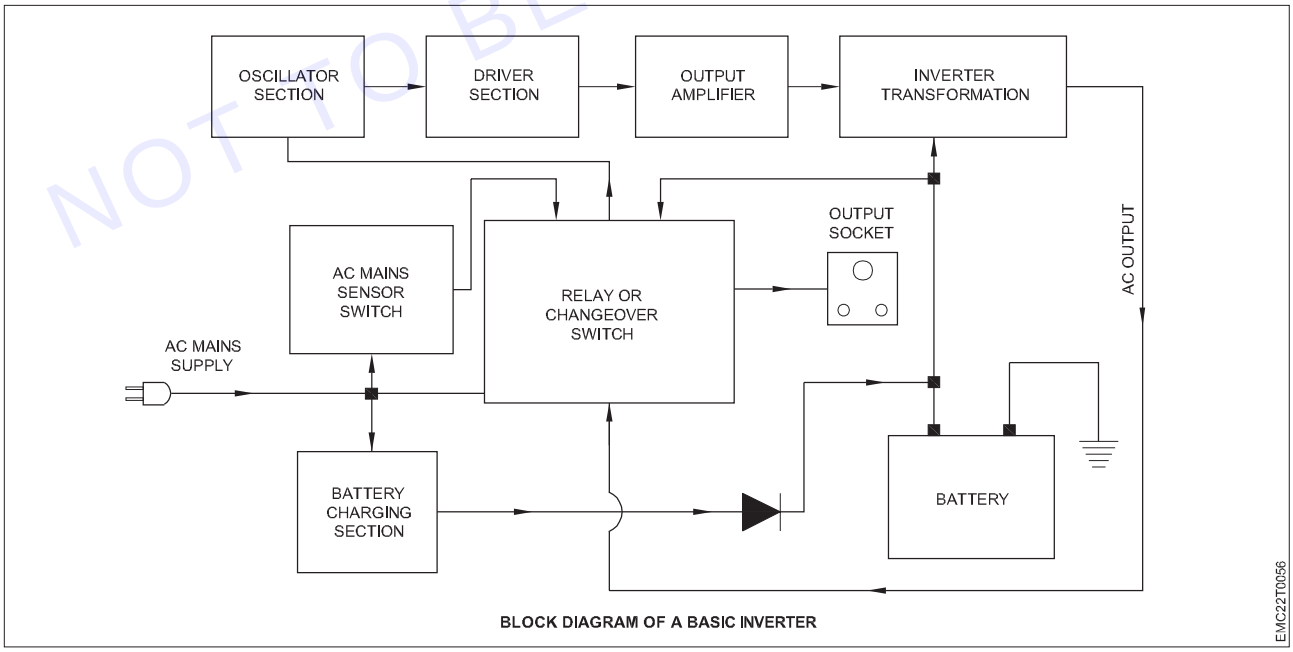
ii When the AC Main Power Supply is not Available When the AC mains power supply is not available, an oscillator circuit inside the inverter produces a 50Hz MOS drive signal. This MOS drive signal will be amplified by the driver section and sent to the output section. MOSFETs or transistors are used for the switching operations. These MOSFETs or transistors are connected to the primary winding of the inverter transformer.

When these switching devices receive the MOS drive signal from the driver circuit, they start switching between ON and OFF states at a rate of 50 Hz. This switching action of the MOSFETS or Transistors cause a 50Hz current to the primary of the inverter transformer. This result in a 220 V AC or 110 V AC (depending on the winding ratio of the inverter transformer) at the secondary or the inverter transformer. This secondary voltage is made available at the output socket of the inverter by a changeover relay.

Automation in an Inverter

Inverter contains various circuits to automatically sense and tackle various situations that may occur when the inverter is running or in the standby. This automation section looks after conditions such as overload, over heat, low battery, over charge, etc. Respective of the situation, the automation section may switch the battery to charging mode or switch OFF. The various conditions will be indicated to the operator by means of glowing LEDs or sounding alarms.

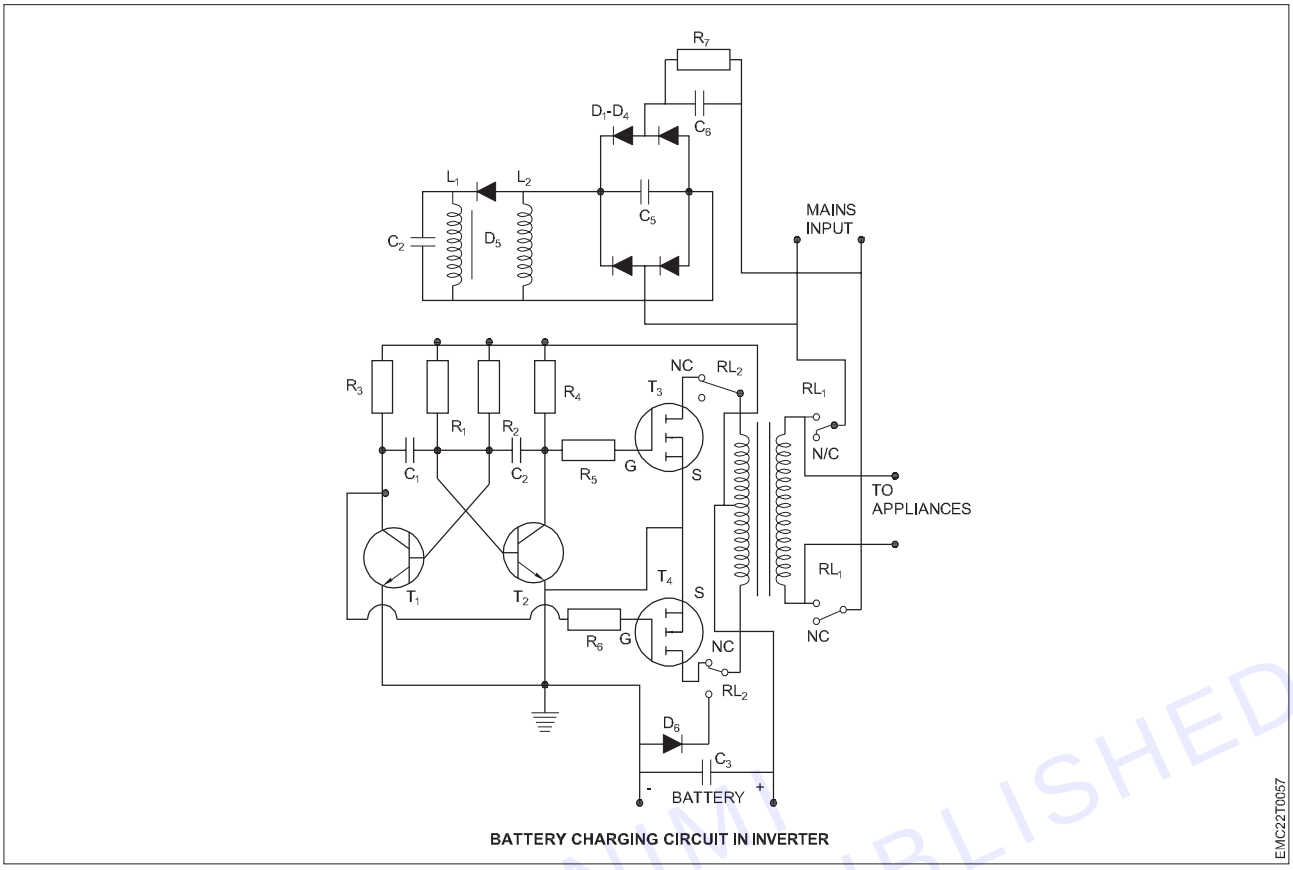
In advanced inverters, LCD screen are used to visually indicate the condition.



BLOCK DIAGRAM OF A BASIC INVERTER

Battery Charging Circuits Used in Inverters

An inverter circuit design may be quite incomplete if it is without an appropriate integrated battery charger circuit. The following article describes a unique design which utilises the inverter transformer for power inverting as well as for charging the battery.



BATTERY CHARGING CIRCUIT IN INVERTER

The good thing about the circuit is that the transformer does not employ separate winding for this rather works with the same input winding and reverts DC to the battery with the help of a few DPDT relays. The circuit diagram of battery charging circuit is given below.

Working of Battery Charging Circuits:

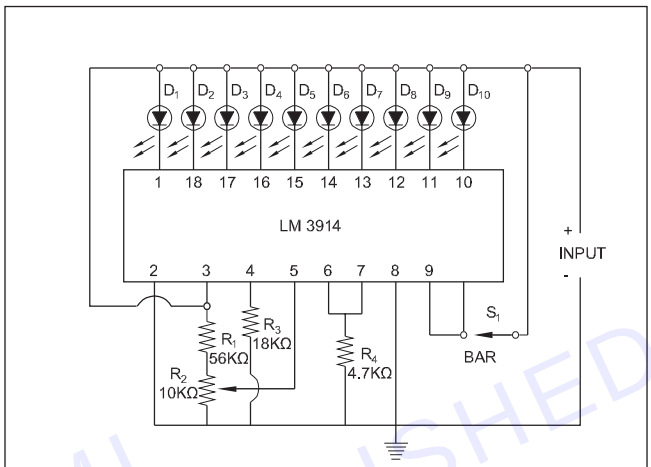
The working of battery charging circuits can be discussed in following points

- The inverter section can be easily recognised in the diagram, R, to R., including the transistors T and T_2 form a general astable multivibrator circuit for producing the required 50 or 60 Hz pulses.
- These pulses drive the MOSFETs alternately which in turn saturate the transformer by switching the battery voltage in it. The secondary winding of the transformer generates the corresponding magnitude of AC which is finally used for operating the connected appliances.
- The given configuration suggests the normal or ordinary inverter operation.
- By adding a couple of DPDT relays in the above discussed operation, we can force the circuit to charge the battery in the presence of an AC mains source.
- The coils of the two relays are powered through a capacitive low current compact power supply, involving Co, C, D_1-Ds.
- The battery charging circuit is connected to a mains AC source, this source is also connected to RL, poles.
- The second relay RL, is wired up with input winding of the transformer.
- In the absence of mains AC, the position of the relay contacts are in the NC as shown in the figure.
- In this position the MOSFETs get linked with the transformer input winding, and the battery with the circuit so that the inverter starts oscillating and the output appliances gets the AC power from the battery.
- In the presence of AC mains, the relay coils instantly get the required DC power and activate the contacts.
- RL, activates and connects the mains input to the transformer, the appliances also get connected with the mains AC in the process.

- Also due to the action of RL_2, the MOSFETs get disconnected from the transformer, while the lower tap connects with D.. Since, the center is already connected to battery positive, the inclusion of D provides a half wave rectified voltage to the battery, which is effectively filtered by C, so that the battery is able to get the required sufficient charging voltage.
- The above charging process continues until mains is present, so it should be monitored manually. When mains fails, the action reverts into inverting mode without interrupting the appliance operations and by using a single transformer for both the operations.
- C, makes sure that RL, always activates a shade later then RL, for safety reasons.

Battery Level:

Battery level means the quantity of charge present in a battery. Normally in mobile phones, the battery level is shown in dot or bar form. This enables you to easily recognise the battery level. By knowing the charge level, an equipment's user can decide that he/she should put his/her device on charging or not. Here we present a circuit that enables you to know the battery level of a device from the number of LEDs that are glowing.



CIRCUIT DIAGRAM OF BATTERY LEVEL INDICATOR USING LM 3914

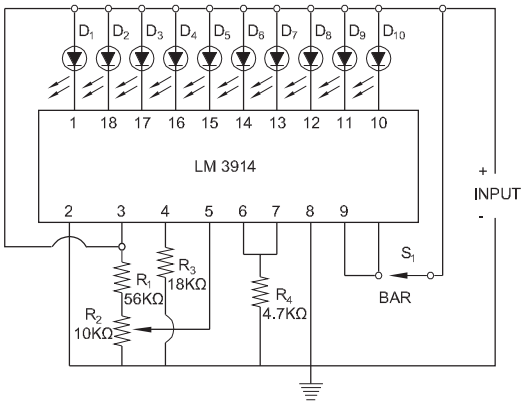
Installation of Inverter

Installing of an inverter in a residential or an official building is not a tough job, but following points should be kept in mind during installation.

- The inverter and battery should be installed in airspace (but not in open space) and the exposure to sunlight should be avoided.
- The place of the installation should be well ventilated and easily accessible for servicing.
- Foreign objects and water must not enter the inverter. Always ensure that no objects containing a liquid are ever kept near the unit.
- Identify the points, which are to be connected to the inverter.
- Ensure the appliances, which are to be provided with backup do not exceed the capacity of the inverter.
- Consider the best suited position for the inverter installation as per the necessary precautions.

Distributed Board Connection:

The battery bank must be connected to the inverter and the input terminal is connected to main power in your distribution board. The output terminal is connected to the relevant miniature circuit breakers, within your DB (Distributed Board) which you would like your inverter to run.



CIRCUIT DIAGRAM OF BATTERY LEVEL INDICATOR USING LM 3914

EMC22T0058

LESSON 56-63 : Uninterrupted power supply (UPS)

Objectives

At the end of this lesson you shall be able to:

- explain the operative principles as UPS
- differentiate between UPS & Invertor
- advantage & disadvantage of UPS.

Concept of Uninterrupted Power Supply

An uninterruptible power supply (UPS) is a type of device that powers equipment, nearly instantaneously, in the event of grid power failure, protecting the equipment from damage.

UPS systems vary significantly in their design and functionality, affecting the amount of time they can power equipment, their ability to improve power quality, and their cost.

Data servers, computer systems, industrial settings, and laboratories commonly use UPS systems. Because a UPS protects equipment, it is appropriate for any situation where electrical loads may be sensitive to power loss or other power quality issues. For example, UPS systems are commonly used for computers and servers because power loss to these loads may result in loss of data or component damage.

The UPS finds wide applications as a reliable power source to computer, telex and fax system and where continuous regular and stable power supplies are required. The major users of UPS are the industries, business houses/ establishments, hospitals, banks, offices, cinema theatres, railway stations and hotels etc. The UPS consists of a battery charger, an inverter, output transformer, a set of batteries, control circuits and transient/ EMI filters.

Major Parts of an UPS:

Following are the main components of a UPS system −

Battery - The battery works as the energy storage unit in the UPS system. It provides the stored electrical energy for a sufficient amount of time during main power failure.

Rectifier or Charger Circuit - It converts the supply voltage of 240 VAC into 12 V (or any other battery voltage) DC. It supplies this rectified DC power to the battery for storage.

Inverter - It converts the DC output power of the battery into ac power to supply the load during mains power failure.

Static Switch - It is a semiconductor device such as a thyristor which transfers the load from the utility to the inverter (and the inverter to the utility) without any interruption in the power supply to the load.

INVERTER

A power inverter, inverter, or invertor is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC). The resulting AC frequency obtained depends on the particular device employed. Inverters do the opposite of rectifiers which were originally large electromechanical devices converting AC to DC.

The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source.

A power inverter can be entirely electronic or maybe a combination of mechanical effects (such as a rotary apparatus) and electronic circuitry. Static inverters do not use moving parts in the conversion process.

Difference between UPS and Inverter

The following table highlights the key differences between a UPS and an inverter

Parameter	UPS	Inverter
Definition	A UPS (or Uninterrupted Power Supply) is a device which provides power to the load in case of a main power failure.	Inverter is a power electronic circuit which converts the direct current into alternating current.
Main parts	The main parts of a UPS are rectifier, battery, inverter and controller.	The main parts of an inverter are inverter circuit and battery.
Function	UPS converts DC into AC and AC into DC at the same time.	Inverter only converts DC into AC.
Types	UPS is of three types as − Offline UPS Online UPS Standby or interruptive UPS	Inverters are of two types as − Standalone inverter Grid tie inverter
Charging of battery	A UPS can charge the battery from AC mains.	Inverter cannot charge a battery itself. It requires an external charge controller to charge the battery.
Backup time	A UPS provides less backup time, up to 10 to 15 minutes, as compared to an inverter. Therefore, UPS supplies power for short duration.	The backup time of an inverter is greater than that of a UPS. It can provide supplies for hours depending on its capacity. Hence, inverters supply power for long duration.
Switching time	The switching time of a UPS is of the order of 2 to 5 milliseconds. Hence, a UPS provides fast switching.	The switching time of an inverter is about 200 m/s to 500 m/s. Thus, the switching of inverters is slower than UPS.
Protection	UPS provides necessary protection against abnormal conditions like short circuits, overload, etc.	Inverters do not provide protection against abnormal conditions.
AVR	UPS is equipped with an AVR (Automatic Voltage Regulator) that provides a constant output voltage to the load.	Inverter does not include AVR, thus the output voltage of the inverter may vary due to change in load.
Circuit complexity	UPS has relatively more complex circuits.	Inverter is a simple circuit than a UPS.
Cost (for same rating)	UPS includes complex circuitry and smart devices to provide necessary protections which makes it more expensive than an inverter.	Inverters are less expensive than a UPS.
Maintenance	UPS are almost maintenance free, except for the battery.	Due to more wiring and the need of distilled water in inverter batteries, the inverters require relatively more & frequent maintenance.
Applications	The UPS are used to supply electric power to PCs, workstations, small office and home office devices like routers, etc.	The inverters are used to supply power to various domestic electric appliances such as lamps, fans, coolers, etc.

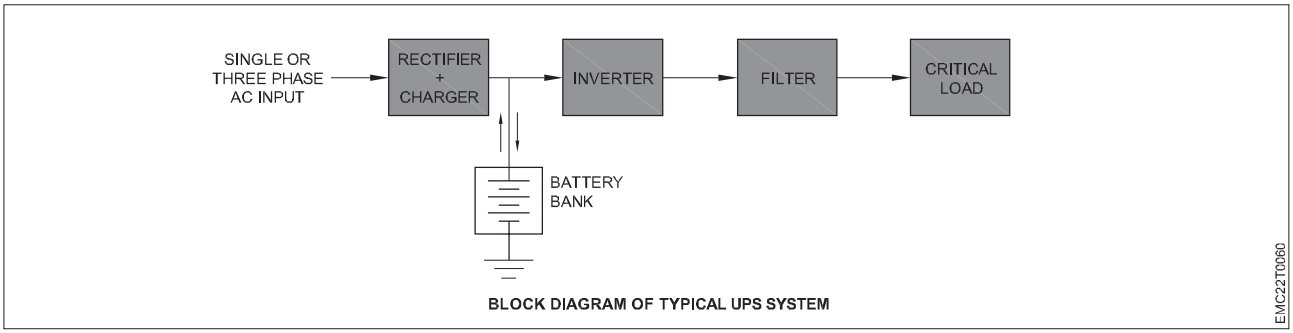
UPS Block Diagram

A typical UPS block diagram is shown in block diagram in the picture below

Operating Principle:

In the simplest form, UPS is a supply system that offers uninterrupted power to the AC load by converting DC into AC. UPS differs from an emergency power supply system or a standby generator, as it can protect devices from power outages by one or more connected batteries. The battery run time is relatively short, typically 5 to 15 minutes, but it is long enough to bring the auxiliary power supply online or protect devices from shutting down.

In normal operating conditions, the current is drawn from the AC main power supply or grid, while UPS provides load current in case of a power outage. Here the battery is used as the backup source to deliver power to the load in case of power failure.



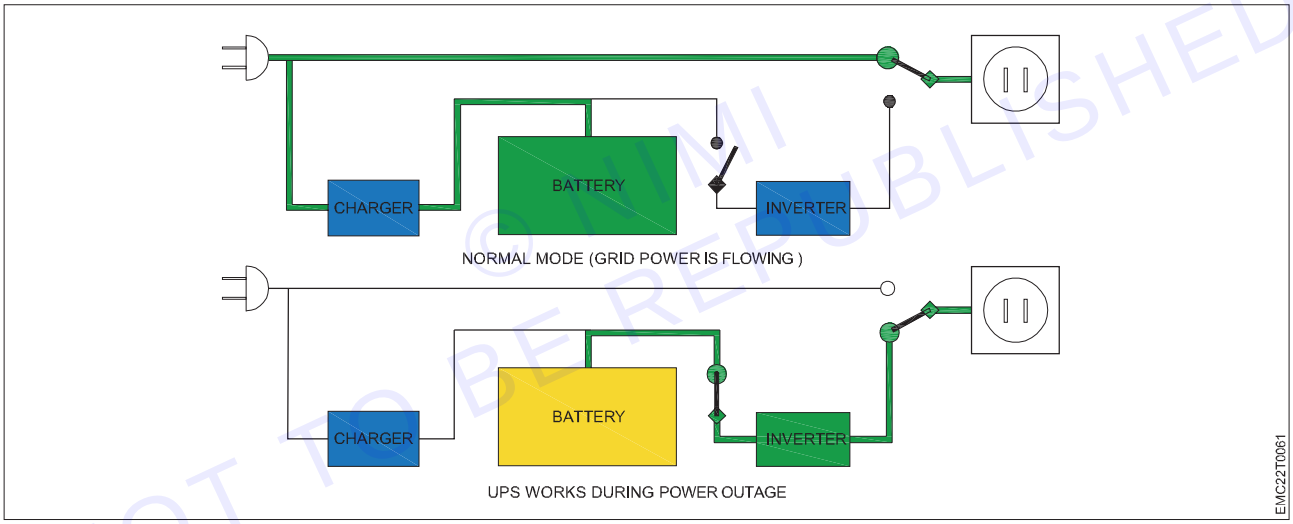
BLOCK DIAGRAM OF TYPICAL UPS SYSTEM

WORKING:

When the AC supply current is flowing, it charges the batteries of the UPS. If this main supply is cut-off the batteries of the UPS provided a DC voltage and then converted inside the UPS to an AC voltage, which is then passed on to the load.

This makes sure that the load receives an uninterrupted supply of AC Power.

We use uninterruptible power supplies for equipment that must always remain switched ON, such as Mainframe Computer, hospital equipment (e.g., life- support machines) and emergency lighting. We shall describe here the working principle of online and offline UPS.



Different types of UPS :

1 Offline UPS (Standby UPS)

2 Online UPS (Double Conversion UPS)

3 Line-Interactive UPS

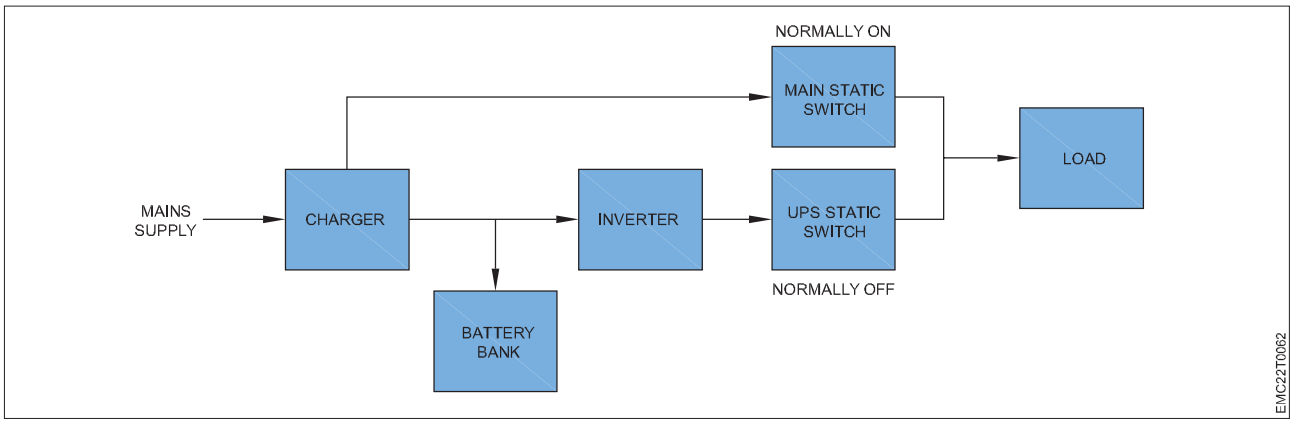
1 Offline UPS:

Offline UPS types are activated only when the main power is gone. In this type, the UPS is connected directly to the consumer load. However, the offline type does not have an acceptable quality for the output power, and its maximum power is limited.

Offline UPS Block Diagram:

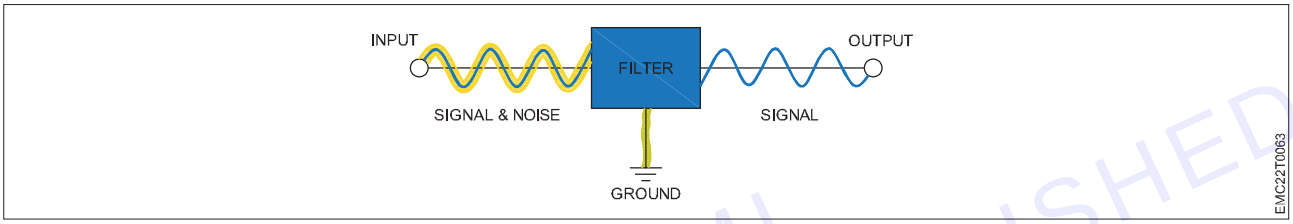
Offline UPS device's major components include a rectifier, inverter, battery bank, filter circuit, and critical load. A single-phase or a three-phase input signal is provided as input to the rectifier.

In normal operating conditions, the current is drawn from the ac main power supply or grid, while the backup source provides current in case of a power outage. Here battery is used as the backup source to deliver power to the load in case of power failure.

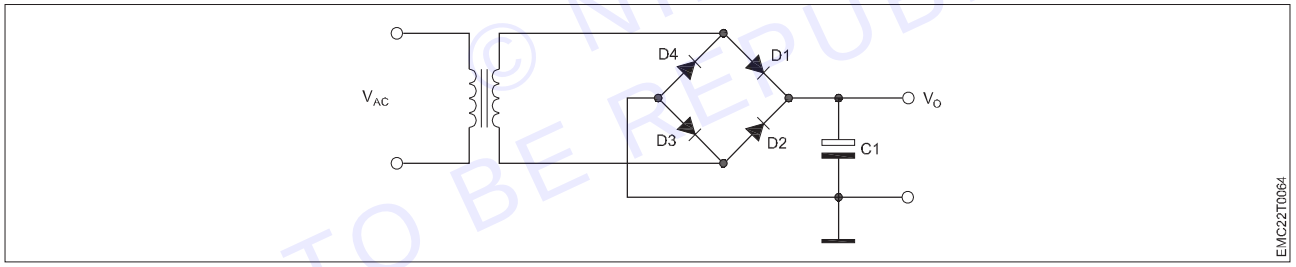


Charger: This block rectifies the input AC and charges the batteries. The charger block unit involves an EMI filter, rectifier, and DC filter. Here is a small explanation of how each sub-component works:

EMI filter: this unit reduces noises and disturbances from the input AC signal.



Rectifier: this unit converts AC current to DC current.



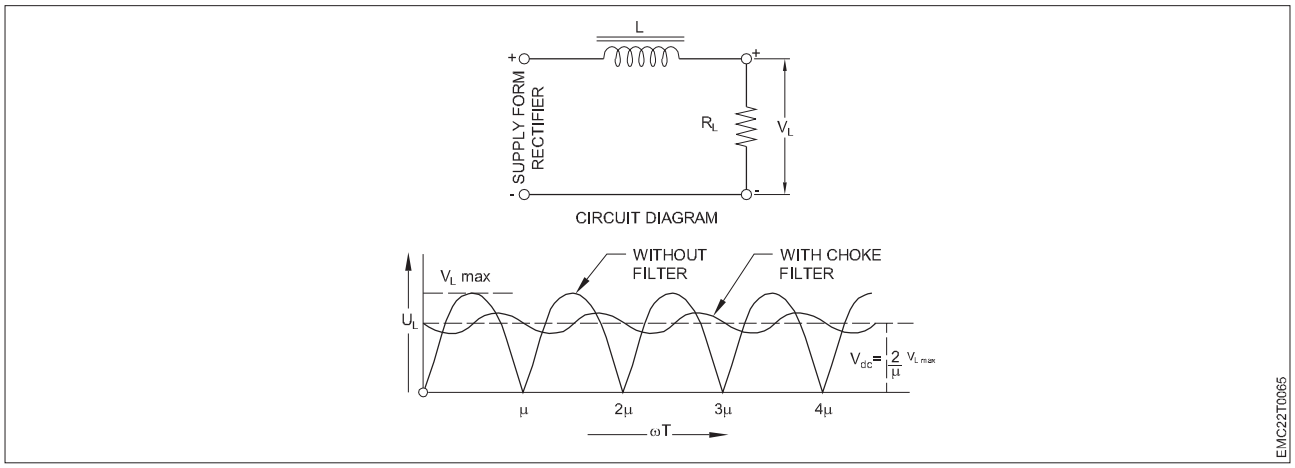
DC filter: The rectifier's needed output voltage is unidirectional and does not change concerning time. It has an average or DC value on which AC components of different frequencies are superimposed (mixed). These undesired AC components mixed in DC are called Ripples. Therefore, filter circuits are necessary for DC Regulation. Thus, this part task reduces the negative ripple effect and makes the output current much more in DC shape.

Static switch: Static Switches are designed to connect or disconnect the load to or from the supply, respectively, without the existence of moving parts.

Inverter: DC to AC inverters is designed to change a DC (direct current) power supply to an AC (alternating current) power supply.

Battery bank: An assemblage of one or more individual batteries used to store energy in electrochemical form is referred to as a battery bank.

Load: Sensitive and critical loads selected by the user.



Advantages

It is more efficient and reliable than online ups. This is because the inverter is not on all the time unnecessarily.

It is inexpensive.

The operation is quite simple due to separate paths for the two modes of operation.

Due to non-continuous operation, large heat sinks are not required.

Disadvantages

It is not suitable for critical loads as here mains and load are not electrically isolated from each other.

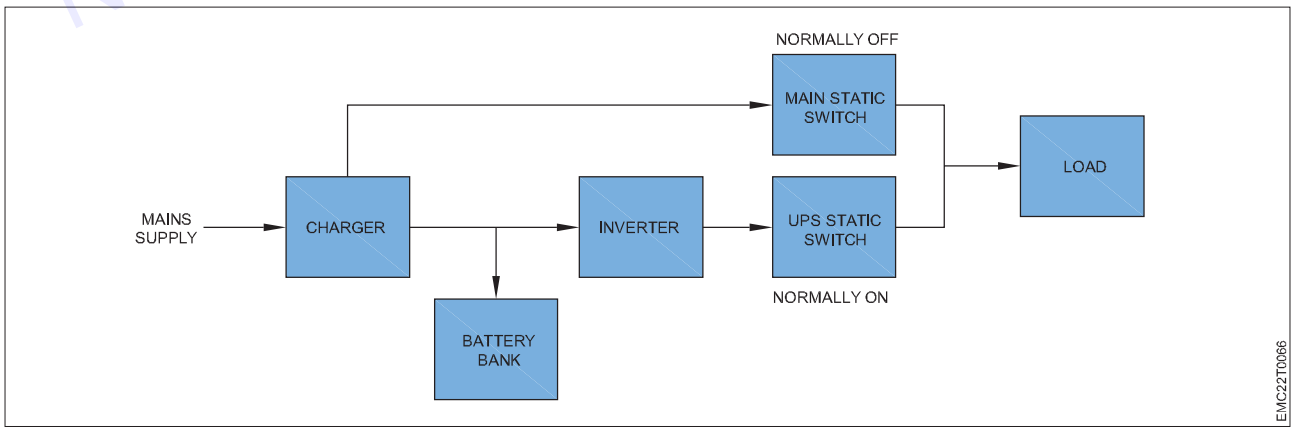
This sometimes fails in case of power fluctuating conditions.

2 Online UPS:

If you also want the proper and suitable output power, the online type can be a good option for you. In online types, the inverter can charge batteries and provide output power simultaneously. It means the grid power is converted into direct current by a rectifier. Then it is converted into alternating current by the inverter section and is ready to use by consumer loads. This conversion can protect consumer devices from volatile grid voltage.

Online UPS Block Diagram

In online UPS, the load draws power from the battery bank and main power supply simultaneously. Because the load initially receives electricity from the main power supply but switches seamlessly to the battery backup in the event of a power outage, the supply delivered to the load is uninterruptible. This is the difference between online and offline UPSs.



Advantages of On-line UPS:

It offers continuous power flow with complete isolation from the main power supply or grid ac input to the end user,

Constantly uninterrupted electricity is given to the load,

Main power supply failure (outage) cannot change the operation mode,

The transfer time is negligible due to the always-on condition,

Wide range of input voltage

Disadvantages of On-line UPS:

Due to Continuous on-mode, it generates more heat. Hence, a large heat sink is required.

It has a Complex design.

It is much more expensive than offline UPS.

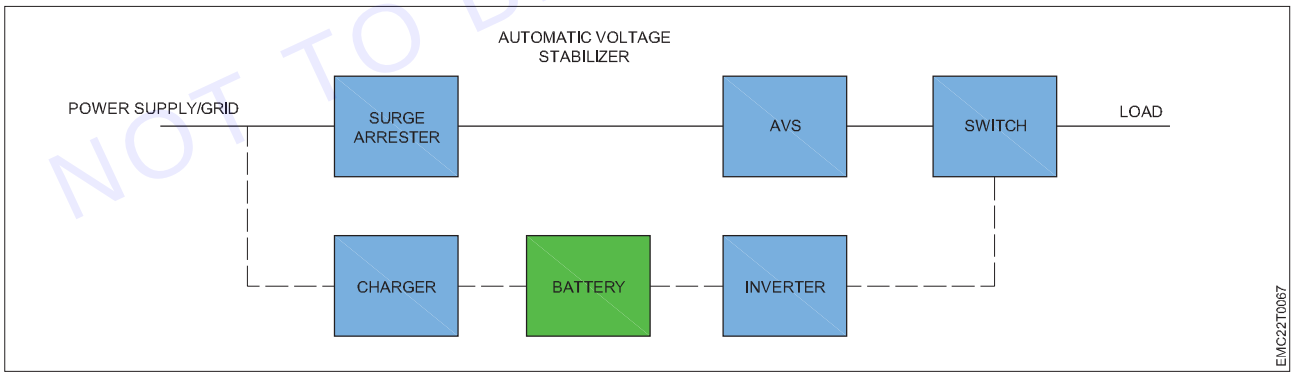
3 Line interactive UPS:

In this type, the inverter always charges the battery in the normal voltage range. Nevertheless, as soon as the input voltage goes beyond or below the normal range, UPS is activated, and supplies the consumer load from the batteries and prevents damage to connected devices. The interactive line type is mostly used in network equipment.

Line Interactive UPS Block Diagram:

Line interactive technology UPSs are being used in places where we have sensitive and expensive devices and equipment because electrical fluctuations will lead Sensitive electrical devices to fail. Thus, they should not be subject to fluctuations or noises. Line interactive UPSs are usually used for network equipment. For instance, line interactive UPS is utilized for departmental servers, websites, and small company servers. The line interactive design is a combination of offline & online schematic. In line with interactive design, the inverter plays a dual role. First, it charges the battery when the main power supply is flowing. Second, it regulates the output voltage and works as a normal inverter in the absence of the main power supply.

Line-interactive UPS can remove slight fluctuations in power flow, such as a decrease or increase in voltage level, without switching to the battery. Line Interactive UPS provides more power protection and reliability than basic Offline designs. The difference is the addition of a tap-changing transformer, voltage regulator, or Automatic voltage stabilizer. This tap-changing transformer regulates the voltage by changing the tap depending on the input voltage. Additional filtering is provided in this UPS, resulting in a lower transient loss. The block diagram is shown below interesting thing about Line Interactive UPS is that using too much battery can greatly impact on its lifetime. Moreover, Line-Interactive inverters are usually designed to resupply load current by main supply power in case of failure in UPS.



Advantages of Line-interactive UPS

1 High reliability and high efficiency,

2 Lower costs than On-line UPS,

3 High power supply,

4 Noise and fluctuation filtering

5 Better protection than Offline UPS

Disadvantages of Line-interactive UPS

1 Line interactive UPS cannot fully filter noise and fluctuation with low power demands (like 5KA and below),

2 Output frequency depends on the input frequency.

3 Line interactive UPS has no power factor correction circuit.

Comparison Between Offline Ups, On-line UPS,Line-interactive UPS

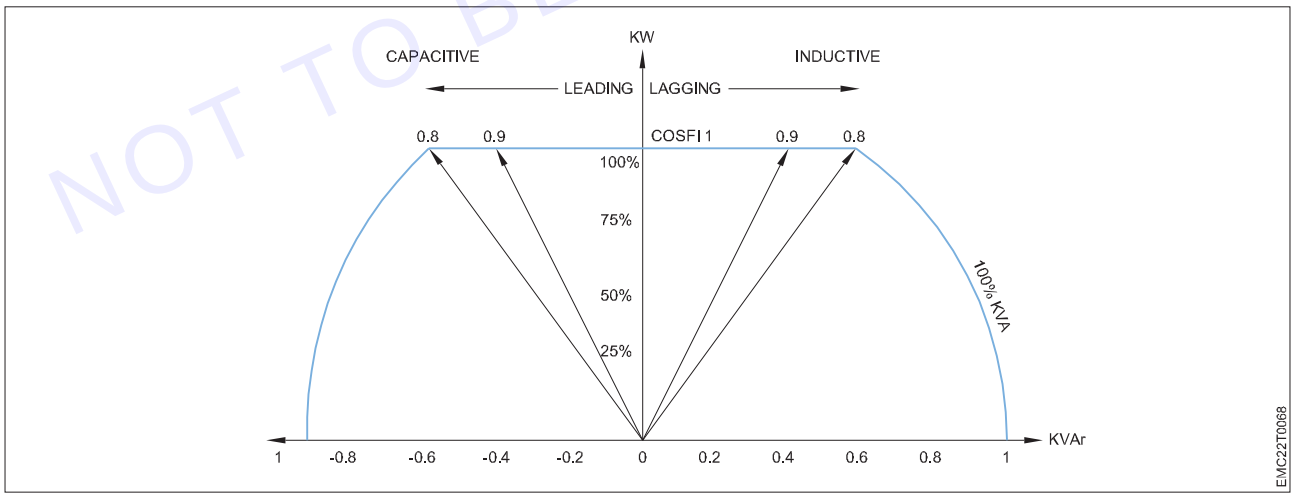
	Offline	Line-interactive	Online
Size	Compact	Typically, large & heavy	Typically, small & light
Practical Power Range (kVA)	0-0.5	0.5-5	5-5000
Voltage Conditioning	Low	Design Dependent	High
Cost per VA	Low	Medium	Medium
Efficiency	High (typically 95-98%)	High (typically 90-96%)	Low-Medium (typically 80-90%)
Cost	Low	Medium	High
Typical Application Fields	Homes; Small Offices	Small and medium businesses	Telecoms; Communications; Banking; Transportation; Industrial Environments

When considering a UPS solution, be aware of the UPS type and corresponding level of protection. The key difference among online vs offline vs line-interactive UPS lies in their working principles, which reflects in the diversities in their features, functionalities, benefits & limitations. Furthermore, the internal design of the topology of a UPS will further affect how it will operate in various application environments.

UPS Specification:

Power factor (pf) is the difference between actual energy consumed (Watts) and the apparent power (Volts multiplied by Amps) in an AC circuit. It is calculated as a decimal or percentage between 0-1 pf and 0-100% i.e. 0.9 pF = 90%.

The nearer the power factor is to unity (1 pf), the closer the two waveforms are in phase with each other, and the device uses power more efficiently, hence why power factor relates to UPS efficiency.

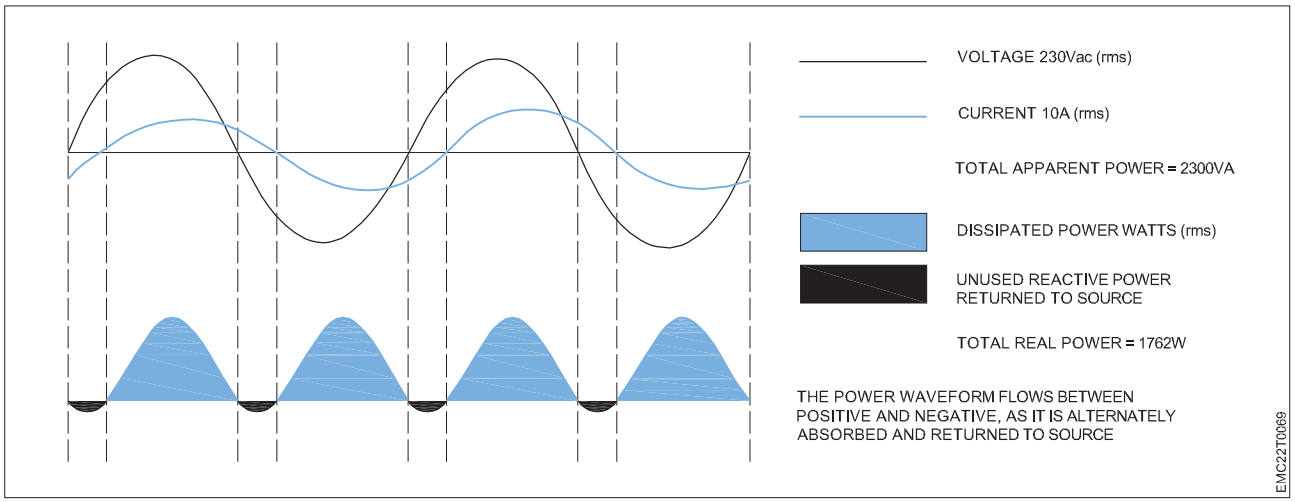


Convention stipulates that inductive loads are defined as positive reactive power, with capacitive loads defined as negative reactive power. But the power factor is never described as positive or negative, it is either lagging or leading.

Lagging Power Factor

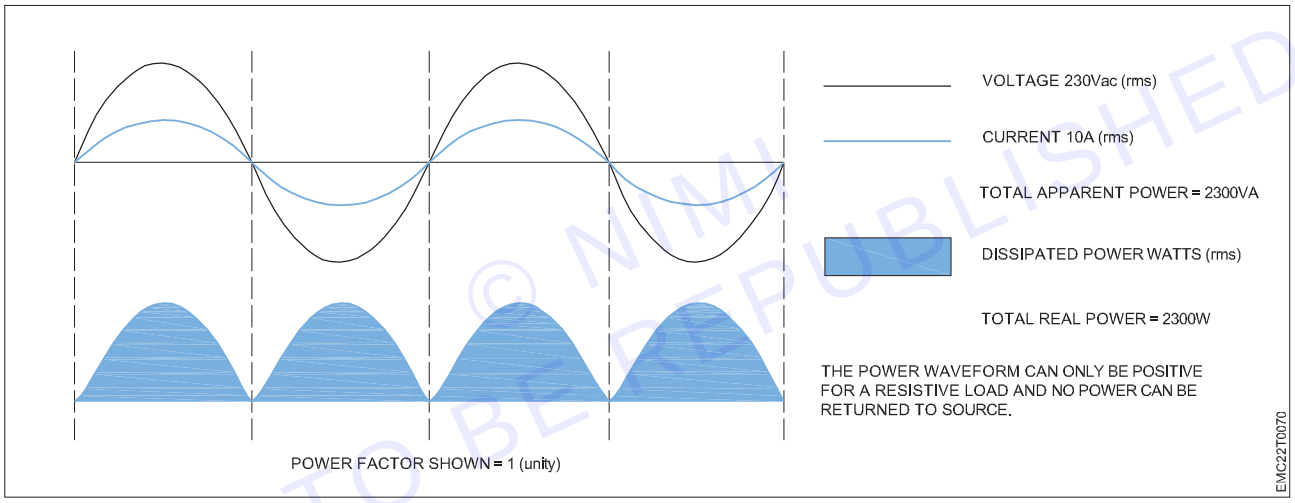
These are loads where the current waveform lags the voltage by a factor equal to the load's reactance, typically between 0.5 and 0.95.

In the below image, a 2300 VA load with a lagging 0.766 pf would have a real power value of 1762 W (1.76 kW).



Unity Power Factor

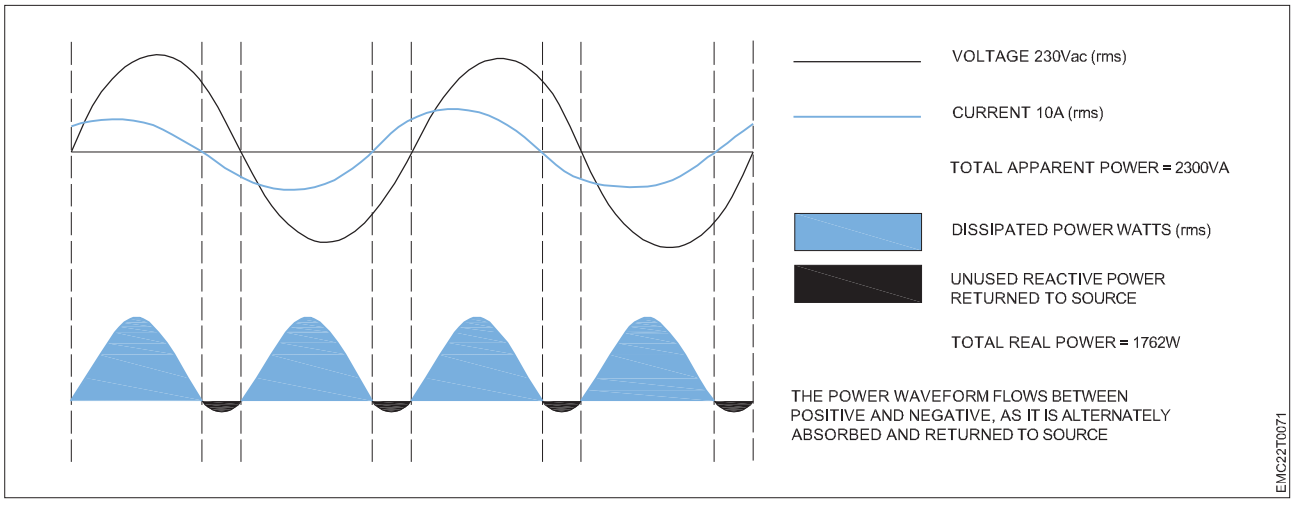
Unity power factor (1 pf) loads have the current and voltage waveforms in phase with each other. In the example below, a 2300 VA load with 1 pf has a real power value of 2300 W (2.3 kW).



Leading Power Factor

Loads with a leading power factor have a current waveform that leads the voltage by a factor equal to the load's reactance, usually between 0.8 and 0.95.

Using the same 2300 VA as in previous examples, a leading power factor of 0.766 has a real power value of 1762 W (1.76 kW).



Symptom	Specification
Rating	600 VA
Input Voltage	150V AC to 275 V AC
Output Voltage	220V AC- Nominal
Protection (input fuse)	Provided
DC Input	12 V
Battery Type	Sealed lead-acid
Battery recharge time	8 hours (up to 90%of full capacity)
Battery Capacity	12V 7AH

Power Range of UPS:

UPS are made in following three power ranges.

Low Power Range – up to 1000 VA

Medium Power Range – up to 10 KVA

High Power Range – above 10 KVA

Selection Of UPS:

When selecting an uninterruptible power system, engineers must consider the following factors that can make or break the success of the system.

Load Size: The Size of the critical load determine the capacity of the initial installation. The UPS must have adequate capacity to reliably serve the critical load and additional loads, without immediate expansion.

Input Voltage: The input voltage available at the site and fluctuations occur generally.

Output Power Range: The total wattage of the load to be connected to the UPS.

Battery Run Time: The battery run time of a UPS is the length of time the UPS can reliably supply power to the critical load after input power has failed. Run time usually is defined as the length of time required for connecting data-processing equipment to save data files and shut down in an orderly fashion, along with a margin of safety. Typically, Battery run time is 15 min. Hence, someone must review the proposed installation to determine if modification is necessary to support the load.

Changeover Period: Changeover period should be less than 1 us for computers.

Indicator Used:

1 **Power on Indicator:** This LED indicates whether the UPS unit is powered on and receiving electricity from an external power source.

2 **Battery Status Indicator:** This LED provides information on the charge level of the UPS's internal battery. It helps users determine whether the battery is fully charged or if it needs to be recharged.

3 **Load Capacity Indicator:** The load capacity indicator helps users gauge the amount of power being drawn from the UPS. It indicates whether the load is within acceptable limits or if it is approaching or exceeding the UPS's capacity.

4 **Fault or Alarm Indicator:** This LED is crucial for identifying any faults or alarms that the UPS has encountered. It can signal issues such as overload, battery failure, or any other problems that require immediate attention.

Protection Required:

UPS components include a rectifier, ups battery, an inverter and a static switch. Within a modern system these are usually set up in an online configuration. This means that during normal operation the incoming mains feeds the rectifier which in turn supplies the inverter with a stable DC voltage as well as float-charging the battery.

If the mains supply transgresses acceptable limits, power to the inverter is provided by the battery until either normal main is restored or the battery is exhausted. As the battery nears exhaustion, the static switch can be used to transfer the load to a bypass supply.

An on-line design offers the greatest degree of critical supply integrity as the load can be always supplied with processed power. The rectifier and inverter block mains borne noise and voltage transients as well as providing a well-regulated output voltage.

For this protection to be valuable, the UPS configuration must offer very high availability and resilience to failure. These attributes can be achieved using modern transformer less technology and the size, weight and energy savings it facilitates.

Precautions:

For UPS battery replacement, only professional electricians are allowed to do so.

Do not burn the battery. It may damage the surroundings.

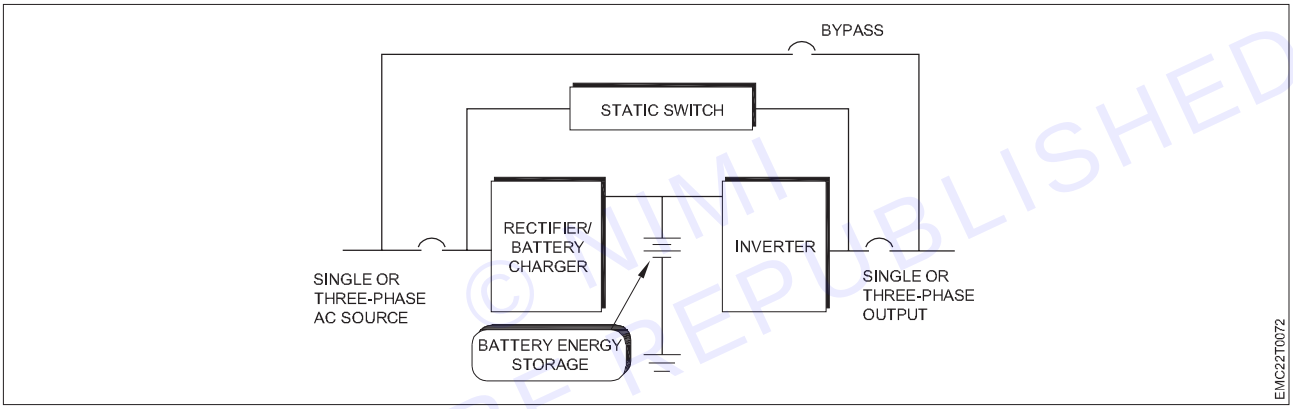
Uninterruptible power supply maintenance should be observed regularly to avoid interruptions and damage while using it.

UPS contains hazardous chemicals inside. ...

UPS should be only installed by qualified electricians.

Avoid placing your UPS in outdoor areas.

UPS CIRCUIT:



UPS Circuit is formed by modifying the inverter circuit. Different Types of circuits can be used by different manufactures, but the basic principle will not change. The following types of sub-circuits are used to form a UPS circuit.

Power Circuit:

Distribution and control circuit of input supply is called power circuit. The input supply is usually 230 V, 50 HZ single phase AC (in India).

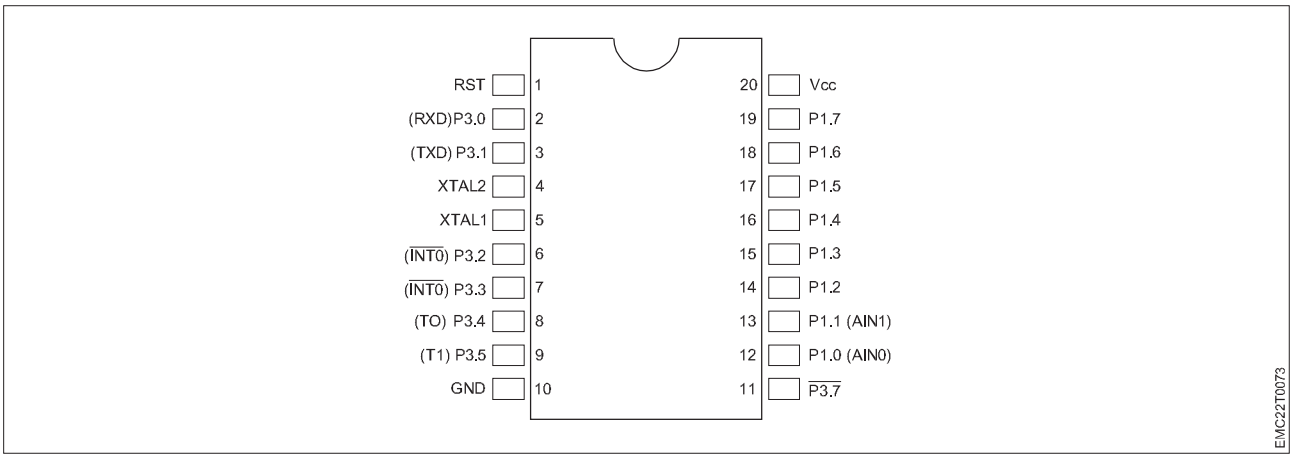
Generally, this supply voltage fluctuates between 210V to 250v. Therefore, a voltage stabilizer circuit is incorporated in UPS. This circuit provides 230v AC output. This stabilizer voltage is supplied to the computer monitor, etc.

Inverter Circuit:

Inverter circuit is used to prepare 230V AC from 12V battery. For this purpose, some devices such as battery charging circuit, overcharging protection circuit, low battery indicator and changeover devices are incorporated in inverter circuit.

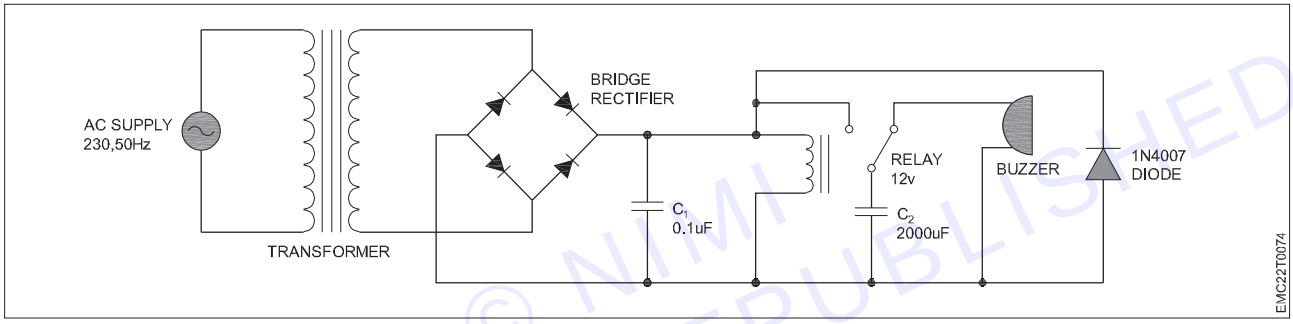
2051 Microcontroller:

The 2051 is a 20 Pin version of the 8051 MC. It is a low voltage, high performance CMOS- 8-bit Microcomputer with 2K bytes of flash programmable and erasable read-only memory. It provides a very flexible, cost-effective solution to many embedded control applications. The Pin layout of 2051 Mc is shown below.



Power Supply Failure and Alarm Circuit:

UPS starts supplying the power to the system when the main power supply i.e., 230 V AC fails. Red LED and an alarm are used to indicate the power supply failure. A simple circuit for this purpose is shown in the figure.

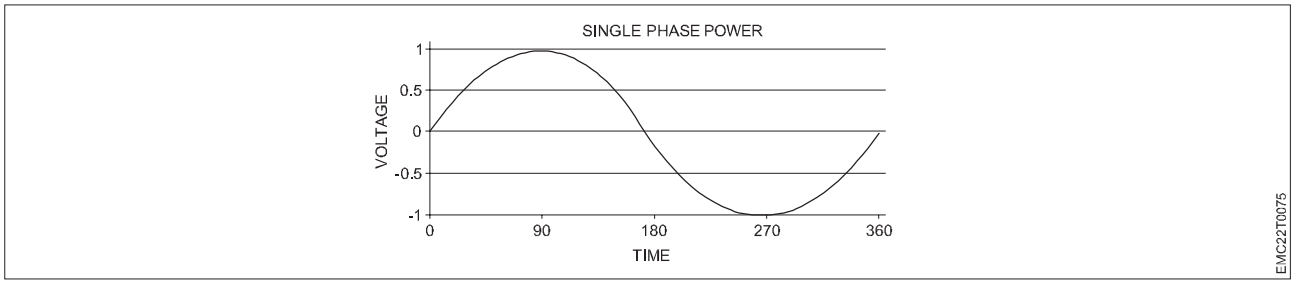


The alarm may sound continuously or at time intervals of 10 to 20s. The above circuit is based on AC 230 V, 50 Hz operated relay. When the main supply is present, the common terminal of the relay rests connected with NO (Normally Open) terminal, thus rendering the LED's Circuit disconnected.

When the main supply fails, the relay gets connected with NC (Normally Closed) terminal. Thus, the battery circuit becomes complete, the red LED starts to glow and the buzzer (or alarm) starts to produce sound. As and when the main supply is restored, the relay gets energized and peaks the circuit of LED and buzzer.

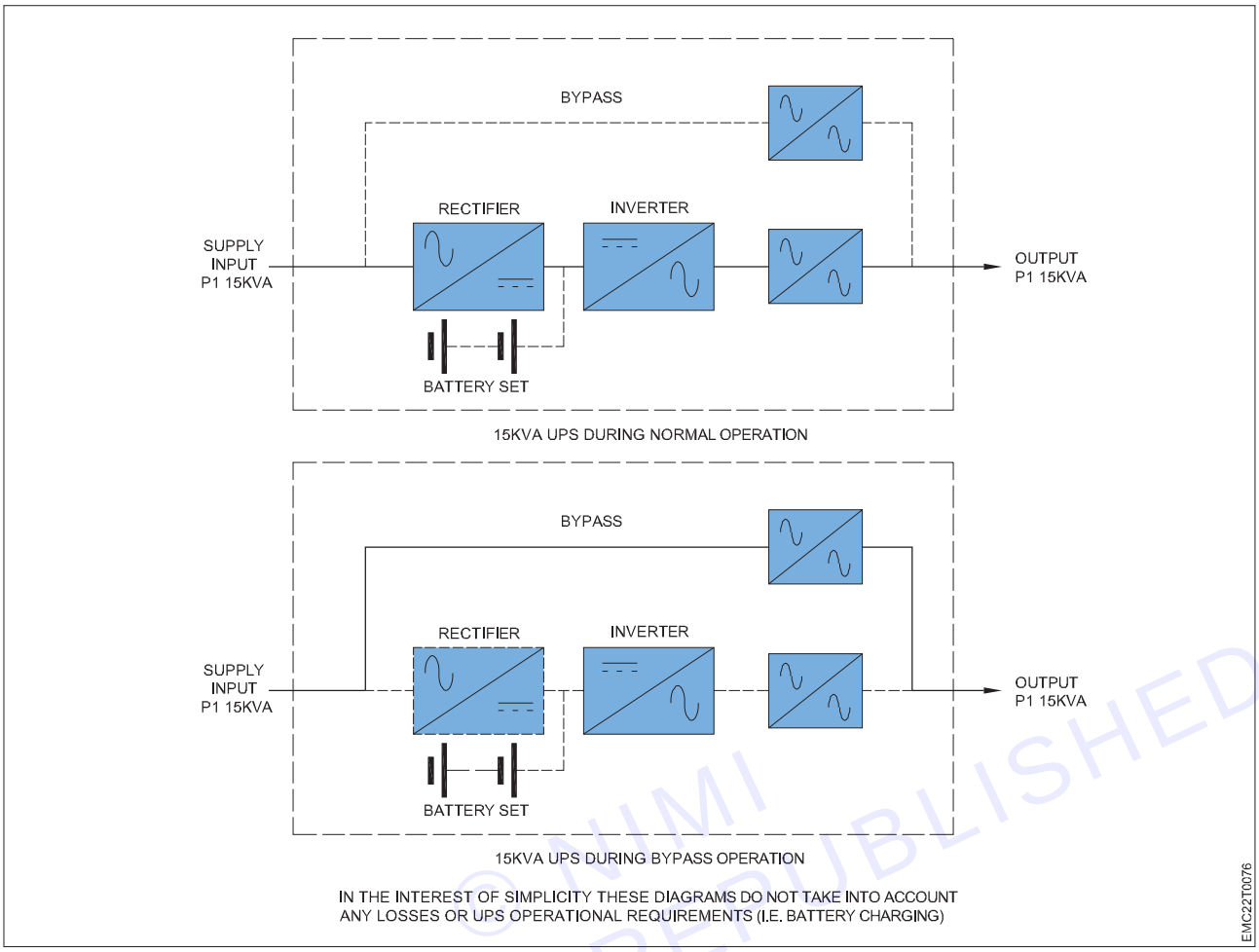
Single Phase UPS:

Single phase is commonly called "residential voltage" because it is widely available in homes. For example, the microwave oven, the coffee machine, your PC in your household can be single phase devices. In different regions there is a similarity for single phase connections: It requires two wires (one voltage wire and one neutral wire) for completing the circuit. The figure below shows the current flow in single phase AC power.



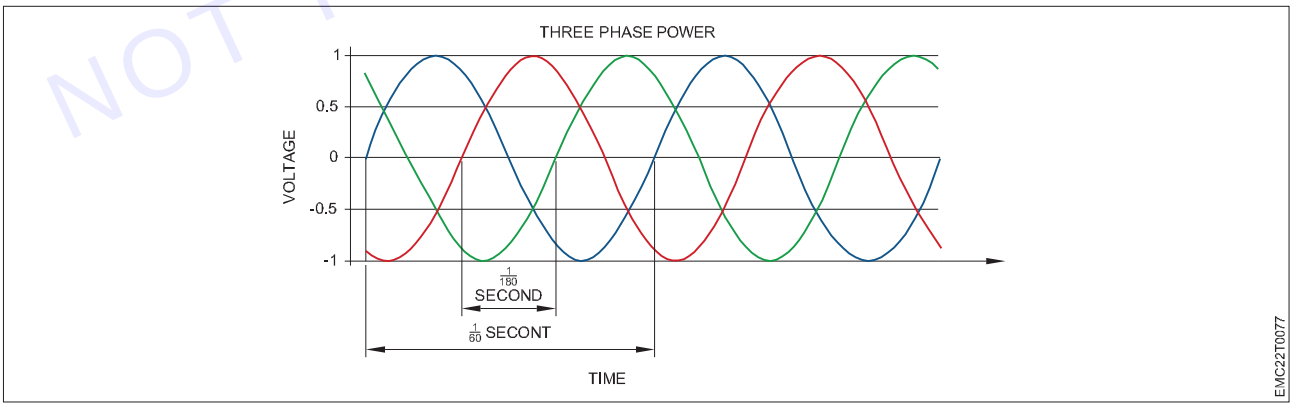
Single-phase UPS have a single input and output source for the electrical equipment. With just one sinewave voltage, it only requires two wires to complete the circuit, one conductor and one neutral.

Single-phase uninterruptible power supplies typically cover requirements up to 20 kVA and are used for smaller installations such as rack-mounted servers, telecoms or computer systems, and network switches, along with any device that runs directly from a standard three-pin plug



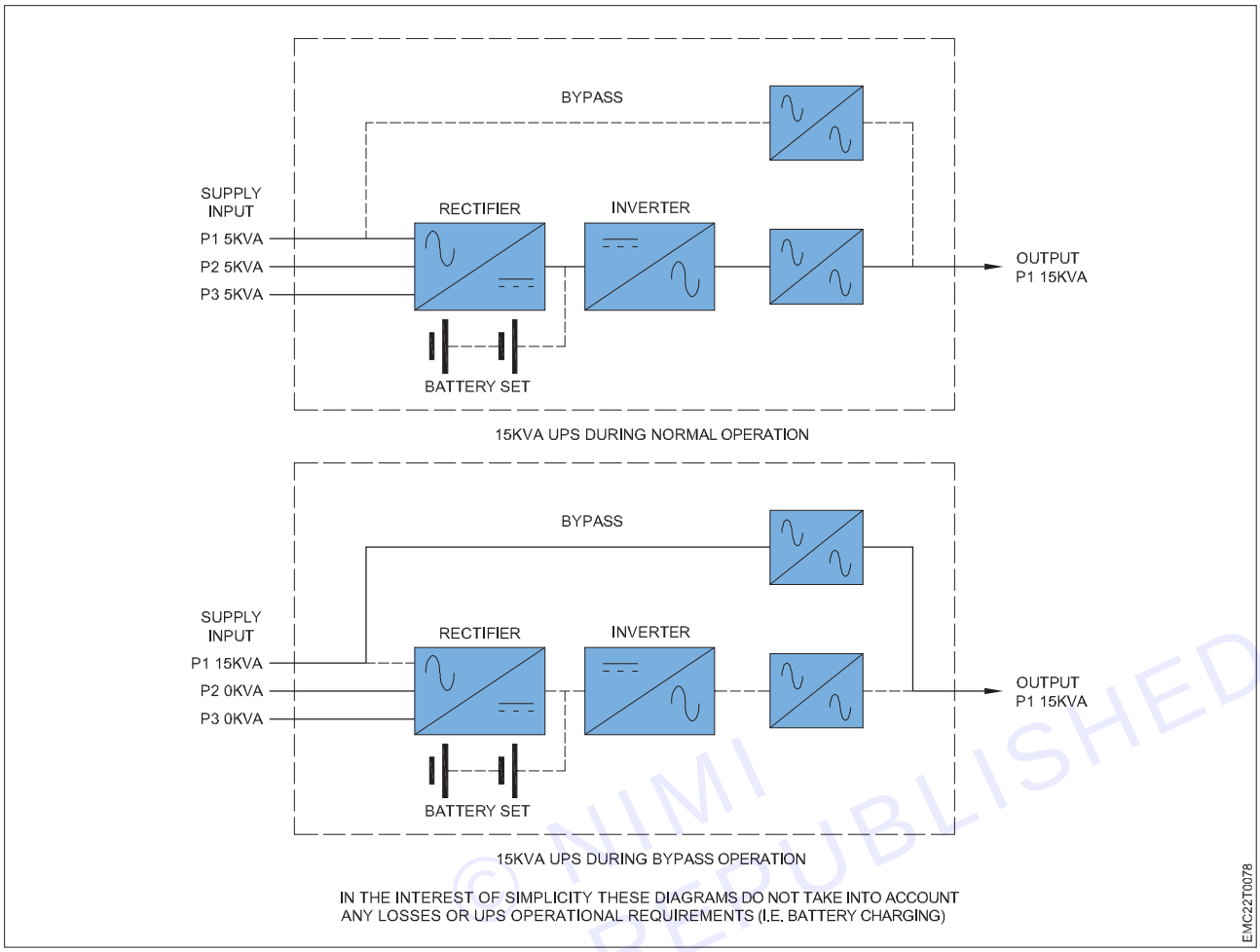
Three Phase UPS:

Three phase power contains either 3 live wires or 4 wires (3 phase wires and a neutral one), providing three alternating currents, separated in phase angle. The total loads are shared by the three wires. Most commercial buildings in North America use three-phase, four-wire power setups.



Three-phase UPS uses three separate conductors providing three sinewaves, each out of phase and spaced 120° apart from each other, to provide continuous power to the load. This means a three-phase system needs a minimum of four wires (three conductors plus one neutral), which enables it to support a single-phase or three-phase output.

Three-phase UPS are the standard choice for larger installations with critical loads such as data centres, industrial applications, and medical environments, as well as protecting equipment with motors such as lifts, pumps, and fans.



Single-phase may also be referred to as 1 phase or 1-phase, while three-phase is known as 3 phase or 3-phase.

For UPS systems, it is common to refer to a single-phase UPS by just its kVA/kW rating i.e. 10 kVA. With three-phase systems, the KVW /kW rating is accompanied by the number of output phases i.e. 20 kVA (3:1) or 200 kVA (3:3).

MODULE 6 : Internet of Things and Its Applications

LESSON 64-68 : Internet of things (IOT)

Objectives

At the end of this lesson you shall be able to:

- introduction about IOT
- state about history, components, role, characteristics, of IOT
- explain about future of IOT
- explain about functions and advantages of IOT.

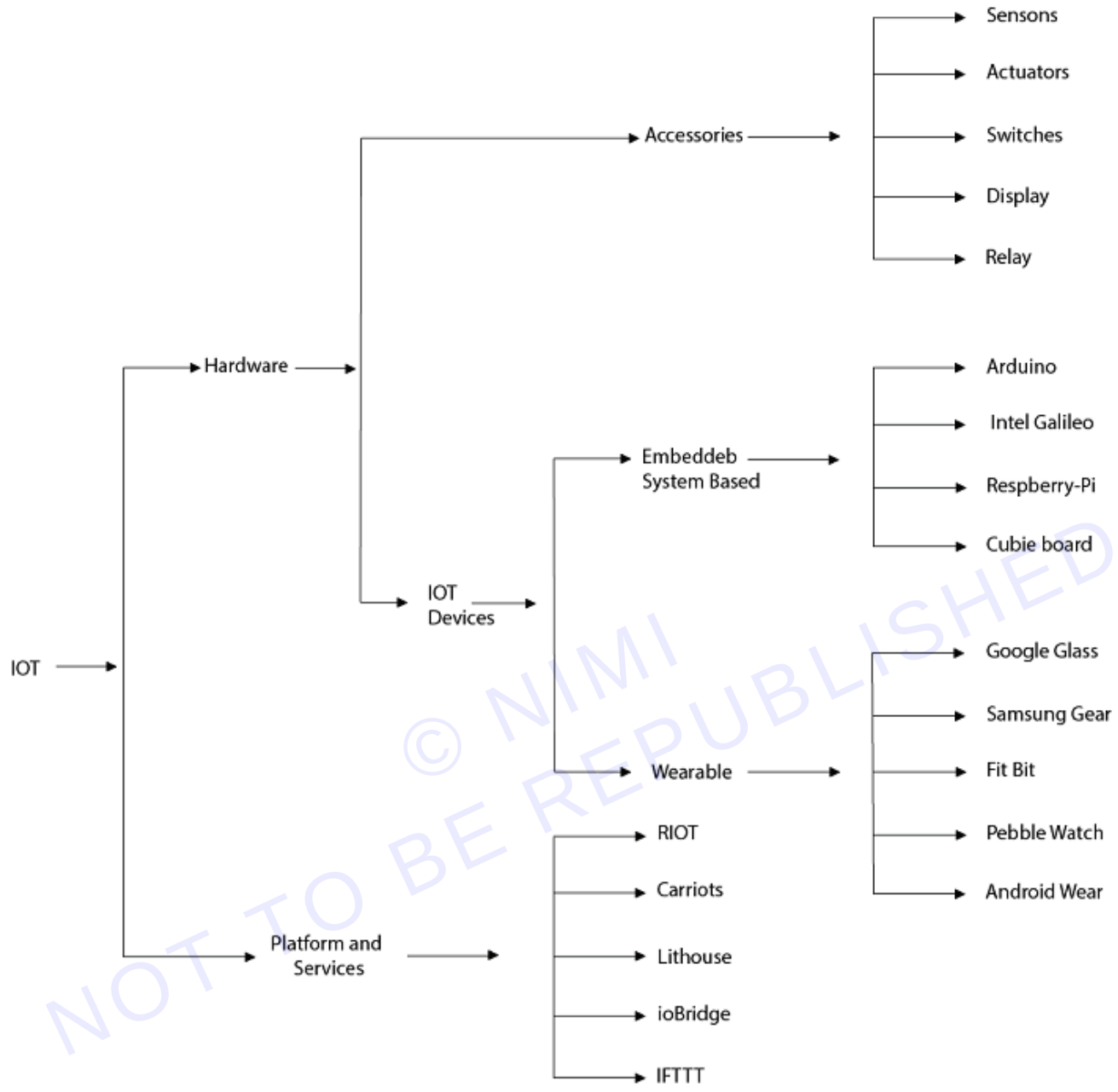
Internet of Things (IoT) is the networking of physical objects that contain electronics embedded within their architecture to communicate and sense interactions amongst each other or with respect to the external environment. In the upcoming years, IoT-based technology will offer advanced levels of services and practically change the way people lead their daily lives. Advancements in medicine, power, gene therapies, agriculture, smart cities, and smart homes are just a few of the categorical examples where IoT is strongly established.

Internet of Things Devices are non-standard devices that connect wirelessly to a network with each other and can transfer the data. IoT devices are enlarging the internet connectivity beyond standard devices such as smartphones, laptops, tablets, and desktops. Embedding these devices with technology enables us to communicate and interact over the networks and they can be remotely monitored and controlled.

There are large varieties of IoT devices available based on IEEE 802.15.4 standard. These devices range from wireless motes, attachable sensor-boards to interface-boards which are useful for researchers and developers.

IoT devices include computer devices, software, wireless sensors, and actuators. These IoT devices are connected over the internet and enable the data transfer among objects or people automatically without human intervention.

Some of the common and popular IoT devices are given below:



IoT Devices and Technologies

IOT is a system of interrelated things, computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers. And the ability to transfer data over a network requiring human-to-human or human-to-computer interaction.

History of IOT:

Here you will get to know about how IOT is involved and from the explanation of each will let you know how IOT plays a role in these innovations!

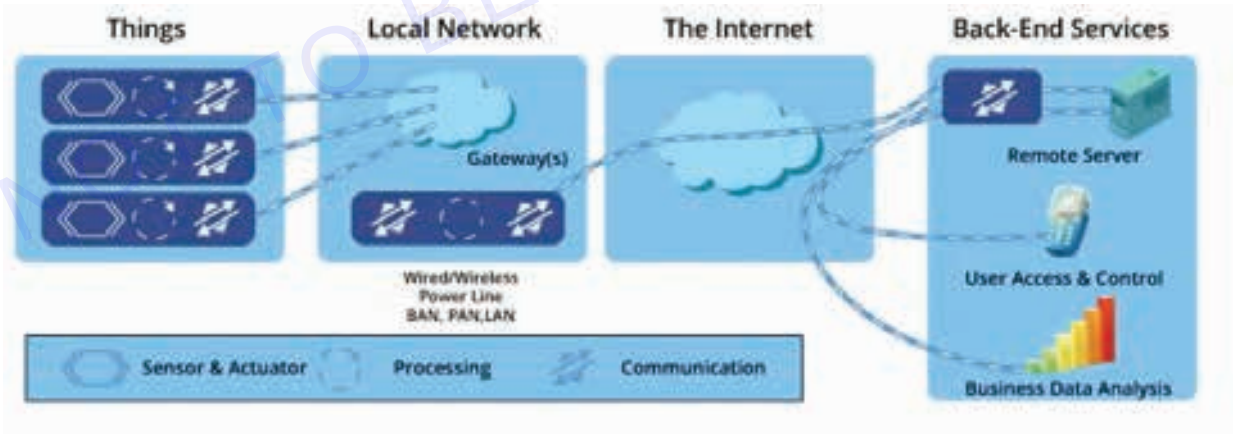
- 1982 – Vending machine: The first glimpse of IoT emerged as a vending machine at Carnegie Mellon University was connected to the internet to report its inventory and status, paving the way for remote monitoring.
- 1990 – Toaster: Early IoT innovation saw a toaster connected to the internet, allowing users to control it remotely, foreshadowing the convenience of smart home devices.

- 1999 – IoT Coined (Kevin Ashton): Kevin Ashton coined the term “Internet of Things” to describe the interconnected network of devices communicating and sharing data, laying the foundation for a new era of connectivity.
- 2000 – LG Smart Fridge: The LG Smart Fridge marked a breakthrough, enabling users to check and manage refrigerator contents remotely, showcasing the potential of IoT in daily life.
- 2004 – Smart Watch: The advent of smartwatches introduced IoT to the wearable tech realm, offering fitness tracking and notifications on-the-go.
- 2007 – Smart iPhone: Apple’s iPhone became a game-changer, integrating IoT capabilities with apps that connected users to a myriad of services and devices, transforming smartphones into hubs.
- 2009 – Car Testing: IoT entered the automotive industry, enhancing vehicles with sensors for real-time diagnostics, performance monitoring, and remote testing.
- 2011 – Smart TV: The introduction of Smart TVs brought IoT to the living room, enabling internet connectivity for streaming, app usage, and interactive content.
- 2013 – Google Lens: Google Lens showcased IoT’s potential in image recognition, allowing smartphones to provide information about objects in the physical world.
- 2014 – Echo: Amazon’s Echo, equipped with the virtual assistant Alexa, demonstrated the power of voice-activated IoT, making smart homes more intuitive and responsive.
- 2015 – Tesla Autopilot: Tesla’s Autopilot system exemplified IoT in automobiles, introducing semi-autonomous driving capabilities through interconnected sensors and software.

How does IoT work?

Internet of Things is a combination of smart electronic devices, local area networks, the Internet, cloud servers, and the user application. An IoT device connects through a local network. Then, it transmits information through the Internet to the cloud servers. Further, the cloud servers provide the data or information of the end-user application to the IoT device. This transfer of information is a two-way communication that helps operate the IoT system.

An IoT system consists of four major components as shown in the below image:



- **IoT Devices:** They are smart electronic gadgets that consist of wireless sensors that help in transferring data over the Internet.
- **Local Network:** It helps in accessing the data from the devices connected to the Internet.
- **The Internet:** It helps the devices connect with the user applications and servers.
- **Back-end Services:** They consist of a remote server, user access and control, and mobile applications. These services constantly help in exchanging streamed data from various IoT devices and end-user applications.

Four Key Components of IOT

- Device or sensor
- Connectivity
- Data processing
- Interface

IoT is a network of interconnected computing devices which are embedded in everyday objects, enabling them to send and receive data.

Over 9 billion 'Things' (physical objects) are currently connected to the Internet, as of now. Soon, this number is expected to rise to a whopping 20 billion.

Main Components Used in IoT

- **Low-power embedded systems:** Less battery consumption, high performance are the inverse factors that play a significant role during the design of electronic systems.
- **Sensors:** Sensors are a major part of any IoT application. It is a physical device that measures and detects certain physical quantities and converts it into signal which can be provided as an input to processing or control unit for analysis purposes.

Smart Street Light

Smart street light systems using IoT technology are the next generation of street lighting systems that offer improved energy efficiency, reduced costs, and better control and management of street lighting. The basic concept of a smart street light system is to incorporate sensors, wireless communication, and intelligent controllers into the street light infrastructure. These smart lights can be programmed to automatically turn on and off based on the surrounding light levels, as well as other factors like pedestrian and vehicular traffic. Additionally, they can be remotely monitored and controlled using IoT technology. IoT technology allows smart street light systems to gather data and feedback on energy consumption, maintenance needs, and other important factors. This data can then be used to optimize the system, improve energy efficiency, and reduce costs.Street lighting is a particularly critical concern for public authorities in developing countries because of its strategic importance for economic and social stability. Inefficient lighting wastes significant financial resources every year, and poor lighting creates unsafe conditions. Energy efficient technologies and design mechanisms can reduce the cost of street lighting drastically. Manual control is prone to errors and leads to energy wastage's and manually dimming during mid-night is impracticable. Also, dynamically tracking the light level is manually impracticable. The current trend is the introduction of automation and remote management solutions to control streetlighting

Smart Water Management Systems

The concept of water management presupposes the implementation of a complex of measures for controlling water quality and organizing the efficient use of water resources. A smart water management system is based on the combination of IoT, AI, and big data technologies that help achieve the set goals by gathering and processing real-time data related to water distribution.

A smart water management system is typically built to cover such processes and activities as developing, planning, and monitoring the use of water resources in various sectors, including manufacturing, farming, agriculture, urban infrastructure, etc.

Thanks to such solutions, farmers, businesses, and utility operators have the possibility to measure, evaluate, and track not only the way water is distributed but also the water quality. As a result, such monitoring can also help to timely detect water pollution and address tech issues that can lead to water waste.

How does a water management system work?

Smart water management has become possible to a greater extent thanks to progress in the IoT (Internet of Things) sphere. Water monitoring is performed with the help of multiple sensors and microcontrollers, including but not limited to flow, ultrasonic, salinity, temperature, conductivity, pressure, humidity, and luminosity sensors. These devices should be installed on pumps and pipes for measuring various parameters that can provide valuable insights into water quality, water distribution, water pollution, and other important aspects.

For example, by getting the most relevant information about water levels and flow, authorities can be able to efficiently react to any dangerous changes detected.

All the data gathered by sensors and any message alerts generated by them are further transmitted to a cloud server over the Internet. On the server, the data should be processed and analyzed. Today, quite often developers apply AI tools that can detect patterns in the accumulated data, define any deviations from the norm, as well as make accurate predictions. After that, the processed data becomes available to employees of the relevant authorities or companies.

Embedded System in IoT

Embedded systems are specialized computer systems designed to perform specific functions within a larger system. They are tightly integrated into a host device or product and are responsible for controlling its operation and providing the desired functionality. Unlike general-purpose computers, which are designed to handle a wide range of tasks, embedded systems are tailored to perform dedicated functions efficiently and reliably.

Embedded systems consist of a combination of hardware and software components carefully designed to work together. The hardware components typically include microcontrollers or microprocessors, memory units, input/output peripherals, and interfaces. These components are chosen based on the specific requirements of the system, such as processing power, memory capacity, and communication capabilities.

Role of Embedded Systems in IoT:

Embedded systems play a crucial role in the success and functionality of the Internet of Things (IoT). They are the backbone of IoT devices, enabling them to connect, communicate, and perform intelligent actions. The integration of embedded systems in IoT opens up a world of possibilities, transforming everyday objects into smart devices with advanced functionality.

One of the main roles of embedded systems in IoT is to collect data from various sensors and input devices. They continuously monitor the environment, capturing information such as temperature, humidity, motion, light, and more. This data is then processed and analyzed in real-time by the embedded system, enabling the device to make intelligent decisions based on the gathered information.

Embedded systems also act as the control center of IoT devices, executing specific actions based on predefined algorithms and logic. For example, in a smart home system, the embedded system may receive data from motion sensors and adjust the temperature setting accordingly or activate security measures in response to suspicious activities.

The integration of embedded systems in IoT devices facilitates seamless communication and connectivity. They enable devices to exchange data with each other, forming complex networks that allow for increased automation and coordination. Embedded systems utilize communication protocols such as Wi-Fi, Bluetooth, Zigbee, or cellular networks to establish connections and interact with other IoT devices, cloud platforms, or user interfaces.

Embedded systems also play a vital role in enhancing the energy efficiency of IoT devices. They implement power-saving algorithms and techniques to optimize energy consumption and prolong battery life. For example, an embedded system in a smart lighting system can adjust the brightness or turn off lights when no one is present, thereby conserving energy.

Moreover, embedded systems in IoT devices enable remote monitoring and control. They allow users to access and manage their devices from anywhere using smartphones, tablets, or computers. This remote accessibility provides convenience and enables real-time monitoring, control, and data analysis, enhancing the overall user experience.

The integration of embedded systems in IoT devices has opened up countless possibilities for enhancing various sectors such as healthcare, transportation, agriculture, industrial automation, and more. In healthcare, embedded systems enable remote patient monitoring, medication adherence tracking, and personalized healthcare services. In transportation, embedded systems power smart navigation systems, vehicle-to-vehicle communication, and autonomous driving features. In agriculture, embedded systems assist in precision farming, enabling efficient water usage, pest control, and crop yield optimization.

The role of embedded systems in IoT is evolving rapidly, and as technology advances, we can expect to see even more innovative applications and use cases. The seamless integration of physical devices with embedded systems, connectivity, and intelligent functionalities paves the way for a smarter and more interconnected world.

Characteristics of Embedded Systems in IoT:

Embedded systems in IoT devices possess distinct characteristics that make them well-suited for the challenges of the interconnected environment. These characteristics enable them to handle the diverse requirements of IoT applications, ensuring seamless integration, efficient communication, and intelligent decision-making. Some of the key characteristics of embedded systems in IoT include:

- **Real-time processing:** Embedded systems in IoT devices often require real-time processing capabilities to respond promptly to events or changes in the environment. Real-time processing ensures that critical tasks are executed within strict time constraints, enabling timely and accurate decision-making. This characteristic is vital in applications such as industrial automation, healthcare monitoring, and autonomous vehicles.
- **Power efficiency:** IoT devices are often constrained by limited power sources, such as batteries or energy harvesting technologies. Embedded systems in IoT devices are designed to be power-efficient, optimizing energy consumption and maximizing battery life. Power-saving techniques such as sleep modes, dynamic frequency scaling, and efficient power management algorithms are implemented to ensure energy-efficient operation, enabling devices to operate for extended periods without frequent charging or battery replacements.
- **Small form factor:** Embedded systems in IoT devices are typically compact and designed to have a small form factor. This enables them to be seamlessly integrated into various devices, ensuring minimal space requirements. The small form factor is particularly important in wearable devices, smart home appliances, and other applications where size is a critical factor.
- **Robustness:** IoT devices can be exposed to harsh environmental conditions such as extreme temperatures, humidity, vibrations, or physical impacts. Embedded systems in IoT devices are designed to be robust, capable of withstanding these challenging conditions. Robustness ensures the reliable operation of the devices, even in demanding environments such as industrial settings or outdoor applications.
- **Interoperability:** Embedded systems in IoT devices are designed to enable seamless connectivity and interoperability. They incorporate various communication protocols and standards to ensure compatibility with other devices and systems. This characteristic allows IoT devices to exchange data and collaborate with each other, facilitating the creation of interconnected ecosystems and enabling cross-platform integration.
- **Security:** Security is a critical aspect of IoT devices, as they often handle sensitive data and operate within interconnected networks. Embedded systems in IoT devices employ various security measures to protect data and ensure secure communication. This may include encryption, authentication mechanisms, secure firmware updates, and secure boot processes, among others. Robust security measures are essential to safeguard the privacy and integrity of the data transmitted and stored within IoT devices.

These characteristics enable embedded systems in IoT devices to meet the unique challenges of the interconnected world. Real-time processing capabilities ensure timely responses and decision-making, power efficiency enables long battery life, small form factor allows for seamless integration, robustness ensures reliable operation in harsh environments, interoperability facilitates seamless connectivity, and security measures protect against potential threats and vulnerabilities.

By possessing these characteristics, embedded systems in IoT devices empower the creation of smart, connected devices that can seamlessly interact with each other and the external world. They are the driving force behind the intelligence, functionality, and connectivity of IoT applications in various domains.

Examples of Embedded Systems in IoT

Embedded systems play a key role in the implementation of IoT solutions across a wide range of industries and applications. Let's explore some examples of how embedded systems are used in IoT:

1 **Smart Home Automation:** Embedded systems are at the heart of smart home automation systems. They control and monitor various devices such as lighting, thermostats, security cameras, and home appliances. Embedded systems collect data from sensors, process it, and make decisions to optimize energy usage, enhance security, and enable seamless control and monitoring of the smart home.

2 **Industrial Automation:** Embedded systems in IoT enable intelligent automation in industrial settings. They connect machines, devices, and systems to gather real-time data and insights for efficient operation, predictive maintenance, and optimization of production processes. Embedded systems monitor machine health, analyze performance metrics, and trigger automated actions to enhance productivity, reduce downtime, and minimize errors.

3 **Healthcare Monitoring:** Embedded systems in IoT devices revolutionize healthcare monitoring. They enable the collection and analysis of patient data in real-time, whether it's through wearable devices, smart medical devices, or remote monitoring systems. Embedded systems track vital signs, measure activity levels, and transmit data to healthcare professionals for continuous monitoring, early detection of health issues, and personalized healthcare management.

4 **Smart Agriculture:** Embedded systems make agriculture more efficient and sustainable. They enable precision farming techniques by collecting data on soil moisture levels, temperature, humidity, and other factors. This data is analyzed to optimize irrigation, automate pest control, and regulate the use of fertilizers. Embedded systems also enable remote monitoring of crops and livestock, ensuring their well-being and maximizing yield.

5 **Connected Vehicles:** Embedded systems in IoT enable smart and connected vehicles. They control and monitor various aspects of the vehicle's operation, including engine performance, navigation, entertainment, and safety features. Embedded systems collect data from various sensors, enabling vehicle-to-vehicle (V2V) communication, real-time traffic updates, and autonomous driving capabilities. They provide a seamless and connected user experience while improving safety and efficiency on the road.

6 **Smart Energy Management:** Embedded systems in IoT devices track and manage energy consumption in residential, commercial, and industrial settings. They intelligently monitor power usage, provide real-time energy insights, and dynamically adjust energy consumption based on demand and availability. Embedded systems enable energy optimization, load balancing, and integration of renewable energy sources, contributing to a more sustainable and efficient energy ecosystem.

7 **Public Infrastructure Monitoring:** Embedded systems in IoT devices play a critical role in monitoring and managing public infrastructure. They track and analyze data from sensors embedded in bridges, roads, buildings, and other structures to detect and assess potential issues. Embedded systems enable real-time monitoring of structural integrity, vibration levels, and environmental conditions. This information helps in preventive maintenance, ensuring the safety and reliability of public infrastructure.

These examples illustrate the versatility and impact of embedded systems in IoT across various domains. Embedded systems enable intelligent automation, real-time monitoring, data analysis, and decision-making in diverse applications, bringing digital connectivity and enhanced functionality to everyday objects.

Challenges in Embedded Systems for IoT

The development and implementation of embedded systems in IoT devices come with various challenges. These challenges need to be addressed to ensure the seamless integration, reliability, and efficiency of these systems. Some of the key challenges in developing embedded systems for IoT include:

1 **Resource Constraints:** Embedded systems in IoT devices often operate with limited resources such as memory, processing power, and energy. Developers need to optimize resource usage, efficiently manage memory, and implement power-saving techniques to ensure optimal performance within resource-constrained environments.

2 **Interoperability:** Interoperability is crucial in the interconnected world of IoT. Embedded systems must be able to communicate and interact effectively with other devices, platforms, and protocols. Developers need to address interoperability challenges by implementing standardized communication protocols, ensuring compatibility, and embracing open standards to enable seamless connectivity and data exchange.

3 **Security and Privacy:** Security is a major concern in IoT, as embedded systems often handle sensitive data and operate within interconnected networks. Developers need to implement robust security measures to protect against unauthorized access, data breaches, and privacy violations. This includes encryption, authentication mechanisms, secure firmware updates, and regular vulnerability assessments to ensure the integrity and confidentiality of data.

4 **Real-time Processing:** Many IoT applications require real-time processing capabilities, where embedded systems must respond to events within strict time constraints. Developers need to design embedded systems with efficient real-time scheduling algorithms, task prioritization, and event-driven architectures to ensure timely and accurate processing of critical tasks and events.

5 **Scalability and Flexibility:** IoT environments are often characterized by a large number of interconnected devices and rapidly changing requirements. Embedded systems need to be scalable and flexible, capable of accommodating growth and adapting to evolving needs. Developers should design systems that can

handle increased data volume, support firmware updates, and integrate new features seamlessly without compromising performance or usability.

6 **Reliability and Fault Tolerance:** Embedded systems in critical IoT applications such as healthcare, transportation, or industrial automation need to be highly reliable and fault-tolerant. Developers need to implement mechanisms for error detection, recovery, and fault tolerance to ensure continuous operation, minimize downtime, and prevent system failures that could have potentially serious consequences.

7 **Testing and Validation:** Testing embedded systems in IoT devices can be challenging due to the complexity and interconnected nature of these systems. Developers need to design comprehensive testing strategies that cover functional testing, performance testing, security testing, and interoperability testing. Rigorous testing and validation processes are crucial to ensure the resilience and reliability of embedded systems in real-world IoT environments.

Future Scope of IoT

Internet of Things has emerged as a leading technology around the world. It has gained a lot of popularity in lesser time. Also, the advancements in Artificial Intelligence and Machine Learning have made the automation of IoT devices easy. Basically, AI and ML programs are combined with IoT devices to give them proper automation. Due to this, IoT has also expanded its area of application in various sectors. Here, in this section, we will discuss the applications and the future scope of IoT in healthcare, automotive, and agriculture industries.

Healthcare

In this section, we will see the future of IoT in healthcare sector. IoT has proved to be one of the best tools for the healthcare industry. It helps provide advanced healthcare facilities to patients, doctors, and researchers. These facilities include smart diagnosis, wearable devices for tracking health, patient management, and many more. Furthermore, IoT devices have reduced unnecessary strain on the healthcare system.

The healthcare devices can directly send the patients' data health to doctors over a safe network. This allows the doctors to diagnose the patients from remote locations.

Reasons for IoT being beneficial in the healthcare industry are as follows:

1 Error reduction in treatments

With the help of IoT devices, there is a decrease in manual errors in diagnosing patients. Thus, patients can get proper treatment on time. Also, the 24/7 diagnosis through gadgets gives a more clear idea about patients' health when compared to manual diagnosis.

2 Decrease in the cost of treatments

Manual diagnosis requires time and the use of various types of costly equipment, along with other hospital charges. Due to this, the overall cost of the treatment increases. We can reduce these costs by using IoT gadgets. Also, the hospital charges and congestion in hospitals can be reduced as patients can be diagnosed from their respective locations.

3 Availability of specialists in remote locations

Internet of Things solves one of the major problems of the healthcare industry that is the availability of doctors, especially specialists, in remote locations. With the help of IoT devices, the treatment of patients in the physical absence of doctors has become possible. The patients just need to wear the device. Then, the device will send all the real-time data of patients' health to the respective doctors for analyzing the condition. In this way, the scope of Internet of Things is helping the healthcare sector give proper treatment to the needy.

Agriculture

One of the three basic human needs is food. To fulfill the need for food, we do farming. However, now, as the population of the world is increasing, the agricultural industry is facing many challenges. Also, changes in weather conditions and climate hugely impact the agricultural industry. To meet the rising demand for food, the industry has hence adopted technology to increase productivity. It includes the use of precision farming, agricultural drones, and smart farming applications.

All these are built on top of the application of Internet of Things. Now, let us discuss how precision farming, smart farming applications, and agricultural drones help in increasing the productivity of the land.

Precision farming

In agriculture, Information and Communication Technology is a tool used for smart farming. With the help of IoT-based devices, crop fields are observed. The technology uses sensors to calculate the moisture of soil, humidity, and temperature. Also, it uses an automated irrigation system to make efficient use of water. Precision farming helps farmers monitor their fields and boost productivity.

Agricultural drones

Drones used for agriculture and farming are one of the best applications of Internet of Things. They are used to enhance agricultural processes. We use agricultural drones for planting crops, irrigating fields, spraying of pesticides, and monitoring the fields. With the help of drones, it becomes easier to evaluate the health of crops. This is all possible with the help of smart IoT-based devices that are used to make agricultural drones.

Smart greenhouses

Farmers use greenhouse farming to enhance the productivity of crops. In greenhouse farming, the environmental factors that affect the growth of crops are controlled by manual intervention. However, manually controlling the mechanism for the growth of crops is less productive. The emergence of IoT and technological advancements has led to the creation of IoT-based greenhouses that consist of various devices such as sensors, climate controllers, etc.

These IoT devices help in measuring the various environmental conditions according to the requirements of plants. As all sensors and devices connect over the Internet servers, they provide accurate information on the environmental conditions. Then, the devices activate actuators to control heaters, fans, windows, and lighting of greenhouses to set according to the environment.

This is how the scope of IoT is enhancing the productivity of the agricultural industry.

Automotive Industry

In the 21st century, the application of IoT is revolutionizing the automotive industry. One of the major applications is the creation of self-driving cars that has changed the trends of the automotive industry. Engineers have created self-driving cars to reduce manual errors and ensure a safe drive. Various companies around the world are creating self-driving vehicles including Google, Tesla, Mercedes-Benz, Volvo, Audi, and many more. These self-driving cars use various technologies such as Data Science, Artificial Intelligence, Deep Learning, and IoT. IoT devices are programmed in such a way that they assist in creating an automated system for self-driving cars.

These IoT devices consist of HD cameras, thermal sensors, smart navigators, speed controller, rain sensors, wireless connectivity, and proximity sensors. While using these cars, you need to enter your location and the destination. Then, the navigator helps locate the destination and tries to find the shortest path. After that, the IoT-based HD cameras help in getting the visuals of the surrounding and send the data to the AI-based systems. These systems analyze and visualize the data of the surrounding and accordingly fix the response of the self-driving cars. Also, there are IoT-based speed controllers that help regulate the speed of these cars according to the traffic and congestion. This is how the scope of IoT is changing the trends in the automotive industry.

Smarts Objects in IoT

The concept of smart in IoT is used for physical objects that are active, digital, networked, can operate to some extent autonomously, reconfigurable and has local control of the resources. The smart objects need energy, data storage, etc.

A smart object is an object that enhances the interaction with other smart objects as well as with people also. The world of IoT is the network of interconnected heterogeneous objects (such as smart devices, smart objects, sensors, actuators, RFID, embedded computers, etc.) uniquely addressable and based on standard communication protocols.

In a day to day life, people have a lot of object with internet or wireless or wired connection. Such as:

- Smartphone
- Tablets
- TV computer

These objects can be interconnected among them and facilitate our daily life (smart home, smart cities) no matter the situation, localization, accessibility to a sensor, size, scenario or the risk of danger.

Smart objects are utilized widely to transform the physical environment around us to a digital world using the Internet of things (IoT) technologies.

A smart object carries blocks of application logic that make sense for their local situation and interact with human users. A smart object sense, log, and interpret the occurrence within themselves and the environment, and intercommunicate with each other and exchange information with people.

The work of smart object has focused on technical aspects (such as software infrastructure, hardware platforms, etc.) and application scenarios. Application areas range from supply-chain management and enterprise applications (home and hospital) to healthcare and industrial workplace support. As for human interface aspects of smart-object technologies are just beginning to receive attention from the environment.

IoT Functional Blocks

IoT systems are composed of a number of building blocks, including sensors/actuators, connectivity, security, services, etc. The functional blocks are responsible for sensing, verification, actuation, management, and communication.

These functional blocks are made up of devices that handle interactions between a web server and the client, enable controls and monitoring functions, manage data transfer, secure the IoT system through authentication and various purposes, and offer an interface for monitoring and managing various concepts. Let's gather more information about the IoT Functional Blocks.

Sensor/Actuator block

The sensor/actuator block serves as the data entry point in an IoT system. Sensors collect data from their surroundings, whereas actuators drive physical processes. Sensors gather data on temperature, humidity, light, motion, and other variables, whereas actuators turn on lights, open doors, and control machines. These gadgets work together to collect data and operate in the physical world.

Connectivity Block

Once the sensor/actuator block has collected data, it must be sent to the remainder of the system. This is when the connection block enters the picture. The connectivity block is in charge of creating and managing communication channels amongst IoT system devices. This can be accomplished with the use of several technologies such as Wi-Fi, Bluetooth, ZigBee, and cellular networks.

Data Processing Block

The obtained data is examined and processed in the data processing block. This block is in charge of filtering out noise and irrelevant data, converting the data into an easily studied format, and recognizing patterns and anomalies in the data. This block can also execute real-time analysis, enabling speedy data-driven decisions.

Application Block

The application block is the component of the IoT system that gives value to the end user. This block is in charge of utilizing the processed data to provide a specified function or service. An application block, for example, could be used to provide insights into energy usage in a building or to adjust the temperature in a greenhouse.

Security Block

The security block is in charge of assuring the IoT system's security and protection against illegal access. This block is in charge of authentication and authorization, as well as data encryption during transmission and storage. It also handles intrusion detection and response, assisting in the prevention and mitigation of threats.

Management Block

The management block is in charge of overseeing the overall operation of the IoT system. This block is capable of handling device configuration, firmware updates, and system monitoring. It can also give analytics and reporting, allowing system administrators to understand how the system is operating and find areas for improvement.

Advantages of IoT Functional Blocks

IoT Functional Blocks provide various advantages to enterprises and people interested in implementing IoT solutions.

These advantages include

Scalability

IoT Scalability is built into Functional Blocks, allowing enterprises to add new devices and services to their IoT system as needed. The capacity to scale assures that an IoT system can grow and react to changing business needs and future technology.

Interoperability

IoT Functional Blocks is a standardized architecture for developing IoT solutions. This standardization means that devices and services from various suppliers may function seamlessly together, enhancing interoperability and lowering integration costs.

Modularity

Because IoT Functional Blocks are modular, they may be swapped, modified, or added as needed. Because of this versatility, enterprises can select the optimal components for their IoT system and easily swap out components as needed.

Flexibility

IoT Functional Blocks offer a variety of deployment choices. Depending on their needs, businesses can implement an IoT system on-premises, in the cloud, or in a hybrid approach.

MODULE 7 : Basic SMD & OCB Rework

LESSON 69 - 72 : Basic SMD (2, 3, 4 terminal components)

Objectives

At the end of this lesson you shall be able to:

- describe the wrong priciples of SMD and their types & advantages

Basic SMD (2, 3, 4 terminal components)

Introduction

Surface Mount Devices (SMDs) are used in a growing number of commercial and industrial products. Due to their small size, prototype manufacturing, rework and repair can be difficult and are best performed using specialized techniques specific to this technology. Learning these techniques will help you succeed when working with these small components. The SMT technique opens advantages and new applications through miniaturizing of the components and increasing of reliability.

Surface Mounted Devices (SMD) are active and passive electronic components without conventional connecting wires.

Surface-mount technology (SMT) is a method for producing electronic circuits in which the components are mounted or placed directly onto the surface of printed circuit boards (PCBs). An electronic device so made is called a surface-mount device (SMD).

Need of surface mount technology

SMDs have improved performance over through-hole component due to their smaller size, shorter internal leads, and smaller board layouts. These factors reduce the circuit's parasitic inductance and capacitance. SMDs can also be more cost effective than traditional through - hole components due to the smaller board size, fewer board layers, and fewer holes. SMDs can be challenging to solder, so it is best to learn general soldering skills on larger components before attempting to work with SMDs.

1 Two terminal packages:

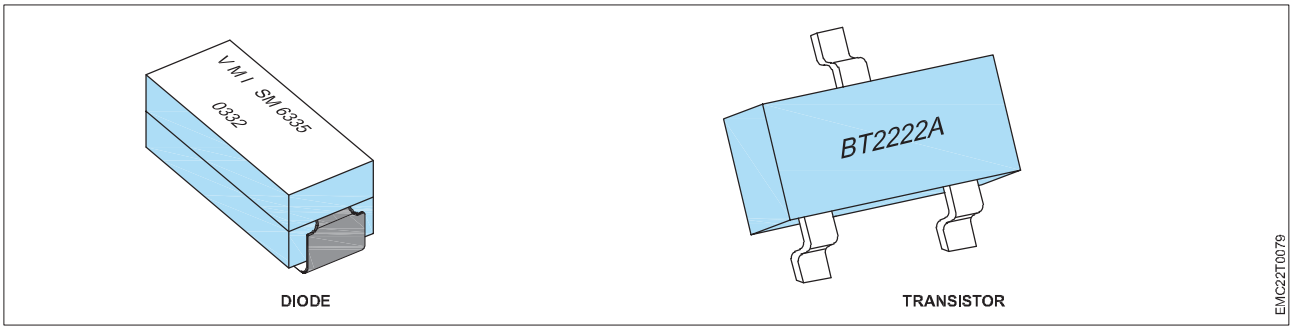
Diodes:

Diode is a two-terminal semiconductor device that will allow current to flow through it in only one direction. With the proper voltage polarity across the device, it will act as a conductor. When the voltage polarity is reversed, the device will act as a nonconductor, allowing no current to flow.

2 Three-Terminal Packages

Transistors

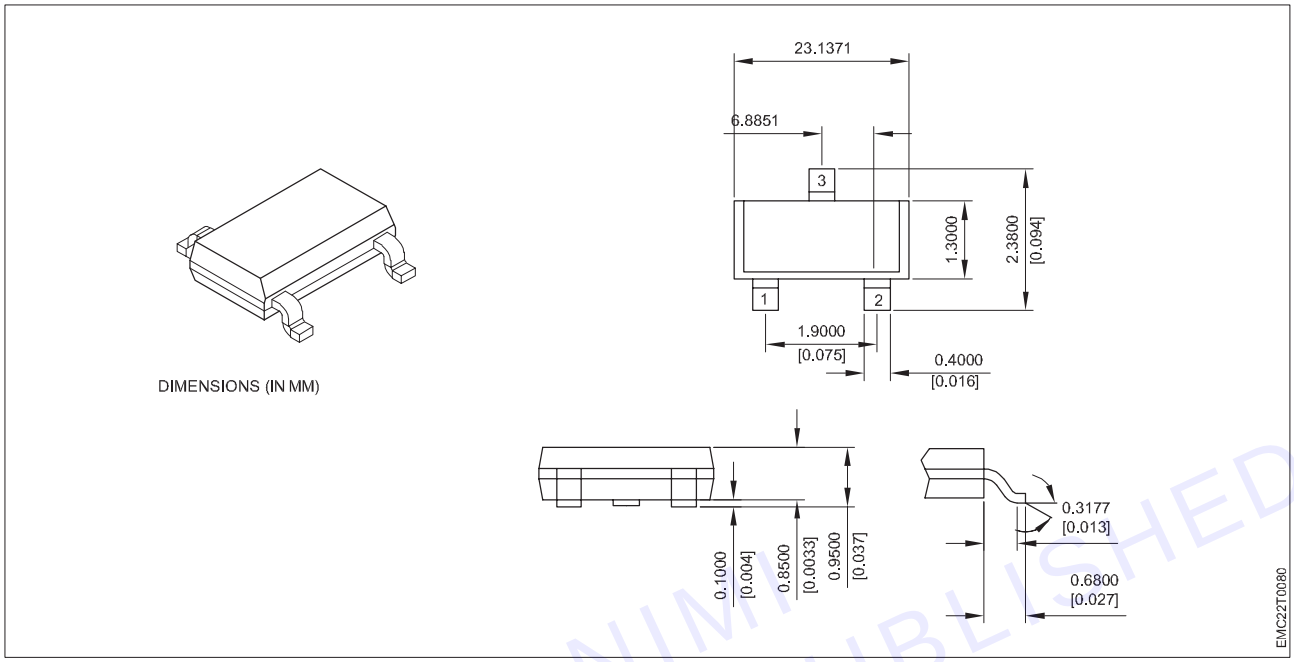
The transistor is a solid-state semiconductor device that can be used for amplification, switching, voltage stabilization, signal modulation and many other functions. It allows a variable current, from an external source, to flow between two of its terminals depending on the smaller voltage or current applied to a third terminal. Transistors are made either as separate components or as part of an integrated circuit.



SOT- Small Outline Transistor:

What is SOT?

SMALL OUTLINE TRANSISTOR SOT package is a rectangular surface mount transistor or diode with three or more gull wings leads. The leads are on two length sides of the package. Popular sizes are the SOT23, SOT143, SOT223 and SOT89.



1 SOT23: SOT23 is a Plastic surface-mounted package with 3 leads.

3 Integrated circuits (Four and more Terminals Packages):

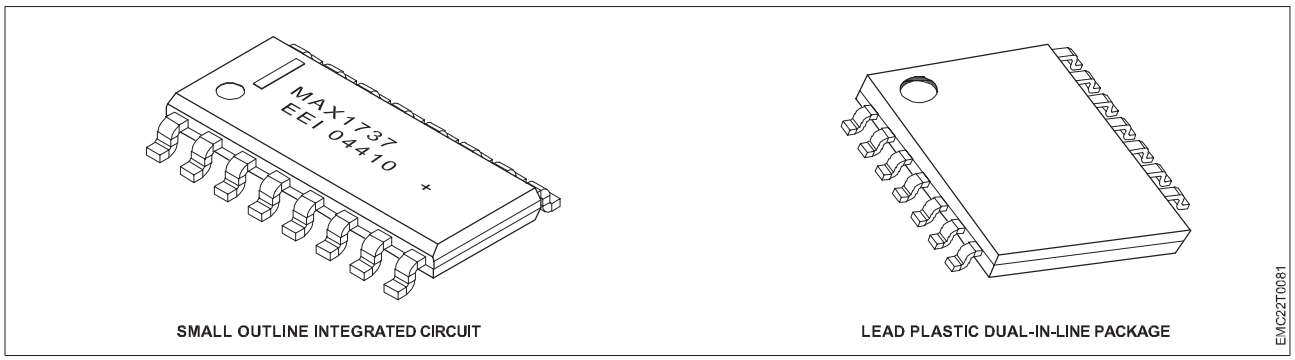
Dual-In-Line:

Dual in-line package (DIP), sometimes called a DIL package, is an electronic device package with a rectangular housing and two parallel rows of electrical connecting pins, usually protruding from the longer sides of the package and bent downward. A DIP is usually referred to as a DIPn, where n is the total number of pins. For example, a microcircuit package with two rows of seven vertical leads would be a DIP14.

SOIC- Small Outline Integrated Circuit

14 Lead Plastic Dual-In-Line Package

Small Outline Integrated Circuit is the standard package for logic ICs and it is the equivalent (although smaller) of the DIL package for leaded components.



3.2 SSOP Shrink Small Outline Package

Shrink Small Outline Package is smaller than the SOIC and has a pin spacing of 0.635 mm.

14 lead plastic dual -In-line package

Advantages of SMDs

Advantages of SMDs are given below

1 PCBs area much smaller than by conventional through - hole components

2 Since the both layers of the PCB could be used for assembling, the final PCBs area for the same circuits could be decreased by 50%.

3 Simple assembling-no bending and cutting of the wires.

4 Automatic assembling very easy. Low cost of the assembling.

5 Small size of components makes very high packingdensity possible. For the same circuits a volume of a module assembled with SMD could be reduced to 30% of the device assembled with the conventional technique. Therefore a size of the whole instrument decreases, too.

6 Very high resistance to mechanical shock and vibration.

7 Low store and transport cost. Low store area and volume.

8 Lack of hole's drilling and metallization.

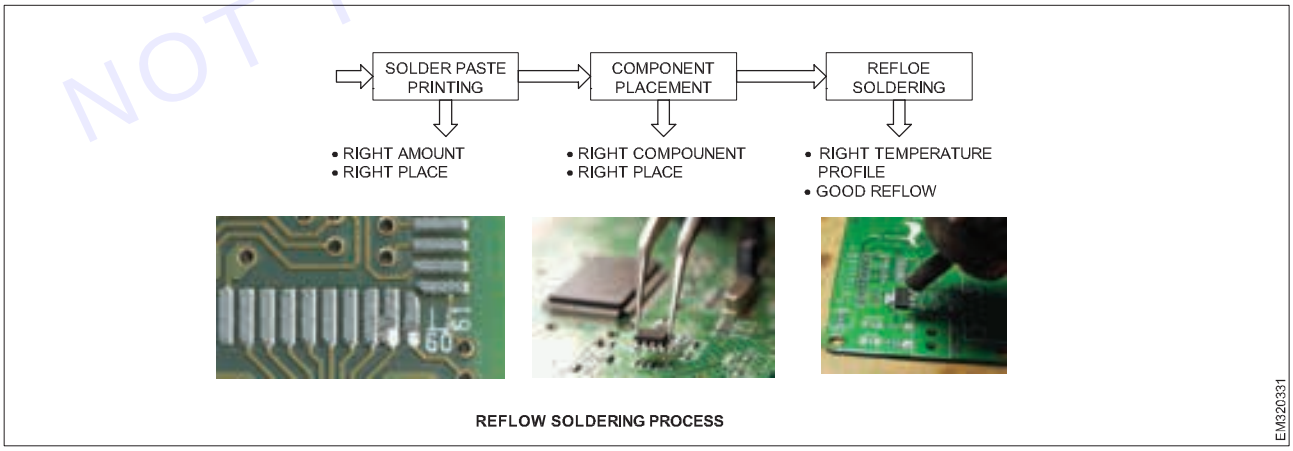
9 Thin pads.

10 For larger volumes, low manufacturing cost.

Reflow soldering and working principle

Reflow soldering is a process in which a solder paste (a sticky mixture of powdered solder and flux) is used to temporarily attach one or several electrical components to their contact pads, after which the entire assembly is subjected to controlled heat, which melts the solder, permanently connecting the joint. Heating may be accomplished by passing the assembly through a reflow oven or under an infrared lamp or by soldering individual joints with a hot air pencil as shown in fig. 1 reflow soldering process.

Reflow soldering is the most common method of attaching surface mount components to a circuit board, although it can also be used for through-hole components by filling the holes with solder paste and inserting the component leads through the paste. Because wave soldering can be simpler and cheaper, reflow is not generally used on pure through-hole boards. When used on boards containing a mix of SMT and THT components, through-hole reflow allows the wave soldering step to be eliminated from the assembly process, potentially reducing assembly costs.

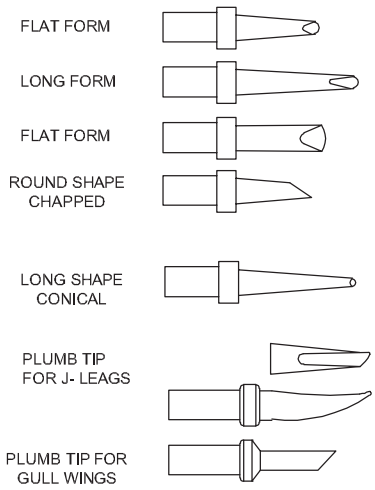


REFLOW SOLDERING PROCESS

Tips and types

Most soldering irons for electronics have interchangeable tips, also known as bits that vary in size and shape for different types of work. Pyramid tips with a triangular flat face and chisel tips with a wide flat face are useful for soldering sheet metal. Fine conical or tapered chisel tips are typically used for electronics work. Tips may be straight or have a bend. Concave or wicking tips with a chisel face with a concave well in the flat face to hold a small amount of solder are available. Tip selection depends upon the type of work and access to the joint; soldering of 0.5mm pitch surface-mount ICs, for example, is quite different from soldering a through-hole

connectionto a large area. A concave tip well is said to help prevent bridging of closely spaced leads; different shapes are recommended to correct bridging that has occurred. Due to patent restrictions not all manufacturers offer concave tips everywhere; in particular there are restrictions in the USA.Older and very cheap irons typically use a bare copper tip, which is shaped with a file or sandpaper. This dissolves gradually into the solder, suffering pitting and erosion of the shape. Copper tips are sometimes filed when worn down. Iron-plated copper tips have become increasingly popular since the 1980s. Because iron is not readily dissolved by molten solder, the plated tip is more durable than a bare copper one, though it will eventually wear out and need replacing. This is especially important when working at the higher temperatures needed for modern lead-free solders. Solid iron and steel tips are seldom used because they store less heat, and rusting can break the heating element.



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LESSON 73 - 76 : PCB Rework introduction to static charger

Objectives

At the end of this lesson you shall be able to:

- explain various types of PCB and various tests carried out on PCB's

PCB Rework introduction to static charger

Static electricity is primarily caused by the movement of electrons from one surface to another. When two materials come into contact and then separate, some electrons may be transferred from one material to the other, leaving one material with a positive charge (having lost electrons) and the other with a negative charge (having gained electrons). This charge imbalance creates static electricity.

Types of Static Charges

Positive Charge (+): When an object loses electrons, it becomes positively charged because it has an excess of protons.

Negative Charge (-): When an object gains electrons, it becomes negatively charged because it has an excess of electrons.

Properties and Effects

Attraction and Repulsion: Objects with opposite charges attract each other, while objects with like charges repel each other. This phenomenon can be demonstrated with simple experiments using objects like balloons, plastic rods, and paper bits.

Electrostatic Discharge: When the charge on an object becomes large enough, it can discharge suddenly, resulting in a spark. This discharge can be seen, for example, when you touch a metal doorknob after walking across a carpeted floor.

Triboelectric Effect: The triboelectric effect is the phenomenon where certain materials become electrically charged after they come into contact and then separate due to the exchange of electrons. This is the principle behind rubbing a balloon on your hair to create static electricity.

Practical Applications

Photocopiers and Laser Printers: Static electricity is used in photocopiers and laser printers to transfer toner (ink powder) to paper.

Air Purification: Some air purifiers use static electricity to remove particles from the air by attracting them to charged plates.

Electrostatic Precipitators: These devices use static electricity to remove pollutants like dust and smoke particles from industrial exhaust gases.

Safety Considerations

While static electricity is generally harmless in small amounts, it can cause damage in certain situations, such as in electronics manufacturing environments where static discharge can damage sensitive components. Precautions such as grounding and using anti-static materials are essential in such cases.

Prevention, Handling Of Static-Sensitive Devices Various:

Prevention and proper handling of static-sensitive devices are crucial in industries where electronic components are manufactured, handled, or repaired. These devices can be damaged by electrostatic discharge (ESD), leading to malfunctions or failure. Various standards and guidelines have been developed to ensure the protection of static-sensitive devices. Here are some key aspects to consider:

Standards For ESD:

ANSI/ESD S20.20: This standard provides a comprehensive framework for establishing an Electrostatic Discharge Control Program. It covers requirements for the design, implementation, and maintenance of ESD control procedures in manufacturing, handling, and assembly processes.

IEC 61340 series: The International Electrotechnical Commission (IEC) 61340 series of standards provides guidance on electrostatic control in various industries. It includes specific standards for different applications, such as IEC 61340-5-1 for packaging materials, IEC 61340-5-2 for handling electronic components, and IEC 61340-4-6 for measuring ESD events.

ANSI/ESD STM series: These are test methods developed by the ESD Association to evaluate the effectiveness of ESD control measures and materials. For example, ANSI/ESD STM11.11 specifies the test method for determining the resistance of materials used in the packaging of static-sensitive devices.

MIL-STD-1686: This military standard provides guidelines for the control of electrostatic discharge in military systems, including requirements for ESD protective packaging, grounding, and handling procedures.

Prevention and Handling Measures:

ESD Control Program: Establishing a formal ESD control program based on industry standards and guidelines is essential. This program should include procedures for personnel training, ESD awareness, equipment grounding, and periodic audits.

ESD Protected Area (EPA): Designate specific areas or workstations as EPAs where static-sensitive devices are handled. These areas should be equipped with ESD control measures such as grounded work surfaces, wrist straps, and ESD-safe packaging materials.

Personal Grounding: Workers should wear ESD wrist straps or heel straps connected to grounded surfaces to prevent the build-up of static charges on their bodies.

Packaging and Storage: Static-sensitive devices should be stored and transported in ESD-safe packaging materials such as conductive bags or containers. These materials dissipate static charges and protect the devices from ESD during handling and shipping.

Equipment Grounding: Ensure that all equipment and surfaces in the EPA are properly grounded to prevent static discharge. This includes workbenches, floors, and shelving units.

Humidity Control: Maintaining appropriate levels of humidity in the EPA can help reduce the accumulation of static charges on surfaces and minimize the risk of ESD events.

Introduction to non soldering interconnections

Non-soldering interconnections refer to methods of joining electrical components or conductors without the use of solder. These methods are employed in various industries, including electronics, telecommunications, and automotive, for assembling circuits, connecting wires, and creating reliable electrical connections. Here's an introduction to some common non-soldering interconnection techniques:

1 Crimp Connections

Description: Crimping involves mechanically deforming a metal sleeve or terminal around a wire or conductor to create a secure connection.

Advantages: Provides a strong and durable connection, suitable for high-vibration environments. Can be easily inspected for quality.

Applications: Commonly used in automotive wiring harnesses, electrical appliances, and industrial equipment.

2 Wire Wrap

Description: Wire wrapping involves tightly wrapping a wire around a post or terminal on a connector or terminal block.

Advantages: Offers excellent mechanical and electrical properties, suitable for high-frequency circuits. Allows for easy modification and repair.

Applications: Used in telecommunications equipment, prototyping, and breadboarding.

3 Compression Connectors

Description: Compression connectors use a mechanical compression force to join conductors together within a connector or terminal block.

Advantages: Provides a reliable and gas-tight connection, resistant to environmental factors such as moisture and corrosion.

Applications: Commonly used in power distribution systems, telecommunications, and RF coaxial cables.

4 Press-Fit Connections:

Description: Press-fit connectors feature pins or terminals that are pressed into plated through-holes on a PCB without soldering.

Advantages: Offers a high-density, reliable connection without the need for soldering. Facilitates easy assembly and disassembly.

Applications: Used in PCB manufacturing, backplane assemblies, and modular electronic systems.

5 Mechanical Fasteners:

Description: Mechanical fasteners such as screws, nuts, bolts, and clips are used to secure components or terminals together.

Advantages: Provides a strong and easily reversible connection. Allows for easy maintenance and repair.

Applications: Widely used in electrical enclosures, panel assemblies, and grounding systems.

6 Twist-On Wire Connectors:

Description: Twist-on wire connectors feature insulated caps with internal threads that twist onto the exposed ends of wires to form a connection.

Advantages: Provides a quick and convenient way to join multiple wires together. Offers electrical insulation and strain relief.

Applications: Used in residential and commercial electrical wiring, lighting fixtures, and junction boxes.

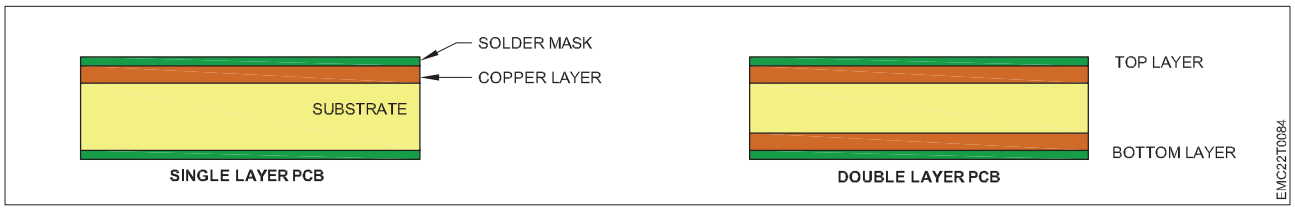
Considerations

Electrical Performance: Ensure that the chosen method provides adequate electrical conductivity, insulation, and reliability for the application.

Environmental Factors: Consider the operating environment, including temperature, humidity, vibration, and exposure to chemicals or contaminants.

Ease of Assembly: Evaluate the ease of assembly, maintenance, and repair, especially for applications requiring frequent modifications or upgrades.

Construction of Printed Circuit Boards (PCB)



1 Single-Layer PCBs:

Substrate: Typically made of a non-conductive material such as fiberglass (FR-4).

Copper Layer: A single layer of copper foil is laminated onto one side of the substrate.

Etching: The unwanted copper is removed using chemical etching, leaving behind the desired circuit traces.

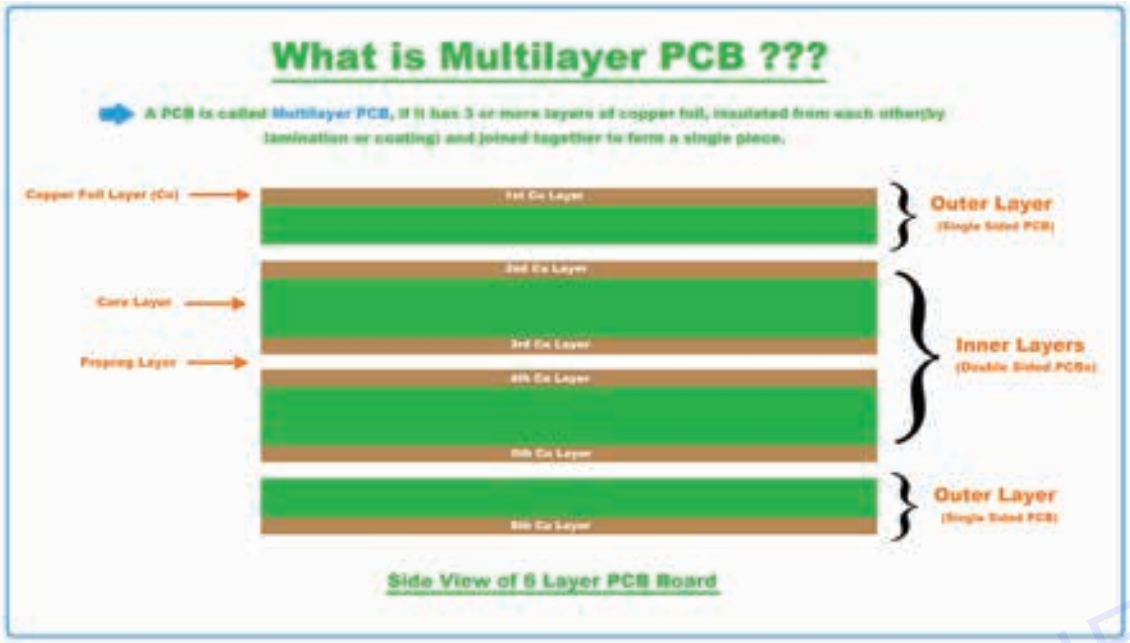
Through-Hole Plating (Optional): Holes are drilled for component leads and plated to provide electrical connections.

2 Double-Layer PCBs:

Substrate: Similar to single-layer PCBs but with copper foil laminated on both sides of the substrate.

Through-Hole Plating: Conductive holes connect traces on both sides, allowing for more complex circuits.

4 Multilayer PCBs:



Substrate: Consists of multiple layers of substrate material sandwiched between copper foils.

Inner Layers: Copper layers are etched to create interconnections, with vias (plated holes) providing vertical connections between layers.

Lamination: Layers are laminated together under heat and pressure.

Outer Layers: Final copper layers are etched to form the outer circuitry.

Important Tests for PCBs:

1 Electrical Continuity Test:

Purpose: To ensure that there are no open or short circuits in the PCB.

Method: Use a multimetar or continuity tester to check for continuity between desired points on the PCB.

2 Insulation Resistance Test:

Purpose: To measure the resistance between conductors and the substrate to ensure proper insulation.

Method: Apply a high-voltage test between conductors and substrate and measure the resistance.

3 Dimensional Accuracy Check:

Purpose: To verify that the PCB dimensions meet design specifications.

Method: Measure critical dimensions such as hole sizes, trace widths, and overall dimensions using calibrated tools.

4 Solderability Test:

Purpose: To ensure that the PCB surface is adequately prepared for soldering.

Method: Perform solderability tests such as dip and look, solderability balance, or wetting balance tests.

5 Thermal Stress Testing:

Purpose: To assess the PCB's ability to withstand temperature variations without delamination or damage.

Method: Subject the PCB to thermal cycling between specified temperature ranges and observe for any physical or electrical failures.

6 High-Potential (Hipot) Test:

Purpose: To verify the dielectric strength of the PCB by subjecting it to high voltage.

Method: Apply a high voltage between conductors and substrate and measure leakage current or insulation breakdown.

7 Microsection Analysis:

Purpose: To inspect internal structures and solder joints for defects such as voids, cracks, or delamination.

Method: Cut and polish a cross-section of the PCB and examine it under a microscope.

8 Environmental Testing:

Purpose: To evaluate the PCB's performance under different environmental conditions such as temperature, humidity, and vibration.

Method: Subject the PCB to environmental chambers or vibration tables according to relevant standards (e.g., MIL-STD-810).

Introduction to Rework and Repair Concepts

Rework:

Rework refers to the process of correcting defects or errors identified during the manufacturing or assembly of electronic components or PCBs before they are completed.

Repair:

Repair involves fixing defects or failures discovered in finished electronic products or assemblies after they have been manufactured and tested.

Common Reasons for Rework and Repair:

Soldering Defects

Examples include solder bridges, insufficient solder joints, cold solder joints, and solder balls.

Component Placement Errors

Incorrect component orientation, misalignment, or missing components.

Electrical and Functional Failures

Circuitry faults, shorts, open circuits, or failures identified during testing or operation.

Physical Damage:

Damage due to mishandling, mechanical stress, or environmental factors such as moisture, heat, or vibration.

Rework and Repair Processes:

Identification and Assessment:

The first step involves identifying the defect or failure and assessing its impact on the functionality and performance of the electronic product or assembly.

Disassembly:

If necessary, the electronic assembly or PCB is disassembled to access the defective or damaged components.

Component Removal:

Defective components are removed using desoldering tools and techniques such as hot air rework stations, soldering irons, or solder wick.

Cleaning and Preparation:

The area around the removed component is cleaned to remove residual solder and flux. PCB pads may be prepped for re-soldering.

Component Replacement:

New components or replacement parts are installed in place of the defective ones. Careful attention is paid to component orientation, alignment, and soldering.

Soldering and Reflow:

Soldering techniques such as hand soldering or reflow soldering are used to secure the replacement components to the PCB.

Inspection and Testing:

The reworked or repaired assembly undergoes thorough inspection and testing to ensure that the defect has been successfully rectified and that the product meets quality standards.

Tools and Equipment:

Soldering Irons and Stations

Desoldering Tools (Solder Suckers, Desoldering Pumps)

Hot Air Rework Stations

Soldering Stations with SMD Rework Attachments

Microscopes and Magnifiers

PCB Rework Kits and Tools

Importance of Rework and Repair:

Cost Savings: Rework and repair can salvage defective components or assemblies, reducing the need for scrapping and re-manufacturing.

Quality Assurance: Ensures that electronic products meet quality standards and customer requirements before being released to the market.

Customer Satisfaction: Minimizes the likelihood of faulty products reaching customers, enhancing brand reputation and customer satisfaction.

Repair Of Damaged Track:

Repairing a damaged track on a printed circuit board (PCB) involves restoring the electrical connection between two points on the board where the conductive copper trace has been damaged or broken. Here's a general guide on how to repair a damaged track on a PCB:

1 **Assessment:** First, identify the damaged track and assess the extent of the damage. Determine whether the track is partially or completely severed and whether nearby components have been affected.

2 **Isolation:** If the damaged track is part of a larger circuit, isolate the damaged section by cutting away any surrounding copper that may be causing short circuits or interference.

3 **Cleaning:** Clean the area around the damaged track using isopropyl alcohol or a specialized PCB cleaning solution to remove any dirt, flux residue, or contaminants that may interfere with the repair process.

4 **Exposure:** Expose the damaged section of the track by carefully scraping away the solder mask or protective coating covering the copper trace using a sharp hobby knife or fiberglass scratch pen. Be cautious not to damage adjacent traces or components.

5 **Repair Method: -** Jumper Wire: The simplest method is to use a thin insulated jumper wire to bridge the gap in the track. Cut a piece of wire to the appropriate length, strip the insulation from both ends, and solder it onto the remaining sections of the track to create a continuous electrical connection. - Conductive Ink or Paint: Alternatively, conductive ink or paint can be used to bridge the gap. Apply the conductive material over the damaged section using a fine-tip applicator or brush, ensuring that it forms a continuous connection between the two points. Allow the ink or paint to dry thoroughly before testing the repair. – Copper Foil: In cases where the damaged track is wide or requires additional strength, a small piece of copper foil can be used to patch the area. Cut a piece of copper foil to fit over the damaged section, apply flux to the damaged area, place the foil over the gap, and solder it into place.

6 **Inspection and Testing:** Once the repair is complete, visually inspect the repaired track to ensure that it's properly connected and there are no solder bridges or other defects. Use a multimeter to check for continuity between the repaired track and adjacent components or traces.

7 **Protection:** After verifying the repair, apply a new layer of solder mask or conformal coating over the repaired area to protect it from moisture, oxidation, and mechanical damage. By following these steps carefully, you can effectively repair a damaged track on a PCB and restore its functionality. However, it's important to note that PCB repair requires precision and skill, so if you're not confident in your abilities, consider seeking assistance from a professional or experienced hobbyist.

Repair Of Damaged Pad And Plated Through Hole

Repairing a damaged pad and plated through hole on a printed circuit board (PCB) can be more complex than repairing a damaged track, but it's certainly possible with the right tools and techniques. Here's a step-by-step guide on how to repair a damaged pad and plated through hole:

1 **Assessment:** Identify the damaged pad and plated through hole on the PCB. Determine the extent of the damage and whether nearby components or traces have been affected.

2 **Isolation:** If the damaged pad and through hole are part of a larger circuit, isolate the damaged section by cutting away any surrounding copper that may be causing short circuits or interference.

3 **Cleaning:** Clean the area around the damaged pad and through hole using isopropyl alcohol or a specialized PCB cleaning solution to remove any dirt, flux residue, or contaminants that may interfere with the repair process.

4 **Exposure:** Expose the damaged pad and through hole by carefully scraping away the solder mask or protective coating covering the area using a sharp hobby knife or fiberglass scratch pen. Be cautious not to damage adjacent traces or components.

5 **Repair Method:** Pad Repair: If the pad is partially damaged but still intact, you can reinforce it by applying a small piece of copper foil or using conductive epoxy to build up the pad. Ensure that the pad is flat and level before proceeding. - **Through Hole Repair**: If the plated through hole is damaged or completely missing, you'll need to create a new connection between the two sides of the PCB. This can be done by drilling out the damaged hole to remove any remaining debris and then inserting a replacement wire or component lead through the hole. Solder the wire or lead to the exposed copper on both sides of the PCB to create a new through connection.

6 **Inspection and Testing:** Once the repair is complete, visually inspect the repaired pad and through hole to ensure that they're properly connected and there are no solder bridges or other defects. Use a multimeter to check for continuity between the repaired pad and through hole and adjacent components or traces.

7 **Protection:** After verifying the repair, apply a new layer of solder mask or conformal coating over the repaired area to protect it from moisture, oxidation, and mechanical damage.

8 **Reassembly:** If any components were removed during the repair process, reassemble the PCB and test it to ensure that it functions as intended. Repairing a damaged pad and plated through hole on a PCB requires careful attention to detail and precision soldering skills. If you're not confident in your abilities, consider seeking assistance from a professional or experienced hobbyist.

REPAIR OF SOLDER MASK:

Repairing solder mask on a printed circuit board (PCB) typically involves touching up areas where the solder mask has been damaged or removed during the manufacturing process or subsequent rework. Here's a step-by-step guide on how to repair solder mask on a PCB:

1 **Assessment:** Inspect the PCB to identify areas where the solder mask is damaged, scratched, or missing. Ensure that the underlying copper traces and components are not affected.

2 **Cleaning:** Clean the damaged area thoroughly using isopropyl alcohol or a specialized PCB cleaning solution to remove any dirt, flux residue, or contaminants that may interfere with the repair process. Allow the area to dry completely before proceeding.

3 **Surface Preparation:** If the damaged area is rough or uneven, gently sand it with fine-grit sandpaper to smooth out the surface. Be careful not to damage any nearby components or traces.

4 **Masking:** Use masking tape or a specialized solder mask damming material to protect surrounding areas of the PCB from the repair process. This will ensure that the solder mask is applied only to the damaged area.

5 **Application of Solder Mask:** Apply solder mask material to the damaged area using a fine-tip applicator or brush. Ensure that the solder mask covers the damaged area completely and forms a smooth, even layer. Be careful not to apply too much solder mask, as excess material can cause bridging or other issues during curing.

6 **Curing:** Cure the solder mask according to the manufacturer's instructions. This typically involves exposing the PCB to ultraviolet (UV) light for a specific duration to harden the solder mask material. Ensure that the PCB is positioned correctly and that the entire damaged area is exposed to the UV light source.

7 **Inspection:** After curing, carefully inspect the repaired solder mask to ensure that it adheres properly to the PCB and forms a consistent layer. Check for any defects, bubbles, or inconsistencies in the solder mask material.

8 **Cleaning and Finishing:** Once the repair is complete and the solder mask has cured, remove any masking tape or damming material from the PCB. Clean the repaired area again with isopropyl alcohol or PCB cleaning solution to remove any residues or contaminants. Ensure that the repaired area blends seamlessly with the surrounding solder mask.

9 **Testing**: After completing the repair, conduct electrical testing or functional testing to ensure that the PCB functions properly and that the repaired solder mask does not affect the performance of the circuit. By following these steps carefully, you can effectively repair damaged solder mask on a printed circuit board. However, it's important to note that solder mask repair requires precision and attention to detail, so if you're not confident in your abilities, consider seeking assistance from a professional or experienced hobbyist.

MODULE 8 : Digital panelmeter and Light emitting diode (LED)

LESSON 77 - 83 : Technician Power Electronics System

Objectives

At the end of this lesson you shall be able to:

- explain seven segment display & its types.

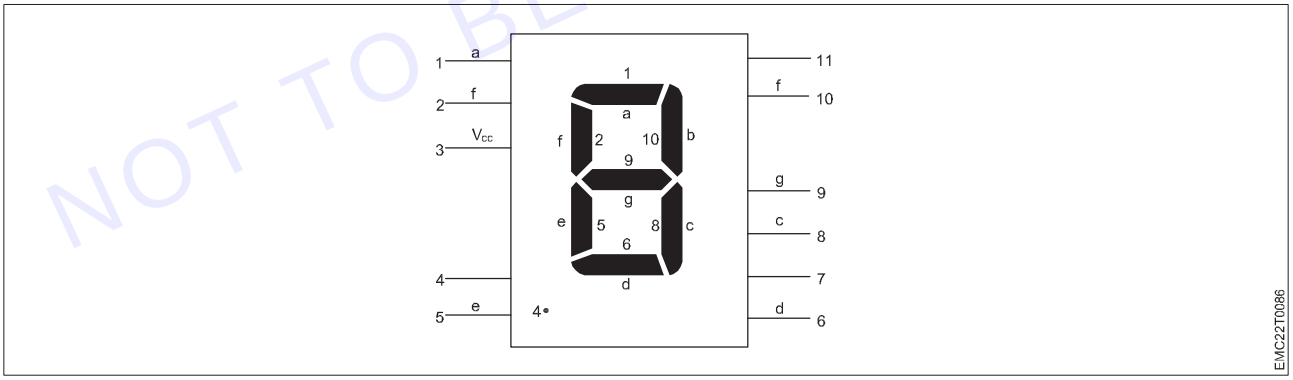
Nowadays, we are using digital displays instead of analog displays such as CRT. This digital display may consist of seven segments display, LCD display and LED display. Seven Segment display is the combination of seven LEDs, which are arranged in rectangular fashion. These LED are called the segment of seven segment display.

It is generally used to display numbers and letters on things such as alarm clocks and digital watches etc. LCD is the combination of solid and liquid states of matter. It uses liquid crystals for producing visible images. LCD is generally used in optical imaging, LCD thermometer and in medical applications, etc.

Due to some disadvantages, a new technology came into existence, which is light emitting display (LED). It is a combination of light emitting diodes (LED), which is a semiconductor device that emits incoherent narrow spectrum light, which is used in LED displays. These are the display components which will be discussed in this chapter with their applications such as digital panel meter and lighting.

Seven Segment Display:

The seven-segment display is the most common display device used in many gadgets, and electronic appliances like digital meters, digital clocks, microwave oven and electric stove, etc. These displays consist of seven segments of light emitting diodes (LEDs) and that is assembled into a structure like numeral 8. Seven segment displays contain about 8-segments wherein an extra 8th segment is used to display dots. This segment is useful while displaying non-integer numbers. Seven segments are indicated as A-G and the eighth segment is indicated as H. These segments are arranged in the form of 8 which is shown in the seven-segment display circuit diagram.



Seven segment displays are generally available in ten pin packages. In those 8 pins relate to the 8 LEDs, the remaining pins at middle are internally shorted. These segments come in two outlines they are common cathode and common anode. In common cathode configuration, the negative terminals are connected to the common pins and the common is connected to the ground. When the corresponding pin is given high, then a particular LED glows. In a common anode arrangement, the common pin is given to a logic high, and the pins of the LED are given low to display a number.

Types of 7-Segment Displays

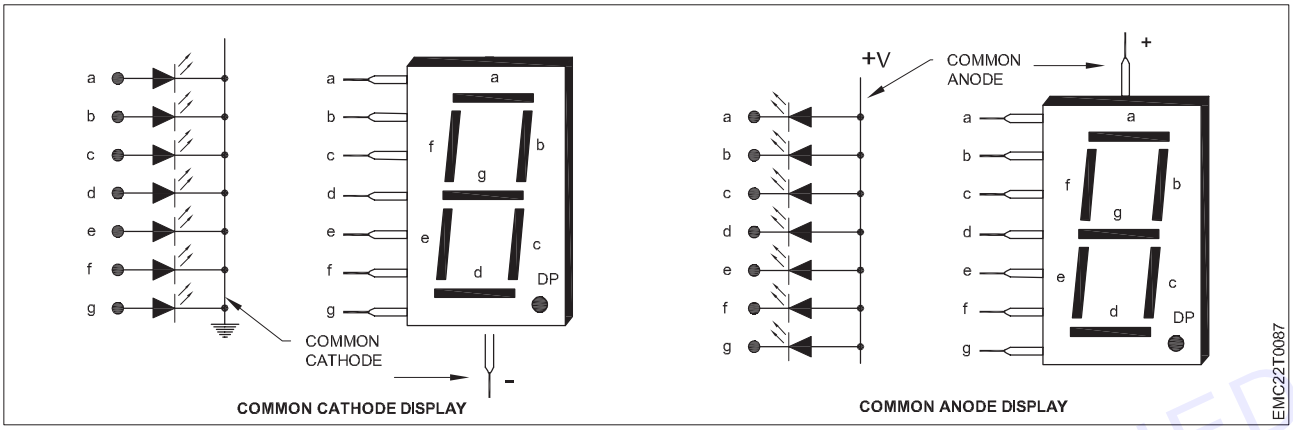
There are two types of seven segment displays available in the market. According to the type of application, these displays can be used. The two configurations of seven segment displays are discussed below.

Common Anode Display

Common Cathode Display

1 **Common Cathode Configuration:** The Common Cathode (CC) – In the common cathode display, all the cathode connections of the LED segments are joined together to logic “0” or ground. The individual segments are illuminated by application of a “HIGH”, or logic “1” signal via a current limiting resistor to forward bias the individual Anode terminals (a-g).

2 **Common Anode Configuration :**The Common Anode (CA) – In the common anode display, all the anode connections of the LED segments are joined together to logic “1”. The individual segments are illuminated by applying a ground, logic “0” or “LOW” signal via a suitable current limiting resistor to the Cathode of the particular segment (a-g).



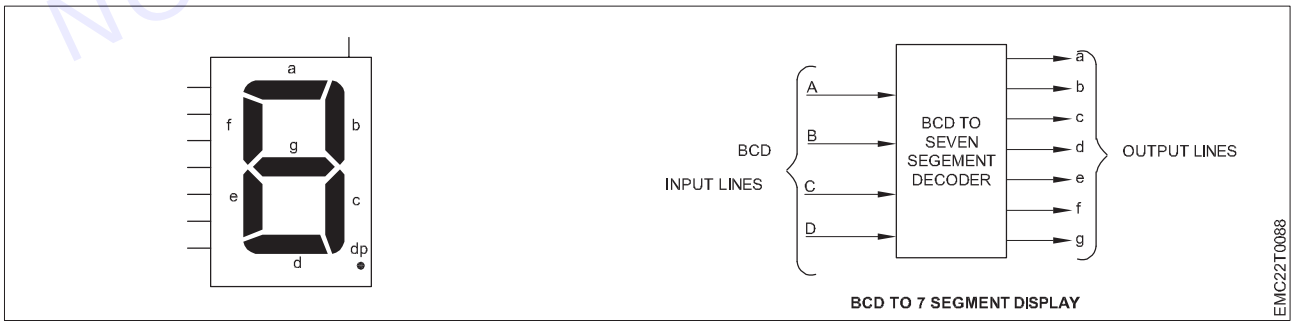
Driver/Decoder IC for LED Using 7-Segment

To design a circuit with four inputs A, B, C, D and seven outputs a, b, c, d, e, f and g, the input to the circuit is the binary representation of one of the ten decimal digits. Its output is chosen so as to display the equivalent decimal value using a seven-segment display. Figure shows a schematic of the seven-segment display. The seven-segment display has seven Light Emitting Diodes (LEDs). By assigning a logical 1 to a given segment, the segment will emit light.

The inputs to the display in figure are shown with labels a to g. The display is found in some calculators with the LEDs replaced by Liquid Crystal Displays (LCDs).

The circuit we want to design has seven outputs. The outputs serve as inputs to the seven-segment display and as a result are labeled a to g as well. The block diagram given in Fig. (b) shows the inputs and outputs to the circuit to be designed. The circuit is called a BCD to seven-segment decoder

The inputs given to the circuit are A, B, C and D. The inputs represent a decimal digit between 0 to 9. The output assigns values to a to g so as to display the corresponding decimal digit.



eg.. When the input ABCD = 0000 is applied, the decimal digit 0 is displayed using decoder IC. By inspection, this occurs when the g output is assigned a value of 0 and all remaining outputs are assigned a value of 1. The truth table associated with the BCD to seven segment decoder circuit is shown in Fig. (c).

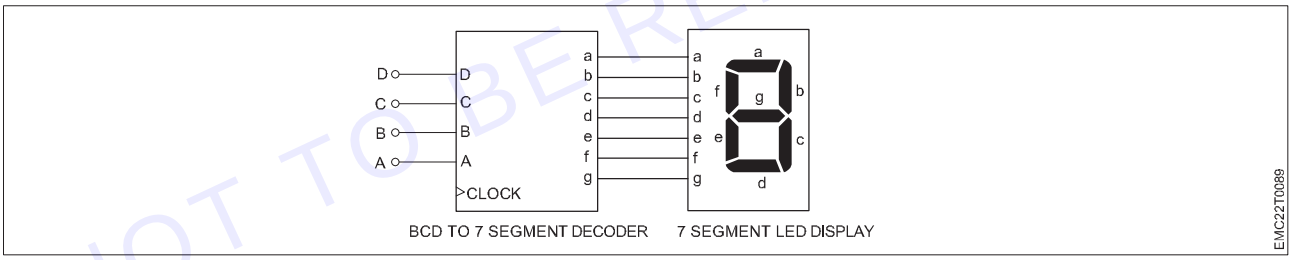
Note that the table does not have output entries associated with binary combinations with decimal values exceeding 9.

Truth table of the BCD to Seven segment Display Decoder:

Digits	Input Lines				Output Lines							Display Pattern
	A	B	C	D	a	b	c	d	e	f	g	
0	0	0	0	0	1	1	1	1	1	1	0	0
1	0	0	0	1	0	1	1	0	0	0	0	1
2	0	0	1	0	1	1	0	1	1	0	1	2
3	0	0	1	1	1	1	1	1	0	0	1	3
4	0	1	0	0	0	1	1	0	0	1	1	4
5	0	1	0	1	1	0	1	1	0	1	1	5
6	0	1	1	0	1	0	1	1	1	1	1	6
7	0	1	1	1	1	1	1	0	0	0	0	7
8	1	0	0	0	1	1	1	1	1	1	1	8
9	1	0	0	1	1	1	1	1	0	1	1	9

The 4543B BCD to 7 segment latch/decoder/driver is designed for liquid crystal displays. Pins A, B, C, D represent BCD inputs with A as a Least Significant Bit (LSB)Significant Bit (MSB). Pins a to g are the seven segment outputs.

The IC 4543B has three control terminals LD (Latch Disable), PH (Phase) and BL (Blank). In normal use, the LD terminal is held high, and the BL. terminal is tied low. The state of the PH terminal depends on the type of display that is being drive. For driving LCD displays, a square wave. About 60 Hz swinging fully between the GND and Voce values must be applied to the phase terminal.



The display can be blanked by simply driving the BL terminal to the logic high state. When the LD terminal is in its normal high state, BCD inputs are decoded and fed directly to the seven segment output terminals of the IC. When the LD terminal is pulled low, the BCD input signals that are present at the moment of transition are latched into memory and fed to the seven segment outputs.

Applications of Decoder Driver ICs:

The following are some important applications of decoder driver ICs −

Decoder driver ICs are used in computers for addressing memory locations.

Decoder driver ICs are also used for code conversion such as BCD to 7-segment, binary to decimal, etc.

Decoder driver ICs are also used in de-multiplexing of digital signals.

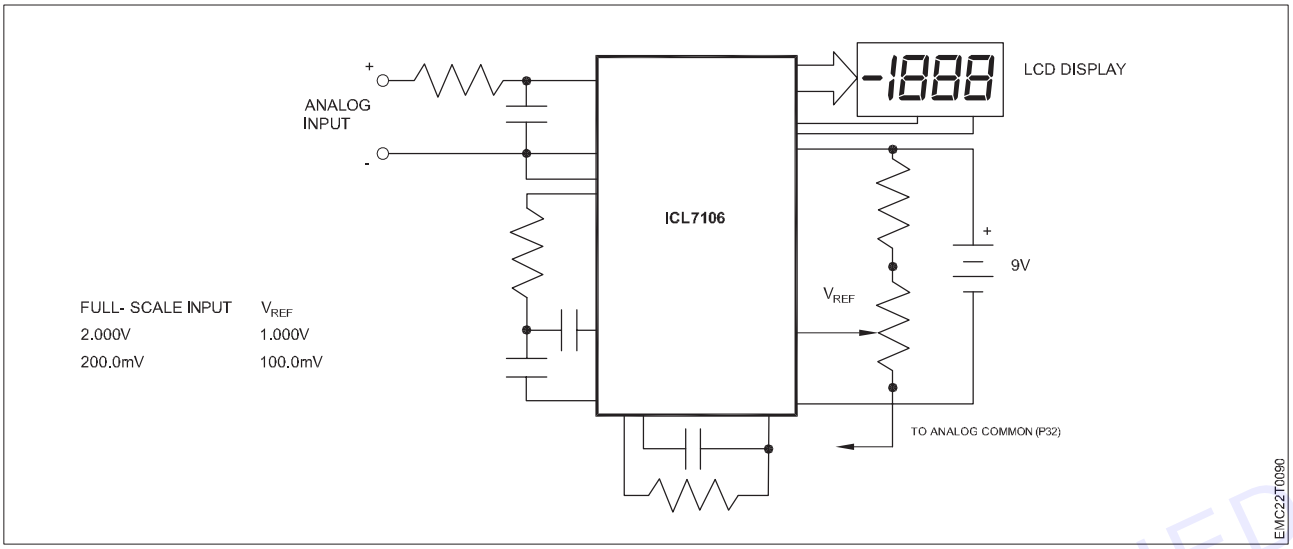
IC L7106 and IC L7107

The Maxim IC L7106 and IC L7107 are monolithic analog-to-digital converters. They have very high input impedances and require no external display drive circuitry. On-board active components include polarity and digit drivers, segment decoders, voltage reference and a clock circuit. The IC L7106 will directly drive a non-multiplexed Liquid crystal display (LCD), whereas the IC L7107 will directly drive a common anode light emitting diode display.

Versatility and accuracy are inherent features of these converters. These devices are used in a wide range of digital panel meter applications. Most applications, however, involve the measurement and display of analog data.

Circuit Diagram of L7106 and L7107:

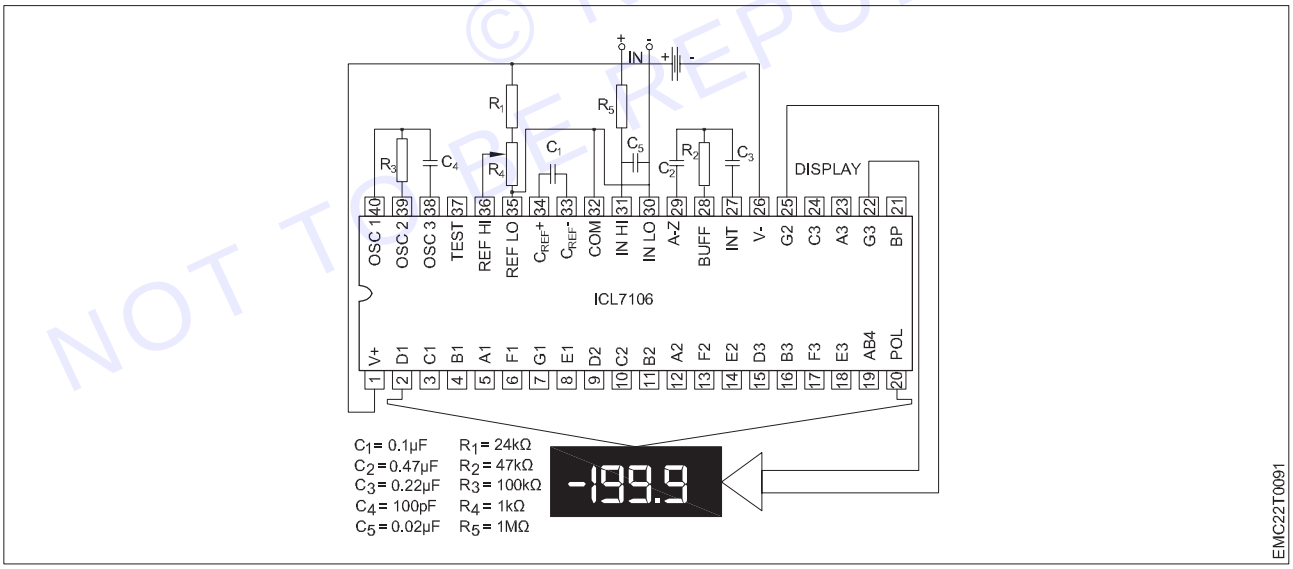
The block diagram of IC L7106 and IC L7107 is shown below:



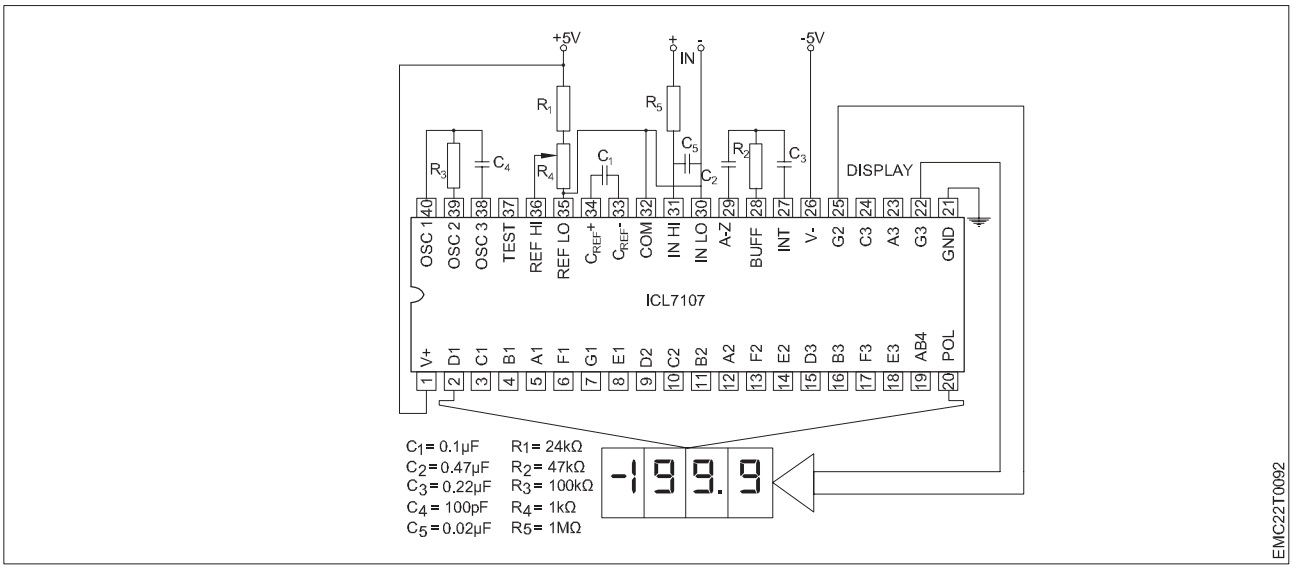
The IC L7106 and&107 are the first ICs to contain all the active circuitry for 3rd digit panel meter as a single chip.

Pin Configuration of IC L7106 and IC L7107

The IC L7106 is designed to interface with a Liquid Crystal Display (LCD) as shown in diagram.



The IC L7107 is intended for Light Emitting Diode (LED) displays as shown in diagram below.



In addition to a precision dual slope converter, both circuits contain BCD to seven segment decoders, display drivers, a clock and a reference.

Key Features of IC L7106 and L7107:

1 High impedance.

2 Low noise (<15 µV).

3 Clock and reference on clip.

4 No' external circuitry required.

For signal transmission accuracy, multiplexing is the best technique. It is also used in TV transmission so we must know about it.

Multiplexing

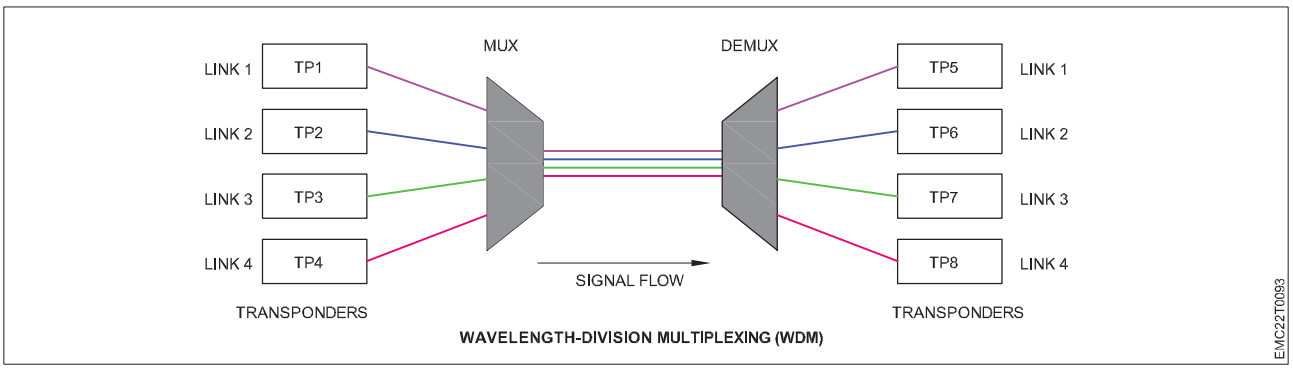
To combine multiple signals (analog or digital) for transmission over a single line or media, a common type of multiplexing combines several low-speed signals for transmission over a single high-speed connection.

Multiplexing is done by using a device called multiplexer (MUX) that combines input lines to generate one output line te, many to one. Therefore, multiplexer has several inputs and one output.

At the receiving end, a device called demultiplexer (DEMUX) is used that separates signals into their component A9 DEMUX has one input and several outputs.

Transmission of Signal Using Multiplexing:

As shown in the figure, multiplexer takes four-input lines and diverts them to single output line. The signal from four different devices is combined and carried by this single line.



At the receiving side, a demultiplexer takes this signal from a single line and breaks it into the original signals and passes them to the four different receivers.

Advantages of Multiplexing:

If no multiplexing is used between the users at two different sites that are distance apart, then separate communication lines would be required

This may not only be costly but may also become difficult to manage. If multiplexing is used then, only one line is required. This leads to the reduction in the line cost and also it would be easier to keep track of one line than several lines.

LCD has lots of applications, but digital panel meter is the most common application of LCD. DPM is a measuring instrument, which uses LCD to display results.

Digital Panel Meter (DPM):

A panel meter is an instrument that receives information from an input signal and then measures and displays the information in a digital or analog format. It is usually mounted inside an instrument panel. It often indica temperature, but may also reflect speed, pressure current, and many other variables.

The most common type of panel meter accepts a single input for display, although multiple channel devices are also available. The units are also available with large displays for visibility. Analog panel meters used to be common, they have been replaced in most circumstances by the more accurate and functional digital meter.

A digital panel meter is used to measure and display all types of processes and electrical variables, fr voltage monitoring to current, flow, speed, and more has a bright LED display that presents information in alphanumerical format with little or no ambiguity.

Many digital panel meters can accept multiple inputs have adjustable or bar graph displays that allow users also have totalizing, recording, conditioning, or other easily switch between these inputs. Digital displays mar functional capabilities.

In addition to being significantly more accurate, a digital panel meter generally has more available features than an analog meter. It can be selected with alarm options along with set point controls that allow users to establish control limits, as well as ON/OFF controls that can activate or deactivate a process unit. Many digital panel meters can be connected to a computer to transfer data, and some have ethernet capabilities that allow them to connect to a LAN or the internet.

Liquid Crystal Display (LCD)

LCD means Liquid Crystal Display. It is a combination of two states of matter, the solid and the liquid. LCD uses liquid crystal to produce a visible image. Liquid crystal displays are super-thin technology display screens that are generally used in TVs, cell phones, laptop/computer screen, etc. LCD's technologies allow displays to be much thinner when compared to Cathode Ray Tube (CRT) technology.

LCD is composed of several layers which includes two polarized panel filters and electrodes.

LCD is either made up of an active-matrix display grid or a passive display grid. The LCD has a unique advantage of having low power consumption than the LEDs or CRTs.

Principle of LCD:

The screen works on the principle of blocking light under than emitting light. LCD requires back light they do not emit light by them.

Construction of LCD:

We need two polarized glass pieces filter in making liquid crystal. The glass which does not have a polarized surface of it, must be rubbed with a special polymer which will create microscopic grooves on the surface of the polarized glass filter. The grooves must be in the same direction as the polarized film. Now, add a coating of pneumatic liquid phase crystal on one of the polarised filters of the polarized glass.

The microscopic channel causes the first layer molecule to to align with filter orientation. When the right angle ppears at the first layer piece, we should add a second piece of glass with the polarized film. The first filter will be actually polarized as the light strikes it at the starting stage.

Thus, light travels through each layer and is guided to the next with the help of molecules. The molecule tends to change its its plane of vibration of the light in order to match their angle.

When the light reaches to the far end of the liquid crystal substance, it vibrates at the same angle as that of the final layer of the molecule vibrates. The light is allowed to enter into the device only if the second layer of the polarized glass matches with the final layer of the molecule.

Working of LCD:

The principle of the LCD is that when an electrical current is applied to the liquid crystal molecule; molecule tends to untwist. This causes the angle of light which is passing through the molecule of the polarized glass and also causes a change in the angle of the top polarizing filter. A little light is allowed to pass the polarized glass through a particular area of the LCD. Thus, that particular area will become dark.

The LCD works on the principle of blocking light. A reflected mirror is arranged at the back of LCDs. An electrode plane is made of indium-tin oxide which is kept on top and a polarized glass with a polarizing film is also added on the bottom of the device. The complete region of the LCD has to be enclosed by a common electrode and above it should be the liquid crystal matter.

The second piece of glass with an electrode in the form of the rectangle on the bottom and on top, another polarizing film. It must be considered that both the pieces are kept at right angles. When there is no current, the light passes through the front of the LCD it will be reflected by the mirror and bounced back.

As the electrode is connected to a battery the current from it will cause the liquid crystals between the common-phase electrode and the electrode shaped like a rectangle to untwist. Thus, the light is blocked from passing through, and that particular rectangular area appears blank.

Advantages and Disadvantages of LCD

Advantages:

LCD consumes less power compared to CRT and LED.

LCDs consist of some microwatts for display in comparison to some mill watts for LED's.

LCDs are low cost.

LCD provides excellent contrast.

LCDs are thinner and lighter when compared to cathode ray tube and LED.

Disadvantages of LCD:

Slightly more expensive than CRT

Can't act as a portal to another dimension

Suffer from a motion blur effect

High refresh rate

Like the backlight ages, it can change colors slightly

The aspect ratio and resolution are fixed.

Different Size of LCDs:

There are different types of size available in the market few of them are:

480p – 720 x 480 pixels

720p (HD) – 1280 x 720 pixels.

1080p (Full HD) – 1920 x 1080 pixels.

1440p (2K QHD) – 2560 x 1440 pixels

2160p (4K UHD) – 3840 x 2160 pixels

4320p (8K UHD) – 7680 x 4320 pixels.

Types of LCDs:

1 Passive Matrix Display

2 Active-Matrix Display

1 Passive Displays:

Passive displays are widely used with segmented digits and characters for small readouts in devices such as calculators, printers and remote controls, many of which are monochrome or have only a few colors. Passive monochrome and color graphics displays were used in the first laptops, and they are still used as an alternative to active matrix.

2 Active-Matrix Displays (TFTs):

Unlike passive matrix LCDs, active matrix displays have a transistor at each red, green and blue subpixel that keeps them at the desired intensity until that row is addressed in the next frame.

Active-matrix screens are sharper and have more contrast than passive matrix displays, and their faster response times eliminate sub-margining. In addition, they are very bright indoors because they use a back light and HDTV sets on the market.

Active matrix is the only type of LCD on laptops. It is called a Thin Film Transistor (TFT) LCD because a thin layer of transistor is deposited on the back of the screen, and they use TN liquid crystal with a 90° twist.

Scrolling Display

In computer displays, film making, television production, scrolling is sliding text, images or video across a monitor or display, vertically or horizontally.

Scrolling may take place in discrete increments (perhaps one or a few lines of text at a time), or continuously (smooth scrolling). Frame rate is the speed at which an entire image is redisplayed.

It is related to scrolling in that changes to text and image position can only happen as often as the image can be redisplayed. When frame rate is a limiting factor, one smooth scrolling technique is to blur images during movement.

Components of Scrolling Display

Scrolling display boards are the most attractive display boards. They are widely used in public transport vehicles, information boards in railway stations, airports, advertisements, etc.

These are commonly made of LCDs and are usually connected to a computer or a simple micro controller which can send the data to the screen. The micro controller can send data to the screen using its serial port. The data could be saved in the me an OPPO A9 troller itself or it is received from a PC.

LESSON 84 - 89 : Light Emitting Diode (LED)

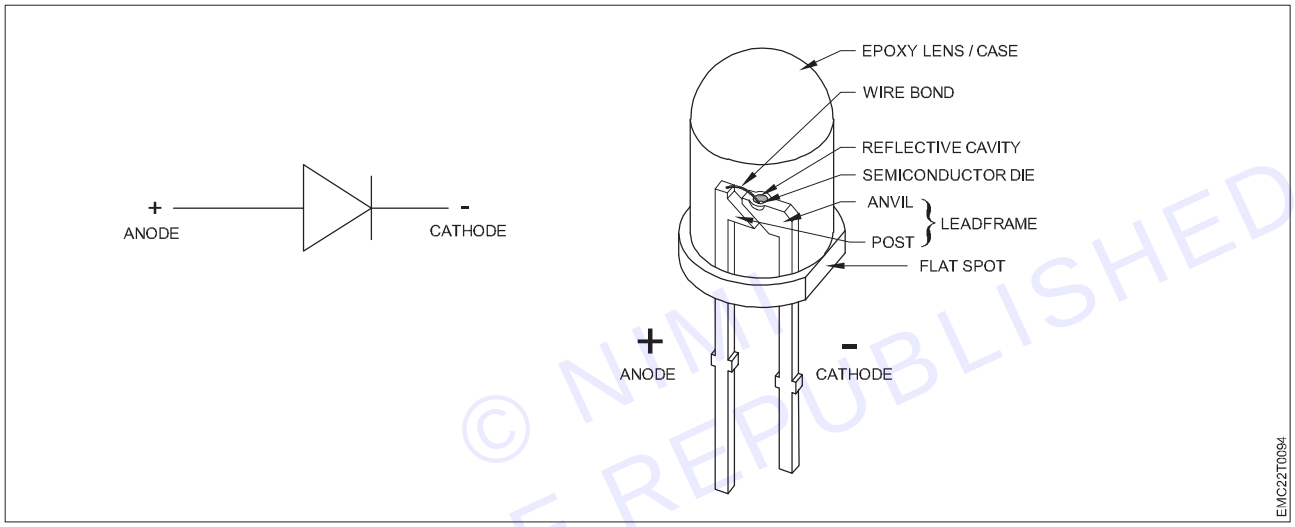
Objectives

At the end of this lesson you shall be able to:

- explain the principle, construction, advantages & disadvantages of LED.

A Light Emitting Diode (LED) is a semiconductor device that emits incoherent narrow-spectrum light when electrically biased in the forward direction. This effect is a form of electroluminescence. The color of the emitted light depends on the composition and condition of the semiconducting material used, and can be near ultraviolet, visible or infrared.

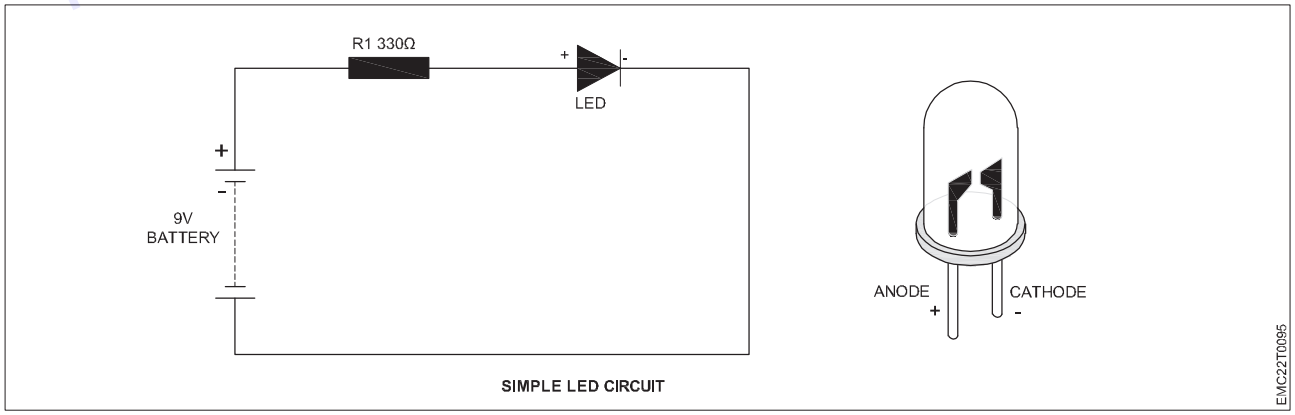
Symbol of LED



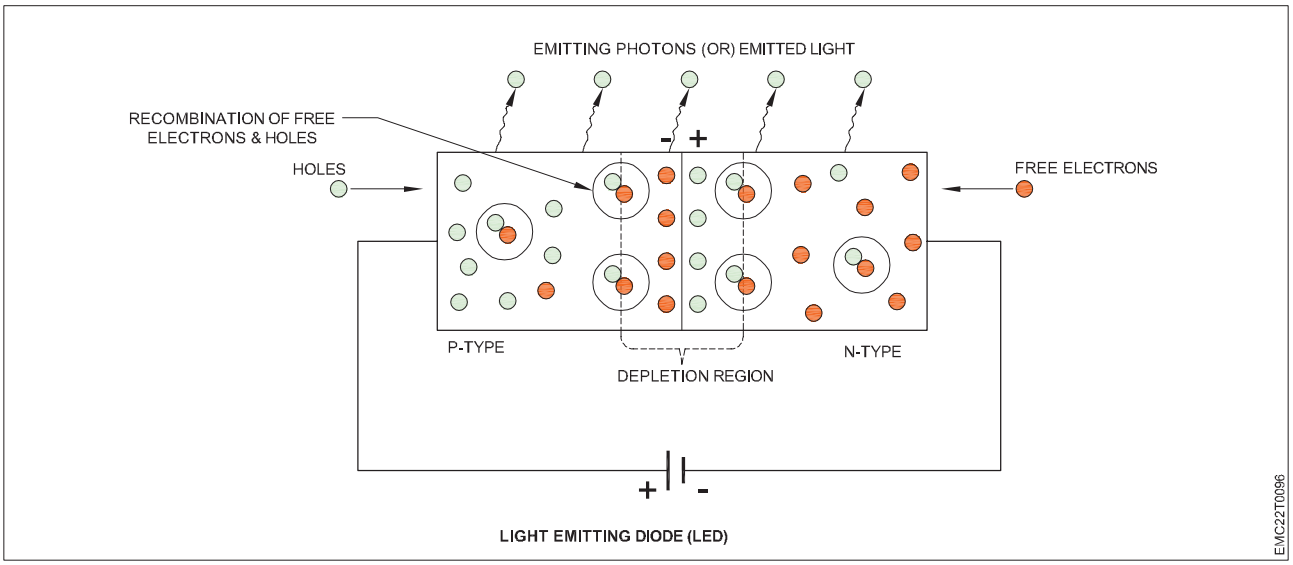
Working of LED:

LED is nothing but a type of diode. It also possesses a unique unidirectional property like general purpose diode. It cannot and should not be used for the purpose of rectifying AC to DC. The simple LED circuit and LED construction diagram is shown below.

LED CONSTRUCTION



SIMPLE LED CIRCUIT



Simple circuit of LED:

In any forward biased p-n junction, there is a recombination of holes and electrons. This recombination requires the energy possessed by the unbound free electron to be transferred from one to another state. In all semiconductor p-n junctions, some of the energy will be given in the form of heat and photons.

Hence, when an electron recombines with a free hole, it falls from higher energy to lower energy level releasing a photon of wavelength corresponding to energy level difference associated with the transition.

It should be remembered that during recombination, the energy difference is given up either in the form of heat or in the

In silicon and germanium, a greater percentage is given up in the form of heat and emitted light is significant. On the other hand, in GaAs, GaP, GaAsP, most of the energy is given in the form of light.

Common types of LEDs are operated at a forward bias of 1 V to 3 V and they emit light at a current of 10 mA to 15 mA. They are made in four different colors green, red, yellow and blue.

GaAs - infrared radiation (invisible)

GaPred - or green light (visible)

GaAsP - red or yellow light (visible)

Advantages and Disadvantages of LED

Advantages:

It is high efficiency.

It has low voltage and current requirements.

They are highly reliable.

No UV rays.

It can be easily controlled and programmed.

It has high levels of brightness and intensity.

LEDs last much longer, up to several years.

Disadvantages:

The luminous efficiency of LEDs decreases as the electrical current increases above 10 mA.

LED in high ambient temperature may result in overheating the LED package and leading to device failure.

Applications of LEDs:

The applications of LEDs in various fields are given below.

1 Sign Applications with LEDs
   a Traffic/VMS.
   b Full color video.
2 Signal Applications with LEDS
   a Rail
   b Runway lights
   c Aviation
   d Emergency/Police vehicle lighting
3 Consumer Electronics and General Indication
   a Household appliances
   b VCR/DVD/stereo/Audio/Video devices
   c Switches
   d Toys/Games instrumentation
4 Mobile Applications with LEDs
   a Mobile phone
   b Digital cameras
   c Laptops
   d General back lighting

Types of LED Panels Used in Various Lighting Applications

With the development of technology, there are aro kinds and types of lights or lamps Le both domestic international markets. Such as LED tube light others. They are various in shape, function, size, de concept and so on. For example, lamps or lights are used for entertainment, decoration, illumination, operating examination actually. Nowadays, a new king of light is very popular. That is the lead panel light.

LED panel light can be hanged on the roof or mean to the walls or on the roof or the surface of other This makes the led panel light applicable convenient for many applications such as windows, offices, bars, exhibition halls, meeting rooms residential lighting, boating, caravans, camping leisure, shop display and light box.

As a dominant force in the commercial light industry, LED panel light is devoted to offering them the highest quality LED light box solutions companies everywhere. Its life span is 10 times long than a fluorescent lamp. Its power consumption is much less than grill lamp by 50%.

LED Panel light is not only fashionable, but also one saving. It can also apply to many applications. It can be used both indoor and outdoor. If used indoors, LED and other things can be used in decoration and illumination. While used outdoors, it can be used for entertainment and landscape in public regions, such as parks and buildings.

There are some LED panel as discussed below.

LED Tube Light

LED tube light is one of the popular lights among consumers both at home and abroad.

Applications of LED tube light

i Decoration of hotel.
ii Restaurant.
iii Dinner room.
iv Shopping mall.
v Public area and etc.

Available in powers 9W, 14W, 16W, 18W, 23W, Energy saving can reach 80%. Longer life span of 30000 or 50000 hours.

LED panel light:

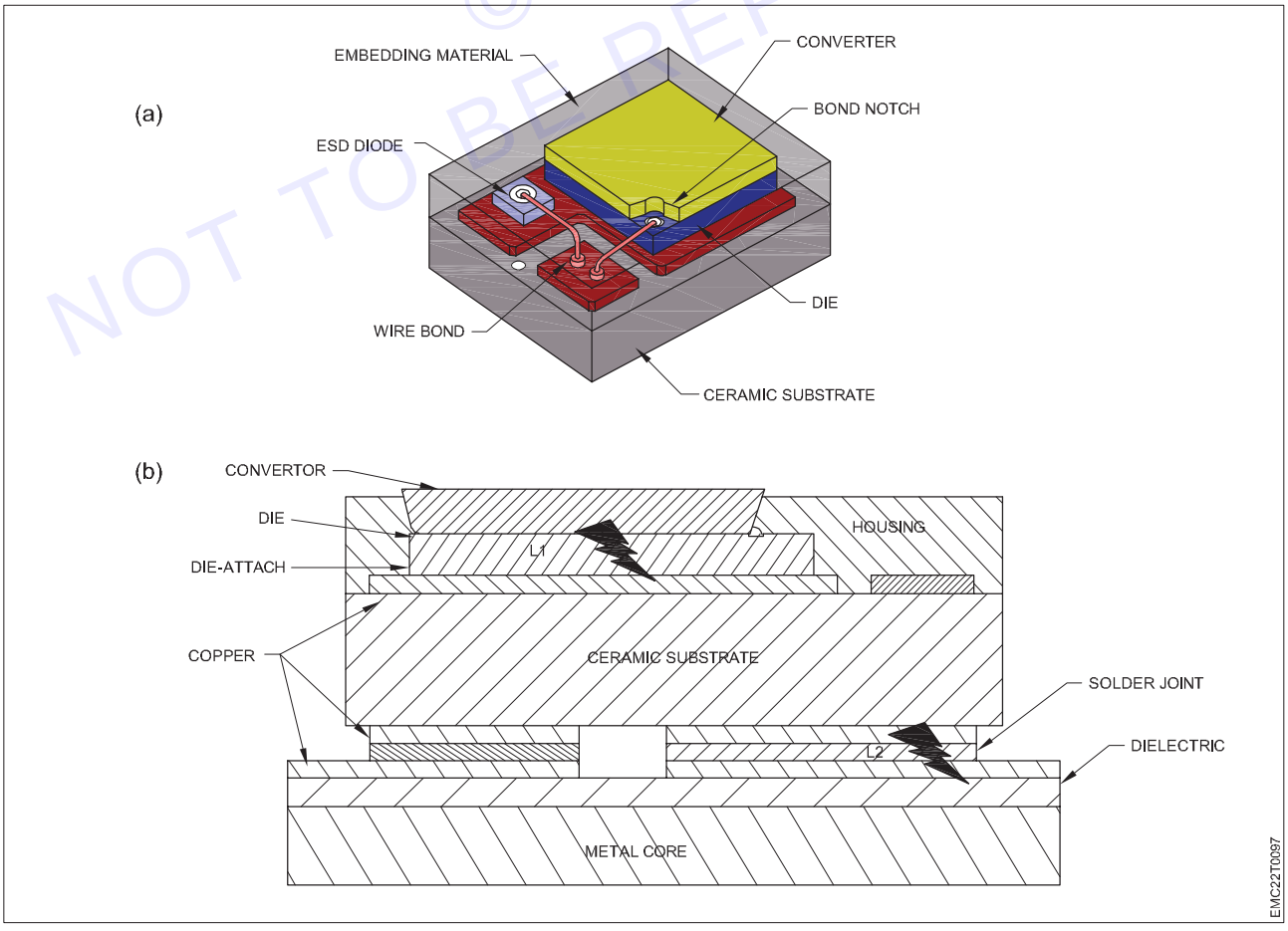
LED Panel lights are designed with the latest fashion design (as shown below). LED panel light can satisfy different illumination requirements.

LEDs panel light with different sizes, such as 200 x300 mm,300*600 mm, 300 *1200 mm, etc.

Stacking of LEDs:

The development of LED in a new manufacturing process is called stacked LED technology. Stacking LED dies directly on a con IC substrate. It helps to enable higher integration in monolithic IC packaging. This paper will introduce stacked LED technology.

The diagram below illustrates a cross sectional view of the stacked LED technology.



The photodiode chip comes with two transparent layers.

i SiO, passivation/insulation.

ii Light transmissive polyamide.

The LED is firmly attached to the photodiode with a transparent connecting layer. Standard dies attach process is used to make all placements.

Advantages of Stacked LEDS:

Some advantages are discussed below.

High Integration:

The stacked LED technology greatly enhances packaging capabilities and flexibility by utilizing conventional IC assembly equipment. An emitter detector chip set can be inserted into any required integrated package.

Reduce Process Steps:

The method requires fewer process steps and hence, is a more efficient manufacturing method.

Small and Thin Profile Package:

The total package height solely depends on the thickness of the combination of the IC, LED, the very thin polymide, and the band wire height to the LED.

Driving of LED Stacks:

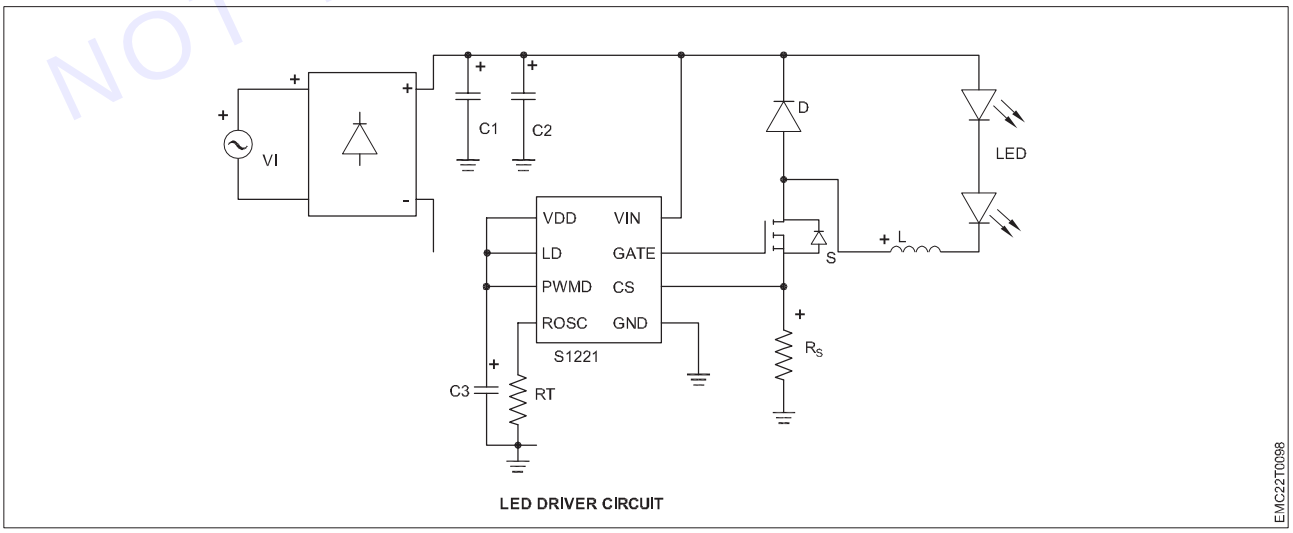
A LED drive circuit is a circuit, which can power a LED. We use a NPN transistor and a few resistors to bring about a circuit which, will minimal current, can produce enough current to drive and light an LED.

If you do not have sufficient current powerful enough to drive an LED, you can connect a transistor to the circuit, so that it provides enough current amplification to drive it. To power the base of the LED and the collector of the transistor, we provide 6 volts of

NPN transistors always need positive voltage applied to the collector in order to work. This is called reverse bias voltage so that the current in the transistor can flow from emitter to collector. These 6 volts can come either from A batteries connected in series or from a DC power supply.

LED Driver Circuit:

When the switch of the circuit is open, no current flows to the base of the transistor. The transistors cannot turn ON, Bipolar Junction Transistors (BITs) need base current and sufficient positive voltage to the collector in order to provide amplification. So, when the switch opens, neither the transistor nor the LED turn ON. When the switch closes, base current flows through the transistor, turning it ON. The transistor now provides amplification to the current, turning the LED ON



LED DRIVER CIRCUIT

If the LED connected straight to the 10-k resistor, without any transistor, it would not produce sufficient current to drive the LED. The current through the LED would be I = V/Rie., 6V/30k = 0.2 mA. This is not sufficient to drive an LED with any type of real brightness. With the NPN transistor in the circuit, amplification usually to the degree of about 100 to 150. Therefore, the current will be amplified by 100, which is 0.2mA 100 = 20mA. It means 20 MAs sufficient to drive and light the LED

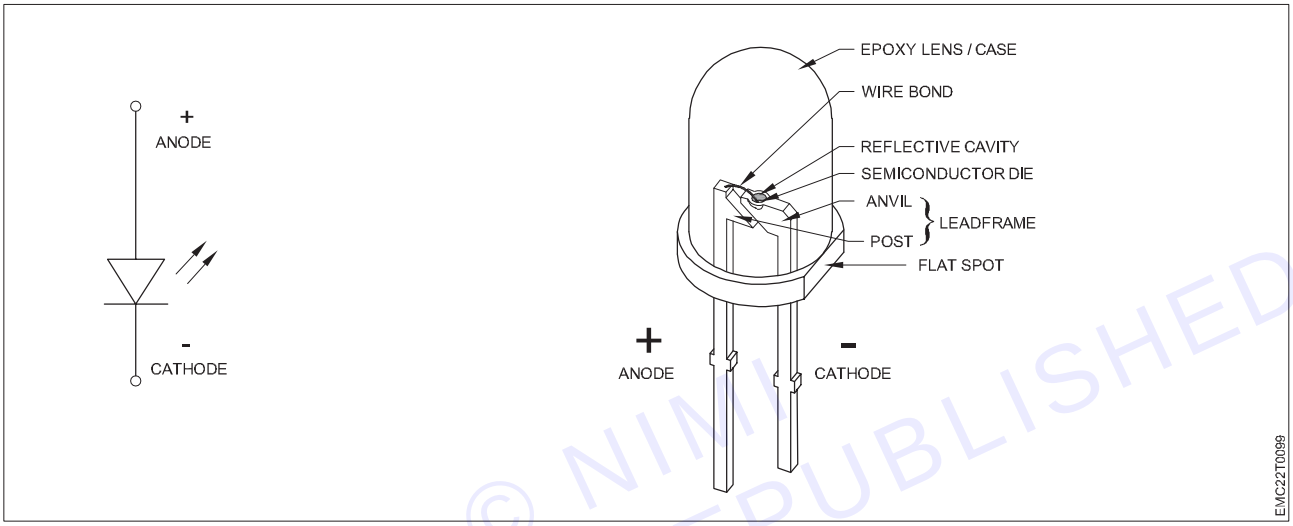
INTRODUCTION

LED Panel Lights have revolutionized the lighting industry with their energy efficiency, durability, and versatility. They are widely used in various applications, including offices, schools, hospitals, retail stores, and residential spaces. These panels offer a cost-effective and eco-friendly lighting solution that can significantly reduce energy consumption while providing high-quality illumination.

LED stands for Light Emitting Diode. They are a special type of diode that convert electrical energy into light. They have very similar electrical characteristics to a normal PN junction diode. That's why the symbol of LED is similar to the normal PN junction diode except that it contains arrows pointing away from the diode indicating that light is being emitted by the diode.

LED Construction:

LEDs are so common, they come in a huge variety of shapes, sizes and colors. The LEDs you are most likely to use are the standard through hole LEDs with two legs. Following figure shows the parts of it.

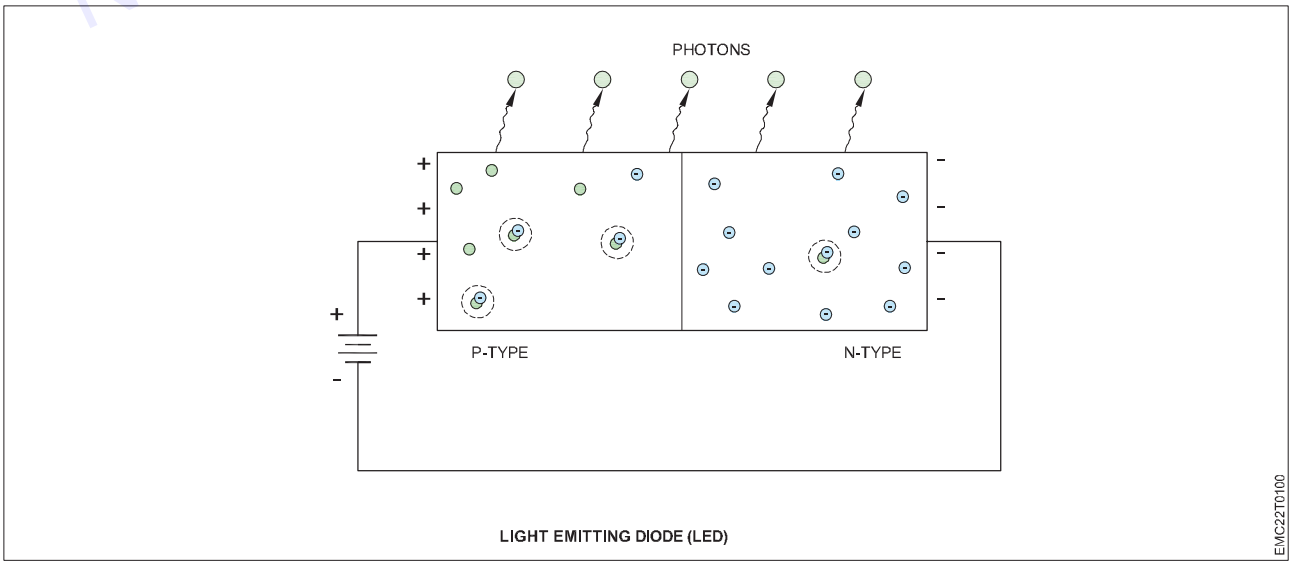


The construction of an LED is very different from an ordinary diode. The PN junction of an LED is surrounded by a transparent, rigid plastic epoxy resin shell.

The shell is constructed in such a way that photons of light emitted by the junction are focused upward through the domed top of the LED, which itself acts like a lens. This is why the emitted light appears brightest on top of the LED.

LED Working:

Like an ordinary diode, the LED operates only in forward bias condition. When the LED is forward biased, the free electrons cross the PN junction and recombine with holes. Since these electrons fall from a higher to a lower energy level, they radiate energy in the form of photons (light).



LIGHT EMITTING DIODE (LED)

In ordinary diodes, this energy is radiated as heat while in an LED, energy is radiated as light. This effect is called Electro luminescence.

Understanding Led Light Panels

LED Panel Lights consist of a flat surface with integrated light-emitting diodes (LEDs). These LEDs emit light when an electric current passes through them, producing a bright and even illumination. LED panels are designed to distribute light uniformly, eliminating shadows and glare, and providing a comfortable lighting environment.

Types Of Led Light Panels:

1 Edge-lit LED Panels

Edge-lit LED panels feature LEDs positioned around the edges of the panel, directing the light towards the center. They utilize a light guide plate to distribute the light evenly across the panel's surface. These panels are known for their slim profile and are ideal for spaces with limited ceiling height.

2 Back-lit LED Panels

Back-lit LED panels have LEDs positioned at the back of the panel, facing the diffuser. The light is evenly distributed across the panel through a diffuser, creating a uniform illumination. These panels offer excellent brightness and are commonly used in commercial settings such as offices and retail spaces.

3 Direct-lit LED Panels

Direct-lit LED panels have individual LEDs distributed across the entire surface of the panel. These panels provide a high level of brightness and are suitable for spaces that require intense illumination, such as warehouses and industrial facilities. Direct-lit panels are also known for their robust construction and long lifespan.

4 Tunable White LED Panels

Tunable White LED panels allow you to adjust the color temperature of the light, ranging from warm white to cool white. This feature enables you to create different lighting moods and adapt the ambiance of the space according to your needs. Tunable White panels are commonly used in applications where dynamic lighting is desired, such as art galleries and hospitality venues.

5 RGB LED Panels

RGB LED panels offer the ability to produce a wide range of colors by combining red, green, and blue LEDs. These panels are often used for decorative purposes, allowing you to create vibrant and eye-catching lighting displays. RGB panels are popular in entertainment venues, architectural lighting, and stage lighting applications.

6 Dimmable LED Panels

Dimmable LED panels provide the flexibility to adjust the brightness level according to the desired ambiance or task requirements. These panels can be dimmed using compatible dimmer switches or control systems, allowing you to create a cozy atmosphere or increase the light output when needed. Dimmable panels are commonly used in residential spaces, restaurants, and hotels.

7 Emergency LED Panels

Emergency LED panels are designed to provide illumination in the event of a power outage. These panels feature an integrated backup battery that automatically activates when the main power supply fails. Emergency panels ensure a safe and well-lit environment during critical situations, making them suitable for areas where uninterrupted lighting is essential, such as hospitals and emergency exits.

8 Customizable LED Panels

Customizable LED panels offer the flexibility to create unique lighting designs tailored to specific requirements. These panels can be customized in terms of shape, size, color temperature, and even graphics or logos. Customizable LED panels are often used in retail spaces, corporate offices, and architectural lighting installations.

Factors To Consider When Choosing Led Panel Lights:

When selecting LED panel lights, several factors should be taken into consideration:

Brightness and Output: Determine the required level of brightness and the desired light output for the intended application.

Color Temperature: Choose the appropriate color temperature that suits the space and the desired lighting ambiance.

Energy Efficiency: Look for panels with high energy efficiency ratings to reduce electricity consumption and operating costs.

Lifespan: Consider the lifespan of the LED panels to minimize maintenance and replacement requirements.

Installation: Ensure the panels are easy to install and compatible with the existing electrical systems.

Warranty and Support: Check for warranty coverage and after-sales support provided by the manufacturer or supplier.

Benefits Of Led Panel Lights:

LED panel lights offer numerous advantages compared to traditional lighting solutions:

Energy efficiency and reduced electricity costs

Long lifespan and low maintenance requirements

Eco-friendly with no hazardous substances like mercury

Instantaneous and flicker-free illumination

Even light distribution without shadows or glare

Versatile and customizable design options

Compatibility with advanced lighting control systems

Installation And Maintenance Tips:

To ensure optimal performance and longevity of LED panel lights, follow these installation and maintenance tips:

Hire a qualified electrician for proper installation.

Clean the panels regularly using a soft cloth or non-abrasive cleaner.

Avoid exposing the panels to excessive heat or moisture.

Inspect the panels periodically for any signs of damage or malfunction.

Follow the manufacturer's guidelines for any specific maintenance requirements.

Conclusion:

LED panel lights offer a versatile and energy-efficient lighting solution for a wide range of applications. Understanding the different types of LED panel lights allows you to make an informed decision when choosing the right lighting option for your needs. Whether it's edge-lit, back-lit, tunable white, or RGB panels, each type offers unique features and benefits. By considering factors such as brightness, color temperature, and energy efficiency, you can create an illuminated environment that enhances productivity, comfort, and aesthetics.

Advantages of LED:

LEDs operate very fast.

These can emit different colors of light.

LEDs do not contain toxic material like mercury which is used in fluorescent lamps.

Brightness of LED can be easily controlled by varying the current.

These are smaller in size, light in weight and have longer in lifetime.

These are very cheap, readily available and consume low energy.

Almost no warm up period. LEDs start emitting light in nanoseconds.

Excellent colour rendering: Colours produced by LED do not fade out making them perfect for displays and retail applications.

Environment friendly: LEDs do not contain mercury or other hazardous substances.

Controllable: Brightness and colour of light emitted by LEDs can be controlled.

Disadvantages of LED:

LEDs are efficiency is low and need more power to operate than normal p-n junction diodes.

Hazardous blue light quality, temperature dependence, voltage sensitivity, high initial cost.

Applications of LED:

Picture phones and digital watches

Camera flashes and automotive heat lamps

Aviation lighting

Digital computers and calculators

Traffic signals and Burglar alarms systems

Microprocessors and multiplexers

Optical Communication

Indicator lamps in electric equipment

LED television

Vehicle head lamps, domestic and decorative illumination, street lighting.

LED STACKING:

To stack LED modules a corresponding substructure is required so that they can be easily stacked up and stand statically secure. The LED stacking from EXACT offers a stable modular system that can be easily attached to the various LED modules on the market.

Stack lights are used in similar applications to beacon lights/strobes, however the information they typically display encompasses more machine/process conditions. Stack lights typically use inincandescent , LED or xenon-type strobes as their illumination source.

Stack lights are generally columnar structures in a variety of shapes, placing colour-coded indicator segments on top of one another in a “stacked” orientation. A stack light will typically have up to five differently coloured segments to indicate various conditions on the machine or process.

Segments in any combination of (typically) red, yellow, green, blue or clear white are actuated independently and are either off, steadily lit, or flashing.

Stack lights are passive devices that may be controlled directly by programmable logic controllers, distributed control systems, PC control systems or hardwired to machine controls such as timers, sensors and latching relays.

Function

Various size stack lights

Stack lights are used in a variety of machines and process environments; specific colour-coding is assigned by the system designer.

Commonly used colour codes for machine state conditions include:

RED: Failure conditions such as an emergency stop or machine fault

AMBER: Warnings such as over-temperature or over-pressure conditions

GREEN: Normal machine or process operation

BLUE: External help request, where an operator might be requesting raw materials, scheduling or maintenance personnel assistance

WHITE: User-defined conditions to a specific machine, often related to productivity monitoring

Optionally an audible alarm buzzer, typically in the range of 70-105dB, may be added to alert machine operators to high priority conditions.

IEC60073 addresses machine state colour-coding & acoustic alerting, which can be applied to devices including panel pilot lights & stack lights. Machine operator intervention is typically required in red and yellow machine states, as these are normally errors or warnings. Manual intervention is possibly necessary in blue and white conditions.

Applications:

Demonstration by technician in Colgate Palmolive of how the Andon Button works

Common applications include, but are not limited to:

Productivity monitoring (often rate-based machine output management with parts-per-hour displays). Uptime & downtime monitoring (overall equipment effectiveness) is a very common use for these devices.

Warning indication and machine fault management

Lean manufacturing - 5S Initiatives

In conjunction with SCADA supervisory control systems and user interface/HMIs: SCADA/HMIs provide more specific machine/process status data; stack lights complement them by providing visual/audible feedback away from the machine operator console.

Assembly station workcells

Maintenance call stations

CNC machining equipment and process monitoring and feedback

Broadcast studios (commonly used in broadcast radio studios) to display status of things such as a studio on air, live microphones, phone calls and even as a doorbell in an environment where silent indication is critical.

Dispatch centers where the dispatcher frequently uses a headset making it difficult to tell when the dispatcher is on the phone or radio. The light will light one color when the radio is keyed and another when on the phone.

Driving of Led Stacks

A LED driver is a power regulator . Technically it is a circuit which is responsible for regulating and supplying the ideal current to the LED. The LED driver provides power and regulates the variable needs of LEDs by providing constant amount of power as the properties of it change with temperature.

An LED driver is a device that regulates and supplies the optimal current and voltage to an LED light. An LED light is a type of lighting that uses light-emitting diodes (LEDs) as the source of light. LEDs are more efficient and durable than traditional bulbs, but they also have different power requirements. LEDs need a constant and precise amount of power to work effectively, as their properties change with temperature and age. An LED driver provides this power by converting the high voltage alternating current (AC) from the building to the low voltage direct current (DC) that the LED needs.

An LED driver is essential for the performance and longevity of an LED light. Without a good LED driver, an LED light may not work properly, or it may burn out quickly. Most LED failures are not caused by the LED itself, but by the driver. The driver is a complex circuit board that has to withstand constant power conversion and regulation. The driver may fail due to overheating, short-circuiting, or poor quality components.

LED Lights can last decades, but only if they have a good LED driver. See our How LEDs work section for more about general LEDs.

In an LED Light the driver does all the heavy lifting. Whether its an LED Corn light bulb or an LED fixture it has a driver inside. That driver takes input from the building in alternating current or ac and converts it to direct current or dc. In your home that means from 120vac down to 36vdc or 48vdc. It works as a giant transformer. Doing that constantly requires a very high end product. Most of the issues we see with LED failures are from the driver.

An LED driver can be found inside any LED light, whether it is an LED corn light bulb or an LED fixture. The driver can vary in size, shape, and design depending on the type and application of the LED light. For example, an LED high bay light may need a more powerful and robust driver than an LED path light. The driver can also have different features, such as dimmers, timers, motion sensors, battery backups, wattage selection or remote controls, that can enhance the functionality and convenience of the LED light.

MODULE 9 : Solar power (renewable energy system)

LESSON 90 - 93 : Solar power

Objectives

At the end of this lesson you shall be able to:

- state the need of solar power
- explain principle involved in solar cell
- difference between conventional & non- conventional sources opf energy.

Solar power

Need for Renewable energy

Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed. Sunlight and wind, for example, are such sources that are constantly being replenished. Renewable energy sources are plentiful and all around us. Fossil fuels - coal, oil and gas - on the other hand, are non-renewable resources that take hundreds of millions of years to form. Fossil fuels, when burned to produce energy, cause harmful greenhouse gas emissions, such as carbon dioxide.

Generating renewable energy creates far lower emissions than burning fossil fuels. Transitioning from fossil fuels, which currently account for the lion's share of emissions, to renewable energy is key to addressing the climate crisis.

Renewables are now cheaper in most countries, and generate three times more jobs than fossil fuels.

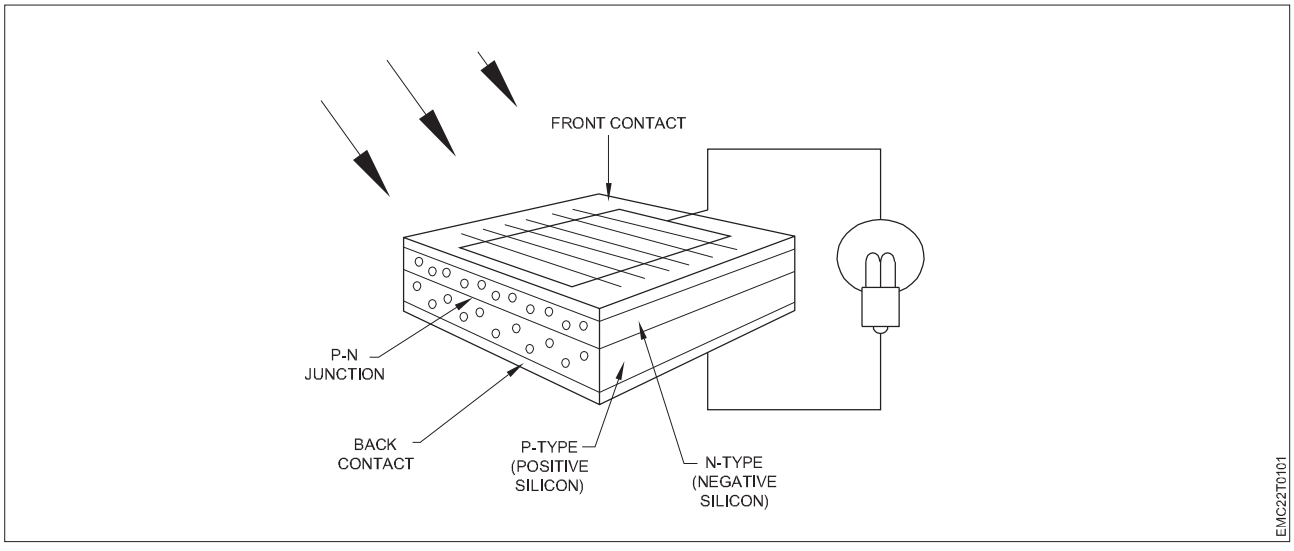
Material used for solar cell

The metal that is highly used in solar cell is silicon as it shows the properties of a semiconductor. Cesium metal is also used in making solar cell due to its low ionization energy and it can easily convert sunlight into electrical energy.

A Solar panels (also known as "PV panels") is a device that converts light from the sun, which is composed of particles of energy called "photons", into electricity that can be used to power electrical loads.

Solar panels can be used for a wide variety of applications including remote power systems for cabins, telecommunications equipment, remote sensing, and of course for the production of electricity by residential and commercial solar electric systems.

Working Principle of Solar Cell: When light reaches the p-n junction, the light photons can easily enter in the junction, through very thin p-type layer. The light energy, in the form of photons, supplies sufficient energy to the junction to create a number of electron-hole pairs.



The incident light breaks the thermal equilibrium condition of the junction. The free electrons in the depletion region can quickly come to the n-type side of the junction. Similarly, the holes in the depletion can quickly come to the p-type side of the junction. Once, the newly created free electrons come to the n-type side, cannot further cross the junction because of barrier potential of the junction. Similarly, the newly created holes Nonrenewable, or "dirty," energy includes fossil fuels such as oil, gas, and coal. Nonrenewable sources of energy centration of holes becomes more in another side, i.e. the p-type side of the junction, the p-n junction will behave like a small battery cell. A voltage is set up which is known as photo voltage. If we connect a small load across the junction, there will be a tiny current flowing through it. Commonly used materials are-Silicon, GaAs, CdTe etc.

Criteria for Materials to be Used in Solar Cell

1 Must have band gap from 1ev to 1.8ev

2 It must have high optical absorption.

3 It must have high electrical conductivity.

4 The raw material must be available in abundance and the cost Of the material must be low.

Basic of Photo voltaic cell

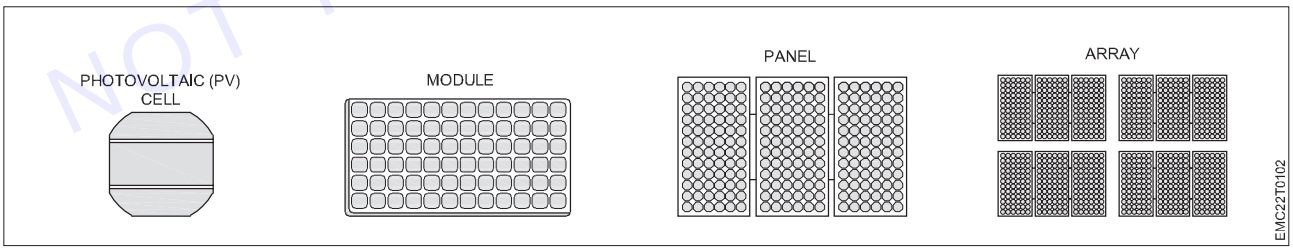
A solar cell (also known as a photovoltaic cell or PV cell) is defined as an electrical device that converts light energy into electrical energy through the photovoltaic effect. A solar cell is basically a p-n junction diode. Solar cells are a form of photoelectric cell, defined as a device whose electrical characteristics – such as current, voltage, or resistance vary when exposed to light.

Individual solar cells can be combined to form modules commonly known as solar panels The common single junction silicon solar cell can produce a maximum open- circuit voltage of approximately 0.5 to 0.6 volts. By itself this isn't much but remember these solar cells are tiny. When combined into a large solar panel, considerable, amounts of renewable energy can be generated.

Construction of Solar Cell

A solar cell is basically a junction diode, although its construction it is little bit different from conventional p-n junction diodes. A very thin layer of p-type semiconductor is grown on a relatively thicker n-type semiconductor. We then apply a few finer electrodes on the top of the p-type semiconductor layer. These electrodes do not obstruct light to reach the thin p-type layer. Just below the p- type layer there is a p-n junction. We also provide a current collecting electrode at the bottom of the n-type layer. We encapsulate the entire assembly by thin glass to protect

Module Panel and Array



A solar cell is the basic building block of a solar module. Each cell produces approximately 1/2 a volt and a solar module can have any number of solar cells. A solar module designed for charging a 12 volt battery will typically have 36 solar cells while the typical residential grid connected system uses solar modules with 60 solar cells. For large commercial and utility scale solar systems, solar modules will have typically 72 solar cells. By increasing the number of solar cells the module voltage and wattage increases.

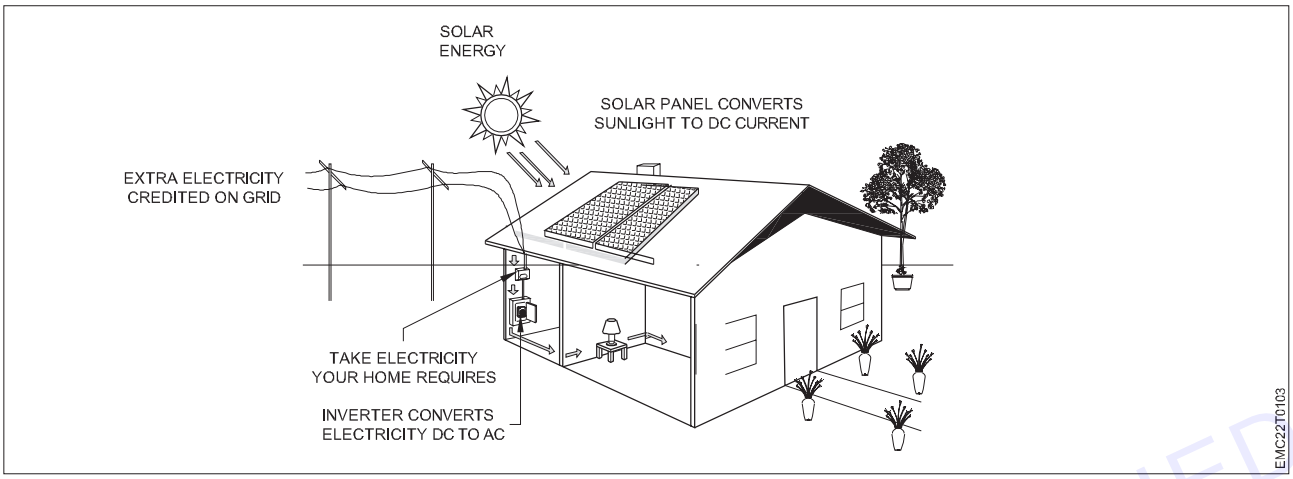
Most solar cells manufactured today are approximately 6″ by 6″. Small custom solar modules will contain solar cells that are cut to smaller sizes. For example if a full size solar cell produces 10 amps and it is cut in half it will now only produce 5A. As the solar cell is cut in half, its typical voltage remains unchanged at 1/2 a volt.

Factor that influence the output of a PV Module

The major that affect the output of module are load resistance ,sunlight intensity (module direction and tilt), cell temperature, shading soiling , module mismatch , invertor conversion losses and solar cell structure.

Solar photovoltaic systems

A photovoltaic system, also called a PV system or solar power system, is an electric power system designed to supply usable solar power by means of photovoltaics It consists of an arrangement of several components, including solar panels to absorb and convert sunlight into electricity, a solar inverter to convert the output from direct to alternating current, as well as mounting, cabling, and other electrical accessories to set up a working system. It may also use a solar tracking system to improve the system's overall performance and include an integrated battery.



Advantages of photovoltaic systems

1 **High reliability:** Photovoltaic systems are still highly reliable even under harsh conditions. Photovoltaic arrays ensure continuous, uninterrupted operation of critical power supplies.

2 **Strong persistence:** Most modules in a PV system have a warranty period of up to 25 years and remain operational even after many years.

3 **Low maintenance costs:** Photovoltaic systems require only regular inspections and occasional repairs, which are extremely low cost compared to conventional fuel systems.

4 **Zero fuel consumption:** Photovoltaic systems do not require fuel and can eliminate associated procurement, storage and transportation costs.

5 **Noise pollution is small:** The photovoltaic system can operate quality with minimum mechanical movement.

6 **There is photovoltaic supervision:** In order to improve energy efficiency, photovoltaic systems may need to add some modules.

7 **Strong security:** Photovoltaic systems do not require fuel and can be safely operated after proper design and installation.

8 **Strong independence:** The reason for adopting this new technology in many residential areas is that photovoltaic systems maintain the independence of energy production and are therefore unaffected by utilities.

Disadvantages of photovoltaic systems

1 High startup cost

Each PV installation should be economically evaluated and compared to existing alternatives. At present, the construction cost of photovoltaic systems is relatively high, but with the reduction of photovoltaic system

Construction costs and the rise of traditional energy prices, photovoltaic systems will have strong economic competitiveness.

2 Available solar radiation instability

For any solar system, weather changes will greatly affect the amount of electrical energy output. Therefore, the system design needs to be adjusted according to changes in climate and location.

3 Have energy storage requirements

Some photovoltaic systems use batteries as energy storage devices. This increases the footprint, cost and complexity of the system.

4 Efficiency needs to be improved

In order for PV systems to reflect cost-effectiveness, we need to use an efficient method to distribute the energy generated during use. However, they are now often used to power alternative inefficient appliances.

5 Lack of knowledge and skills

Photovoltaic technology is an emerging technology. The lack of relevant information limits the development of its markets and technologies.

Differences between Conventional and Non-conventional Sources of Energy:

1 Conventional sources of energy are derived from fossil fuels like coal, oil, and natural gas, while non-conventional sources of energy come from renewable sources such as solar, wind, hydro, geothermal, and biomass.

2 Conventional sources have limited availability and are non-renewable, meaning they will eventually run out, while non-conventional sources are abundant and renewable.

3 Conventional sources contribute significantly to carbon emissions and climate change, whereas non-conventional sources have low or zero carbon emissions, making them environmentally friendly.

4 Conventional energy technologies are well-established and widely used, whereas non-conventional energy technologies are still evolving and gaining popularity.

5 Conventional energy sources are generally cheaper initially, while non-conventional sources require higher upfront costs but offer long-term savings.

6 Conventional sources rely on centralized grids to distribute energy, while non-conventional sources enable the use of distributed energy systems, reducing dependency on centralized infrastructure.

7 Conventional sources are often associated with geopolitical conflicts due to their reliance on limited resources from specific regions, where as non-conventional sources reduce such conflicts as they can be harnessed locally.

8 Conventional sources have a significant environmental impact, including air and water pollution, habitat destruction, and resource depletion, whereas non-conventional sources have minimal environmental impact.

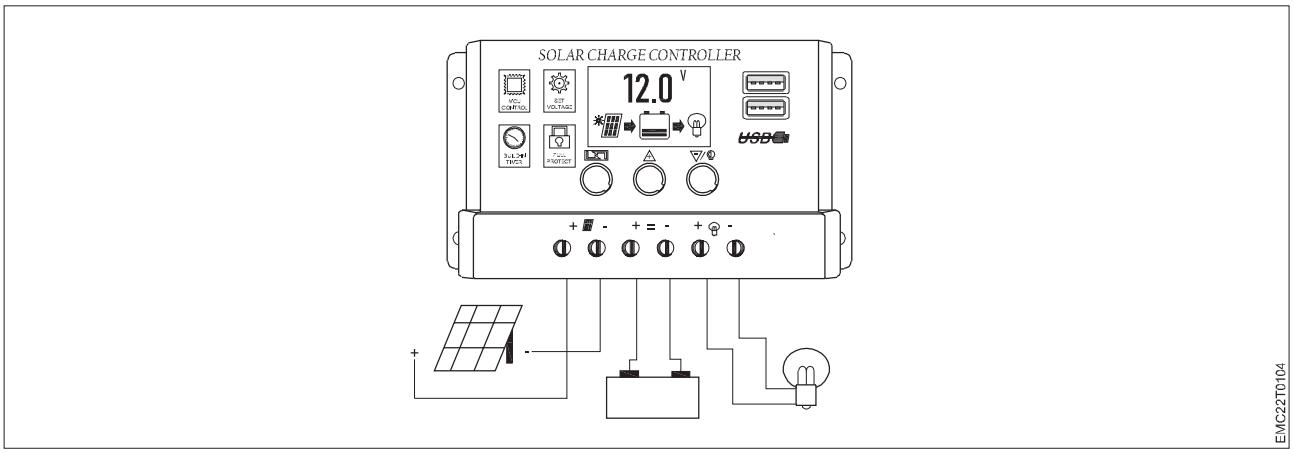
9 Conventional energy is considered a mature industry with well-established supply chains and job markets, whereas non-conventional energy represents a growing industry with increasing employment opportunities.

10 Conventional sources require on going extraction and transportation, whereas non-conventional sources enable local generation and can enhance energy independence.

Solar charge controller

A solar charge controller is used to keep the battery from overcharging by regulating the voltage and current coming from the solar panel to the battery. It is programmed at 15-A/200-W unit and uses MPPT (maximum power point tracking) to accelerate solar charging of the battery up to 30% per day

This device manages the power flow from your solar panels to your batteries, ensuring optimal performance and longevity.



Solar controller is three types

Maximum Power Point Tracking (MPPT)

Pulse Width Modulation (PWM)

Simple 1 or 2 Stage Controllers.

1 MPPT Solar Charge Controllers

MPPT controllers use cutting-edge technology to let your solar array operate at its maximum power point. This ensures optimal current and voltage, converting any extra energy into more power for your batteries.

This contrast with older PWM controllers, which let some of this extra energy go to waste. Over the years, MPPT technology has become more affordable, making it the go-to option for many residential solar systems. In fact, you can boost your solar system's efficiency by up to 30% using an MPPT controller. These controllers achieve this by transforming extra voltage into added current, funneling more energy into your batteries. Even though MPPT controllers are pricier upfront, they save you money in the long run by maximizing the energy you get from your solar panels.

They're especially useful when your battery levels are low; the MPPT controller will convert extra voltage into more current to recharge the battery more quickly.

If setting up a solar system from scratch seems daunting, there are all-in-one packages that can help. All you have to do is buy the solar panels that fit your needs, and you're ready to go.

2 PWM Solar Charge Controller

PWM, or Pulse Width Modulation controllers, are an older and less costly option for solar systems.

They're not as efficient as MPPT controllers, so it takes longer to fully charge a battery if you're using a PWM controller. Like MPPT controllers, PWM ones also manage the flow of energy to your battery bank, but they do it in a unique way. They reduce the electrical current gradually while charging, and when the battery is full, they keep sending a tiny amount of power to keep the battery full.

For a PWM controller to work, your solar panels and batteries have to run at the same voltage level. This makes them a poor fit for big home solar systems. With a PWM controller, you're restricted to using the power that matches your battery voltage, usually about 12V. Any extra power generated by your solar panels is lost. This is in contrast to MPPT controllers, which can change extra voltage into more current. PWM controllers are a better fit for hot areas, where the benefits of an MPPT controller aren't as noticeable.

They're also a cost-effective choice for small setups where an MPPT controller might not be worth the investment.

3 Simple 1 or 2 Stage Controllers

These are the most basic types and are often used in very small systems like solar yard lights. They basically connect or disconnect the solar panel to control voltage, but they offer the least amount of control and efficiency.

How to Choose controller

How to Choose Which Type of Solar Charge Controller Is Right for You? For modern homes or large leisure solar setups, your main options are MPPT and PWM charge controllers.

An MPPT charge controller is the go-to choice for home solar projects, RVs, cabins, and other places off the grid. Unless you're only using a single or a pair of solar panels, like on a camping trip, the extra benefits of an MPPT controller make it worth the somewhat higher cost.

MPPT controllers use updated tech to work at the best voltage for power, which is especially useful in cold weather when the voltage from the solar panels is much higher than the battery's.

MPPT controllers can also work with higher voltages and less current, making your setup simpler. PWM controllers are smaller and work at the same voltage as your battery. With PWM controllers, your solar panels have to be the same voltage as your battery. This limits your options.

Many solar panels that work great with MPPT controllers won't work with PWM controllers because of the voltage difference.

Step Solar Panel Installation Process:

Solar panel installation requires proper training and equipment to perform in order to prevent accidents. While it may seem complicated, the process can actually be divided into seven steps.

These are the seven steps for a successful solar panel installation.

1 Set Up the Scaffolding

Scaffolding needs to be set up before installing the solar system. This step takes up the most time to build, usually about an entire day. These are required for the safety of the ones installing the panels. If you're not installing your solar panel system onto the roof, setting up any safety measures may take less time.

2 Install the Solar Panel Mounts

Once all safety measures are in place, it's time to install the solar panel mounting system. This will hold your panels in place and provide a stable foundation for your solar system.

You'll have to lift your roof tiles to install your mounting system onto the rafters of your loft. It must be tilted between 18 and 36 degrees so the solar PV panels can collect direct sunlight.

3 Mount the Solar Panels

Next, install the solar panels onto the mounting structure. Before securing them, position or tilt them properly to maximise the sun's energy they can receive and absorb. Ensure that you tighten all the bolts to keep the panels in place.

4 Secure the Electrical Wiring

The next step is setting up the electrical wiring, which can vary depending on the model. The most common are the MC4 connectors, which are compatible with most panels. Most panels come pre-wired from the manufacturer for easier installation. However, it's still best to have this step performed by a professional electrician.

Safety tip

Ensure your household's electricity is switched off before working on this step.

5 Connect the Solar Inverter

The solar inverter is installed near the main panel. It's best not to mount this on the roof since it's supposed to be located in a cool place without sunlight. This part of the installation process can take about 4-6 hours, depending on the complexity of your solar panels.

It's important to set this up properly because the direct current (DC) electricity will be converted to alternating current (AC) electricity. Any system failures can cause fires and easily invalidate your home insurance. You can connect a generator meter to track how much electricity you generate daily with your solar panels.

6 Bond the Inverter to the Solar Battery

Then, you have to connect your solar inverter to the consumer unit to generate electricity. Solar batteries can be considered as an extra cost by some people. It helps store excess energy and keep your home powered even when your whole system is affected by cloudy days.

Once everything is connected to the consumer unit and grid input, you can check the connected generation meter for its performance. You can also use a computer to verify that your panels collect enough energy to power your home.

7 Test the Newly Installed Solar Panels

The installation process isn't complete until you've tested the panels. Switch the power back on and monitor each part. Ensure everything works and is properly producing energy. Series wiring can be useful if you need to increase the voltage to reach a certain level, while parallel wiring can help if you need to increase the current to power a larger load. Ultimately, the decision between series and parallel wiring comes down to your specific needs and preferences.

Factors to Consider Before Installing Solar Panels

There are many factors to consider when installing solar panels on your roof. Besides checking if you have a home suitable for solar/thermal energy, you'll also have to check on the other factors involved in the installation process.

While switching to solar power has many potential benefits, it's best to ensure that it's the right renewable source for reducing your carbon footprint.

Safety Tips for Solar Installers

Workers installing solar panels may face possible risks, but by using safety precautions, the likelihood of mishaps and injuries can be reduced. Some safety advice for photovoltaic contractors is provided below-

Training properly: Before starting work on solar panel installation tasks Employee should undergo proper safety training.

Wear the right PPE: To safeguard themselves from possible dangers, workers should put on the right personal protective equipment (PPE), such as hard hats, safety eyewear, gloves, and fall protection gear.

Check weather conditions: Before starting a job, employees should check the temperature, and they should avoid working on slick or wet areas.

Identify potential hazards: Potential dangers should be noted by workers so that proper safety precautions can be taken, such as avoiding unstable areas or overhead power lines.

Proper ladder use: Employers should use ladders firmly and cautiously, adhering to OSHA regulations.

Employ the right tools: When dealing with live cables, employees should use insulated tools, which are the right instruments for the task.

Operate in teams: Employees should collaborate to make sure that someone is always on hand to offer help if necessary.

Advantages of Solar Cell

1 No pollution associated with it.

2 It must last for a long time.

3 No maintenance cost.

Disadvantages of Solar Cell

1 It has high cost of installation.

2 It has low efficiency.

3 During cloudy day, the energy cannot be produced and also at night we will not.

MODULE 10 : Fiber optics communication

LESSON 94 - 99 : Fiber optics communication

Objectives

At the end of this lesson you shall be able to:

- define optic fibre and its types
- state the specifications, advantages, properties etc of optic fibre.

Fiber optics communication

Introduction

Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. The light forms an electromagnetic carrier wave that is modulated to carry information. Fiber is preferred over electrical cabling when high bandwidth, long distance, or immunity to electromagnetic interference are required. This type of communication can transmit voice, video, and telemetry through local area networks, computer networks, or across long distances. Optical fiber is used by many telecommunications companies to transmit telephone signals, Internet communication

Fiber Optics

Fiber optics is the technology used by internet services such as Verizon Fios home internet to transmit information as pulses of light through strands of fiber made of glass or plastic over long distances (TIR-Total Interanl Reflection)

Optical fiber has two layers, the inner layer, and the outer layer.

The inner layer is called the core.

The data pass through a core. This core is made of dense glass or plastic.

The outer layer of a fiber is called cladding.

It is also made of glass or plastic.

Cladding is used in the optical fiber to prevent any refraction while passing data.

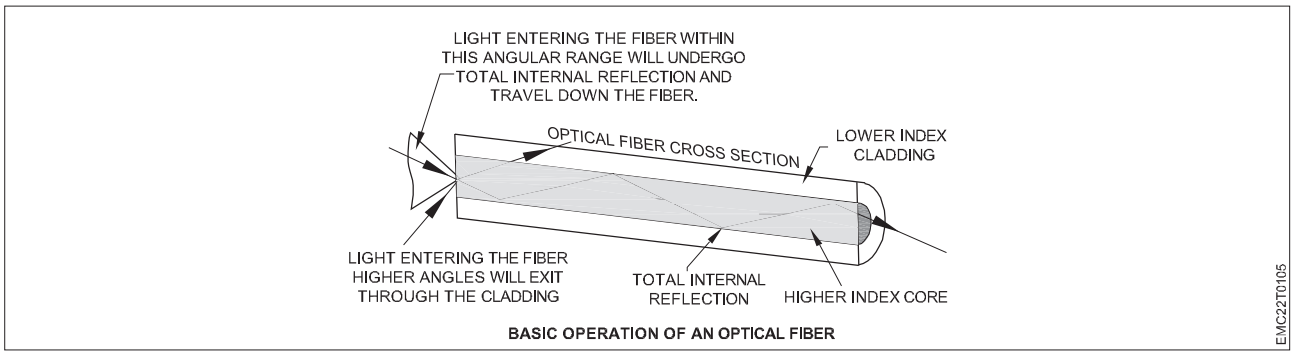
The process of communicating using fiber- optics involves the following basic steps:

creating the optical signal involving the use of a transmitter, usually from an electrical signal

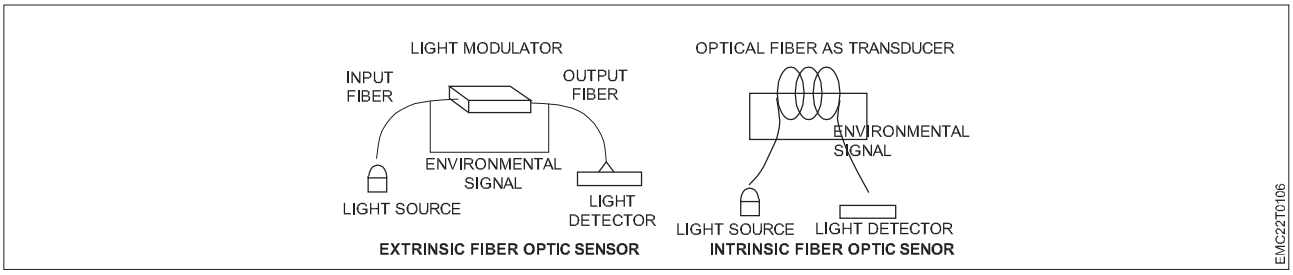
relaying the signal along the fiber, ensuring that the signal does not become too distorted or weak

receiving the optical signal

converting it into an electrical signal



BASIC OPERATION OF AN OPTICAL FIBER

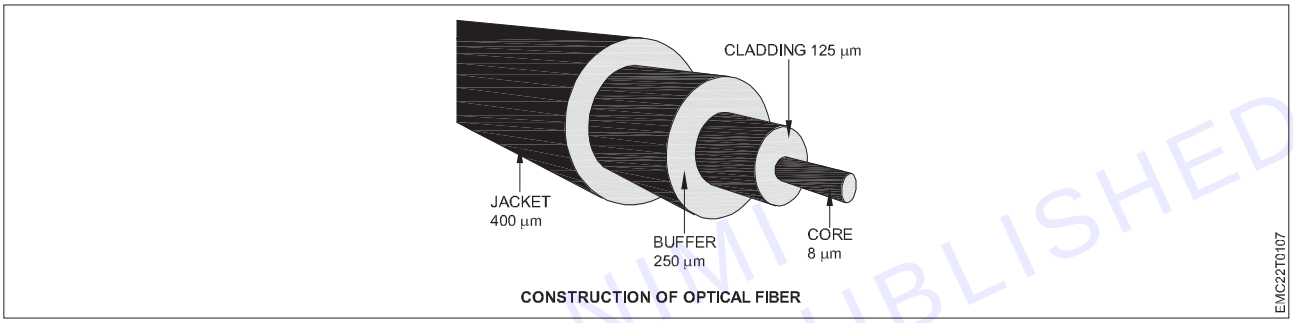


Main element of Fiber Optics:

Core: It is the central tube of very thin size made of optically transparent dielectric medium and carries the light transmitter to receiver and the core diameter may vary from about 5um to 100 um.

Cladding: It is outer optical material surrounding the core having reflecting index lower than core and cladding helps to keep the light within the core throughout the phenomena of total internal reflection.

Buffer Coating: It is a plastic coating that protects the fiber made of silicon rubber. The typical diameter of the fiber after the coating is 250-300 um.

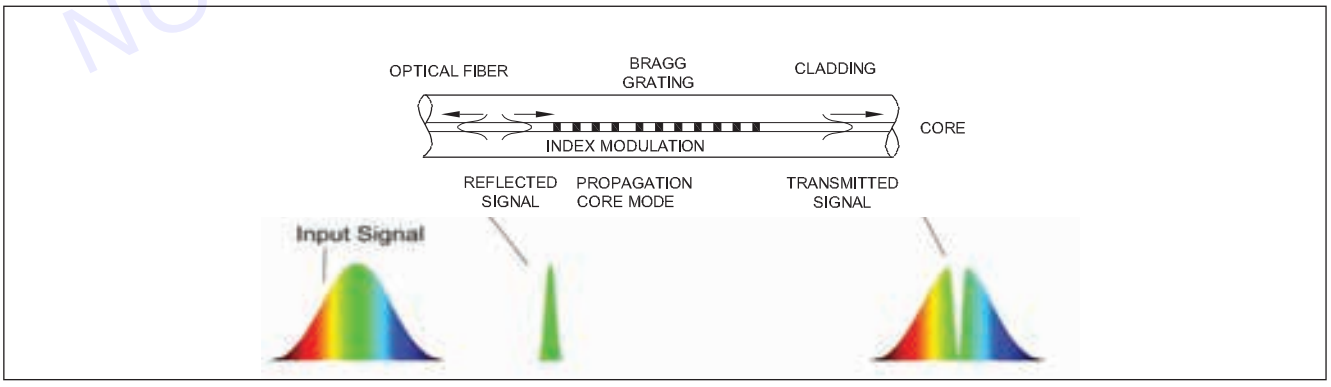


Types of Fiber optics:

On the basis of the Number of Modes:

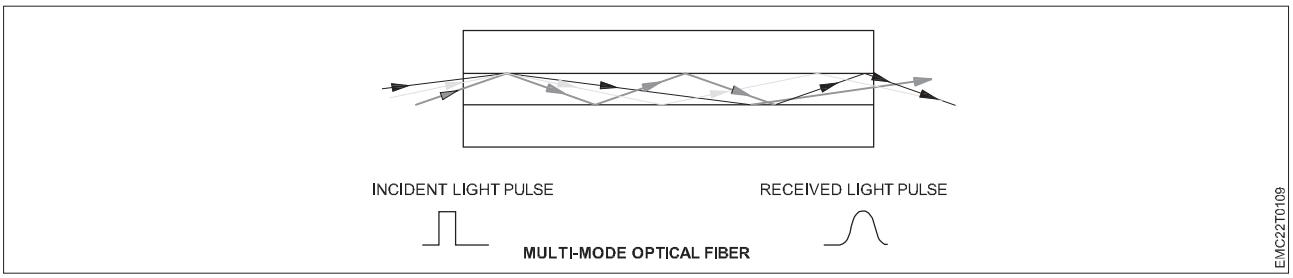
1 Single-mode fiber:

In single-mode fiber, only one type of ray of light can propagate through the fiber. This type of fiber has a small core diameter (5um) and high cladding diameter (70um) and the difference between the refractive index of core and cladding is very small. There is no dispersion i.e. no degradation of the signal during traveling through the fiber. The light is passed through it through a laser diode.



2 Multi-mode fiber:

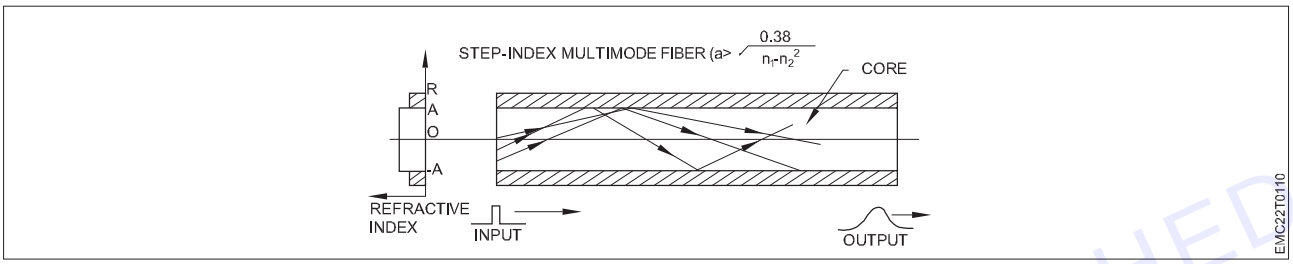
Multimode fiber allows a large number of modes for the light ray traveling through it. The core diameter is generally (40um) and that of cladding is (70um). The relative refractive index difference is also greater than single mode fiber. There is signal degradation due to multimode dispersion. It is not suitable for long-distance communication due to large dispersion and attenuation of the signal. There are two categories on the basis of Multi-mode fiber i.e. Step Index Fiber and Graded Index Fiber. Basically these are categories under the types of optical fiber on the basis of Refractive Index



On the basis of Refractive Index:

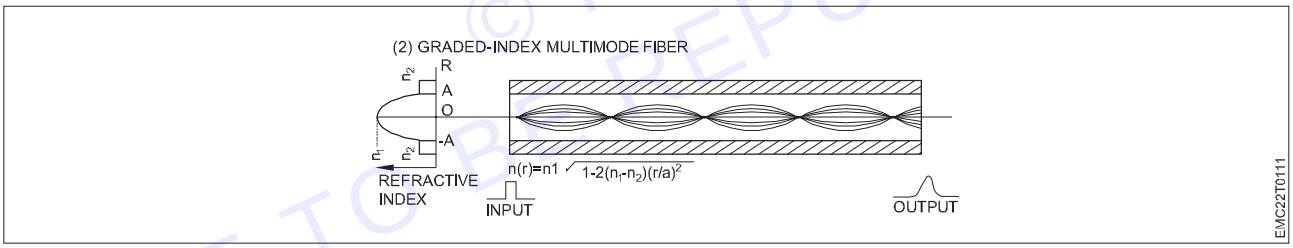
Step-index optical fiber:

The refractive index of core is constant. The refractive index of the cladding is also constant. The rays of light propagate through it in the form of meridional rays which cross the fiber axis during every reflection at the core-cladding boundary



Graded index optical fiber:

In this type of fiber, the core has a non-uniform refractive index that gradually decreases from the centre towards the core-cladding interface. The cladding has a uniform refractive index. The light rays propagate through it in the form of skew rays or helical rays. it is not cross the fiber axis at any time.



On the basis of Material Used:

Plastic Optical Fibres: For transmission of light, polymethylmethacrylate is used as core material

Glass Fibres: It is an extremely fine glass fibres, core and cladding of the optical fibre is made of plastic.

Advantages of Fiber Optic Transmission:

Optical fibers have largely replaced copper wire communications in core networks in the developed world, because of its advantages over electrical transmission. Here are the main advantages of fiber optic transmission

1 Extremely High Bandwidth:

No other cable-based data transmission medium offers the bandwidth that fiber does. The volume of data that fiber optic cables transmit per unit time is far great than copper cables.

2 Longer Distance:

In fiber optic transmission, optical cables are capable of providing low power loss, which enables signals can be transmitted to a longer distance than copper cables.

3 ResistancetoElectromagneticInterference:

In practical cabled eployment,it's in evitable to meet environments like power substations, heating, ventilating and other industrial sources ofinterference. However, fiber has a very low rate of bit error (10 EXP-13), as a result of fiber being so resistant to electromagnetic interference. Fiber optic transmission is virtually noise free.

4 Low Security Risk:

The growth of the fiber optic communication market is mainly driven by increasing awareness about data security concerns and use of the alternative raw material. Data or signals are transmitted via light in fiber optic transmission. Therefore there is no way to detect the data being transmitted by “listening in” to the electromagnetic energy “leaking” through the cable, whichensures the absolute security of information.

5 Small Size:

Fiber optic cable has a very small diameter. For instance, the cable diameter of a single OM3 multimode fiber is about 2mm, which is smaller than that of coaxial copper cable. Small size saves more space in fiber optic transmission.

6 Light Weight:

Fiber optic cables are made of glass or plastic, and they are thinner than copper cables. These make them lighter and easy to install

7 Easy to Accommodate Increasing Bandwidth:

With the use of fiber optic cable, new equipment canbe added to existing cable infrastructure. Because optical cable can provide vastly expanded capacity overtheoriginallylaidcable.AndWDM(wavelengthdivisionmultiplexing) technology, including CWDM and DWDM, enables fiber cables the ability to accommodate more bandwidth

Disadvantages of Fiber Optic Transmission:

Thoughfiberoptictransmissionbringslotsofconvenience,itsdisadvantagesalsocannotbe ignored.Fragility: usually optical fiber cables are made of glass, which lends to they are more fragile than electrical wires. In addition, glass can be affected by various chemicals including hydrogen gas (a problem in underwater cables), making them need more cares when deployed under ground.

1 Difficultt Install:

2 Attenuation & Dispersion: as transmission distance getting longer, light will be attenuated and dispersed, which requires extra optical components like EDFA to be added.

3 Cost Is Higher Than Copper Cable:

4 SpecialEquipmentIsOftenRequired

Properties of Fiber Optics:

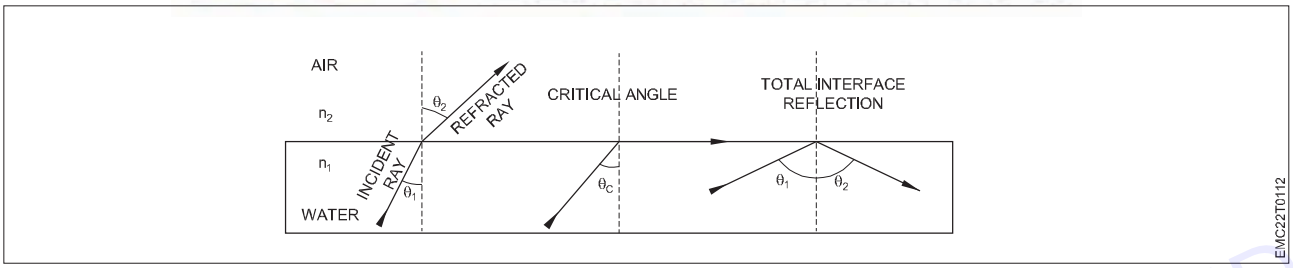
The most important properties for communications are attenuation, light collection and propagation, fiber dispersion, and mechanical strength

NOTE: Nonlinear effects can be important in some cases, particularly for sensing and high-performance systems.

Optical fiber has non-induction characteristic, as well as low-loss and broad-bandwidth transmission characteristics, compared with conventional metallic transmission lines Therefore, optical fiber is foreseen as an excellent transmission line medium, which is versatile and economical in use for various digital.

Fiber optic cables:

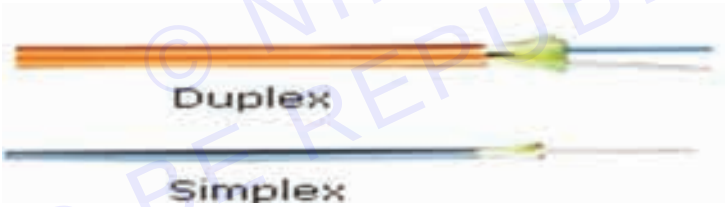
Fiber optic cables are composed of one or more transparent fibers enclosed in protective coverings and strength members. Fiber optic cables allow signals, such as light, to travel through without interference. A real fiber optic cable is made of glass which is incredibly pure to allow light to pass through over very long distances. The glass is then coated in two layers of plastic. The plastic gives the equivalent mirror effect which creates total internal reflection. Light traveling through the fiber bounces at shallow angles and stays completely within the fiber. This happens when the light hits the interface at angle larger than the critical angle. At this angle it will not pass through to the second medium at all



Fiber Optic Cable Type:

Simplex

Simplex cables are fiber optic cables with a single optical fiber. They are used in applications that only require one-way data transfer.



Duplex

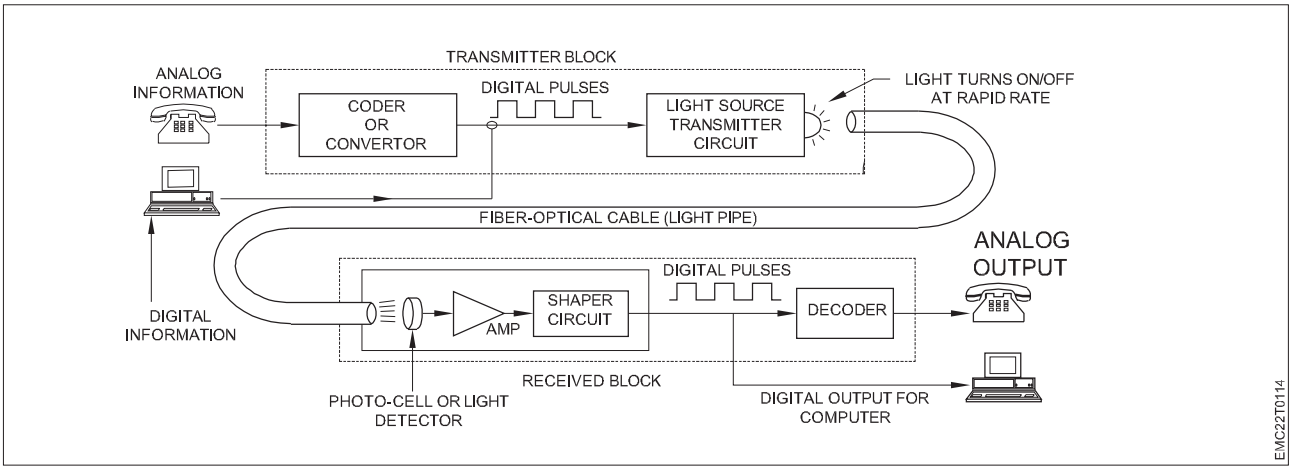
Duplex cables are fiber optic cables with two optical fibers. They are usually set up side-by-side and can be used for applications that require simultaneous, bi-directional data transfer. Duplex fiber is availabl single mode and multimode.

Encoding data of optical fiber

Encoding data into light is generally called modulation. Common parameters of light that are modulated are amplitude, phase, frequency/wavelength and polarization states. For most business applications it is usually a combination of these.

Data encoding is a process that involves converting data into a new format using a scheme. Encoding is a reversible process.

Fiber-optic telecommunication systems use pulse-code modulation. Information is transmitted as a series of pulses. The digital pulse-code-modulated signal is coupled into a fiber.



Types of Joints in Optical Fiber

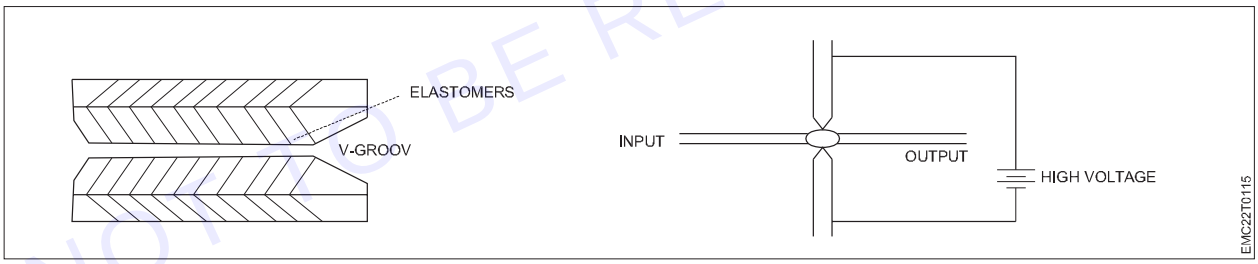
Dr Narinder Kripany is known as the father of fiber optics who is an Indian-born American physicist. The term fiber optics was coined by him in the year 1956. He is well known for his pioneer work on FIBER OPTICS. Nowadays fiber optic cables are used extensively in network communication and unlike a normal wire joint there are some special joints for fiber optics which are classified below

Types of Joints in Optical Fiber

Splice : It is a joint which is permanent or semi-permanent and can be used only once. Splice can be of two following types:

1 **Mechanical Splice –** These are the joints that mechanically hold the two fiber ends and are just an alignment device enabling light to pass from one end to the other.

2 **Fusion Splice –** It is a process in which two fiber ends are fused together using an electric arc. Generally monochromatic light is passed through one fiber end (input) and the other fiber end is adjusted in such a way that the output signal is maximum. At this point, high voltage is passed in an electric arc causing fusion of the two fiber ends.



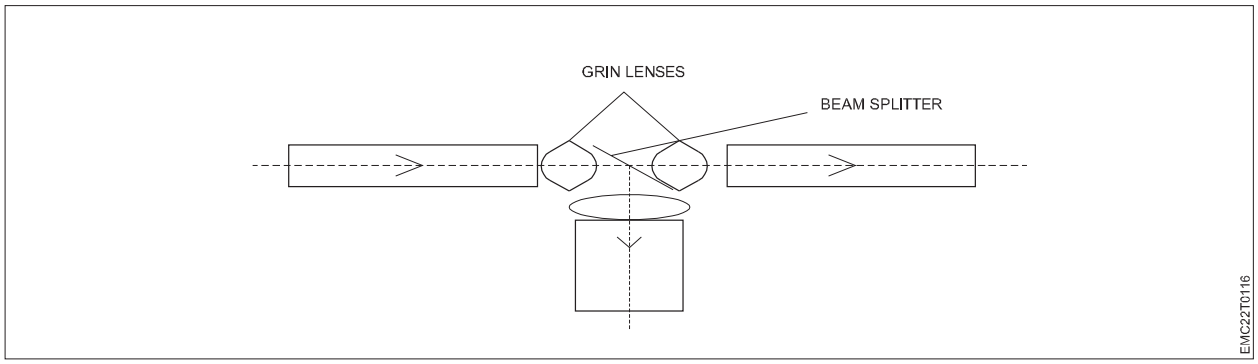
Connector : It is a joint which is temporary and can be used time and again i.e. it is reusable. Some types of connector are:

DNP connector – Dry No Polish connector.

SMA connector – Surface Mount Adapter Connector.

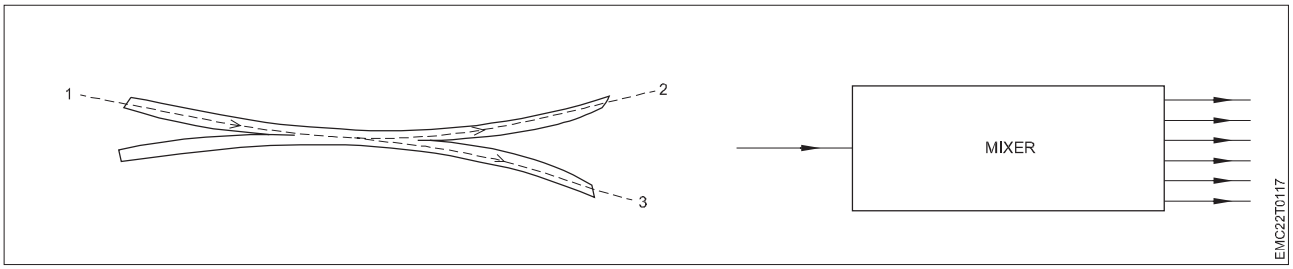
Coupler : It is a device that is used for multiplexing and de-multiplexing a signal. When a coupler is used for de-multiplexing a signal it is known as a Combiner. There are many types of coupler such as :

T-Coupler- It splits the incoming signal into two parts.



Star – It splits the incoming signal into many parts.

Three Port Coupler – It splits the incoming signal into two parts. Here, grin lenses or beam splitter is not used.



While Handling Optical Cables

Never allow a fiber to contact an uncontrolled surface (floor, etc.) where it may be stepped upon, rolled over with a chair castor, etc. Take care with fingernails and jewelry when handling optical fiber. Gloves or finger cots may prevent such damage, but also limit the ability to detect damage using tactile senses

Never let a fiber-optic cable hang free from the connector.

Avoid bending fiber-optic cables beyond their minimum bend radius. Bending fiber-optic cables into arcs smaller than a few inches in diameter can damage the cables and cause problems that are difficult to diagnose.

Applications of Optical Fiber Communications

Fiber optic cables find many uses in a wide variety of industries and applications. Some uses of fiber optic cables include

- Medical Used as light guides, imaging tools and also as lasers for surgeries
- Defense/Government Used as hydrophones for seismic waves and SONAR , as wiring in aircraft, submarines and other vehicles and also for field networking • Data Storage Used for data transmission
- Telecommunications Fiber is laid and used for transmitting and receiving purposes
- Networking Used to connect users and servers in a variety of network settings and help increase the speed and accuracy of data transmission
- Industrial/Commercial Used for imaging in hard to reach areas, as wiring where EMI is an issue, as sensory devices to make temperature, pressure and other measurements, and as wiring in automobiles and in industrial settings
- Broadcast/CATV Broadcast/cable companies are using fiber optic cables for wiring CATV, HDTV, internet, video on demand and other applications Fiber optic cables are used for lighting and imaging and as sensors to measure and monitor a vast array of variables. Fiber optic cables are also used in research and development.

The optical fibers have many applications. Some of them are as follows

- Used in telephone systems
- Used in sub-marine cable networks
- Used in data link for computer networks, CATV Systems
- Used in CCTV surveillance cameras
- Used for connecting fire, police, and other emergency services.
- Used in hospitals, schools, and traffic management systems.
- They have many industrial uses and also used for in heavy duty constructions

Fiber materials

Most of the fibers are made up of glass consisting of either Silica (SiO_2) or .Silicate. High- loss glass fibers are used for short-transmission distances and low-loss glass fibers are used for long distance applications. Plastic fibers are less used because of their higher attenuation than glass fibers. Glass Fibers. The glass fibers are made from oxides. The most common oxide is silica whose refractive index is 1.458_at 850 nm. To get different index fibers, the dopants such as GeO_2, P_2O_5 are added to silica. GeO_2 and P_2O_3 increase the refractive index whereas fluorine or B203 decreases the refractive index.

Fiber compositions are given below as follows:

GeO_2 – SiO_2 Core: SiO_2 Cladding

P_2Q_5 – SiO_2, Core; SiO_2Cladding

The principle raw material for silica is sand. The glass composed of pure silica is referred to as silica glass, nitrous silica or fused silica. Some desirable properties of silica are,Resistance to deformation at temperature as high as 1000°C.High resistance to breakage from thermal shock.Good chemical durability.High transparency in both the visible and infrared regions.

LESSON 100 - 107 : LCD TV / LED TV / Smart TV

Objectives

At the end of this lesson you shall be able to:

- state the differences between CTV,LCD, LED & smart TV
- state the principle & working of different types of TV
- state the principle & working of TV remote.

LED TV

Introduction

LED TV, or Light Emitting Diode Television, represents a significant advancement in display technology that has revolutionized the way we experience television and multimedia content. Unlike traditional cathode ray tube

(CRT) or older LCD (Liquid Crystal Display) TVs, LED TVs employ light- emitting diodes to illuminate the display, resulting in a sleeker design, improved energy efficiency, and enhanced picture quality.

The key feature of LED TVs lies in the use of LEDs for backlighting. There are two main types of LED backlighting: edge-lit and direct-lit. In edge-lit LED TVs, the LEDs are placed along the edges of the display, allowing for a thinner and lighter design. Direct-lit LED TVs, on the other hand, have LEDs spread across the entire back panel, providing better control over local dimming and improving overall picture quality.

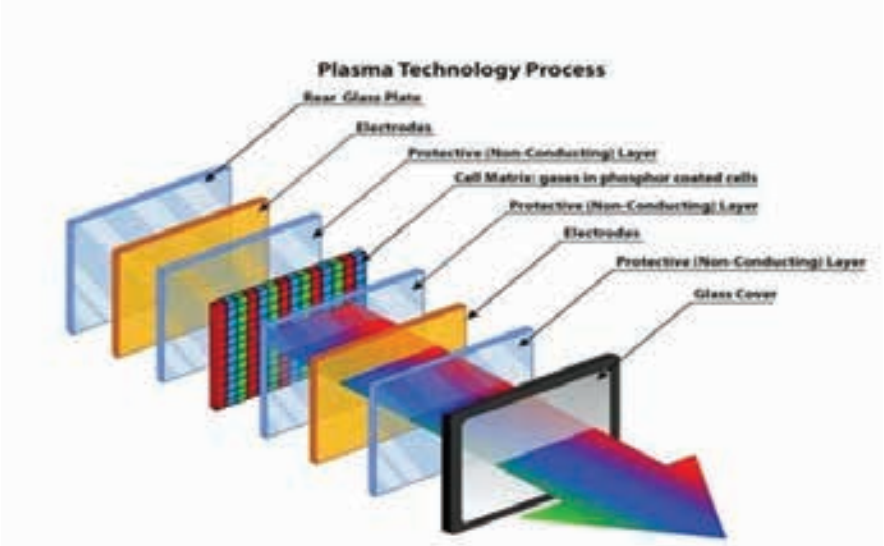
LED TVs offer several advantages over their predecessors. One notable benefit is the improved colour accuracy and contrast ratio, leading to sharper and more vibrant images. The use of LED technology also enables these TVs to achieve higher levels of brightness, enhancing visibility even in well-lit environments.

Energy efficiency is another significant advantage of LED TVs. Compared to traditional CRTs and LCDs, LED TVs consume less power, contributing to lower energy bills and reduced environmental impact. Additionally, LED TVs are known for their longer lifespan and durability, providing users with a reliable and long-lasting entertainment solution.

The evolution of LED TV technology has also given rise to innovations such as Smart TVs. These televisions are equipped with internet connectivity, allowing users to access streaming services, browse the web, and download applications directly on their TV screens.

Construction and working process of LED TV

The construction and working process of an LED TV involves several key components and layers that work together to produce images and deliver audio. Here's a general overview of the construction of an LED TV



1 Outer Casing

- The TV's exterior is typically made of plastic or metal and serves as a protective casing for the internal components.
- The design of the outer casing contributes to the aesthetics and overall appearance of the TV.

2 Display Panel

- The display panel is the heart of the LED TV and is responsible for producing images. Common types of display panels include LCD (Liquid Crystal Display) and OLED (Organic Light Emitting Diode).
- The display panel consists of a matrix of pixels that can change colour and brightness to form images.

3 LED Backlighting

- LED TVs use light-emitting diodes (LEDs) for backlighting. These LEDs are positioned behind the display panel.
- There are two main types of LED backlighting: edge-lit and direct- lit. Edge-lit LEDs are placed along the edges of the screen, while direct-lit LEDs cover the entire back panel.

4 Colour Filters and Liquid Crystal Layer

- Each pixel on the display panel is associated with red, green, and blue colour filters.
- In LCD panels, a layer of liquid crystals is present, which controls the passage of light through each pixel. When an electric current is applied, the liquid crystals adjust to regulate the amount of light, determining the colour and brightness of each pixel.

5 Local Dimming (if applicable)

- Some LED TVs feature local dimming technology, allowing dynamic adjustment of the backlight in different areas of the screen. This enhances contrast by controlling the amount of light in specific regions.

6 Image Processing Circuitry

- LED TVs have built-in processors responsible for image processing tasks. This includes upscaling lower-resolution content, adjusting contrast and colour levels, and managing motion processing to reduce motion blur.

7 Audio Components

- LED TVs include audio components such as amplifiers, speakers, and audio processing software to deliver sound. The placement of speakers can vary, with some TVs having front-facing speakers, while others have downward or rear-facing speakers.

8 Power Supply and Circuit Boards

- The TV includes a power supply unit to convert electrical power for the various components.

- Multiple circuit boards are present, including the main logic board, input/output boards, and other specialized boards for specific functions.

9 Connectivity Ports

- LED TVs are equipped with various ports for connecting external devices. Common ports include HDMI, USB, audio jacks, and network ports.

10 Smart TV Features

- Modern LED TVs often come with Smart TV capabilities, including an operating system, user interface, and internet connectivity. These features allow users to access streaming services, apps, and other online content.

11 Remote Control and User Interface

- Users interact with the TV through a remote control or, in the case of Smart TVs, through various input methods like voice commands, gestures, or smartphone apps.

Advantage and Disadvantage of LED TV

Advantages of LED TVs

1 **Energy Efficiency:** LED TVs are generally more energy-efficient compared to older technologies like CRT (cathode ray tube) and even some LCD TVs. This can result in lower electricity bills and reduced environmental impact.

2 **Slim and Lightweight Design:** LED TVs are known for their slim and lightweight design, making them aesthetically pleasing and easy to mount on walls. This is especially true for edge-lit LED TVs.

3 **Improved Picture Quality:** LED backlighting allows for better control of brightness and contrast, leading to improved picture quality with higher colour accuracy and dynamic range compared to older technologies.

4 **Longer Lifespan:** LED technology tends to have a longer lifespan compared to traditional backlighting methods, contributing to the overall durability and longevity of LED TVs.

5 **Faster Response Time:** LED TVs typically have faster response times compared to older technologies, reducing motion blur and making them suitable for fast-paced content like sports and action movies.

6 **Flexibility in Screen Size:** LED TVs are available in a wide range of screen sizes, from small to very large, providing consumers with flexibility to choose a size that fits their preferences and viewing environment.

7 **Smart TV Features:** Many LED TVs come equipped with Smart TV features, including internet connectivity, streaming apps, and the ability to browse the web. This enhances the overall entertainment experience.

Disadvantages of LED TVs

1 **Cost:** LED TVs can be more expensive than some other types of TVs, particularly when compared to basic LCD or CRT models. However, prices have become more competitive over time.

2 **Limited Viewing Angles:** In some cases, LED TVs may exhibit limited viewing angles, where the picture quality diminishes when viewed from the side. This is more noticeable in certain types of LED TVs, like those with twisted nematic (TN) panels.

3 **Uniformity Issues:** LED TVs, especially edge-lit models, may experience issues with uniformity, where the backlighting is not evenly distributed across the screen. This can result in uneven brightness or “clouding” in certain areas.

4 **Risk of Image Retention (LCD):** In LCD-based LED TVs, there may be a risk of image retention or “ghosting” in certain situations, where static images displayed for extended periods can leave a temporary residue on the screen.

5 **Limited Colour Range (some models):** While LED technology itself supports a wide colour range, the colour reproduction can vary between different models. Some lower-end LED TVs may have a more limited colour gamut compared to high-end models or OLED TVs.

6 **Environmental Impact:** While LED TVs are generally more energy- efficient during use, the manufacturing process involves the use of materials that can have environmental consequences. Proper disposal and recycling of electronic waste are crucial to mitigate these impacts.

Introduction of LCD

LCD TV, short for Liquid Crystal Display Television, represents a significant technological advancement in the realm of home entertainment. Introduced as a modern alternative to traditional cathode ray tube (CRT) televisions, LCD TVs have transformed the viewing experience with their sleek design, vibrant displays, and energy-efficient operation.

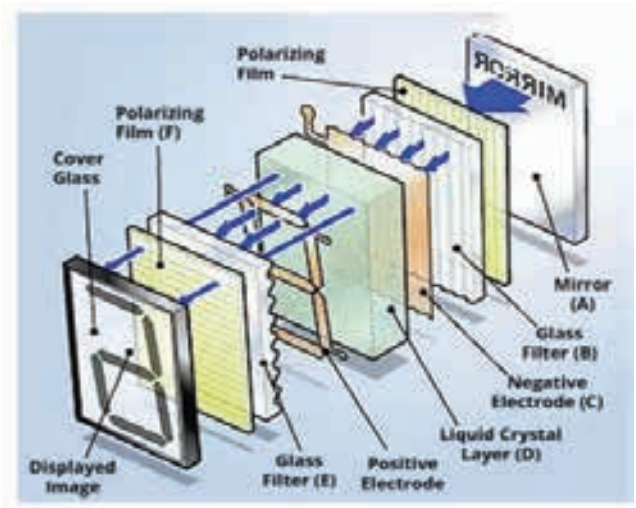
At its core, an LCD TV employs liquid crystal technology to produce images on its screen. This technology utilizes a backlight source, typically fluorescent lamps or light-emitting diodes (LEDs), to illuminate the liquid crystal display panel. The liquid crystals, when subjected to an electric current, twist and align to control the passage of light, thus forming the images we see on the screen.

One of the most notable features of LCD TVs is their slim profile, which allows for space-saving installation and integration into modern living spaces. Additionally, LCD TVs offer superior image quality with sharp details, vibrant colors, and high-resolution displays, making them ideal for watching movies, sports, and gaming.

Moreover, LCD TVs consume less power compared to their CRT counterparts, contributing to energy conservation and lower utility bills. This energy efficiency, coupled with their long lifespan and reduced heat emissions, has made LCD TVs a popular choice among consumers seeking both performance and sustainability.

As technology has advanced, LCD TVs have evolved to incorporate various features such as high-definition (HD) resolution, smart TV capabilities, internet connectivity, and advanced image processing technologies like HDR (High Dynamic Range) for enhanced contrast and color accuracy.

Construction and working process of an LCD TV



The construction and working process of an LCD TV involve several key components and processes that work together to produce images on the screen. Here's an overview

1 **Liquid Crystal Display (LCD) Panel:** The LCD panel is the primary component of an LCD TV. It consists of two layers of glass with a liquid crystal solution sandwiched between them. The liquid crystals are organic compounds that can change their molecular structure when an electric current is applied.

2 **Backlighting System:** Behind the LCD panel, there is a backlighting system that provides illumination to the display. In older LCD TVs, fluorescent lamps were commonly used as the backlight source. However, in modern LCD TVs, Light Emitting Diodes (LEDs) are the preferred choice due to their energy efficiency and better color reproduction.

3 **Color Filters:** On top of the LCD panel, there are color filters arranged in red, green, and blue (RGB) sub-pixels. These filters control the passage of light and determine the colors displayed on the screen. By varying the intensity of the backlight and the alignment of the liquid crystals, different colors and shades can be produced.

4 **Polarizing Filters:** Polarizing filters are placed on both sides of the LCD panel. These filters help control the orientation of the light passing through the liquid crystals. The first polarizing filter polarizes the light from the backlight source, while the second polarizing filter controls the light that reaches the viewer's eyes.

5 **Transistor Array:** Each pixel on the LCD panel is controlled by a thin film transistor (TFT) array. The TFT array acts as a switch, regulating the voltage applied to the liquid crystals in each pixel. By applying the appropriate voltage, the liquid crystals twist and align to control the passage of light, thus forming the images on the screen.

6 **Controller Circuitry:** The controller circuitry consists of integrated circuits and processors that receive input signals from various sources, such as HDMI, VGA, or component inputs. These signals are then processed and converted into electrical signals that control the operation of the LCD panel and other components of the TV.

Working Process

1 The backlighting system emits white light.

2 The white light passes through the first polarizing filter and enters the liquid crystal layer.

3 The liquid crystals twist and align according to the electrical signals received from the TFT array, modulating the passage of light.

4 The modulated light passes through the color filters, which determine the colors displayed on the screen.

5 Finally, the polarized light passes through the second polarizing filter and reaches the viewer's eyes, forming the images and colors on the screen.

Advantages and Disadvantages of LCD TV

LCD TVs offer several advantages and disadvantages compared to other types of televisions like CRT or plasma. Here's a breakdown

Advantages of LCD TV

1 **Slim Profile:** LCD TVs are much slimmer and lighter compared to older CRT televisions, making them easier to mount on walls or place in various locations within a room.

2 **Energy Efficiency:** LCD TVs consume less power than CRT TVs, making them more energy-efficient and environmentally friendly. This results in lower electricity bills and reduced carbon footprint.

3 **High Resolution:** LCD TVs typically offer high-resolution displays, providing sharp and clear images with vibrant colors and excellent detail, especially in HD and UHD (4K) models.

4 **No Screen Burn-In:** Unlike plasma TVs, LCD TVs are not susceptible to screen burn-in, where static images can become permanently imprinted on the screen over time.

5 **Wide Viewing Angles:** Modern LCD TVs have improved viewing angles compared to earlier models, ensuring that viewers can enjoy consistent picture quality from various positions in the room.

6 **Long Lifespan:** LCD TVs have a relatively long lifespan compared to CRT TVs, with many models lasting for several years with proper maintenance and care.

Disadvantages of LCD TV

1 **Limited Contrast Ratio:** LCD TVs typically have lower contrast ratios compared to plasma or OLED TVs, which can result in less dynamic and vibrant images, especially in dark scenes.

2 **Motion Blur:** Some LCD TVs may experience motion blur, especially in fast-paced action scenes, due to slower response times of liquid crystal displays.

3 **Limited Color Reproduction:** While modern LCD TVs offer excellent color reproduction, they may not match the deep blacks and rich colors produced by OLED or plasma displays.

4 **Potential for Backlight Bleeding:** LCD TVs may suffer from backlight bleeding, where light leaks around the edges of the screen, leading to uneven brightness and reduced image quality, especially in dark scenes.

5 **Limited Viewing Angles:** While viewing angles have improved, LCD TVs still have limitations compared to OLED and plasma displays, with color and contrast degradation when viewed from extreme angles.

6 **Risk of Dead Pixels:** LCD TVs are susceptible to dead pixels, where individual pixels on the screen may become stuck or permanently off, affecting image quality.

The comparison between LCD and LED

The comparison between LCD (Liquid Crystal Display) and LED (Light Emitting Diode) TVs can be a bit nuanced since LED TVs are essentially a subset of LCD TVs. Here's a breakdown of the differences and similarities between the two

LCD TVs

1 **Backlighting:** LCD TVs use a cold cathode fluorescent lamp (CCFL) or LED backlighting to illuminate the liquid crystal display panel. The backlight provides the light source for the display.

2 **Energy Efficiency:** LCD TVs with LED backlighting are generally more energy- efficient compared to those with CCFL backlighting. LED backlighting consumes less power and allows for thinner designs.

3 **Thickness:** LCD TVs with CCFL backlighting tend to be thicker compared to LED- backlit LCD TVs. LED backlighting allows for slimmer designs and lighter weight.

4 **Picture Quality:** LCD TVs can offer good picture quality, but it may vary depending on factors like backlighting technology, panel quality, and image processing capabilities.

5 **Viewing Angles:** Traditional LCD panels can have limitations in viewing angles, with color and contrast degradation occurring when viewed from extreme angles.

LED TVs

1 **Backlighting:** LED TVs use light-emitting diodes (LEDs) as the backlight source. They are placed either behind the entire screen (direct-lit) or around the edges (edge-lit) to illuminate the LCD panel.

2 **Energy Efficiency:** LED TVs are generally more energy-efficient than traditional LCD TVs with CCFL backlighting. LED backlighting consumes less power and produces less heat.

3 **Thickness:** LED TVs are typically thinner and lighter compared to LCD TVs with CCFL backlighting. LED backlighting allows for slimmer designs and more flexibility in form factor.

4 **Picture Quality:** LED TVs often offer better picture quality compared to traditional LCD TVs. They can achieve higher brightness levels, better contrast ratios, and improved color accuracy.

5 **Local Dimming:** Some LED TVs feature local dimming technology, which allows certain areas of the backlight to dim or turn off completely to enhance contrast and improve black levels.

Comparison

- LED TVs are essentially a type of LCD TV. The main difference lies in the backlighting technology.
- LED TVs generally offer better energy efficiency, thinner designs, and improved picture quality compared to traditional LCD TVs with CCFL backlighting.

- Both types of TVs may suffer from issues like motion blur, limited viewing angles, and potential backlight uniformity issues.

Introduction of Smart TV

A Smart TV is a television set or a TV device that integrates internet connectivity and interactive features alongside traditional television functions. It represents a significant evolution in home entertainment technology, combining television viewing with internet-based content and services.

The introduction of Smart TVs has revolutionized how people consume media, offering a wide range of features and capabilities that enhance the viewing experience. Here's an overview of the key aspects of Smart TVs:

1 **Internet Connectivity:** Smart TVs are equipped with built-in Wi-Fi or Ethernet ports that allow them to connect to the internet. This connectivity enables users to access a variety of online content and services directly from their TV screens.

2 **Streaming Services:** One of the primary features of Smart TVs is the ability to stream content from popular online streaming services such as Netflix, Hulu, Amazon Prime Video, Disney+, and others. Users can access a vast library of movies, TV shows, documentaries, and original content on-demand.

3 **App Store Access:** Smart TVs often come with their own app stores or platforms where users can download and install additional applications. These apps may include gaming, social media, news, weather, sports, and other entertainment options, expanding the functionality of the TV beyond traditional broadcasting.

4 **Web Browsing:** Smart TVs typically include web browsing capabilities, allowing users to surf the internet directly from their TV screens. This feature enables access to websites, online shopping, social networking sites, and other online resources.

5 **Screen Mirroring and Casting:** Many Smart TVs support screen mirroring and casting features, allowing users to mirror the screen of their smartphones, tablets, or computers onto the TV display wirelessly. This enables easy sharing of photos, videos, presentations, and other content with friends and family.

6 **Voice Control and Smart Assistants:** Some Smart TVs are equipped with voice recognition technology and built-in smart assistants like Amazon Alexa, Google Assistant, or Samsung Bixby. Users can control their TVs, search for content, adjust settings, and even control other smart home devices using voice commands.

7 **Interactive Features:** Smart TVs may offer interactive features such as interactive gaming, quizzes, polls, and social media integration, enhancing user engagement and interactivity while watching TV.

Construction and working process of a Smart TV

The construction and working process of a Smart TV involve various components and technologies that enable its internet connectivity, interactive features, and traditional television functions. Here's a breakdown:

Construction of a Smart TV

1 **Display Panel:** Like traditional televisions, Smart TVs feature liquid crystal display (LCD), organic light-emitting diode (OLED), or quantum dot LED (QLED) panels that display images and videos.

2 **Processor and Memory:** Smart TVs contain processors (CPUs) and memory (RAM) to handle tasks such as app processing, streaming, and interface navigation.

3 **Connectivity Hardware:** Smart TVs include Wi-Fi, Ethernet, and Bluetooth hardware for connecting to the internet and other devices wirelessly.

4 **Operating System (OS):** Smart TVs run on specialized operating systems such as Android TV, Tizen (Samsung), webOS (LG), or Roku OS, which provide the user interface and manage apps and services.

5 **App Store and Software Platform:** Smart TVs have their own app stores or software platforms where users can download and install apps for streaming, gaming, social media, and other purposes.

6 **Remote Control:** Smart TVs come with remote controls that allow users to navigate menus, select apps, control volume and settings, and interact with the TV.

7 **Sensors and Inputs:** Some Smart TVs feature sensors such as motion sensors or voice recognition technology for hands-free control. They also include various inputs such as HDMI, USB, and AV ports for connecting external devices like gaming consoles, Blu- ray players, and USB drives.

Working Process of a Smart TV

1 **Power On:** When a user turns on the Smart TV, the processor boots up the operating system, and the display panel lights up.

2 **Connectivity:** The Smart TV connects to the internet via Wi-Fi or Ethernet, allowing access to online content and services.

3 **Operating System Interface:** The operating system's interface appears on the screen, presenting options such as apps, settings, and inputs.

4 **App Launching:** Users can launch apps from the app store or software platform to access streaming services like Netflix, YouTube, or Hulu, as well as other apps for gaming, social media, news, and weather.

5 **Content Streaming:** Smart TVs stream content from online services over the internet, providing access to movies, TV shows, music, and videos on demand.

6 **Web Browsing:** Users can browse the internet using the built-in web browser, accessing websites, online shopping platforms, and social networking sites directly from the TV screen.

7 **Voice and Gesture Control:** Some Smart TVs support voice and gesture control, allowing users to interact with the TV using spoken commands or hand movements.

8 **Updates and Maintenance:** Smart TVs may receive software updates over the internet to improve performance, add new features, and fix bugs. Users can also perform maintenance tasks such as clearing cache and managing storage.

Advantages and disadvantage of Smart TV

Advantages of Smart TVs

1 **Internet Connectivity:** Smart TVs allow users to access the internet directly from their TV screens, enabling them to stream online content, browse websites, and use internet- based services without the need for additional devices.

2 **Streaming Services:** Smart TVs offer access to a wide range of streaming services such as Netflix, Hulu, Amazon Prime Video, Disney+, and others, allowing users to watch movies, TV shows, documentaries, and original content on-demand.

3 **App Store Access:** Smart TVs feature app stores or platforms where users can download and install additional applications, including gaming, social media, news, weather, sports, and other entertainment options, expanding the functionality of the TV beyond traditional broadcasting.

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7 **Interactive Features:** Smart TVs offer interactive features like gaming, quizzes, polls, and social media integration, enhancing user engagement and interactivity while watching TV.

Disadvantages of Smart TVs

1 **Cost:** Smart TVs tend to be more expensive than traditional TVs due to the additional features and technology required for internet connectivity, streaming services, and interactive functions.

2 **Complexity:** Smart TVs can be more complex to set up and operate compared to traditional TVs, especially for users who are not familiar with technology or internet connectivity.

3 **Security Risks:** Smart TVs connected to the internet are susceptible to security risks such as malware, viruses, hacking, and data breaches, especially if proper security measures are not implemented or updated regularly.

4 **Privacy Concerns:** Smart TVs may collect and transmit data about users' viewing habits, preferences, and behavior to manufacturers, advertisers, and third-party service providers, raising privacy concerns and potential risks of data misuse or unauthorized access.

5 **Reliability:** Smart TVs rely on internet connectivity and software updates to function properly, which can lead to reliability issues such as network outages, software glitches, and compatibility problems with apps and services.

6 **Limited Lifespan:** Smart TVs may have a limited lifespan compared to traditional TVs due to rapid advancements in technology, software obsolescence, and discontinued support for older models.

3D TV

Basic principal and working

1 Stereo Vision

- Human vision relies on the perception of depth through stereo vision, where each eye sees a slightly different image due to their separation. This difference in perspective helps the brain gauge depth.

2 Creating Depth Perception

- 3D TV utilizes this principle by presenting two separate images, one for each eye, simulating the stereo vision effect.
- These images are slightly offset to mimic the different perspectives seen by the left and right eyes in real life.

3 Display Technology

- Different technologies can be used to display these separate images. One common method is using specialized glasses with active or passive shuttering systems.
- Active Shutter Glasses: These glasses rapidly alternate between blocking the left and right lens in synchronization with the display, ensuring each eye sees the correct image.
- Passive Polarized Glasses: These glasses use different polarization for each lens. The TV screen alternately displays images with different polarizations, ensuring each eye receives the correct image.

4 Content Production

- 3D content for TV typically involves shooting scenes with two cameras positioned at eye distance apart to capture the left and right-eye views.
- Post-production processes may involve editing and aligning these views to ensure accurate depth perception.

5 Displaying 3D Content

- The 3D TV alternately displays frames for the left and right eyes in rapid succession, synchronized with the glasses.
- When the viewer wears the appropriate glasses, each eye sees only the corresponding image, creating the illusion of depth.

6 Depth Perception

- The brain combines the images received from each eye, taking advantage of the slight differences between them to perceive depth in the image.
- This creates the illusion of objects appearing to have depth and dimensionality on the TV screen.

7 Compatibility and Formats

- 3D TV systems must be compatible with various formats of 3D content, such as side-by-side, top-bottom, or frame sequential.
- The TV should also be able to convert 2D content into a simulated 3D effect, although this may not provide the same depth perception as native 3D content.

IPS (IN-PLANE SWITCHING) PANELS AND THEIR FEATURES.

1 Color Accuracy and Consistency

- IPS panels offer excellent color accuracy and consistency across wide viewing angles. This means colors remain true and vibrant even when viewed from different angles, making them suitable for tasks like photo and video editing where color accuracy is crucial.

2 Wide Viewing Angles

- IPS panels have significantly wider viewing angles compared to other LCD panel types like TN (Twisted Nematic) or VA (Vertical Alignment). This means images on an IPS display remain clear and consistent even when viewed from extreme angles, making them ideal for group viewing or multimedia consumption.

3 Better Contrast Ratio and Black Levels

- While IPS panels generally offer better color accuracy and viewing angles, they may not always achieve the same contrast ratio and deep black levels as some VA panels. However, advancements in IPS technology have led to improved contrast ratios over time.

4 Uniformity

- IPS panels typically have better uniformity across the entire screen compared to TN panels, which may suffer from issues like color shifting or uneven brightness. This ensures a more consistent visual experience across the display.

5 Response Time

- Historically, IPS panels have had slightly slower response times compared to TN panels, which may result in motion blur or ghosting in fast-paced gaming or video content. However, modern IPS panels, especially those with higher refresh rates and adaptive sync technologies like NVIDIA G-SYNC or AMD FreeSync, have significantly reduced this issue, making them suitable for gaming.

6 Energy Efficiency

- IPS panels generally consume more power compared to TN panels due to their construction and backlighting methods. However, advancements in LED backlighting technology have improved energy efficiency in newer IPS displays.

7 Applications

- IPS panels are widely used in professional-grade monitors, where color accuracy and wide viewing angles are critical, such as graphic design, photography, and video editing.
- They are also popular in consumer-grade monitors, laptops, and TVs for multimedia consumption, general productivity tasks, and gaming, especially for users who prioritize color accuracy and viewing angles.

8 Price

- IPS panels tend to be more expensive to manufacture compared to TN panels, which can affect the price of products using IPS technology. However, as technology advances and production costs decrease, IPS displays have become more affordable and widely available in various devices.

Different type of interface HDMI , USB, RGB

1 HDMI (High-Definition Multimedia Interface)

- HDMI is a digital interface used for transmitting high-definition video and audio signals between devices.
- It supports uncompressed video and audio data, including standard definition, high definition, and 4K resolutions.
- HDMI cables are commonly used to connect devices like TVs, monitors, gaming consoles, Blu-ray players, and streaming devices.

2 USB (Universal Serial Bus)

- USB is a versatile interface used for connecting peripherals and devices to computers, laptops, and other host systems.

- USB supports data transfer, power supply, and various communication protocols.
- Different USB versions include USB 1.0, USB 2.0, USB 3.0, USB 3.1, and USB 3.2, with each version offering improved data transfer speeds and power delivery capabilities.

3 RGB (Red, Green, Blue)

- RGB is a color model commonly used in digital displays and image processing.
- In the context of interfaces, RGB refers to connections used to transmit analog video signals, typically via separate red, green, and blue cables.
- RGB connections are commonly found in older TVs, monitors, and video game consoles, providing analog video output.

4 VGA (Video Graphics Array)

- VGA is an analog video interface commonly used for connecting computers, laptops, and projectors to display devices.
- VGA cables typically have 15 pins arranged in three rows and transmit analog RGB video signals.

5 DVI (Digital Visual Interface)

- DVI is a digital interface used for transmitting video signals between devices, such as computers, monitors, and projectors.
- DVI cables can carry both analog and digital video signals, depending on the type of connector (DVI-I, DVI-D, or DVI-A).
- While DVI is still used in some devices, it has largely been replaced by HDMI and DisplayPort in newer products.

6 DisplayPort

- DisplayPort is a digital interface primarily used for connecting computers, laptops, and monitors.
- DisplayPort supports high-resolution video and audio, as well as features like multi-stream transport and daisy-chaining multiple monitors.
- DisplayPort cables and connectors come in various versions, with each version offering increased bandwidth and additional features.

7 Thunderbolt

- Thunderbolt is an interface developed by Intel that combines PCI Express and DisplayPort into a single connection.
- Thunderbolt supports high-speed data transfer, video output, and power delivery over a single cable.
- Thunderbolt cables and connectors are commonly used in Apple devices and high-end PCs for connecting peripherals like external storage drives, displays, and docking stations.

TV Remote Controls

Types of TV Remote Controls

1 Infrared (IR) Remote Control

- Most traditional TV remote controls use infrared technology to transmit signals to the TV.
- IR remotes require a direct line of sight between the remote and the TV for communication.

2 Radio Frequency (RF) Remote Control

- RF remote controls use radio frequency signals instead of infrared.
- RF remotes don't require a direct line of sight and can work through walls and obstacles.

3 Bluetooth Remote Control

- Bluetooth remote controls connect to the TV via Bluetooth wireless technology.

- Bluetooth remotes also don't require line-of-sight communication.

Parts of a TV Remote Control

1 Buttons or Keys

- These are the physical buttons on the remote control used to perform various functions such as power on/off, volume control, channel selection, menu navigation, and accessing specific features like input selection or smart TV functions.

2 Battery Compartment

- This is where the batteries are inserted to power the remote control.

3 IR Transmitter (for IR Remotes)

- The IR transmitter emits infrared signals containing commands to control the TV. These signals are interpreted by the TV's IR receiver.

4 Circuit Board and Electronics

- The circuit board contains the electronics responsible for processing user inputs and generating the appropriate signals for transmission.

5 Enclosure or Casing

- This is the outer shell of the remote control that houses all the components.

Functions of a TV Remote Control

1 Power On/Off

- Turns the TV on or off.

2 Volume Control

- Adjusts the volume level of the TV.

3 Channel Selection

- Changes the channel being viewed.

4 Menu Navigation

- Navigates through the TV's menu system to access settings and features.

5 Input Selection

- Switches between different input sources such as HDMI, AV, or antenna.

6 Numeric Keypad

- Enters numeric values for channel selection or other functions.

7 Function Buttons

- Provides quick access to specific functions such as mute, subtitles, info, guide, etc.

IR Code Transmitter and Receiver

1 IR Code Transmitter

- The IR code transmitter emits modulated infrared light containing specific codes corresponding to each button press on the remote control.
- These codes are interpreted by the IR receiver on the TV, triggering the desired actions.

2 IR Code Receiver

- The IR code receiver on the TV detects the modulated infrared signals from the remote control.
- It decodes these signals and sends corresponding commands to the TV's internal circuitry to perform the desired actions.

Working Principle, operation of remote control

1 User Input

- The user presses a button on the remote control corresponding to a specific function, such as power on/off, volume control, or channel selection.

2 Button Activation

- When the user presses a button, it completes an electrical circuit within the remote control.

3 Signal Generation

- Upon button activation, the remote control's internal circuitry generates an electrical signal corresponding to the selected function.
- In the case of an infrared (IR) remote control, this signal is typically a series of modulated infrared pulses. For other types of remotes, such as RF or Bluetooth, the signal may be transmitted using radio frequency or Bluetooth technology.

4 Signal Transmission

- The generated signal is then transmitted from the remote control to the target device, such as a TV or other electronic equipment.
- In the case of an IR remote control, the signal is emitted as infrared light from the IR transmitter (LED) located on the front of the remote control.

5 Reception by the Device

- The target device, equipped with a corresponding IR receiver (such as the TV), receives the transmitted signal.
- The IR receiver detects the incoming signal and processes it to extract the command encoded within the signal.

6 Command Execution

- After decoding the received signal, the target device executes the command associated with the received signal.
- For example, if the user pressed the volume up button on the remote control, the TV would increase the volume accordingly.

7 Feedback (Optional)

- In some cases, the target device may provide feedback to the user to indicate that the command has been received and executed successfully.
- This feedback could be in the form of a visual indicator on the device's display or an audible sound.

General fauts in remote control

General Faults:

1 Non-Responsive Buttons:

- Buttons on the remote control may become unresponsive or intermittently work due to wear and tear, dirt buildup, or internal circuitry issues.

2 Interference

- Radio frequency (RF) remote controls may experience interference from nearby electronic devices or wireless signals, leading to erratic behavior or non-functionality.

3 Physical Damage

- Dropping the remote control or exposing it to moisture can cause physical damage to internal components, leading to malfunctions.

4 Faulty IR Transmitter

- If the IR transmitter (LED) on the remote control is malfunctioning or damaged, it may fail to emit infrared signals properly, resulting in non-operation.

5 Circuitry Issues

- Internal circuitry faults, such as damaged traces, loose connections, or component failures, can cause various operational issues in the remote control.

6 Programming Errors

- Programmable remote controls may experience errors or glitches in programming, resulting in incorrect button mappings or functionality.

7 Worn-out Buttons

- Continuous use of certain buttons on the remote control may lead to wear and tear, causing the buttons to become less responsive or fail entirely.

Difference between LCD,LED & SMART TVPA

LCD TV (Liquid Crystal Display TV):	LED TV (Light Emitting Diode TV):	Smart TV:
1 **Technology:** LCD TVs use liquid crystal displays to create images. These liquid crystals do not emit light on their own and require a backlight source. 2 **Backlighting:** LCD TVs typically use cold cathode fluorescent lamps (CCFLs) for backlighting, which are placed behind the LCD panel. 3 **Thickness:** LCD TVs tend to be thicker compared to LED TVs because of the CCFL backlighting. 4 **Energy Efficiency:** LCD TVs with CCFL backlighting are less energy-efficient compared to LED TVs.	1 **Technology:** LED TVs are a type of LCD TV that uses light-emitting diodes (LEDs) for backlighting instead of CCFLs. 2 **Backlighting:** LED TVs use LEDs for backlighting, which can be placed behind the entire screen (direct-lit) or around the edges (edge-lit). 3 **Thickness:** LED TVs are generally thinner and lighter compared to LCD TVs with CCFL backlighting, allowing for sleeker designs. 4 **Energy Efficiency:** LED TVs are more energy-efficient than LCD TVs with CCFL backlighting, as LEDs consume less power.	1 **Functionality:** Smart TVs integrate internet connectivity and interactive features alongside traditional television functions. 2 **Internet Connectivity:** Smart TVs have built-in Wi-Fi or Ethernet ports, allowing users to access online content and services directly from their TV screens. 3 **Streaming Services:** Smart TVs offer access to streaming services such as Netflix, Hulu, Amazon Prime Video, and others, enabling users to watch movies, TV shows, and original content on-demand. 4 **App Store Access:** Smart TVs come with app stores or platforms where users can download and install additional applications for gaming, social media, news, weather, sports, and other entertainment options.

MODULE 12 : DTH system

LESSON 108 - 117 : DTH system

Objectives

At the end of this lesson you shall be able to:

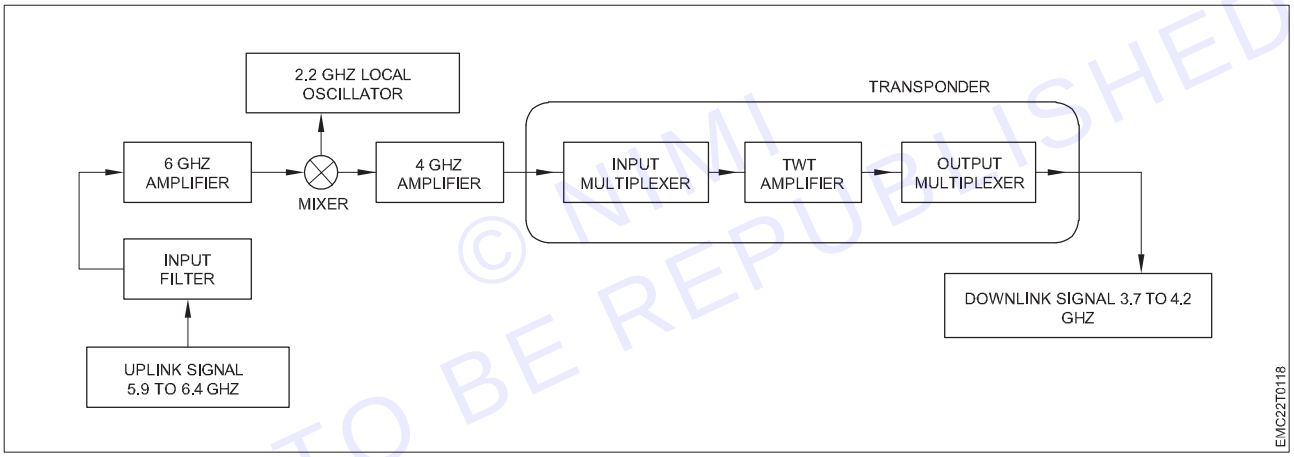
- state the working principle of DTH
- state the advantages & disadvantages of DTH system.

DTH system

Satellite communication is transporting information from one place to another using a communication satellite in orbit around the Earth. Watching the English Premier League every weekend with your friends would have been impossible without this. A communication satellite is an artificial satellite that transmits the signal via a transponder by creating a channel between the transmitter and the receiver at different Earth locations.

Telephone, radio, television, internet, and military applications use satellite communications. Believe it or not, more than 2000 artificial satellites are hurtling around in space above your heads.

Satellite Communication Block Diagram



Advantages of Satellite Communication

- The following are the advantages of satellite communication:
- Installments of circuits are easy.
- The elasticity of these circuits is excellent.
- With the help of satellite communication, every corner of the earth can be covered.
- The user fully controls the network.

Disadvantages of Satellite Communication

- The following are the disadvantages of satellite communication:
- Initial expenditure is expensive.
- There are chances of blockage of frequencies.
- Propagation and interference.

Applications of Satellite Communication

- Telephone
- Television
- Digital cinema
- Radio broadcasting

- Amateur radio
- Internet access
- Military
- Disaster Management

Type of satellite and its orbits

In most cases, after being launched, a satellite is placed in one of several predetermined orbits around the Earth. But in some cases, it may be directed to interplanetary journey, following a path around the Sun until it reaches its ultimate destination.

Satellites are usually classified based on their orbital altitude (distance from the Earth's surface), which directly affects their coverage and the speed at which they travel around the planet. When choosing the type of orbit, spacecraft developers should consider its intended purpose, the data it acquires, and the services it offers, as well as the cost, coverage area, and feasibility of different orbits.

The 5 main types of satellites based on their orbits are:

- low Earth orbit (LEO)
- medium Earth orbit (MEO)
- geostationary orbit (GEO)
- Sun-synchronous orbit (SSO)
- geostationary transfer orbit (GTO)

Let's dig deeper into the nature of these 5 different types of satellites' orbits to learn more about their characteristics and potential uses.

Low Earth Orbit (LEO) Satellites

Low Earth Orbit satellites are moving at an altitude of roughly 160–1,500 kilometers above the Earth's surface. They have a short orbital period, between 90 and 120 minutes, meaning they can travel around the planet up to 16 times a day. This makes them particularly well-suited to all types of remote sensing, high-resolution earth observation, and scientific research, as data can be acquired and transmitted rapidly.

Medium Earth Orbit (MEO) Satellites

A Medium Earth type of orbit is located between low Earth and geostationary orbits, typically at an altitude of about 5,000 to 20,000 kilometers. Positioning and navigation services, like GPS, extensively use MEO type of satellites. Recently, high-throughput satellite (HTS) MEO constellations have been put into operation to enable low-latency data communication to service providers, commercial and government organizations.

Geostationary Orbit (GEO) Satellites

Spacecraft in geostationary Earth orbit are positioned 35,786 kilometers above Earth's surface, precisely over the equator. Three evenly spaced machines in GEO can give nearly worldwide coverage thanks to the huge area they cover on Earth.

Objects in GEO appear motionless from the ground because their orbital period is identical to Earth's rotation — 23 hours, 56 minutes, and 4 seconds. This allows a terrestrial antenna to always point toward the same device in space. That's why this type of satellites is perfect for always-on communication services like TV and phones. Also, this type can be used in meteorology to keep an eye on the weather in particular regions and track the development of local patterns. The downside of GEO type of spacecraft for real-time communication is the longer signal delay caused by their great distance from Earth.

Sun-Synchronous Orbit (SSO) Satellites

The Sun-synchronous orbit type of satellites goes from north to south across the polar regions at an altitude of 600 to 800 km above the Earth. The orbital inclination and altitude of SSO spacecraft are calibrated so that they always cross any given location at precisely the same local solar time. Thus, the lighting conditions are consistent for imaging, making this type of satellite ideal for earth observation and environmental monitoring

This also implies that SSO's current and historical satellite images are well-suited for change detection. Scientists

use these image sequences to learn about the development of weather patterns, forecast cyclones, monitor and prevent wildfires and floods, and gather information on long-term issues like deforestation and coastline changes. But because of their lower orbital altitude, SSO type of spacecraft can only cover a smaller region at once and need more machines to do so continuously

Geostationary Transfer Orbit (GTO) Satellites

The most frequent type of satellite transfer orbit is a geostationary one utilized to migrate from a transition orbit to GEO. Spacecraft are not always placed directly into their ultimate orbit when propelled from Earth into space by launch vehicles such as Falcon 9. Rockets carrying payload to GEO drop it off at transfer orbits, which are halfway points on the path to its final position. Then a satellite's engine fires to reach its destination orbit and adjust its inclination . This shortcut allows the machine to reach geostationary orbit with minimal resources.

Satellite frequency bands

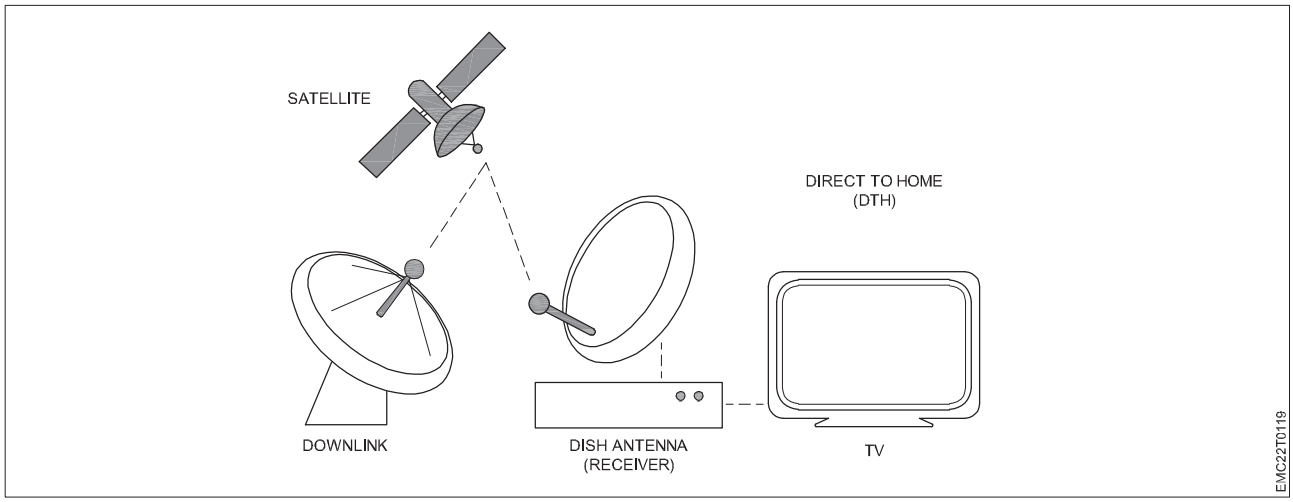
Satellite technology is developing fast, and the applications for satellite technology are increasing all the time. Not only can satellites be used for radio communications applications, but they are also used for astronomy, weather forecasting, broadcasting, mapping and very many more applications. In view of the variety of satellite frequency bands that can be used, designations have been developed so that they can be referred to easily. The satellite frequency bands chart given below provides information about the most commonly used designations for the satellite frequency bands.

Direct to Home (DTH) technology

Satellite frequency bands chart	
Letter designation for satellite frequency band	**Frequency range (GHZ)**
L	1 -2
S	2 – 4
C	4 – 8
X	8 - 12
	(8 - 12.5 in North America)
Ku	12 - 18 (12.5 - 18 in North America)
K	18 – 27 (18 - 25.5 in North America)
Ka	27 – 40 (26.5 - 40 in North America)
O	40 – 50
V	50 – 75

Direct-to-Home satellite broadcasting or DTH is the distribution of television signals from high-powered geostationary satellites to small dish antennas and satellite receivers in homes across the country.

Early satellite television was broadcast in C band - radio in the 3.4-gigahertz (GHz) to 7-GHz frequency range. Digital broadcast satellite transmits programming in the Ku frequency range (10 GHz to 14 GHz).



The Components

There are five major components involved in a direct to home (DTH) or direct broadcasting (DBS) satellite system: the programming source, the broadcast center, the satellite, the satellite dish and the receiver.

a The programming source

Satellite TV providers get programming from two major sources: International turnaround channels (such as HBO, ESPN and CNN, STAR TV, SET, B4U etc) and various local channels (SaBe TV, Sahara TV, Doordarshan, etc). Turnaround channels usually have a distribution center that beams their programming to a geostationary satellite. The broadcast center uses large satellite dishes to pick up these analog and digital signals from several sources.

b The broadcast center

The broadcast center converts all of this programming into a high-quality, uncompressed digital stream. At this point, the stream contains a vast quantity of data — about 270 megabits per second (Mbps) for each channel. In order to transmit the signal from there, the broadcast center has to compress it. Otherwise, it would be too big for the satellite to handle. The providers use the MPEG-2 compressed video format — the same format used to store movies on DVDs. With MPEG-2 compression, the provider can reduce the 270-Mbps stream to about 3 or 10 Mbps (depending on the type of programming).

With digital compression, a typical satellite can transmit about 200 channels. Without digital compression, it can transmit about 30 channels.

c Encryption & Transmission

After the video is compressed, the provider needs to encrypt it in order to keep people from accessing it for free. Encryption scrambles the digital data in such a way that it can only be decrypted (converted back into usable data), if the receiver has the correct decoding satellite receiver with decryption algorithm and security keys. Once the signal is compressed and encrypted, the broadcast center beams it directly to one of its satellites. The satellite picks up the signal, amplifies it and beams it back to Earth, where viewers can pick it up.

d The Dish

A satellite dish is just a special kind of antenna designed to focus on a specific broadcast source. The standard dish consists of a parabolic (bowl-shaped) surface and a central feed horn. To transmit a signal, a controller sends it through the horn, and the dish focuses the signal into a relatively narrow beam. The dish on the receiving end can't transmit information; it can only receive it. The receiving dish works in the exact opposite way of the transmitter. When a beam hits the curved dish, the parabola shape reflects the radio signal inward onto a particular point, just like a concave mirror focuses light onto a particular pointThe curved dish focuses incoming radio waves onto the feed horn.

e The Receiver

The end component in the entire satellite TV system is the receiver. The receiver has four essential jobs: It de-scrambles the encrypted signal. In order to unlock the signal, the receiver needs the proper decoder chip for that programming package. It takes the digital MPEG-2 signal and converts it into an analog format that a standard television can recognize.

Some receivers have a number of other features as well. They pick up a programming schedule signal from the

provider and present this information in an onscreen programming guide. Many receivers have parental lock-out options, and some have built-in Digital Video Recorders (DVRs), which let to pause live television or record it on a hard drive.

Advantages of DTH Technology:

- The advantages of DTH Technology include:
- Greater service coverage.
- More channels.
- Better signal quality.
- Multiple language options.
- Pay only for the channels and services that the user wants.
- Applications such as Parental Lock, Pre-booked Pay-Per-View and Impulse Pay-Per-View.

Disadvantages of DTH Technology

The disadvantages of DTH Technology include:

One of the major problems for the subscribers of Direct To Home service is unable to view any channel during heavy rains due to weak signals.

Changing service provider is not easy as the user has to pay additional cost to buy new Set Top Box from new service provider.

Satellite television installation basics

To receive satellite television broadcasts, a TV antenna capable of receiving the satellite broadcasts is required as well as a television that can cover the required frequencies and also power the electronics in the satellite television antenna.

The system for a satellite television installation is a little different to that required for terrestrial television.

The overall satellite dish installation requires a number of different elements:

Satellite dish antenna: This refers to the antenna itself. Typically parabolic reflector antennas are used as these operate well at the frequencies used, giving high levels of gain within a relatively small space.

LNB / LNBF: The satellite TV LNB or low noise block is used to amplify the signal at the antenna and convert it to a lower frequency that can be fed along coax feeder with acceptable levels of loss.

Coaxial feeder: The coax feeder is used to transport the signal from the low noise block to the television receiver.

Satellite capable television / set top box: the satellite television or set top box receives the down-converted signals within the required band and also supplies power along the centre conductor of the coax feeder to power the satellite TV LNB or LNBF.

Deeper descriptions and explanations of these different elements of a satellite antenna installation are given below.

Types of Cables

Cables are classified as

- Twisted pair
- Coaxial
- Optical fiber

Twisted pair cables consist of color-coded pairs of insulated copper wires, one wire carries the signal, and the other is used for ground reference. Every two wires are twisted around each other to form pairs that are encased in a plastic sheath each wire with a diameter of 0.4 mm to 0.8 mm.

The number of pairs varies depending on the cable type. More twists per foot in a pair of wires, less the cross talk.

The significance of twisting is it reduces or nullifies the interference such as noise or cross talk caused due to radiofrequency of electromagnetic interference.

By twisting the wires, the effect of noise or disturbance is the same on both wires. Since the receiver takes only the difference between the two wires the effective noise is canceled.

Twisted pair cables are two types

- Shielded Twisted cable (STP)
- Unshielded Twisted pair cable (UTP).

Shielded Twisted Pair cable (STP)

As the name implies, Shielded twisted pair cable adds a conductive layer (typically a metal foil or a mesh) surrounding either each pair or entire cable.

Purpose

Shield on twisted pair allows a higher transmission rate.

Advantages

- Easy installation.
- It has a higher capacity as compared to UTP cable.
- It is shielded that provides a higher data transmission rate.

Disadvantages

- Cables are bigger in diameter more expensive compared to UTP or coaxial cable.

Applications

Used as instrumentation cable in industrial applications.

Used in harsh cold and hot environments.

Research applications.

Un Shielded Twisted Pair cable (UTP)

Unshielded twisted pair cable uses no additional shielding like mesh or aluminum foil which adds bulk are used.

There are different types of unshielded twisted pair cable, all support different bandwidths.

Category 1: Is used for a telephone line that has a low-speed data rate.

Category 2: It can support up to 4 Mbps.

Category 3: It can support up to 16 Mbps.

Category 4: It can support up to 20 Mbps.

Category 5: It can support up to 200 Mbps.

Purpose

Untwisted pair cable is used for voice, low speed, and high-speed data and audio support systems.

Advantages

It is cheap compared to coaxial or optic fiber cable.

Used in computer networking such as Ethernet for short to medium distances.

Disadvantages

This cable can be used for shorter distances because of the signal attenuation.

Applications

Used in LAN.

Coaxial Cable

Coaxial cables are also called coax (short form).

Coaxial cable is a type of cable with multiple layers.

Coaxial cables have an inner conductor is called the core, which carries the radio frequency signal. The core wire may be a single solid conductor or multi strands of twisted cable. It is surrounded by a dielectric insulator.

The dielectric insulator separates the inner conductor and outer copper braided mesh. The dielectric insulator is covered by copper mesh (foil or braided conductor). The dielectric insulator may be polyethylene foam or PTFE which minimizes ohmic losses arising from contact with the conductors. Outer jacket is to protect the cable from environmental and mechanical damages. A common choice is PVC.

Both inner conductor and braided wire mesh conductor is in the cable share a common central axial, hence the term coaxial. Coaxial cables are rated in ohms for their impedance. Common impedances are 50 ohms, 75 ohms, 95 ohms.

There are many types of coaxial cable connectors.

Four are common. BNC, SMA, N, F types. Coaxial cables are categorized based on the type of signal transmission. One is Baseband and the other is Broadband cable.

Baseband cable

It is a 50 ohms resistance cable that is capable of digital transmission. Used in short distances for optimum performance.

Broadband cable

It is a 75 ohms resistance cable used for analog data transmission. It is used up to 100 km.

Based on Radio Gauge (RG) standards, there are two types of Coaxial cables:

Thicknet and Thinnet

Thicknet: RG 8, RG 9, RG 11 coaxial cable is also known as Thick Ethernet or 10Base5 systems. 10 means, it is 10 Mbps speed and 5 refers to 500 meters distance between nodes or repeaters. Where Base indicates that the transmission type is a “Baseband transmission”

Thicknet cabling uses heavier gauge coaxial cable than Thinnet.

Thinnet: RG 58 Coaxial cable is used 10Base2 systems. 10 means 10mbps speed and 2 refers to 200 meters distance between nodes or repeaters.

Advantages

Coaxial cable is useful for both analog and digital data transmission.

It has a higher bandwidth, so it supports a mixed range of services.

Relatively less expensive compare to fiber optic cable.

Disadvantages

The number of node connections is limited.

Prone to damage due to lightning strikes.

Applications

Broadband internet, high-speed computer data buses, cable TV, Ethernet.

Optical Fiber Cable

It also is known as fiber optic cable consists of strands of one or more fibers inside the casing and its assembly is similar to electrical cable.

Optical fiber has three parts

Core

It is the inner layer is called the core, with refractive index n1. Light is guided in this part. The core will have a higher refractive index than cladding.

Cladding

which surrounds the core, with refractive index n2. Whose refractive index is less than the core? The purpose of cladding is to keep the light reflections in core instead of being reflections.

Casing

Which is an outer layer for protecting the cable from damages.

There are two types of optical fibers, glass, and plastic. Plastic fiber is used for short communication. Optical fiber transfers data at the speed of light in the glass.

Optical fiber cable uses light pulses instead of electrical pulses to transmit data. The potential hazard of Infrared red light used in telecommunications cannot be seen by the naked eye.

Optical fiber cable comes in single-mode or multimode connections.

Single Mode

The single-mode allows only one mode of light to transmit at a time through the core, which makes for higher bandwidth.

Single-mode fiber optic, the number of light reflections in the core is less resulting in low attenuation and allowing data to travel further, faster. Single-mode provides the lowest losses in communication.

Multi-Mode

Multimode connections have a larger core diameter. It allows multiple wavelengths of light transmitted in multiple paths at once.

Multimode connections are used over shorter distances as signal attenuation will be more, the data transfer rate is slow as a number of reflections in the core are more.

Advantages

Extremely high bandwidth and speed.

Impervious to electromagnetic interference.

Several kilometers of optical fiber cable can be made cheaper than the equivalent length of copper cable.

Optical fibers usually have a longer life cycle for more than 100 years.

The loss of signal in fiber optic cable is very less than that in copper wire.

The smaller size and lightweight than a comparable copper wire cable.

Less weight can be bundled together.

Optical fiber is thinner and can be drawn to smaller diameters than copper wire.

Disadvantages

More unsafe than damage compared to copper wires.

Should not twist or bend fiber optic cables too tightly. Follow specification for cable bend radius.

Applications

Used in Telephone signals, internet communication, cable television.

Multi Dwelling Unit (MDU)

The Multi Dwelling Unit is a customized solution for connecting multiple TVs within the same multi storied building with a single or two Dish Antennae to receive Direct-to-Home service. Common dish is installed on the terrace of the multi storied building which gives signal to DTH STBs connected to TV sets in multi storied building. Once the dish is installed, residents have the choice to subscribe for the DTH services.

Direct-to-Home entertainment is based on the concept of receiving the services directly on your television from a satellite through DTH box. A small dish is installed in your home to receive the signals from the satellite. However, one connection needs one dish to receive the satellite signals. This leads to many dishes in any multi storied building having many subscribers.

MDU is the solution that reduces the number of dishes to one or two in a multi storied building for all the subscribers in the building.

Advantage of MDU

Each and every customer in the building does not have to have a separate Dish Antenna to receive DTH services.

Additional dish is not required to be installed for any additional subscriber in the building.

It is easy to maintain one or two dish antenna in a building.

Headed Amplifier

An amp head is just a preamp and a power amp section without any speakers. It processes the signal and amplifies it before it goes into a speaker cabinet. We can find this same formation with some home stereo systems with a separate amplifier and passive speakers.

Line amplifier

The 20dB Satellite In-Line Amplifier are used to boost the signal from your satellite to your receiver or multi-switch. Simply install the amplifier at the satellite dish or signal source for an instant 20dB boost. In-line amplifiers are required when the signal is too weak or for long cable runs over 100 feet. This amplifier supports signals from 900 to 2400 MHz.

Features

20dB +/- 1dB Gain

Line Powered

Power Passing

Low Noise Figure: 4dB Max

Outdoor Rated

Bandwidth 900 to 2400 MHz

Power Consumption: 22VDC 40mA

Cascade input\output Multi Switch:

Cascade multi-switch for 1 Satellite position with 5 inputs and 5 trunk outputs, suitable for distributing satellite and terrestrial signals in small to large sized systems. Available with 12 subscriber outputs and powered by the TMS PSU external power supply either directly or via the SAT trunk lines.

Main features

Low insertion loss

High isolation

Low power consumption

RED compliant

ESD Protection

Flexibility

Easier to select the right product

Fewer products to stock

Active/Passive Terrestrial Switch

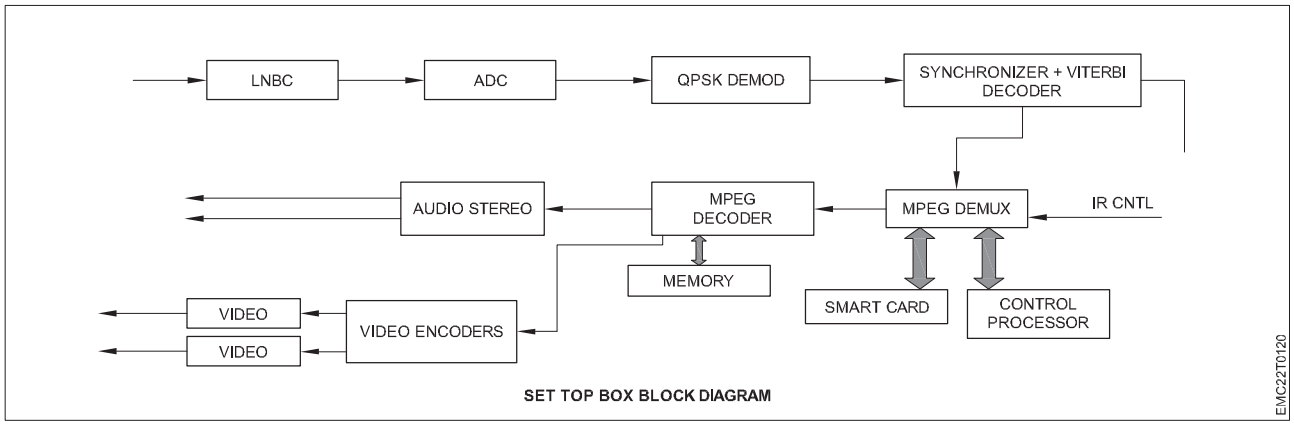
Convenience

Set-Top Box (STB):

Used by TV viewers around the world, set-top boxes (STBs) are devices that connect to the television and convert cable, satellite, or digital signals, or internet data, to TV signals so video content can be viewed on the television.

Originally used to deliver cable television services to analogue televisions, set-top boxes now come in several forms and are used to receive and convert digital signals, access cable or satellite television services, or send and receive internet data via cable or telephone connections.

Some set-top boxes also have a built-in digital video recorder (DVR) for recording content. Also known as ‘receivers’, set-top boxes initially sat on top of the chunkier older-style TV sets (before slimmer flat screens became commonplace), hence the name ‘set top’.



SET TOP BOX BLOCK DIAGRAM

Types of Set Top Box:

Shortened to STB, a set top box is similar in size and shape to a video cassette recorder (VCR). It tunes into, receives and decodes HDTV signals.

HDTV signals can come from over-the-air broadcasts, digital satellites, or digital cables. But be careful when shopping for a STB as there are several types available on the market.

Listed below are the common kinds of STBs:

HDTV tuners: This device tunes in, receives and decodes free over-the-air HDTV and DTV signals with an antenna.

DirectTV receivers: It tunes in, receives, and decodes digital satellite signals with a satellite dish.

All-in-one receivers: For this type of STB, it tunes in, receives and decodes both over-the-air and digital satellite HDTV and DTV signals. It requires both an antenna and a satellite dish.

Cable HDTV receivers: It tunes, receives, and decodes digital cable signals.

Features To Look Out For

To ensure you are getting the best set top box unit for your home entertainment needs, here are the features you should look out for.

Features Of A Set-Top Box:

India is rapidly moving towards digitization. In the home entertainment sector, the switch-over to digital TV from the traditional analogue cable TV is one of the most remarkable measures undertaken. The digital set-top box has now become indispensable. Set-top boxes now come with features that have extended well beyond basic TV viewing. You can use your set-top box to play games, set up alarms, or even record live TV. A simple comparison of the digital set-top box price might not be the best strategy anymore.

We recommend the following six features that are a 'must have' for your set-top box.

Electronic Program Guide

The EPG (electronic program guide) provides the viewers with updated menus displaying schedules for ongoing and upcoming programs on various TV channels. The EPG feature of the digital set-top box makes lives easier by telling us when our favourite shows will be aired and when the repeats will be telecast. The EPG is certainly one of the greatest gifts of modern digital TV.

Favourites

The digital set-top box also allows users to set up their preferred channels as favourites – making them quicker and easier to access when desired. This feature comes quite handy especially when there are tons of channels and remembering their numbers can be a little tricky. This functionality works similar to the 'bookmarks' feature in internet browsers.

Timer

The timer – a basic yet useful feature – allows viewers to switch between channels at pre-set times. You can also use this for generic/ parental control to switch the set-top box off at a stipulated time. The timer also comes in handy to record live TV on more than one channel when the user is away.

Live TV Recording

Lately, set-top boxes have started allowing users to record live TV broadcast on an attached hard disk drive. The feature instantly gained popularity and has become a standard feature in most set-top boxes. Users can playback the recorded broadcast, delete and overwrite previous recordings with ease.

Universal Remote Controls

Many set-top box manufacturers provide remote controls that not only support controlling the provided box, but they are also compatible with many televisions from various brands and models. Such remote controls are commonly referred to as universal remotes. They can control most of the basic functions of your TV along with controlling your set-top box, thereby adding convenience and ease of use.

Parental Locks

Some set-top boxes allow users above 18 years of age to set up parental locks. Simply put, parents can put up filters on certain type of channels that are not appropriate for children. They can choose to block some or all of the channels listed in a particular category or block multiple channels listed across different categories.

Cable Modem Termination Systems (CMTS):

Cable modem termination system (CMTS) is a hardware device at the headend of a cable TV network that is used to connect cable subscribers to the Internet Service Provider (ISP). They provide high speed data services like Internet or Voice over Internet Protocol (VoIP) over the cable TV network.

Functions

CMTS has both radio frequency interfaces and Ethernet interfaces.

It transmits and receives user data packets to and from the cable modem attached to the subscriber through HFC network. It then converts them to Internet Protocol packets (IP packets) and routes them to the concerned Internet Service Provider (ISP).

Cable modems cannot directly communicate among themselves. So, all data communications should be done via CMTS.

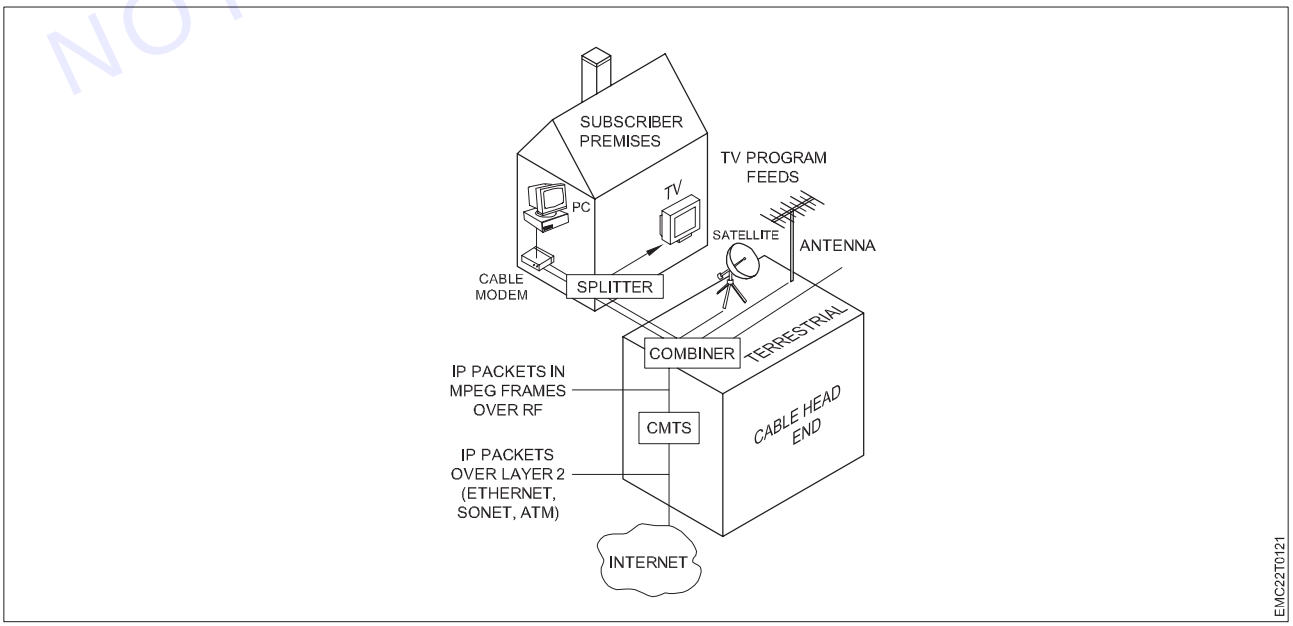
CMTSs can act as a bridge or a router in the network.

CMTSs can serve different population sizes of cable modems.

The quality of service provided by a CMTS to the cable modems is independent of their distances.

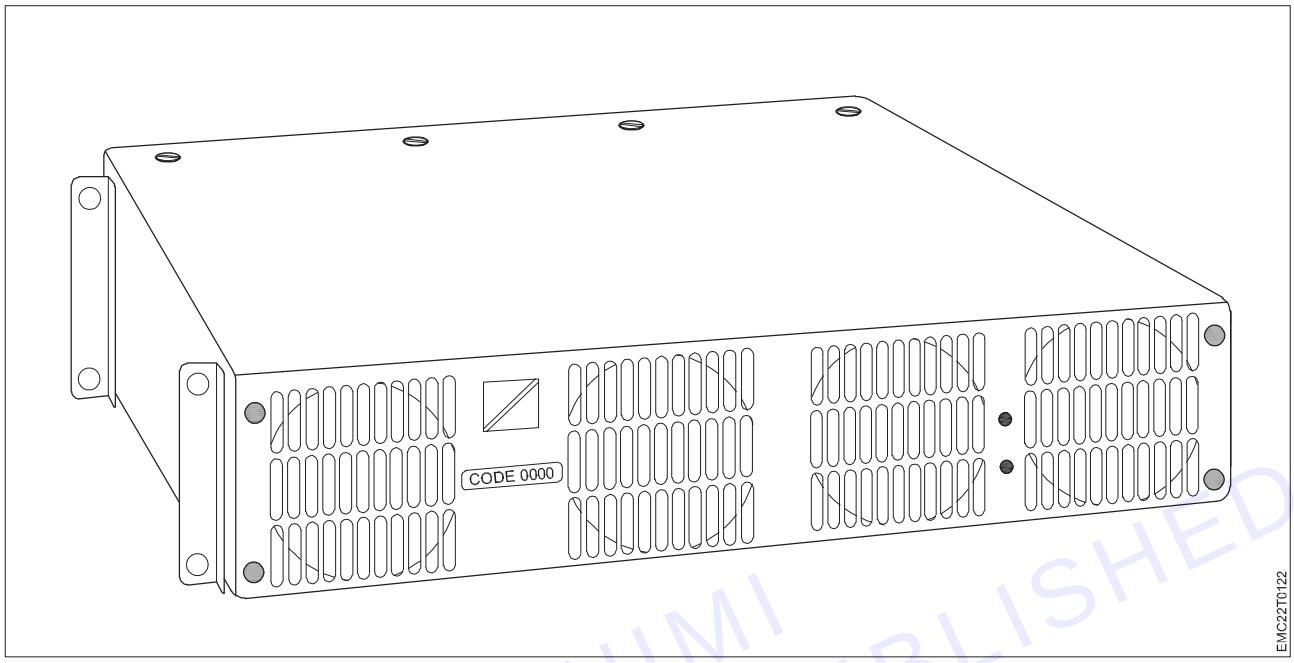
They provide authorization to users.

They can also provide basic filtering against threats and attacks.



Cable Modem InfrastructureA CMTS performs packet format conversion and IP address assignment (see DHCP). It may also provide routing, bridging, filtering and traffic shaping. The combiner merges the TV programming feeds with the RF data from the CMTS.

This CMTS supports approximately 1,300 users. It provides one downstream port of 40 Mbps and up to 6 upstream ports of 10 Mbps



Types of Cable Modems

The main two types of CMTS are

Integrated CMTS (I-CMTS) – All the components of I-CMTS are in the same chassis. Thus the RF interface and the IP components are in a single device.

Modular CMTS (M-CMTS) – Here, the architecture is broken into two components –

the physical downstream component, called the Edge QAM, and IP networking and DOSCIS MAC component, called M-CMTS Core each. (Image courtesy of ADC Telecommunication, Inc.)

Customer Premises Equipment (CPE)

CPE refers to any telecommunications device that physically stays with the customer for use instead of the service provider. Examples of common customer premises equipment include telephone handsets, cable TV boxes, and DSL routers. In most cases, these devices are rented from the service provider, and they will be serviced or replaced in the event of a problem. Their functionality is directly tied to the service and if the service is discontinued, a company will be directed to return them and will receive new CPE that is compatible with their new service provider..

Customer-Premises Equipment (CPE)

Customer-Premises Equipment (CPE) refers to the hardware and devices located on the customer's premises or site that enable data, computing, telephony, and networking services. CPE serves as the interface between the customer and the service provider, allowing the customer to access and utilize various services and functionalities.

In the context of data, computing, telephony, and networking systems, CPE can include the following components:

1 **Data CPE:** Devices such as routers, switches, modems, or gateways that enable connectivity to data networks, such as the internet. These devices facilitate the transmission and reception of data packets between the customer's network and the service provider's network.

2 **Computing CPE:** Computing devices, such as desktop computers, laptops, servers, or thin clients, that are used by the customer to process, store, and manage data and applications. Computing CPE forms the foundation for running software applications and performing various computing tasks within the customer's premises.

3 **Telephony CPE:** Equipment used for voice communication, including analog or digital telephones, VoIP (Voice over Internet Protocol) phones, private branch exchange (PBX) systems, or fax machines. Telephony CPE enables voice calls and related telecommunication services within the customer's premises.

4 **Networking CPE:** Components that facilitate local area network (LAN) or wide area network (WAN) connectivity. This can include switches, wireless access points, network interface cards (NICs), or network adapters. Networking CPE enables the creation and management of a network infrastructure for data sharing, communication, and resource access within the customer's premises.

CPE is typically owned and managed by the customer, although service providers may also provide and maintain certain CPE components as part of their services. The CPE interacts with the service provider's network infrastructure, allowing the customer to access data, computing resources, telephony services, or network connectivity as per their subscription or service agreement.

CPE plays a critical role in enabling customers to utilize and leverage various data, computing, telephony, and networking systems within their own premises, providing them with the necessary tools and infrastructure to connect, communicate, and access services efficiently and securely.

The benefits of using a CPE

Using CPE offers a variety of benefits that can help businesses maximize their network performance and efficiency. Here are some of the key benefits of using CPE:

1 **Improved Network Performance:** CPE provides businesses with access to high-speed network connections, allowing them to handle more network traffic and improve their overall network performance.

2 **Cost Savings:** By using CPE, businesses can avoid having to purchase and maintain their own network equipment, resulting in significant cost savings.

3 **Improved Scalability:** CPE is designed to be easily scalable, allowing businesses to quickly and easily expand their networks as their needs grow.

4 **Enhanced Security:** CPE provides businesses with an additional layer of security, as they typically have more robust security features built-in, such as firewalls, VPNs, and advanced encryption.

Overall, CPE offers businesses a variety of benefits that can help them improve their network performance, reduce costs, and enhance their data centers & network security. By using CPE, companies can ensure business needs for internet service are met & that their networks will operate at optimal levels.

The quality of the CPE matters

The type of CPE that is installed can have a significant impact on the quality and reliability of the customer's telecommunications network service. For example, a high-quality router can help to ensure that internet connections are fast and reliable, while a low-quality router may result in slow and unreliable connections.

CPE can also be used to add features and functionality to a customer's telecom data service. For example, a customer may choose to install a VoIP adapter to their CPE in order to use VoIP services.

In general, CPE is an important part of telecommunications service & infrastructure and can have a significant impact on the quality and reliability of service.

LESSON 118 - 126 : Cell Phones

Objectives

At the end of this lesson you shall be able to

- explain basic concepts involved in cellular system
- explain various aspects involved in cellular communication.

Mobile Communication is the use of technology that allows us to communicate with others in different locations without the use of any physical connection (wires or cables). Mobile communication makes our life easier, and it saves time and effort. In mobile communications, high-frequency electromagnetic fields are used for wireless transmission of voice and data. In free space they propagate as waves at the speed of light while being able to transmit energy and information over long distances.

History of Wireless Communication

The history of the wireless communications started with the understanding of magnetic and electric properties observed during the early days by the Chinese, Roman and Greek cultures and experiments carried out in the 17th and 18th centuries. A short history of wireless communication is presented in the tabular form:

Year	Description
1880	Hertz-Radio Communication
1897	Marconi- Radio Transmission
1933	FCC (Federal Communication Commission)
1938	FCC rules for regular services
1946	Bell telephone laboratories 52 MHz
1956	FCC - 450MHz (Simplex)
1964	Bell telephone active research 800 MHz
1964	FCC - 450 MHz (Full Duplex)
1969	FCC - 40 MHz bandwidth
1981	FCC? release of cellular land phone in the 40 MHz
1982	At & T divested and Server RBOC (Regional Bell Operation Companies) formed to manage the cellular operation.
1984	Most RBOC market in operations
1986	FCC allocates 5MHz extended band.
1988	TDMA was voted as digital cellular standard in North America.
1992	GSM (Group Special Mobile) operable Germany D2 system.
1993	CDMA (Code Division Multiple Access)
1994	PDCC (Personal Digital Cellular Operable) in Tokyo, Japan
1995	CDMA operable in Hong Kong
1996	Six Broad Band PCS (Personal Communication Services) licensed bands (120 MHz) almost reader 20 billion US dollar
1997	Broad band CDMA constructed and of the 3rd generation mobile.
1999	Powerful WLAN systems were evolved, such as Bluetooth. This uses a 2.4 MHz spectrum.

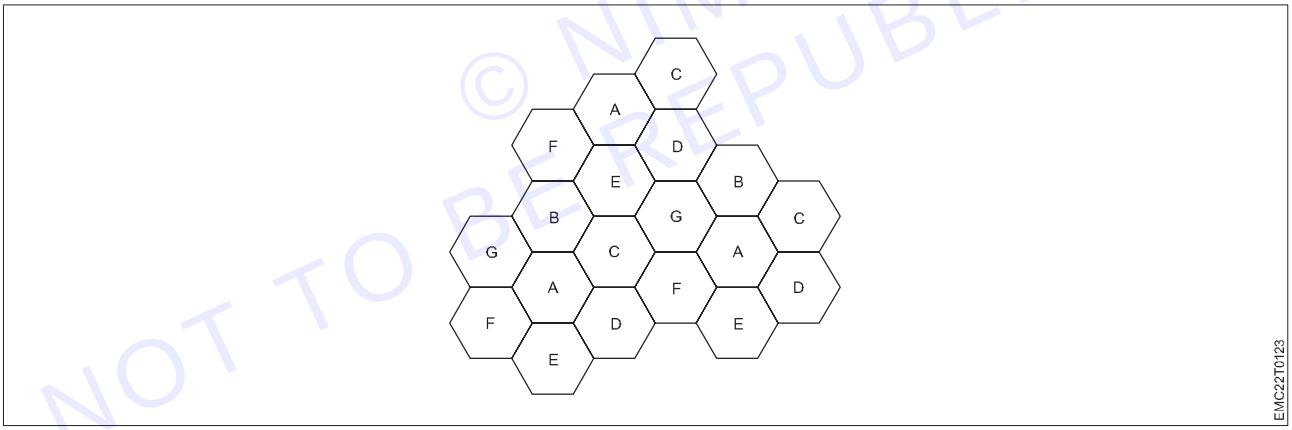
Cellular Systems - Basic Concepts

- Cellular system solves the problem of spectral congestion.
- Offers high capacity in limited spectrum.
- High capacity is achieved by limiting the coverage area of each BS to a small geographical area called cell.
- Replaces high powered transmitter with several low power transmitters.
- Each BS is allocated a portion of total channels and nearby cells are allocated completely different channels.
- All available channels are allocated to small no of neighboring BS.
- Interference between neighboring BS's is minimized by allocating different channels.
- Same frequencies are reused by spatially separated BS's.
- Interference between co-channels stations is kept below acceptable level.
- Additional radio capacity is achieved.
- Frequency Reuse-Fix no of channels serve an arbitrarily large no of subscribers.

Frequency Re-use:

The design process of selecting and allocating channel groups for all the cellular base stations within a system is called frequency reuse or frequency planning.

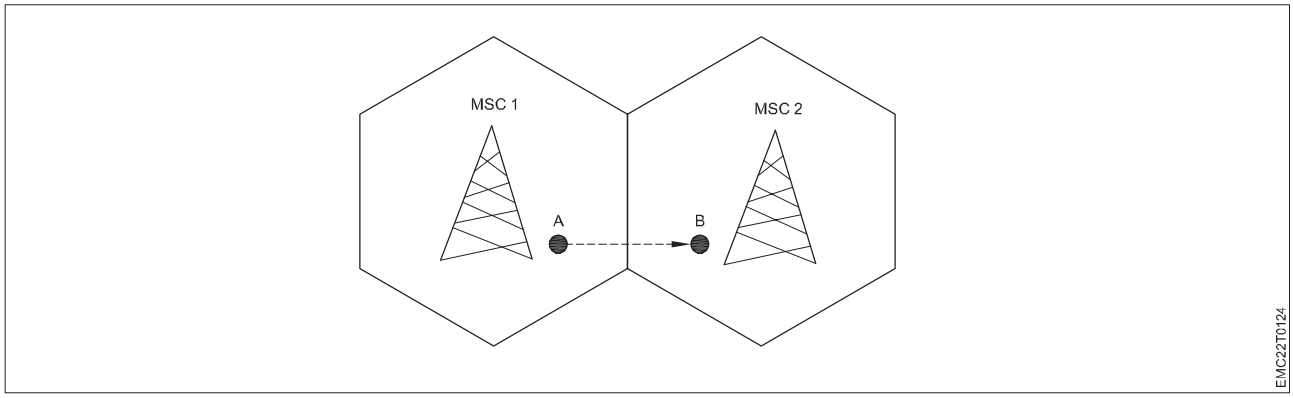
- Cell labeled with same letter use the same set of frequencies.
- Cell Shapes - Circle, Square, Triangle and Hexagon.
- Hexagonal cell shape is conceptual; it is irregular in shape.



- In hexagonal cell model, BS transmitter can be in center of cell or on its 3 vertices.
- Centered excited cells use omni directional whereas edge excited cells use directional antennas.
- A cellular system having 'S' duplex channels, each cell is allocated 'k' channels (k<S)
- If S channels are allocated to N cells into unique and disjoint channels, the total no of available channel is
- S = kN.

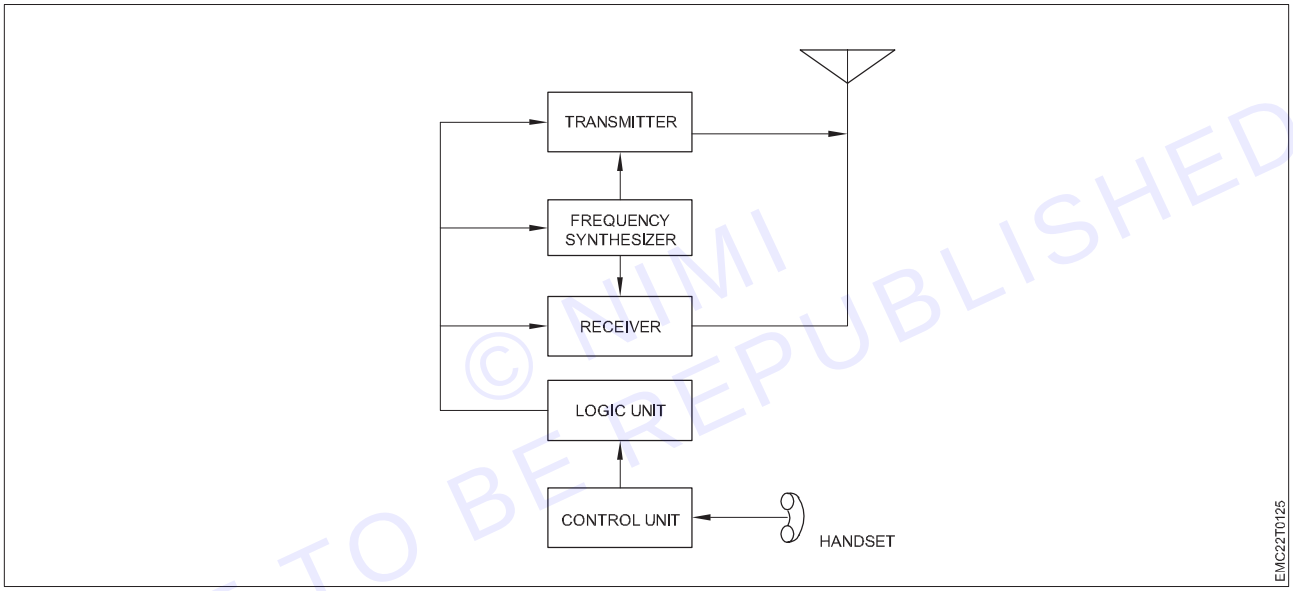
Hand off Strategies

In cellular telecommunications, the terms handover or handoff refers to the process of transferring an ongoing call or data connectivity from one Base Station to another Base Station. When a mobile moves into a different cell while the conversation is in progress then the MSC (Mobile Switching Center) transfers the call to a new channel belonging to the new Base Station.



When a mobile user A moves from one cell to another cell then BSC 1 signal strength loses for the mobile User A and the signal strength of BSC 2 increases and thus ongoing calls or data connectivity for mobile users goes on without interruption.

Block Diagram Of Cell Phone:



Transmitter: It is a low power FM unit operating in the frequency range of 825 to 845MHz. There are 666, 30 KHZ transmit channels. The carrier is furnished by a frequency synthesizer which is a phase modulated by voice signal.

Receiver: The RQ receiver is a dual conversion super heterodyne. The incoming signal frequency is converted twice to frequency of 455KHz or 10.7MHMz with the help of mixer and IF amplifier stages. The signal is then demodulated, emphasized and filtered and given to loudspeaker.

Frequency Synthesizer: This block generates all the signals used by transmitter and receivers. It uses standard PLL circuits and a mixer.

Logic Unit: This unit contains a master control circuit for a cellular radio. It is made up of microprocessor with RAM and ROM and additional circuit used for interpreting signals from MSC and BS and generates control signal for the transmitter and receiver.

Control unit: The control unit contains the handset with speaker and microphone. The control unit is operated by a separate microprocessor that drives the LCD display and other indicators.

WORKING:

When you speak into a cellphone, a tiny microphone in the handset converts the up-and-down sounds of your voice into a corresponding up-and-down pattern of electrical signals. A microchip inside the phone turns these signals into strings of numbers. The numbers are packed up into a radio wave and beamed out from the phone's antenna (in some countries, the antenna is called an aerial). The radio wave races through the air at the speed of light until it reaches the nearest cellphone mast.

The mast receives the signals and passes them on to its base station, which effectively coordinates what happens inside each local part of the cellphone network, which is called a cell. From the base station, the calls are routed onward to their destination. Calls made from one cellphone to another cellphone on the same network travel to their destination by being routed to the base station nearest to the destination phone, and finally to that phone itself. Calls made to a cellphone on a different network, or a land line follow a lengthier path. They may have to be routed into the main telephone network before they can reach their ultimate destination.

A cellphone handset contains a radio transmitter, for sending radio signals onward from the phone, and a radio receiver, for receiving incoming signals from other phones. The radio transmitter and receiver are not very high-powered, which means cellphones cannot send signals very far. That's not a flaw— it's a deliberate feature of their design! All a cellphone must do is communicate with its local mast and base station; what the base station must do is pick up faint signals from many cellphones and route them onward to their destination, which is why the masts are huge, high-powered antennas (often mounted on a hill or tall building).

Features of Mobile Communication

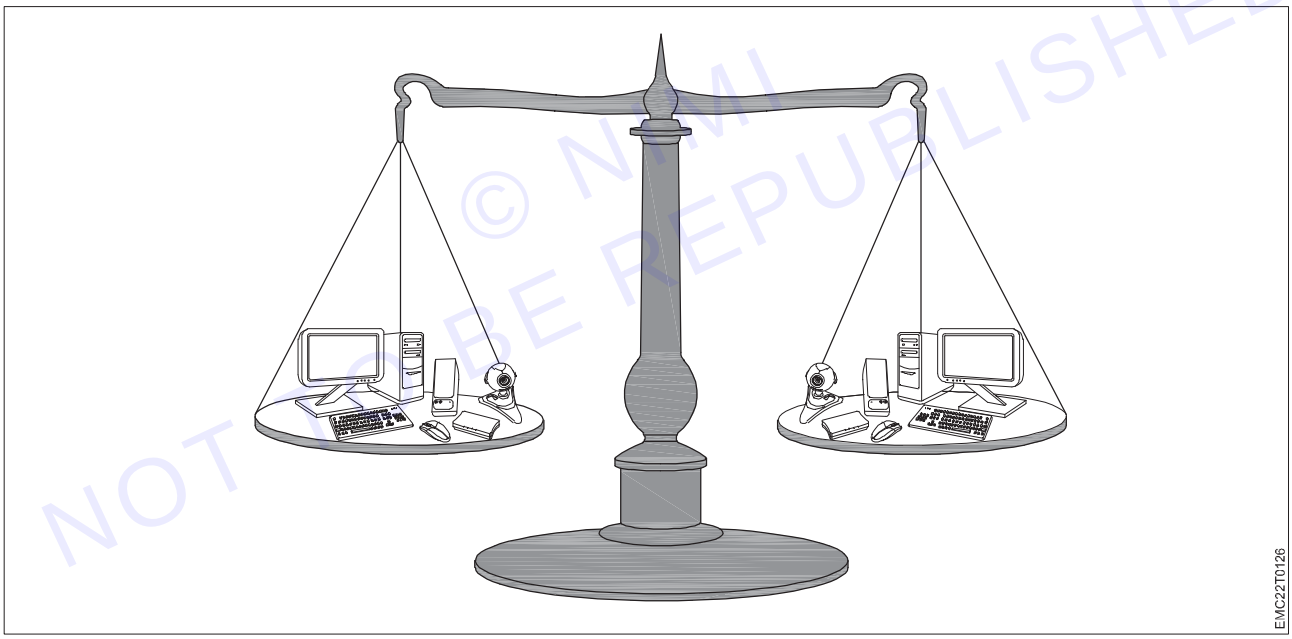
The following are the features of mobile communication:

High-capacity load balancing:

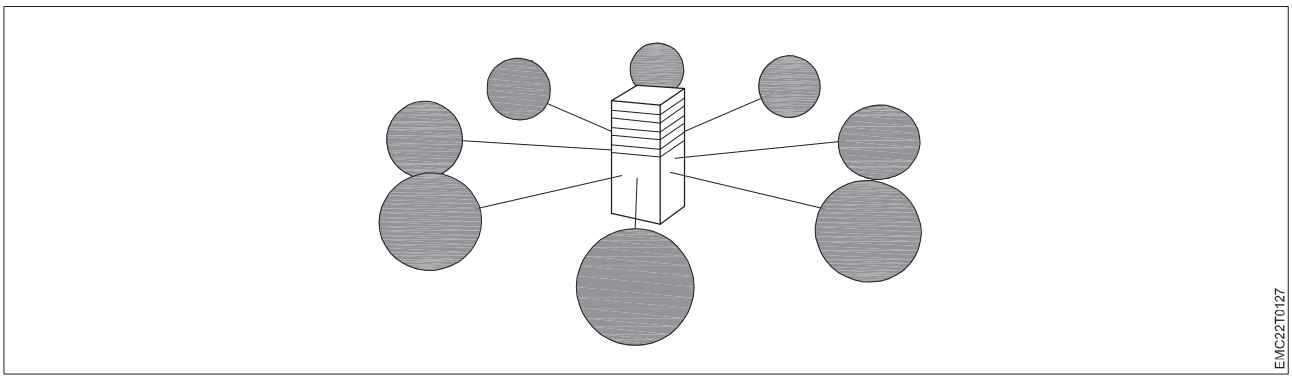
Each wired or wireless infrastructure must incorporate high-capacity load balancing.

High capacity load balancing means, when one access point is overloaded, the system will actively shift users from one access point to another depending on the capacity which is available.

Scalability: The growth in popularity of new wireless devices is continuously increasing day by day. The wireless networks can start small, if necessary, but expand in terms of coverage and capacity as needed - without having to overhaul or build an entirely new network.



Network management system: Now a day, wireless networks are much more complex and may consist of hundreds or even thousands of access points, firewalls, switches, managed power and various other components. The wireless networks have a smarter way of managing the entire network from a centralized point.



Role based access control: Role based access control (RBAC) allows you to assign roles based on what, who, where when and how a user or device is trying to access your network.

Once the end user or role of the devices is defined, access control policies or rules can be enforced.

Indoor as well as outdoor coverage options: It is important that your wireless system has the capability of adding indoor coverage as well as outdoor coverage.

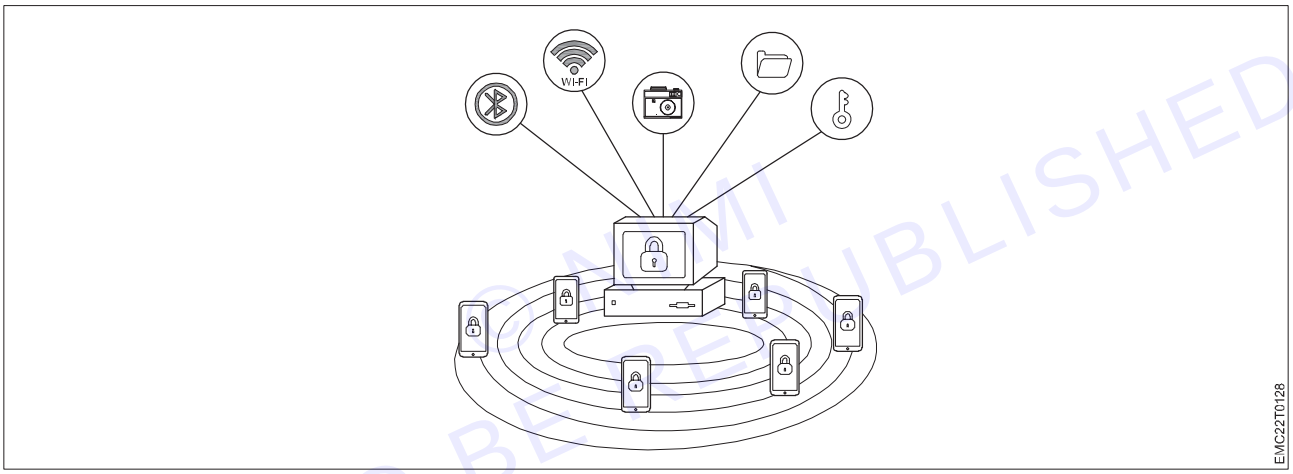
Network access control: Network access control can also be called mobile device registration. It is essential to have secure registration.

Network access control (NAC) controls the role of the user and enforces policies. NAC can allow your users to register themselves to the network. It is a helpful feature that enhances the user experience.

Mobile device management: Suppose many mobile devices are accessing your wireless network; now think about the thousands of applications that are running on those mobile devices.

How do you plan on managing all these devices and their applications, especially as devices come and go from your business?

Mobile device management can provide control of how you will manage access to programs and applications. Even you can remotely wipe the device if it is lost or stolen.



Roaming: You don't need to worry about dropped connections, slower speeds or any disruption in service as you move throughout your office or even from building to building wireless needs to be mobile first.

Roaming allows your end-users to successfully move from one access point to another without ever noticing a dip in performance.

For example, allowing a student to check their mail as they walk from one class to the next.

Redundancy: The level or amount of redundancy your wireless system requires depends on your specific environment and needs.

For example: A hospital environment will need a higher level of redundancy than a coffee shop. However, at the end of the day, they both need to have a backup plan in place.

Proper Security means using the right firewall: The backbone of the system is your network firewall. With the right firewall in place, you will be able to:

See and control both your applications and end users.

Create the right balance between security and performance.

Reduce the complexity with:

Antivirus protection.

Deep Packet Inspection (DPI)

Application filtering

Protect your network and end users against known and unknown threads including:

Zero- day.

Encrypted malware.

Ransomware.

Malicious botnets.

Switching: Basically, a network switch is the traffic code of your wireless network which makes sure that everyone and every device gets to where they need to go.

Switching is an essential part of every fast, secure wireless network for several reasons:

It helps the traffic on your network flow more efficiently.

It minimizes unnecessary traffic.

It creates a better user experience by ensuring your traffic is going to the right places.

Advantages of Mobile Communication

There are following advantages of mobile communication:

Flexibility: Wireless communication enables people to communicate with each other regardless of location. There is no need to be in an office or some telephone booth to pass and receive messages.

Cost effectiveness: In wireless communication, there is no need for any physical infrastructure (Wires or cables) or maintenance practice. Hence, the cost is reduced.

Speed: Improvements can also be seen in speed. The network connectivity and accessibility were much improved in accuracy and speed.

Accessibility: With the help of wireless technology easy accessibility to remote areas is possible. For example, in rural areas, online education is now possible. Educators or students no longer need to travel to far-flung areas to teach their lessons.

Constant connectivity: Constant connectivity ensures that people can respond to emergencies relatively quickly. For example, a wireless device like mobile can ensure you a constant connectivity though you move from place to place or while you travel, whereas a wired landline can't.

GSM (Global System for Mobile communication)

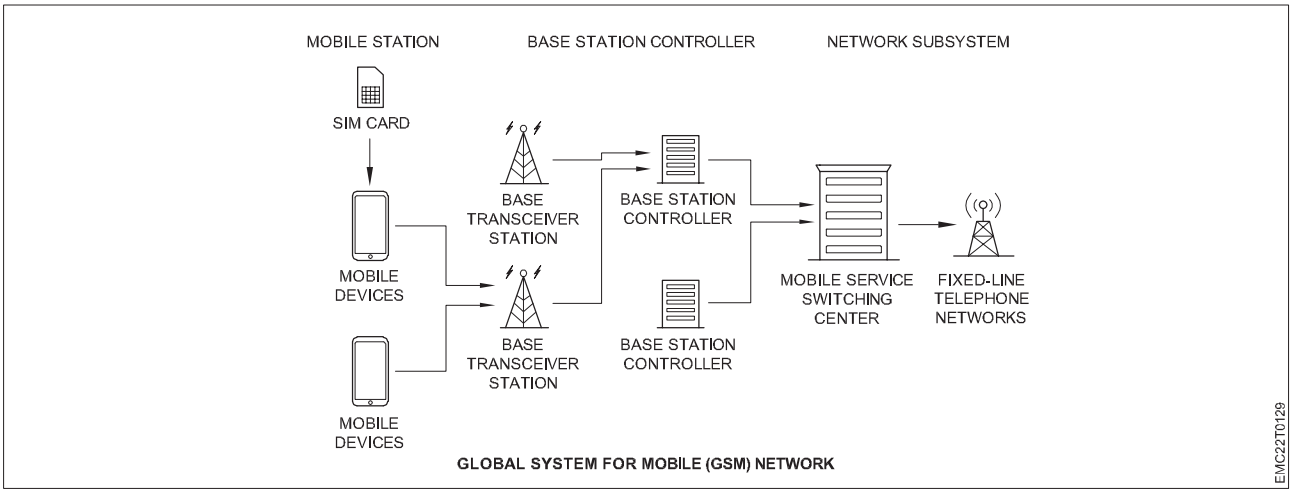
GSM (Global System for Mobile communication) is a digital mobile network that is widely used by mobile phone users in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies: TDMA, GSM and code-division multiple access (CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 megahertz (MHz) or 1,800 MHz frequency band.

GSM, together with other technologies, is part of the evolution of wireless mobile telecommunications that includes High-Speed Circuit-Switched Data (HSCSD), General Packet Radio Service (GPRS), Enhanced Data GSM Environment (EDGE) and Universal Mobile Telecommunications Service (UMTS).

Composition of the network

The GSM network has four separate parts that work together to function as a whole: the mobile device itself, the base station subsystem (BSS), the network switching subsystem (NSS) and the operation and support subsystem (OSS).

The mobile device connects to the network via hardware. The subscriber identity module (SIM) card provides the network with identifying information about the mobile user.



GLOBAL SYSTEM FOR MOBILE (GSM) NETWORK

Diagram of the GSM network organization

The BSS handles traffic between the cellphone and the NSS. It consists of two main components: the base transceiver station (BTS) and the base station controller (BSC). The BTS contains the equipment that communicates with the mobile phones, largely the radio transmitter receivers and antennas, while the BSC is the intelligence behind it. The BSC communicates with and controls a group of base transceiver stations.

The NSS portion of the GSM network architecture, often called the core network, tracks the location of callers to enable the delivery of cellular services. Mobile carriers own the NSS. The NSS has a variety of parts, including mobile switching center (MSC) and home location register (HLR). These components perform different functions, such as routing calls and Short Message Service (SMS) and authenticating and storing caller account information via SIM cards.

Because many GSM network operators have roaming agreements with foreign operators, users can often continue to use their phones when they travel to other countries. SIM cards that hold home network access configurations may be switched to those with metered local access, significantly reducing roaming costs, while experiencing no reductions in service.

CDMA: Code Division Multiple Access

CDMA stands for Code Division Multiple Access. It is a channel access method used by several radio communication technologies. It is a digital cellular technology and an example of multiple access. It is generally used for mobile communication.

Multiple access means that several transmitters can send information simultaneously over a single communication channel. In this system, different CDMA codes are assigned to different users, and the user can access the whole bandwidth for the entire duration. It optimizes the use of available bandwidth as it transmits over the entire frequency range and does not limit the user's frequency range.

Thus, CDMA allows several users to share a band of frequencies without undue interference between the users. It is used as an access method in many mobile phone standards.

Usage:

It is used in the Global Positioning System (GPS).

It is used by several mobile phone companies (e.g., Qualcomm standard IS-2000, also known as CDMA2000)

W-CDMA is used in UTMS 3G mobile phone standards.

CDMA has been used in Omni TRACS satellite system for transportation.

Categories of CDMA:

Synchronous CDMA (orthogonal codes)

Asynchronous CDMA (pseudorandom codes)

Difference between CDMA and GSM

The major difference between CDMA and GSM are given below.

Criteria	CDMA	GSM
Technology	CDMA is based on spread-spectrum technology, which makes the optimum use of available bandwidth.	GSM operates on the wedge spectrum. It uses both time division multiple access (TDMA) and frequency division multiple access (FDMA). TDMA provides multi-user access by cutting up the channel into different time slices, and FDMA provides multi-user access by separating the used frequency.
Security	CDMA is more secure than GSM.	GSM is less secure than CDMA.
Global reach	CDMA is used in the USA and some parts of Canada and Japan. CDMA is used only by 24% of users worldwide.	GSM is used in over 80% of the world network in over 210 countries. GSM is used by 76% of users worldwide.
Data Transfer Rate	CDMA has faster data transfer than GSM.	GSM has slower data transfer as compared to CDMA.
Radiation exposure	CDMA phones emit less radiation than GSM phones.	GSM phones emit continuous wave pulses and emit almost 28 times more radiation than CDMA phones.

IMEI

The IMEI (International Mobile Equipment Identity) is a unique number to identify GSM, WCDMA, and iDEN mobile phones, as well as some satellite phones. Mostly phones have one IMEI number, but in dual SIM phones are two.

The IMEI is only used for identifying the device and has no permanent or semi-permanent relation to the subscriber. The number is used by the GSM network to identify valid devices and therefore can be used for stopping a stolen phone from accessing the network in that country.

How toTrack Phone Using IMEI No.

Method 1: IMEI Tracker by I Staunch

Method 2: Contact Your Mobile Carrier

Method 3: File a Police Report

Method 4: Contact the Manufacturer

Additional Strategies and Tips

In addition to the methods mentioned above, there are several additional strategies and tips that can enhance your efforts to track a lost phone using the IMEI number and protect your personal data.

Act Promptly: Time is of the essence when it comes to tracking a lost phone. The sooner you report the loss to your mobile carrier and law enforcement, the higher the chances of successful recovery. Prompt action can prevent the thief from selling or resetting your device.

Keep a Record of Your IMEI: Before you lose your phone, it's good practice to make a note of your IMEI number and keep it in a safe place. This will save you time and effort when reporting the loss to your mobile carrier and law enforcement.

Enable Remote Tracking and Locking Features: Many smartphones have built-in features that allow you to track the device's location and remotely lock it. Ensure these features are enabled on your device before it goes missing. Apple users can use "Find My iPhone," while Android users can use "Find My Device" (formerly Android Device Manager).

Use Two-Factor Authentication: Enable two-factor authentication (2FA) on your online accounts and apps to add an extra layer of security. This can help prevent unauthorized access to your accounts if your phone falls into the wrong hands.

Report to Device Manufacturers: In addition to contacting your mobile carrier, reach out to the device manufacturer as well. They may have specific tools or advice for locating your device, especially if it is equipped with manufacturer-specific tracking features.

Monitor for Suspicious Activity: Keep an eye on your financial accounts and online profiles for any suspicious activity. If you had personal information or sensitive data on your lost phone, take steps to secure your accounts and change passwords if necessary.

MODULE 14: Smartphones app tester and SD card installation procedure

LESSON 127 - 129 : Smartphones CUM app tester

Objectives

At the end of this lesson you shall be able to:

- define smart phone
- state various uses of smartphones.

Smartphones cum app tester

Phones used to be all about making calls, but now your mobile can do so much more. The range of new touchscreen smartphones allows you to access the internet, use social media, get live news updates, play music and video, and much more. They almost universally use touchscreens for control, however, which can be a challenge for people new to the technology.

Smartphone

OVERVIEW In the past, mobile phones were mostly about making phone calls. They had a number pad, a digital phone book and a pick-up/hang-up button and not much more. Now smartphones offer so much more – they're really fully-fledged computers that you can fit in your pocket. They can run programs and games, access the internet, send email and much more. Nearly all smartphones now use touchscreen controls. Instead of having hardware buttons like before, one side of the phone is taken up mostly by a touchscreen that you control using taps and gestures. There aren't even any number buttons; when you want to make a call, a number pad will pop up on the touchscreen. Becoming familiar with a smartphone can take a little bit of practice. But when you do become familiar with it, you'll find that a smartphone can do more than you ever thought possible on a mobile phone.

A brief history of smartphones :

The first smartphones, the IBM Simon and Nokia Communicator 9000 were released way back in 1994 and 1996 respectively, and integrated the features of a mobile phone and a personal digital assistant (PDA) for managing calendars and contacts. Both were much larger than regular phones. It wasn't until 2000 that the first real smartphone, the Ericsson R380, was released. It wasn't any larger than a regular phone, and in the early 2000s many others followed suit, with phones like the Palm and BlackBerry achieving big success. In 2007, Apple released the iPhone, which eschewed hardware buttons for full touchscreen control and has been the template for smartphones ever since

A smartphone can:

Make voice calls (of course!)

Make video calls

Access the internet and browse the web

Take photos, and upload them to the web

Navigate with GPS if the phone has GPS built-in

Play back music and video stored on the phone (and connect to a PC to copy media to it)

Manage your contacts and appointments

Send emails

Play in-built games

Run new applications and games downloaded for the internet.

Data plans:

To get the most out of a smartphone, you need a mobile plan that includes data. This is not strictly a necessity – you can still use a smartphone without a data plan – but you won't be able to access the internet, download new applications and send emails without it. In some cases, you may not be able to use GPS navigation.

Post-paid :A post-paid plan involves paying a fixed monthly fee for your calls and data, and typically means signing a one or two year contract. These plans typically come with a phone that is subsidised by the plan, meaning it's cheaper than if you bought it outright.

Pre-paid : A pre-paid plan is where you pay for your minutes and data as you use it. These plans do not require contracts, and the phone is an additional cost.

Overview smartphone operating systems :

There are many models of smartphone. Smartphones are made by every major phone manufacturer: Apple, Samsung, LG, HTC, Nokia, Sony Ericsson, Motorola, RIM, Palm and others.

There are three major operating systems on phones:

1 Google Android is the most popular operating system on mobile phones, and there are hundreds of phone models from dozens of manufacturers that use it. It looks and works very similar to the iPhone OS (iOS) – to launch an application or start a phone feature, you either tap an icon on the screen or press a hardware button on the side. Most Android phones are customised by their manufacturer, so a phone from, say, Samsung is not exactly the same as a phone from HTC.

2 Apple iOS comes on the Apple iPhone, and is the same system that is used on the Apple iPad. It's a very simple system – you just touch an icon to launch a particular phone feature or app.

3 Windows Phone is made by Microsoft and it looks a lot like the new Windows 8 interface. Touching one of the onscreen blocks starts up different applications and phone features.

How the screen works

Nearly all touchscreen phones now use what is called a capacitive touchscreen. It responds not to pressure but to the electrical charge inside your body. For this reason, they need only the slightest touch to work – they will register even the lightest contact. It also means that to the phone a slight touch is the same as a heavy one – if something isn't working, pressing harder won't change anything! Another characteristic of capacitive touchscreens is that you generally can't use them with gloves on – unless the gloves are thin enough not to insulate your finger. They also won't be activated by your clothes, so carrying the phone around in your pocket won't trigger the touchscreen.

How touch screens work

With the exception of a few hardware buttons (which are typically used for turning on and off, volume controls, returning to the Home screen and perhaps taking photos), most of the operations on your smartphone are managed with the touchscreen. For example, to start an application, you tap on its onscreen icon. To dial a number, you use an onscreen keypad, tapping on numbers on the screen to dial them. If you're looking at your list of SMS messages, to view one in full you'd just tap on the one you want. Phones, like tablets (if you've attended our Introduction to Tablets workshop), also use what are called gestures. These are special motions that have different effects. The simplest gesture is the tap, where you just touch a part of the screen. But there are others that you can use as well.

Although there are a variety of gestures that smartphones can use (some even involving using your whole hand), there are six key ones:

Tap

This is simply a quick touch of the screen.

It's the simplest gesture there is. It's used to launch apps, select items, follow web links and so on.

It's the equivalent of a left-click on your PC.

Tap and hold (and drag)

Touch a part of the screen, and keep your finger in contact with the screen.

The effect of this varies, depending on the application.

On your Home screen, it can be used to move icons and widgets around. Tap and hold so that the icon appears to 'detach', then drag it to where you want it. It might be used for similar drag and drop operations in other applications.

Scroll

Simply touch a part of the screen that doesn't have a button or link that would be triggered by a tap. Keep your finger in contact with the screen and move it up or down, left or right.

This is most commonly used for scrolling. If you visit a web page that's too long to see on the screen, for example, touch any part of the page that's not a link near the bottom of the screen, then push your finger up the screen, as if you were pushing the web page up to reveal the rest of it. This will cause the web page to scroll. If you're looking at your contact list (and it takes more than a page), you can scroll up or down the list in the same way.

Swipe

This is a quick slash across the screen. It can be in whatever direction is needed.

It's most commonly used when flipping between pages (in a book) or images (in a slideshow). The swipe is like flinging the current page or image aside to reveal to the next page or image.

In an image program for example, swipe right to left to move to the next image.

Swipe is also used on your smartphone's Home page: if you have a lot of apps installed (too many to fit on one screen), you can have several Home pages. You swipe left or right to switch between them.

Swipe can also be used for fast scrolling – you can fling a page up or down. The velocity of the swipe actually determines how far it scrolls.

Pinch-to-zoom

This gesture actually requires more than one finger. Place two fingers (usually the thumb and forefinger, but it doesn't really matter) around a part of the screen you want to enlarge or zoom out of. Then move the two fingers apart to zoom in (enlarge that part of the screen), or pinch them closer together to zoom out.

You can think of it like squeezing or expanding the screen.

It's often used in web browsers, allowing you to zoom in on part of the page that might not be clear (or might have a link that's difficult to press). It's also used in image programs to zoom in and out of a photo.

Double tap

This gesture involves simply tapping on the screen twice in quick succession.

It most often serves a similar function as pinch-to zoom: in your web browser, double tap on a part of the page you want to zoom in on (which makes it easier to touch hyperlinks); double tap again to zoom out.

"MOTIONS On top of gestures, some phones also support motions. They might respond to shaking the phone, tilting the phone, holding it to your ear, rotating the phone and more. The user manual for the phone will reveal any motions it supports, and what each motion does."

Turning the phone on and off

Press and hold the power button on the smartphone. The start up sequence will commence. If this is the first time you've used the SIM card in this phone, you may be asked to enter the PIN number provided with your SIM. The Unlock screen will appear. This will vary, depending on the phone model. On most phones it requires that you tap and drag a slider or circle from one part of the screen to another. The phone screen will automatically switch off after a few seconds of inactivity. This doesn't mean the phone is switched off. To bring the screen back on, just quickly tap the power button. Generally, you never really need to switch off a smartphone, but if you need to, press and hold the power button for a few seconds. (A quick tap will just switch off the screen

Making a call:

This takes you to the phone menu on your smartphone. Now touch the Keypad button. A number set will appear onscreen. Tap in the number you want to call. You enter numbers just by touching them on the screen. Once you've entered the number, tap the green Call button (which usually looks like a green phone handset). The keypad will disappear and the call will start.

When you want to end the call, just tap on the red End Call icon or button.

Adding a contact

You don't want to have to remember and type in the phone number of everyone you want to call. That's why you add contacts to your phone. On your phone's Home or application screen, tap on the Contacts button. On an iPhone it looks something like the image opposite, but on your phone it may look a little different. The Contacts list will appear. To add a new contact, tap on the Add Contact button (sometimes just a + button). The Add Contact page will appear. There will be fields that you can fill in. To fill out a field, tap on the field box. The onscreen keyboard will popup, allowing you to tap in appropriate details. You'll see that the keyboard only displays letters and possibly a limited selection of punctuation marks. If you want to type in numbers you need to press the ?123 button. That switches the keyboard to numbers. (Tapping the ABC button switches back to letters). If you want to type upper case letters, tap on the Shift key, which is the arrow pointing upward. This has the same function as the Shift key on a PC keyboard (except that it locks on when you tap it, tap it again to turn it off). The keyboard will appear in any situation where you need to type letters on your phone. It will appear, for example, if you open up the web browser and need to type in a web address. It's also used for texting and emailing. It may seem impossibly hard right now to target letters – but it gets easier with practice. For now, you only really need to give the person a name and a phone number, but you can add a street address, an email address and photo if you like (the photo can be taken right now, or you can use a photo that's already on your phone). When you're done, tap on the Save button. The person will now be in the Contacts list.

An introduction to apps

Remember at the beginning of the workshop how we talked about smartphones being a lot like computers? Well, like computers, you can install new programs on your smartphone. On phones and tablets, these are called apps (short for applications). Your phone probably comes with a whole suite of them pre-installed. On your Home screen or your Apps screen, you'll see a host of buttons in addition to the ones we've already talked about. Each of these buttons launches a unique app. Feel free to experiment with the apps by tapping on their icon.

Apps can be just about anything

Games

Web browsers

Music and video players

Personal organisers and calendars

Web services like YouTube and Flickr

Productivity programs like word processors

News feeds

Email and social networking applications

Many other useful and fun tools.

There are literally hundreds of thousands of apps available for smartphones. In addition to pre-installed apps, every phone comes with a link to an online market where you can get more apps. You'll need to create an account with that market to download apps.

You can also download movies, music and TV shows directly to your phone from online media stores. This media can be played on your phone using its built-in media player application.

Mobile Application Testing

The term mobile testing refers to different types of testing, such as native mobile app testing, mobile device testing, and mobile Web app testing. We use mobile app testing to refer to "testing activities for native and Web applications on mobile devices using well-defined software test methods and tools to ensure quality in functions,

behaviors, performance, and quality of service, as well as features, such as mobility, usability, interoperationability, connectivity, security, and privacy."

Related Work in Mobile Application Testing

Many studies address different issues and topics in mobile application testing. Due to space constraints, we provide a high-level view of recent mobile testing work.

White-box testing

Existing white-box testing methods are still applicable to mobile apps. For example, Java Pathfinder 1 is a mobile program verification tool supporting white-box mobile Java program testing. Engineers can use this tool to detect race conditions and deadlocks based on UML state charts and symbolic execution. Riyadh Mahmood and his colleagues 2 use a whitebox approach to generate test cases with two program-based models (call graph and architectural) to achieve mobile program code coverage.

Black-box testing

Many black-box testing techniques are useful in mobile app testing. Random testing and the scenario-based testing method 3 are good examples. GUI-based testing has been discussed in numerous papers. For instance, Saswat Anand and his colleagues 4 introduced an automated testing approach to validating mobile GUI event sequences for smartphone apps. Similarly, Domenico Amalfitano and his colleagues 5 presented a tool called Android Ripper that uses an automated GUI-based technique to test Android apps in a structured manner.

Usability testing

Usability testing helps enhance the quality of the user experience on mobile devices. Anne Kaikkonen her colleagues6 present a usability testing study and comparative findings in the laboratory as well as in the field.

Quality-of-service testing

The QoS requirements for mobile apps include software performance, reliability, availability, scalability, and loading speed. Rabeb Mizouni and his colleagues7 evaluated the Web service performance of handheld resource-constrained clients using SOAP and RESTful technologies. Their focused QoS parameters included response time, availability, throughput, and scalability.

Wireless connectivity testing

Today, mobile devices support diverse wireless connectivity options, so mobile apps must be validated with specified wireless connectivity and contexts. Tapani Puhakka and Marko Palola8 addressed this need for B3G applications and presented an experimental system for automated testing of B3G mobile apps on multiple mobile phones at the same time. Ichiro Satoh9 presented a new approach, called the flying emulator, to test the software executed on mobile terminals. Unlike existing approaches, it lets engineers construct emulators as mobile agents that can travel between computers.

Different mobile test infrastructures:

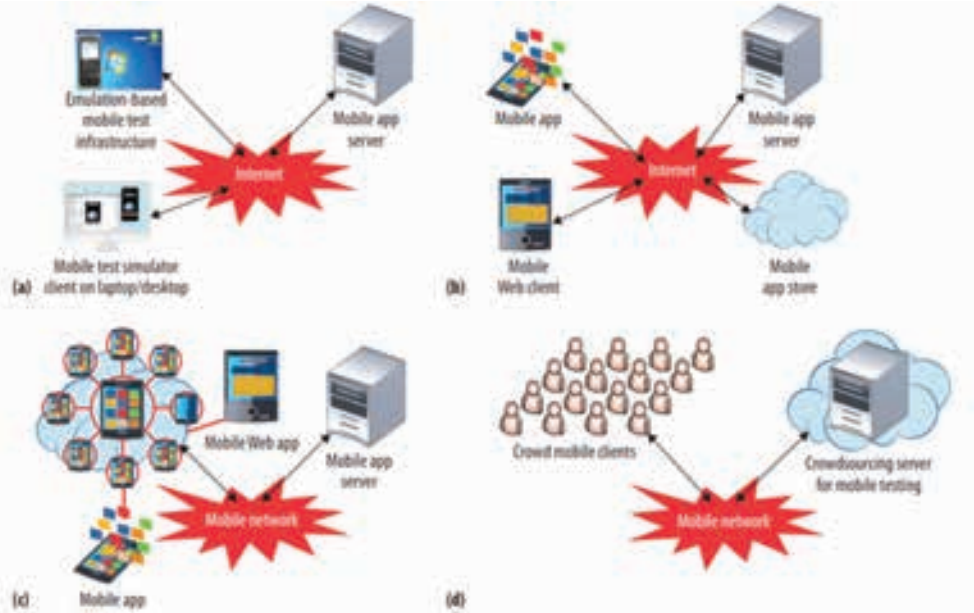
a emulation,

b cloud,

c device, and

d crowd based.

Related Work in Mobile Application Testing



Testing approaches:

We have identified four popular mobile app testing approaches, based on the underlying client–server infrastructure. Figure 1 illustrates the different infrastructures. Table 1 compares these approaches for different testing activities.

Table 1. Mobile application testing approaches.

Testing		Emulation-based testing	Device-based testing	Cloud testing	Crowd-based testing
Functionality and behavior	Function features	Single emulator or simulator-based	Device-based single client	Large-scale device-based testing	Ad hoc or managed testing
	Mobile user operations	Yes	Yes	Yes	Yes
	Mobile gestures	Limited	Yes	Yes	Yes
Quality of service	Load testing	Limited scale	Limited scale	Large scale	Ad hoc scale
	Performance testing	Function-based	Single client	Large scale	Ad hoc scale
	Reliability/ availability	Single client	Single client	Large scale	Ad hoc scale
	Scalability	No	No	Yes	Yes
Interoperability	Crosses devices	No	No	Yes	No
	Crosses platforms	No	Yes	Yes	No
	Crosses browsers	Yes	Yes	Yes	Yes
	Crosses networks	Limited	Limited	Yes	Limited
Usability and internationaliza-tion	Internationalization of mobile user operation	High cost and manual	High cost and manual	Automation enabled	Low cost and manual
Security and privacy	User security and privacy	Limited	Limited	Large scale	Ad hoc scale
	Communication security	No	Yes	Yes	Yes
	Transaction security	Yes	Yes	Yes	Yes
	Session security	Yes	Yes	Yes	Yes
	Server security	Limited	Yes	Yes	Yes
Mobility	Location-based function and behaviors	Based on simulated location	Preconfigured location	Based on configured mobile locations	Based on user locations
	Location-based user data and profile	Simulated user pro-file and data	Single user profile and data	Large-scale user profile and data	Crowd user profile and data
Compatibility and connectivity	Browser compatability	Single mobile browser	Single mobile browser	Configurable brows-ers on different devices	Browsers on various user devices
	Network connectivity	No	Singled network connectivity	Diverse connectivity	Preconfigured connectivity
	Platform compatability	Single platform	Any	Any	Any
Multitenancy	Tenant-based func-tions and behaviors	Yes	Yes	Yes	Yes
	Tenant-based QoS	Limited scale	Limited scale	Large scale	Ad hoc scale
	Tenant-based interfaces	Yes	Yes	Yes	Yes

MODULE 15: Smartphone hardware, software and Installation procedure

LESSON 130 - 145 : Smartphone

Objectives

At the end of this lesson you shall be able to:

- state various hardware components of smart phone
- explain about wifi & internet.

Smartphone

The introduction of smartphones revolutionized the way we communicate, work, and interact with the world around us. While there isn't a single event that marks the beginning of smartphones, their development can be traced back to the late 20th century.

A smartphone is a cellphone with advanced features, so the two terms aren't interchangeable, even if people sometimes use them that way. Technically, a smartphone is a cellphone, but a cellphone is not always smart. We compared smartphones and cellphones to help you decide which device best suits your phone needs.

Smartphones:

Make calls, send texts, take photos, access the internet, play games, and use apps.

May include a digital assistant like Siri or Google Assistant.

Sophisticated operating system with customization options.

Cellphones:

Make calls,

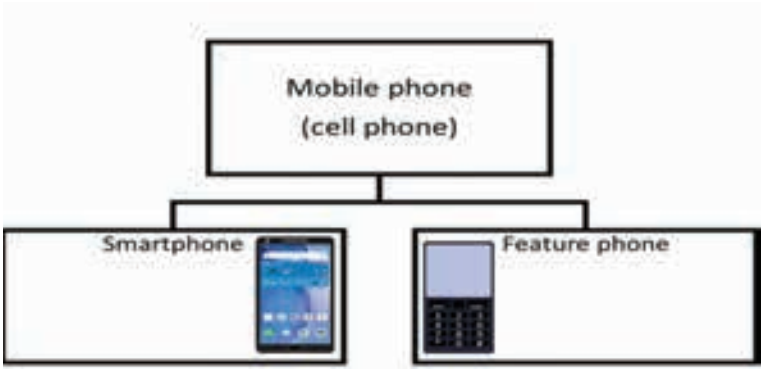
send texts, take photos, and access the internet.

Cheaper alternative to a smartphone.

Straightforward, simple interface.

Difference between a smartphone and a feature phone:

Smartphones are advanced cell phones with computer-like capabilities in addition to the basic phone features; feature phones are simpler cell phones that only allow voice calls, SMS and essential online services. Both smartphones and feature phones are types of mobile phones (cell phones).



Smartphones and feature phones are types of cell phones

There was a time, not that long ago, when most people used to have mobile phones primarily manufactured by companies like Nokia, Sony Ericsson, Motorola and some others. While phones from these companies are still available (except Sony Ericsson phones now replaced by Sony phones), we have many more choices. There are new leaders in the market, and we have new categories like iPhones, Android, Windows phones etc., that are

collectively called smartphones. The simpler phones that were more common over a decade ago are now called feature phones.

Before the launch of 4G networks, a few enhancements like HSPA (High-Speed Packet Access) were added to the mobile networks, which improved the quality of mobile data (internet). As mobile internet became more common, we were able to browse the web and stream videos in good quality directly from our mobile phones. The demand for 'staying connected' increased lots of people started using mobile phones for online communication, including emails. In 2007 with the iPhone launch, the industry changed in favour of mobile phones that allowed people to do more online activities than just voice calls and SMS (Short Message Service).

Both smartphones and feature phones are types of mobile phones where feature phones only provide basic phone features, whereas smartphones offer all the features that feature phones offer plus advanced features through apps, browsers and sensors.

Smartphone work:

Smartphones, like computers, have a microprocessor, RAM, internal and external storage, web browsers, superior OS and a vast number of applications (apps) available from the app marketplace. Mobile apps use device hardware and software capabilities to perform a range of tasks for the user.

Many business applications, including security apps, can run on these phones also. Smartphones are pretty common nowadays, and there are many phone manufacturers out there. Nearly all smartphones have touch-screen capability. Smartphone users can make and receive regular voice calls and send and receive text messages (SMS). In addition, the users can also access advanced applications and browse the web just like on a computer. Through the use of specific apps, smartphones make it easier for users to access internet-based voice calling and messaging services such as WhatsApp. Email and satellite navigation are among the other services that smartphones enable in an easy to use way.

A smartphone user, just like any mobile phone user, requires a connection that they can get from a mobile operator or service provider. Once the service is enabled (through a plastic SIM or eSIM), the smartphone can connect to the mobile network and get access to all the services, including phone calls, text messages, and the internet.

Smartphones can use multiple technologies for getting access to web services. The packet-switched part of the mobile network enables internet connectivity through 2G, 3G and 4G technologies like GPRS, EDGE, HSPA and LTE. But smartphones are also Wi-Fi capable so they can connect to any available hotspots. Most smartphones nowadays have embedded GPS capability (Global Positioning System), which enables satellite navigation for the users. It is worth highlighting that the packet-switched technology GPRS and the satellite technology GPS are two completely different technologies and it is important not to get confused between the two. Smartphones also have specific applications for email services with the ability to send push notifications to the users so they know when they receive emails.

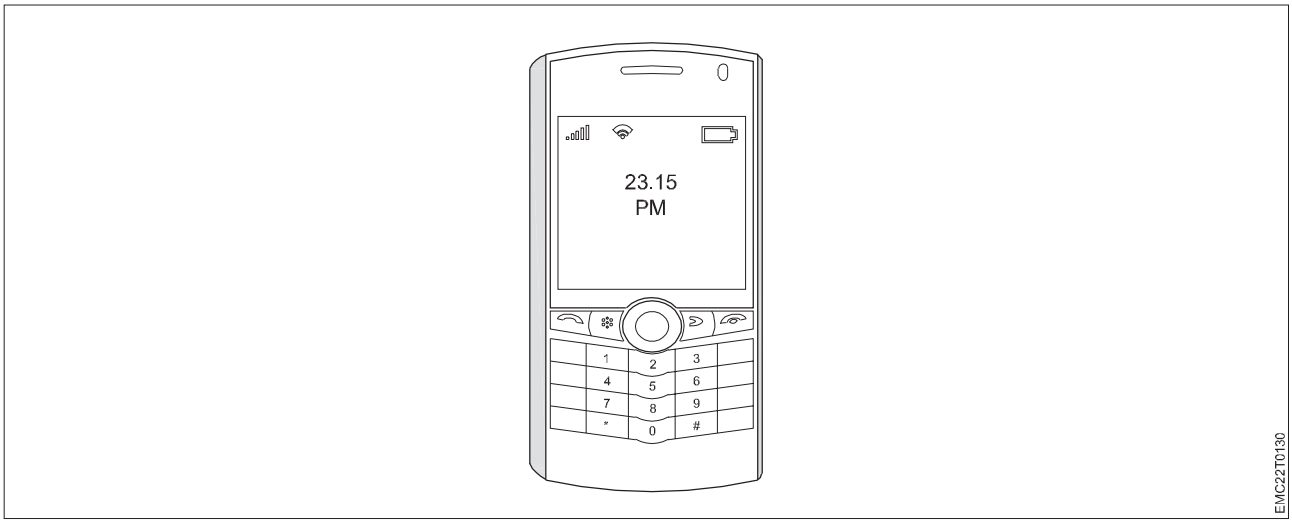
You may have different mobile operating systems (OS) depending on the phone manufacturer. The two most prominent operating systems are Android and iOS, which make up most of the mobile OS market share. Other operating systems include but are not limited to Windows, Series 40, Symbian and Blackberry. iOS is from Apple for iPhones, while Android is from Google and is used by a number of manufacturers, including Google themselves (Google Pixel), Samsung, Huawei, Honor and a few others. The mobile apps for any operating system can be downloaded directly from their respective app stores.

Feature phone work:

Feature phones are simpler mobile phones that offer basic phone services, including traditional voice calls, text messages and web connectivity. They are less heavy on the internet side of things; however, some feature phones include a basic browser and a limited number of pre-installed mobile apps.

While smartphones are the norm nowadays, there are still people who prefer to use simpler mobile phones, also known as feature phones. Feature phones provide essential features such as voice calls, text messages, and possibly limited web services. Typically, a customer can make and receive phone calls by using buttons instead of having to swipe somewhere on the screen. In addition, they can also send and receive text messages through the traditional SMS service (Short Message Service).

Feature phones also include built-in mobile applications and a web browser. All the mobile applications are installed on the feature phones directly by the manufacturer, and the users are not required (or able) to download or install any apps.



Compare a mobile phone to a smartphone:

	Mobile phone	Smartphone
Making phone calls	Yes	Yes
Send texts	Yes	Yes
Browsing the Internet	No	Yes
Download apps	No	Yes
Keyboard	Usually physical	Usually virtual
Camera	Average (if present)	Mediocre to excellent

Here's a brief overview of the introduction and evolution of smartphones:

Early Days (1990s-2000s): The concept of a smartphone began to take shape with devices like IBM's Simon Personal Communicator in 1994, which combined the functionality of a mobile phone with features like email, fax, and a touch screen. However, these early devices were bulky and lacked widespread adoption.

BlackBerry and Palm (2000s): The early 2000s saw the rise of BlackBerry and Palm devices, which offered features such as email, web browsing, and basic productivity tools. BlackBerry, in particular, gained popularity among professionals for its secure email capabilities and physical keyboards.

Apple iPhone (2007): The introduction of the iPhone by Apple in 2007 marked a significant milestone in the smartphone industry. The iPhone combined a sleek design with a multi-touch interface, a robust app ecosystem (via the App Store), and features like Safari web browser, iPod functionality, and email. It set a new standard for smartphones and paved the way for modern touchscreen devices.

Android (2008): Google's Android operating system, launched in 2008, provided an open-source platform for smartphones, allowing for customization and innovation by various manufacturers. Android quickly gained traction and became a major competitor to Apple's iOS.

Subsequent Developments: Over the years, smartphones have continued to evolve with advancements in hardware, software, and connectivity. Features such as high-resolution cameras, biometric authentication (such as fingerprint and facial recognition), augmented reality (AR), artificial intelligence (AI) assistants (like Siri and Google Assistant), and 5G connectivity have become standard in modern smartphones.

Current Trends: In recent years, smartphone manufacturers have focused on improving battery life, enhancing camera capabilities (including multiple lenses and computational photography), integrating foldable and flexible display technologies, and promoting sustainability through recycling programs and eco-friendly materials.

Future Prospects: The future of smartphones is likely to involve further integration with other technologies such as wearable devices, smart home systems, and advancements in areas like virtual reality (VR) and augmented reality (AR). Additionally, there is increasing emphasis on privacy and security features to protect user data.

Overall, smartphones have transformed from simple communication devices to powerful pocket-sized computers that have reshaped how we live, work, and interact with the world.

Study various part of smartphone architecture.

Hardware Components:

Processor (CPU): This is the brain of the smartphone, responsible for executing instructions and running applications.

Memory (RAM): Random Access Memory (RAM) stores data and instructions that the processor needs while executing tasks.

Storage: Smartphones have internal storage for storing operating system files, apps, photos, videos, and other user data.

Display: The touchscreen display allows users to interact with the device, displaying information, images, videos, and user interface elements.

Battery: Provides power to the smartphone, allowing it to operate without being plugged into a power source.

Camera: Smartphones typically have one or more cameras for capturing photos and videos.

Sensors: Various sensors such as accelerometer, gyroscope, proximity sensor, ambient light sensor, and fingerprint sensor enable features like auto-rotation, gesture recognition, screen brightness adjustment, and biometric authentication.

Operating System:

Smartphones run on operating systems like iOS (Apple), Android (Google), or in some cases, other proprietary operating systems.

The operating system manages the smartphone's hardware resources, facilitates communication between hardware components and software applications, and provides the user interface.

It also supports multitasking, allowing users to run multiple apps simultaneously and switch between them.

Software Applications:

Users interact with smartphones through software applications (apps) that run on the operating system.

Apps can be downloaded and installed from an app store (such as the Apple App Store or Google Play Store) or pre-installed by the manufacturer.

Apps offer a wide range of functionality, including communication (e.g., messaging, email, social media), productivity (e.g., office suites, calendar, task managers), entertainment (e.g., games, streaming media), utilities (e.g., maps, weather, fitness tracking), and more.

Connectivity:

Smartphones support various wireless connectivity options, including Wi-Fi, Bluetooth, GPS, and cellular data (3G, 4G, and increasingly, 5G).

These connectivity options enable internet access, location services, wireless file transfer, and connection to other devices such as headphones, speakers, smartwatches, and IoT (Internet of Things) devices.

Security and Privacy:

Smartphone operating systems incorporate security features such as encryption, secure boot, and sandboxing to protect user data and prevent unauthorized access.

Users can enhance security by using features like screen locks (PIN, pattern, password), biometric authentication (fingerprint, face recognition), and secure messaging apps.

Privacy settings allow users to control the information apps can access and share, such as location data, contacts, and device identifiers.

Overall, smartphones are complex devices that combine hardware, software, and connectivity to provide users with a versatile and powerful tool for communication, productivity, entertainment, and more.

Advantages:

Communication: Smartphones allow instant communication through calls, texts, emails, and various messaging apps, keeping people connected regardless of their location.

Internet Access: With built-in Wi-Fi and cellular data connectivity, smartphones provide access to the internet, enabling users to browse websites, access social media, stream videos, and perform online transactions on the go.

Multimedia Entertainment: Smartphones serve as portable multimedia devices, offering access to a wide range of entertainment options such as music, videos, movies, e-books, podcasts, and gaming apps.

Productivity Tools: Smartphones come equipped with productivity apps such as calendars, notes, document editors, and task managers, helping users stay organized, manage their schedules, and be more productive.

Information Access: With search engines and apps, smartphones provide instant access to vast amounts of information on almost any topic, empowering users to learn, research, and solve problems on the fly.

Navigation and Mapping: Built-in GPS capabilities enable smartphones to provide navigation and mapping services, helping users find directions, locate points of interest, and explore new places.

Camera and Photography: Smartphones feature high-quality cameras that allow users to capture photos and videos conveniently, edit them using built-in software, and instantly share them with others via social media.

Convenience: Smartphones consolidate various devices and functionalities into a single, portable device, eliminating the need to carry separate gadgets such as cameras, music players, GPS devices, and physical maps.

Disadvantages:

Screen Addiction: Excessive smartphone use can lead to addiction, causing users to spend excessive amounts of time on their devices, neglecting real-life interactions, work, and other responsibilities.

Distraction: Notifications, alerts, and constant connectivity can be distracting, reducing productivity and concentration, especially in work and academic settings.

Privacy Concerns: Smartphones collect and store vast amounts of personal data, raising concerns about privacy and data security, especially in the context of data breaches, hacking, and unauthorized access.

Health Issues: Prolonged smartphone use can lead to physical health problems such as eye strain, neck and wrist pain (due to poor posture), and sleep disturbances (caused by blue light emitted from screens).

Social Isolation: While smartphones facilitate communication, excessive reliance on digital communication can lead to decreased face-to-face interaction and a sense of social isolation or loneliness.

Cost: High-end smartphones can be expensive to purchase outright, and ongoing costs such as monthly service plans and app purchases can add up over time, potentially straining users' budgets.

Battery Life: Despite advancements in battery technology, many smartphones still struggle with battery life, requiring frequent recharging throughout the day, especially with heavy usage.

Cybersecurity Risks: Smartphones are vulnerable to various cybersecurity threats, including malware, phishing attacks, and identity theft, particularly when users download apps from untrusted sources or connect to insecure Wi-Fi networks.

While smartphones offer numerous benefits and have become an integral part of modern life, it's essential for users to be mindful of their usage habits and take steps to mitigate the potential drawbacks. Balancing the advantages of smartphones with their disadvantages can help individuals make the most of these powerful devices while minimizing the negative impact on their well-being and privacy.

Overview of mobile operating system:

A mobile operating system (OS) is software that allows smartphones, tablets and other devices to run applications and programs.

A mobile OS provides an interface between the device's hardware components and its software functions. It typically starts when a device powers on, presenting a screen with icons or tiles that show information and provide

application access. Mobile operating systems also manage cellular and wireless network connectivity and phone access.

Millions of people use mobile operating systems worldwide, powering a wide range of devices, from smartphones to tablets and wearable technology. These systems offer users a wide selection of features, including calling and messaging, internet and cellular data connectivity, multitasking capabilities, interactive user interfaces and access to a wide range of third-party applications and services to enhance the user experience even further.

Types of mobile operating systems:

There are several mobile operating systems on the market today, but two of the most widely adopted are the iPhone's OS, Apple iOS, and Google's open source OS, Google Android. These two mobile OSes take different approaches to the mobile operating system and end-user experience.

Apple distributes the only devices that natively support iOS, and it takes a "walled garden" approach, in which Apple regulates all mobile apps and services that can run on iOS devices. Apple developed iOS to run on its own XNU kernel. Apple has also released several device-specific mobile operating systems, such as watchOS for the Apple Watch and iPadOS for iPad tablets.

Concept of Android and Windows Technology in mobile System.

Android:

Open Source: Android is an open-source operating system developed by Google, which means it is freely available to device manufacturers and developers to modify and distribute.

Customizability: One of the key features of Android is its high level of customization. Users can personalize their devices with custom launchers, widgets, and themes.

Google Integration: Android devices come with built-in Google services such as Gmail, Google Maps, Google Drive, and Google Photos, providing seamless integration with the Google ecosystem.

App Ecosystem: The Google Play Store hosts millions of apps, ranging from productivity tools to games, catering to various interests and needs of users.

Notification System: Android's notification system allows users to receive and manage notifications from apps, providing quick access to important information.

Voice Assistant: Android devices come with Google Assistant, a voice-controlled virtual assistant, which can perform tasks, answer questions, and control smart home devices.

Multitasking: Android supports multitasking, allowing users to run multiple apps simultaneously and switch between them effortlessly.

Popular Android Applications:

Social Media: Facebook, Instagram, Twitter

Communication: WhatsApp, Messenger, Telegram

Productivity: Google Docs, Microsoft Office, Evernote

Entertainment: YouTube, Netflix, Spotify

Utilities: Google Maps, Dropbox, Adobe Acrobat Reader

Windows:

User Interface: Windows offers a familiar user interface with a Start menu, taskbar, and desktop, providing easy navigation and access to applications.

Compatibility: Windows is widely compatible with a vast range of hardware and software, making it a versatile choice for both personal and professional use.

Microsoft Integration: Windows comes with built-in Microsoft services such as Office suite (Word, Excel, PowerPoint), OneDrive cloud storage, and Microsoft Edge web browser.

Gaming: Windows is a popular platform for gaming, with support for a wide range of PC games and gaming accessories.

Security: Windows includes built-in security features such as Windows Defender antivirus and Windows Firewall to protect against malware and cyber threats.

Productivity: Windows offers various productivity features such as virtual desktops, task view, and Cortana voice assistant to help users stay organized and efficient.

Updates: Windows regularly releases updates to improve performance, fix bugs, and enhance security.

Popular Windows Applications:

Office Suite: Microsoft Word, Excel, PowerPoint

Web Browsing: Microsoft Edge, Google Chrome, Mozilla Firefox

Multimedia: VLC Media Player, Windows Media Player, Adobe Photoshop

Communication: Skype, Slack, Microsoft Teams

Gaming: Steam, Epic Games Launcher, Origin

Overall, both Android and Windows offer a wide range of features and applications to cater to the diverse needs of users in various domains.

Basic Feature of Android & windows and its application.

Android Operating System:

Android is a Linux-based operating system it is designed primarily for touch screens mobile devices such as smartphones and tablet computers. The operating system has developed a lot in the last 15 years starting from black and white phones to recent smartphones or mini computers. One of the most widely used mobile OS these days is android. The android is software that was founded in Palo Alto of California in 2003.

Features of Android Operating System:

The unique features/characteristics of the android operating system include the following:

Near Field Communication (NFC)

Alternate Keyboards

IR Transmission

No-Touch Control

Automation

Wireless App Downloads

Storage & Battery Swap

Custom Home Screen

Widgets

Custom ROMs

Headset layout

Storage

Connectivity: GSM/EDGE, IDEN, CDMA, Bluetooth, WI-FI, EDGE,3G,NFC, LTE,GPS.

Messaging: SMS, MMS, C2DM (could to device messaging), GCM (Google could messaging)

Multilanguage support

Multi-touch

Video calling

Screen capture

External storage

Streaming media support

Optimized graphics

Application:

You will find all the android applications at the top layer and you will write your application and install it on this layer. Examples of such applications are contacts, books, browsers, services, etc. Each application performs a different role in the overall applications.

Function Of Smartphone Components.

Processor (CPU): The processor is the brain of the smartphone, responsible for executing instructions and processing data. It performs tasks such as running applications, handling user input, and managing system resources.

Memory (RAM): RAM (Random Access Memory) is used to temporarily store data and instructions that the processor needs to access quickly. It allows for faster multitasking and smoother performance by providing quick access to frequently used information.

Storage (ROM): ROM (Read-Only Memory) is used to store the operating system, system files, and user data such as apps, photos, and videos. It provides long-term storage for data even when the device is powered off.

Display: The display is the screen that shows visual output to the user. It allows users to interact with the device through touch input and provides visual feedback for apps, videos, games, and other content.

Battery: The battery provides power to the smartphone, allowing it to operate without being connected to a power source. It stores electrical energy and powers the various components of the device.

Sensors: Smartphones contain various sensors that provide input to the device and enable features such as orientation detection, motion sensing, proximity sensing, ambient light sensing, and fingerprint recognition.

Camera: Smartphones typically include one or more cameras for capturing photos and videos. Modern smartphones often feature advanced camera systems with multiple lenses, image stabilization, and high-resolution sensors.

Connectivity Modules: Smartphones include various connectivity modules such as Wi-Fi, Bluetooth, GPS, and NFC (Near Field Communication). These modules allow users to connect to wireless networks, transfer data between devices, navigate using GPS, and make contactless payments.

Audio Components: Smartphones include speakers, microphones, and audio jacks (or wireless connections like Bluetooth) for playing audio, making phone calls, and recording sound.

Operating System: The operating system (e.g., Android, iOS) manages the smartphone's hardware and software resources, provides a user interface, and supports the installation and execution of applications.

These components work together seamlessly to provide a wide range of functionalities, allowing users to communicate, access information, navigate, capture memories, and perform various tasks using their smartphones.

Wi-Fi, short for Wireless Fidelity, is a technology that allows electronic devices to connect to a wireless local area network (WLAN) using radio waves. It enables devices such as smartphones, laptops, tablets, and other wireless-enabled devices to access the internet, communicate with each other, and share data without the need for physical wired connections

Concepts Of Wi-Fi:

We all know about Wi-Fi, in our mobile, laptop everywhere Wi-Fi is supported. Wi-Fi is a wireless networking technology, by which we can access networks or connect with other computers or mobile using a wireless medium. In Wi-Fi, data are transferred over radio frequencies in a circular range.

Wi-Fi, a brand name given by the Wi-Fi Alliance (formerly Wireless Ethernet Compatibility Alliance), is a generic term that refers to the communication standard for the wireless network which works as a Local Area Network to operate without using the cable and any types of wiring. It is known as WLAN. The communication standard is IEEE 802.11. Wi-Fi works using Physical Data Link Layer.

Nowadays in all mobile computing devices such as laptops, mobile phones, also digital cameras, smart TVs has the support of Wi-Fi. The Wi-Fi connection is established from the access point or base station to the client connection or any client-to-client connection within a specific range, the range depends on the router which provides the radio frequency through Wi-Fi. These frequencies operate on 2 types of bandwidth at present, 2.4 GHz and 5 GHz.

All the modern laptops and mobiles are capable of using both bandwidths, it depends on the Wi-Fi adapter which is inside the device to catch the Wi-Fi signal. 2.4 GHz is the default bandwidth supported by all the devices. 2.4

GHz can cover a big range of areas to spread the Wi-Fi signal but the frequency is low, so in simple words, the speed of the internet is less and 5 GHz bandwidth is for a lower range of area but the frequency is high so the speed is very high.

Let's say, if there is an internet connection of 60 MB/s bandwidth, then for 2.4 GHz bandwidth, it provides approx 30 to 45 MB/s of bandwidth connection and for 5 GHz bandwidth, it provides approx 50 to 57 MB/s bandwidth.

Then in 1990, IEEE 802.11 Working Group for Wireless LANs is established by Vic Hayes, who was known as the "Father of WiFi".

Applications of Wi-Fi :

Wi-Fi has many applications, it is used in all the sectors where a computer or any digital media is used, also for entertaining Wi-Fi is used.

Accessing Internet: Using Wi-Fi we can access the internet in any Wi-Fi-capable device wirelessly.

We can stream or cast audio or video wirelessly on any device using Wi-Fi for our entertainment.

We can share files, data, etc between two or more computers or mobile phones using Wi-Fi, and the speed of the data transfer rate is also very high. Also, we can print any document using a Wi-Fi printer, this is very much used nowadays.

We can use Wi-Fi as HOTSPOTS also, it points Wireless Internet access for a particular range of area. Using Hotspot the owner of the main network connection can offer temporary network access to Wi-Fi-capable devices so that the users can use the network without knowing anything about the main network connection. Wi-Fi adapters are mainly spreading radio signals using the owner network connection to provide a hotspot.

Using Wi-Fi or WLAN we can construct simple wireless connections from one point to another, known as Point to point networks. This can be useful to connect two locations that are difficult to reach by wire, such as two buildings of corporate business.

One more important application is VoWi-Fi, which is known as voice-over Wi-Fi. Some years ago telecom companies are introduced VoLTE (Voice over Long-Term Evolution). Nowadays they are introduced to VoWi-Fi, by which we can call anyone by using our home Wi-Fi network, only one thing is that the mobile needs to connect with the Wi-Fi. Then the voice is transferred using the Wi-Fi network instead of using the mobile SIM network, so the call quality is very good. Many mobile phones are already getting the support of VoWi-Fi.

Wi-Fi in offices: In an office, all the computers are interconnected using Wi-Fi. For Wi-Fi, there are no wiring complexities. Also, the speed of the network is good. For Wi-Fi, a project can be presented to all the members at a time in the form of an excel sheet, ppt, etc. For Wi-Fi, there is no network loss as in cable due to cable break.

Also using W-Fi a whole city can provide network connectivity by deploying routers at a specific area to access the internet. Already schools, colleges, and universities are providing networks using Wi-Fi because of its flexibility.

Wi-Fi is used as a positioning system also, by which we can detect the positions of Wi-Fi hotspots to identify a device location.

Types of Wi-Fi:

Wi-Fi has several types of standards, which are discussed earlier, here just the name of the standards are defined,

Standards	Year of Release	Description
Wi-Fi-1 (802.11b)	1999	This version has a link speed from 2Mb/s to 11 Mb/s over a 2.4 GHz frequency band
Wi-Fi-2 (802.11a)	1999	After a month of release previous version, 802.11a was released and it provide up to 54 Mb/s link speed over 5 Ghz band
Wi-Fi-3 (802.11g)	2003	In this version the speed was increased up to 54 to 108 Mb/s over 2.4 GHz
802.11i	2004	This is the same as 802.11g but only the security mechanism was increased in this version
802.11e	2004	This is also the same as 802.11g, only Voice over Wireless LAN and multimedia streaming are involved

Wi-Fi-4 (802.11n)	2009	This version supports both 2.4 GHz and 5 GHz radio frequency and it offers up to 72 to 600 Mb/s speed
Wi-Fi-5 (802.11ac)	2014	It supports a speed of 1733 Mb/s in the 5 GHz band

A new version will release in 2020 named 802.11ax developed by Huawei, which can support, a maximum of 3.5 Gb/s. it will know Wi-Fi 6.

Wi-Fi working:

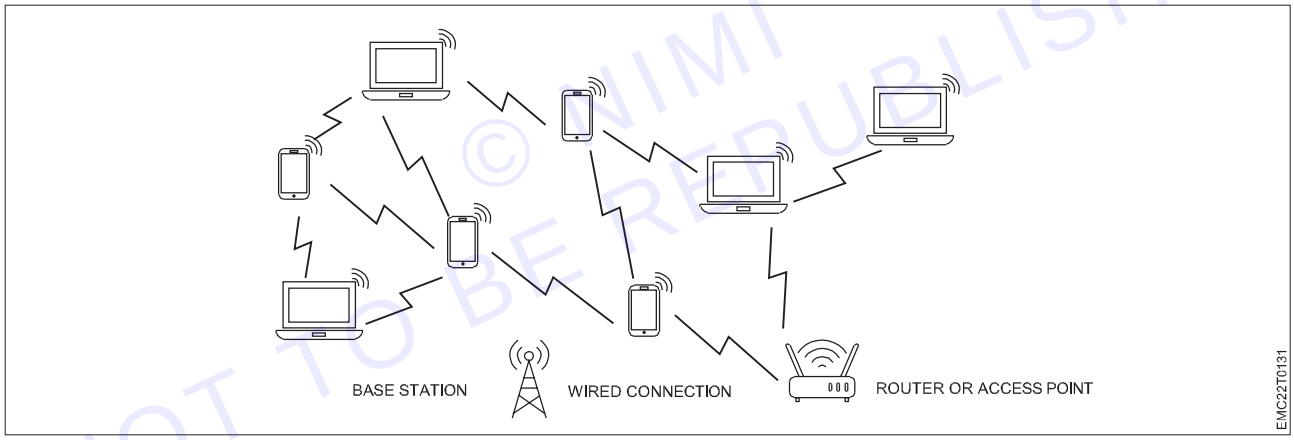
Wi-Fi is a wireless technology for networking, so it uses Electromagnetic waves to transmit networks. We know that there are many divisions of Electromagnetic waves according to their frequency such as X-ray, Gamma-ray, radio wave, microwave, etc, in Wi-Fi, the radio frequency is used. For transmitting Wi-Fi signal there is three medium,

Base station network or an Ethernet(802.3) connection: It is the main host network from where the network connection is provided to the router.

Access point or router: it is a bridge between a wired network and a wireless network. It accepts a wired Ethernet connection and converts the wired connection to a wireless connection and spreads the connection as a radio wave.

Accessing devices: It is our mobile, computer, etc from where we use the Wi-Fi and surfing internet.

All the electronics devices read data in binary form, also router or our devices, here routers provide radio waves and those waves are receive by our devices and read the waves in binary form. We all know how a wave looks like, the upper pick of the wave is known as 1 and the lower pick of the wave is known as 0 in binary.



Advantages of Wi-Fi:

It is a flexible network connection, no wiring complexities. Can be accessed from anywhere in the Wi-Fi range.

It does not require regulatory approval for individual users.

It is salable, can be expanded by using Wi-Fi Extenders.

It can be set up in an easy and fast way. Just need to configure the SSID and Password.

Security in a high in Wi-Fi network, its uses WPA encryption to encrypt radio signals.

It is also lower in cost.

It also can provide Hotspots.

it supports roaming also.

Disadvantages of Wi-Fi:

Power consumption is high while using Wi-Fi in any device which has a battery, such as mobile, laptops, etc.

Many times there may be some security problems happening even it has encryption. Such as many times has known devices become unknown to the router, Wi-Fi can be hacked also.

Speed is slower than a direct cable connection.

It has lower radiation like cell phones, so it can harm humans.

Wi-Fi signals may be affected by climatic conditions like thunderstorms.

Unauthorized access to Wi-Fi can happen because it does not have a firewall.

To use Wi-Fi we need a router, which needs a power source, so at the time of power cut, we cannot access the internet.

Downloding Through Internet:

3 Basic Issues:

An organizational tip:

Create a “downloads” folder, then create a Desktop Shortcut (Windows 95/98) to this folder. Save all files you download from the Internet to this Downloads folder for quick and easy access to these files!

To create a new folder:

In the My Computer Window, double-click the C: drive icon.

In the C: drive window, on the Menu Bar click File, select New, then click Folder.

Type a name for your folder (i.e. Downloads) and press Enter.

To create a desktop shortcut:

In the C: drive window, right-click and drag the new folder to an open area on the Windows 95/98 Desktop, then release the right mouse button.

Select Create Shortcut Here from the popup menu that appears.

Right-click the folder’s icon on the Desktop and select Rename from the popup menu. Type a new name for the shortcut (i.e. Downloaded Files) and press Enter.

Share With Bluetooth:

Select the files you want to send, then choose the share or send option to transfer music, photos, and other files without an internet connection

Android: Open the file manager, select the files, then go to Share > Bluetooth. Tap the destination device.

Windows: Right-click one or more files. Go to Send to > Bluetooth File Transfer. Select device, then press Next.

macOS or iOS: Open Finder > locate the file > Share > AirDrop. Follow on-screen instructions.

This article explains how to use Bluetooth to wirelessly transfer files like photos to and from your mobile devices without incurring data charges.

Send Files from Smartphones and Tablets:

To transfer files from a smartphone or tablet to a PC over Bluetooth, first find the file on your device and then use the share function to send it over. Here’s a step-by-step look at how it’s done from an Android phone:

Open your device’s file manager app. It might be called Files, Explorer, My Files, or something similar. On Android Marshmallow or later, open the Settings app to fnd the file manager.

Locate and select the file(s) you want to transfer. To send more than one at a time, press-and-hold each file.

Tap the Share button.

Choose Bluetooth from the list of sharing options.

If you see a prompt to enable Bluetooth, do so now by following the on-screen directions.

Tap the device you want to transfer the files to. A message that displays “Sending # Files to [device]” appears on the screen.

A file transfer notification appears on the receiving device that shows the file name, file size, and the sending device. This window may disappear (nothing will be transferred) if no action is taken within 15 seconds. If this happens, send the files again.

Select Accept on the receiving device to download the files. If the other device is a computer, choose a folder to save the data to.

Send Files from Computers:

While macOS supports Bluetooth, file transfers are managed by AirDrop. Here's how to send files from a Windows PC to an Android phone:

Open File Explorer and go to the folder that contains the file you want to send.

Right-click a file, or select multiple files and then right-click one of them.

Select Send to > Bluetooth File Transfer, or on some versions of Windows, Send to > Bluetooth.

Select the device and press Next to start the transfer.

A few seconds later, a notification appears on the receiving device. Tap Accept on that device to receive the file.

Wait while the transfer finishes. Depending on the number of files you're sending and their sizes, it could take anywhere from a few seconds to several minutes or longer.

Share Internet via Hotspot:

You can use your phone's mobile data to connect another phone, tablet, or computer to the internet. Sharing a connection this way is called tethering or using a hotspot. Some phones can share Wi-Fi connection by tethering.

Most Android phones can share mobile data by Wi-Fi, Bluetooth, or USB.

Important: Some mobile carriers limit or charge extra for tethering. We recommend checking with your carrier.

Important: Some of these steps work only on Android 9.0 and up.

Turn on your hotspot

Swipe down from the top of the screen.

Tap Hotspot .

If you don't find Hotspot , at the bottom left, tap Edit and drag Hotspot into your Quick Settings.

Connect another device to your phone's hotspot

On the other device, open that device's list of Wi-Fi options.

Pick your phone's hotspot name.

Enter your phone's hotspot password.

Click Connect.

If you don't want your hotspot to require a password:

Swipe down from the top of the screen.

Touch and hold Hotspot .

Under "Security," tap None.

Data Cables:

Data cables are essential components for any technology setup that requires a physical connection for data transfer between devices. In the world of ecommerce, data cables are crucial for seamless communication between different hardware, software, and peripherals. Here are some of the most common types of data cables available:

USB cables: USB cables are the most widely used data cables and come in various types such as Type-A, Type-B, and Type-C. They are used for charging devices, connecting peripherals like printers, scanners, and cameras to computers, and for transferring data.

Ethernet cables: Ethernet cables are used to connect devices to a network or the internet. They are essential for ecommerce sites as they provide high-speed data transfer and communication between servers, computers, and other hardware components.

HDMI cables: HDMI cables are used to transmit high-definition video and audio signals between devices like computers, TVs, and gaming consoles. They are important for ecommerce sites that rely on video content to showcase their products.

Display Port cables: DisplayPort cables are similar to HDMI cables and are used to transmit high-quality video and audio signals between devices like computers and monitors. They are ideal for ecommerce sites that need to display high-quality images and videos.

Thunder bolt cables: Thunderbolt cables are used to transfer data and video signals between devices like laptops, monitors, and hard drives. They are faster and more versatile than USB cables and are ideal for ecommerce sites that require high-speed data transfer.

Card Reader:

A card reader is a device that can decode the information contained in a credit or debit card's magnetic strip or microchip.

In finance, the term "card reader" refers to the technologies used to detect the account number, cardholder information, and authorization code contained on a credit card. This information is contained either in the magnetic strip of the card, or in the microchip embedded in chip-enabled cards.

Although historically card reading technologies relied on physical copies being made and stored by the vendor, today's card readers are able to scan and process this information electronically at nearly instantaneous speeds.

Concept of OTG, OTA, LTE, SNS and NFC:

OTG : This stands for On the Go and what that implies is that devices with OTG support USB On the Go. Meaning that with OTG supported devices you can easily use USB devices directly on them, USB devices like your flash drives, printers, scanners etc. without necessarily needing a PC to transfer your files, print and scan documents.

You need a compactible OTG cable for that and some companies even include these cables as part of accessories on your purchases for OTG supported devices or you can get them separately sold in the market.

OTA: OTA stands for Over the Air technology. It is a technology that allows you to receive direct update notifications to your devices and also to be able to update your devices immediately and directly without any PC as far as you have high speed internet connectivity.

LTE: LTE stands for Long Term Evolution and it is basically the 4G network technology architecture that you used to hear about. A device with LTE means that that very device has a 4G network support. Those devices also have those other lower network supports as in 2G and 3G network included.

SNS: This stands for Social Network Service. When you see or hear that a device has SNS Integration feature, it simply means that the device is enabled to establish social network of people via platforms like Facebook, Twitter, E-mails and other notable social networks.

NFC: NFC stands for Near Field Communication. This is a technology that is quite similar to that of your Bluetooth but varies in number of ways. With NFC enabled devices, you will be able to transfer data to another NFC device in a more secured manner but at a very short range.

Mobile Phone (Smartphone) Repairing Tools and Equipment

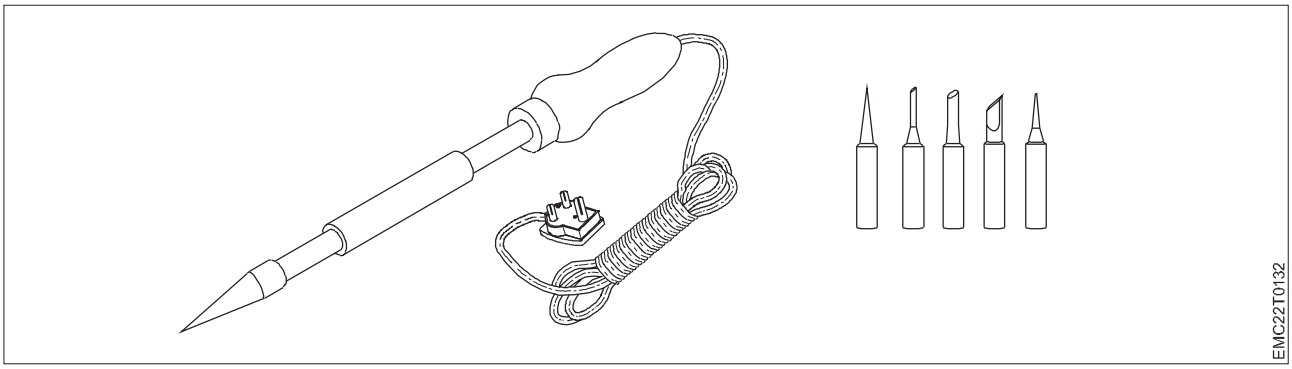
When selecting mobile phone repairing tools and equipment, it is important to select the best tools, even if it costs little more. Cheap or inexpensive tools and equipment may not be handy or comfortable (ergonomic) when repairing a mobile cell phone.

On the other hand, little expensive but best quality tools and equipment will help you to repair a mobile phone easily and comfortable. I am personally trained in mobile cell phone repairing and my personal experience says that we must always select and buy the best tools available in the market or online. These good quality tools may cost a little more but in the long term you will be happy that you bought the best tools.

Below is list of all the professional tools and equipment needed for mobile cell phone repairing:

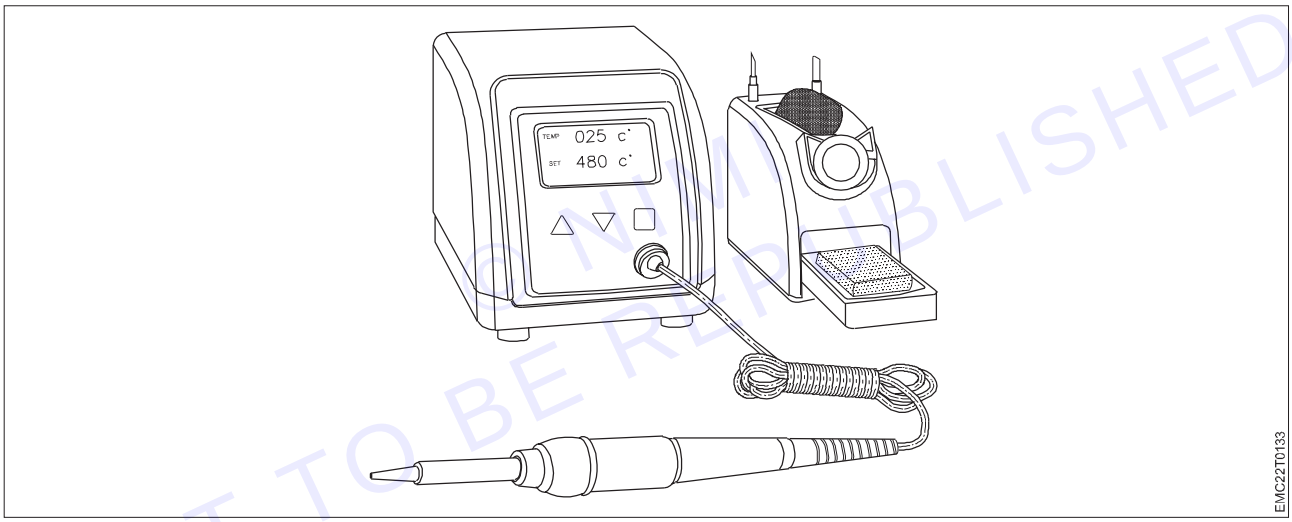
1 Soldering Iron:

A soldering iron is used to solder small components like capacitor, resistor, diode, transistor, regulator, speaker, microphone, display etc. A 50 watt soldering iron is good enough for most mobile phone repairing job.



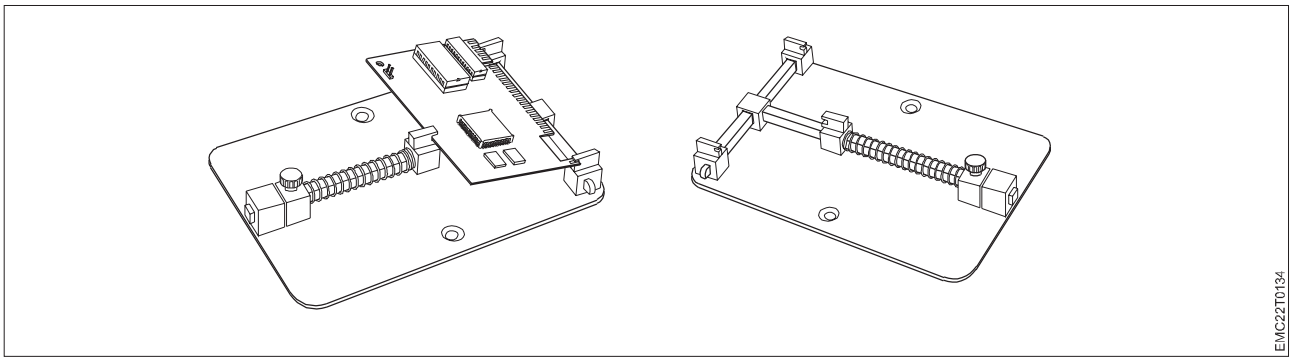
2 Soldering Station:

A soldering station has 2 units – a station and an iron. It has option to control temperature depending on the heat requirement of the soldering job being done. The soldering iron is attached with the soldering station. It is better and more convenient than traditional soldering iron. It makes soldering work much easier and faster. When buying a soldering station for mobile phone repairing one must always select an ESD-Safe (Antistatic) model. Goot, Weller and Soldron are some good and trusted world renowned brands who manufacture, sell and export world class soldering irons and other soldering tools and equipments.



3 PCB Holder / PCB Stand:

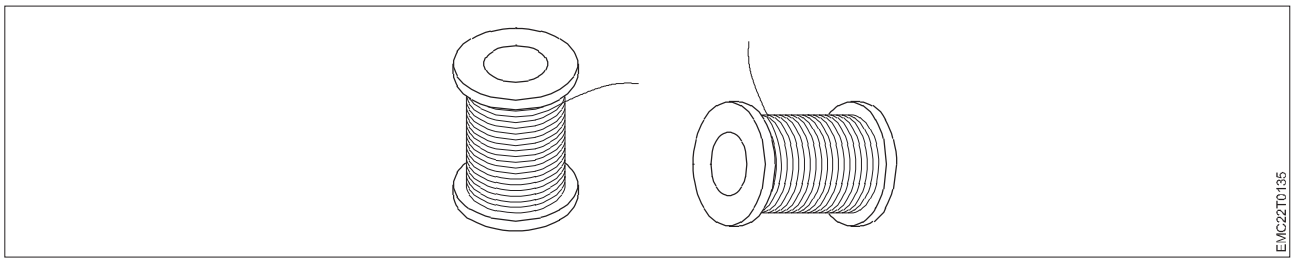
A PCB (Printed Circuit Board) holder or PCB stand is used to hold different types of PCB of a mobile phone while soldering or repairing. It holds the PCB very strongly and doesn't allows it to move thus helping in repairing. Again, it is important and wise to select a good quality PCB holder rather than a cheaper and inexpensive one.



4 Solder Wire:

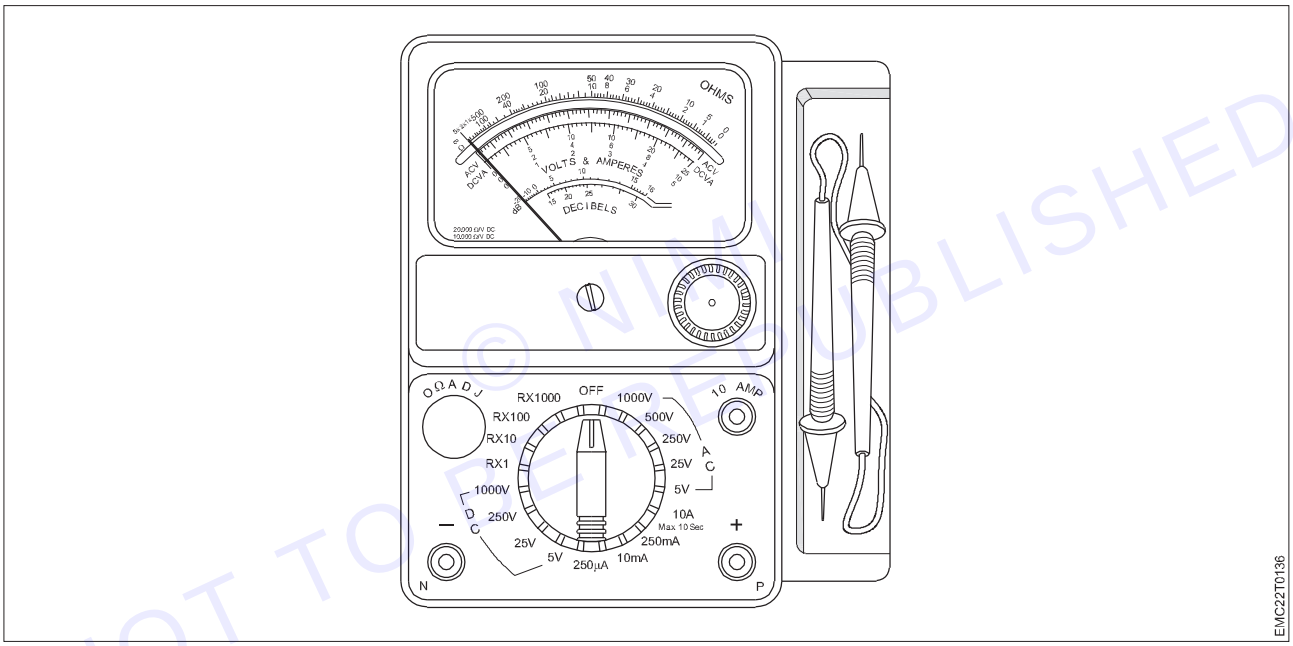
Solder wire is used to solder electronic components, ICs or jumper. Composition of most solder wire is Tin / Lead in the ratio 60:40 or 63:37. Since the introduction of RoHS (Restriction of Hazardous Substances) from electronics, more and more companies are using lead-free solder.

Lead-free solder wire is available in many compositions but the most common composition is Tin / Silver / Copper in the Ratio 96.5% / 3.0% / 0.5. Solder wire is available in different diameters such 2.0mm, 1.5mm, 1.0mm, 0.5mm, 0.2mm etc. For mobile phone repairing 0.5mm solder wire is best suitable. Alpha Cookson is a world renowned manufacturer and supplier of solder wire and other soldering material.



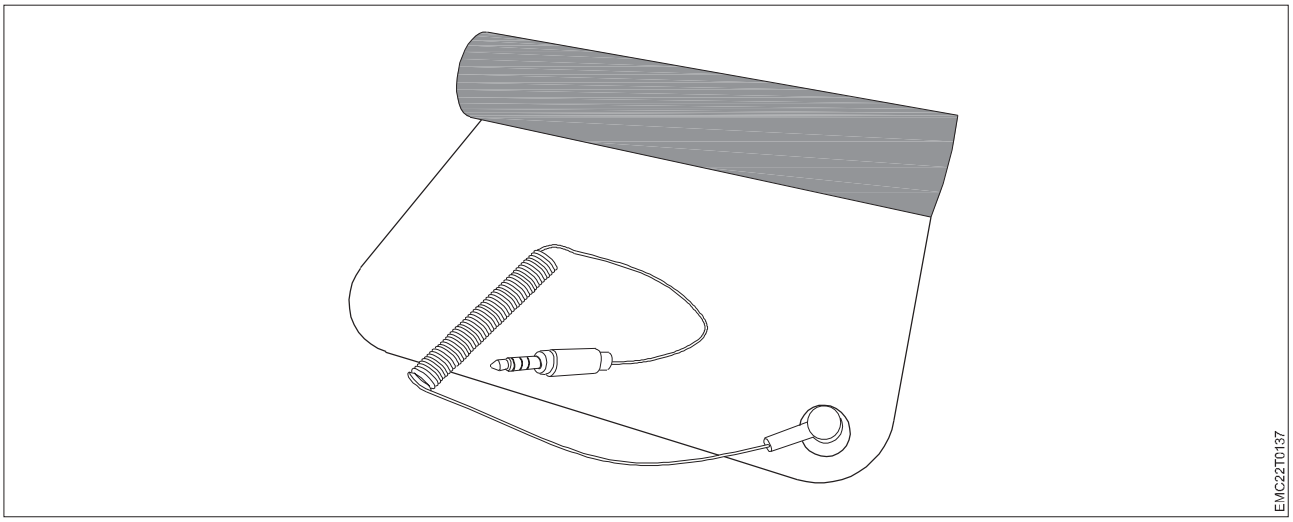
5 Multimeter:

A multimeter can be analog or digital. In mobile phone repairing, mostly a digital multimeter is used to find faults, check track and components. Always buy a good quality reliable ESD-Safe digital Multimeter for mobile repairing works.



6 Antistatic Mat (ESD Mat):

An ESD Mat or Antistatic Mat is laid or placed on the table or workbench where mobile repairing is done. The mat is grounded using a grounding cord or normal grounding wire. This prevents damage from static electricity.



7 Microscope or Magnifier:

These used to see a magnified view of PCB or electronic components. These are available in different zoom options like 2X, 3X, 5X, 10X etc. Many microscopes can also be connected to a computer or a monitor.

Because SMD components on a Mobile Phone PCB are very tine, we need a magnification equipment tool or equipment to see the PCB and Components enlarged. There are Tools and Equipment like Microscope, USB Microscope, Table Top Magnifying Lamp and Head Magnifier with LED Light.

8 Magnifying Lamp:

It is used to see the magnified view of the PCB of a mobile phone. Most magnifying lamps also have light. Magnifying lamps are available in different magnification such as 3x, 4x, 5x, 10x, 50x etc.

9 Hot Air Blower:

A hot air blower is also called SMD (Surface Mount Device) rework station and SMD repair system. It has control to regulate or manage temperature and flow of hot air. Always buy a good quality ESD-Safe hot air blower.

10 Mobile Phone Repairing Tool Kit:

A mobile repair electronic tool kits consists of most of the small tools need for most electronic repairing jobs. Most such tools consists of soldering iron, desoldering pump, solder wire, desoldering wick, precision screwdrivers, tweezers etc. So, there is no need to buy all these tools individually.

Concept of different types of IC used in smartphones:

Integrated Circuit or IC is an SMD Electronic Component made up of combination of several transistors, diode, resistor, capacitors in a tiny semiconductor chip. Integrated Circuit Electronic Components or IC are of small size and very light weight. They produce excellent results at low power.

Types of Integrated Circuit (IC):

On the basis of external structure, ICs or SMD can be classified as follows:

Single in-line pin package (SIPP).

Dual in-line pin package (DIPP).

Quard pin package (QPP).

Pin Grid Array Package (PGA).

Ball Grid Array Package (BGA).

Leadless Chip Carrier (LCC) Package.

Types of Integrated Circuit (IC) on Basis of Technology:

There are two types of IC on the basis of technology:

Linear IC: This type of IC works on analog signal where output signal varies according to the variable input signal.

Digital IC: This type of IC works on digital signal. A defined output signal is received from a defined input signal. On the basis of electronic components used, the digital IC are of various types.Examples of Digital IC – CMOS (Complimentary Metal Oxide Semiconductor), DSP (Digital Signal Processor), DRAM (Dynamic Random Access Memory), ROM (Read Only Memory), PROM (Programmable Read Only Memory).

Different kind of Application that is used in windows and android:

Application software is a program that developers write in a high-level programming language and install on the user's system. For example, Windows Media Player, Adobe Photoshop, Skype, Any Desk, VMWare, and MS Paint are application software. Users can access the Software as a Service and download installation packages of other application software from online repositories. Vendors can also pre-install some applications on the system. Furthermore, installing an Operating System includes incorporated applications like Control Panel, Snipping Tool, File Explorer, and more.

Users download and install Application Software on their computer system, which requires a system software, primarily an Operating System. Whether it's a GUI-based OS or a command-line based, it is the basic necessity of every application.

Therefore, without any additional delay, let's dive deep into various categories of application software.

Different Types of Application Software List for 2024:

Web Browsers

Application Development Software

Enterprise Software

Spreadsheet Software

Multimedia Software

Gaming Software

Word Processors

Database Software

Simulation Software

Penetration Testing Software

1 Web Browsers:

Web browsers are the most common type of application software, which comes pre-installed on every system. Google Chrome, Microsoft Edge, Vivaldi, Brave, Firefox, and Safari are some of their examples and most recommended browsers to use based on security and compatibility. The user requires an internet connection to search and navigate websites using a browser.

Moreover, users can access the Software as a Service and download other application software installation packages.

Examples of Web Browsers:

Google Chrome

Microsoft Edge

Safari

Firefox

Opera Mini

2 Application Development Software:

Several IDEs are freely available in online repositories, and you can effortlessly download and install them on their system to write code for innovating a new application. For Example, users can configure Visual Studio on the computer system to produce code for developing a .NET application for mobile and desktop devices. Moreover, users can compile, test, and debug code using this software.

Examples of Application Development Software:

Android Studio

Xcode

Visual Studio

Eclipse

Unity

3 ERP Application Software:

Enterprise Resource Planning (ERP) is another business software application to link multiple departments and remote offices through a single dashboard. It can cover and automate the tasks of accounting, project management, risk management, decision-making, supply chain, transaction management, and so forth. Customizing artificial intelligence according to business requirements streamlines workflows and decreases bottlenecks.

Examples of ERP Application Software:

Microsoft Dynamics 365

Oracle NetSuite ERP

Acumatica Cloud ERP

4 Spreadsheet Software:

This application software comprises rows and columns and helps store, process, and evaluate the data. The software flawlessly integrates with third-party tools to collect data from online forms. It can also be customized according to business requirements, enabling workflow streamlining and reducing bottlenecks.

Moreover, it empowers the user to perform various arithmetic calculations quickly for a large amount of data. Google Sheets, Microsoft Excel, and Apple number are the standard applications easily accessible and integrated with cutting-edge APIs for better collaboration. In addition, it flawlessly integrates with third-party tools to collect data from online forms.

Example of Spreadsheet Software:

Google Spreadsheets

Microsoft Excel

5 Multimedia Software:

Software aiding the user to open, edit, and record image and video files are multimedia applications. The entertainment and telecommunication sector mainly uses it for viewing and editing recorded videos. Furthermore, it integrates with several APIs, allowing organizations to broadcast and share videos on the internet with a single click.

Example of Multimedia Software:

VLC media

VidMate

Windows Media Player

iTunes

6 Gaming Software:

End-users can download the package through a web browser to install games on their device. GTA V, Dota, Rocket League, and Counter-Strike are examples of some of the most popular gaming applications played worldwide. Users install applications such as Steam and Twitch to play and stream games on digital platforms. These apps connect to the internet, allowing users to create teams and play with their friends and associates.

Example of Gaming Software:

Steam

Epic Games Store

PlayStation Network (PSN)

Xbox Live

Origin

7 Word Processor Software:

Notepad is a common word-processing application software installed by default on every system. This kind of solution aids in inputting and editing files and adding tables, images, and links to them. Also, in advanced word software, like Microsoft Word, the user is provided with features to format text using different formats and put references. Moreover, users can select multiple color combinations, page boundaries, page color, font style, and size to make their text more appealing.

Example of Word Processor Software:

Microsoft Word

Google Docs

Notepad

8 Database Software:

Video editing software is used in the entertainment and telecommunication sectors to view and edit recorded videos. These software application development types integrate with various APIs, enabling organizations to broadcast and share videos online effortlessly. Users also install gaming applications like Steam and Twitch to play and stream games on digital platforms, allowing them to connect with friends and associates.

The list of application software mainly functions as a backend for other solutions and helps in data flow operations. For example, an E-commerce solution can embed it and store the username and password details of a new user in the database whenever they sign up.

Example of Database Software:

Oracle

PostgreSQL

MongoDB

9 Simulation Software:

Simulation applications utilize mathematical calculations, 3-D graphics, and algorithms to visualize real-life scenarios. They train and educate individuals about resources that are challenging to create or access, often limited to a select few. Industries such as defense, education, and IT extensively employ simulation applications in their operations. Cisco Network Simulator is an easy-to-remember example of this application, as industries use it to train their staff about installing, configuring, and maintaining network components.

Example of Simulation Software:

Autodesk Fusion 360

PTC Creo

Teamcenter

10 Penetration Testing Software:

Testing applications are used to maintain data confidentiality and integrity by businesses at multiple stages. For example, Netsparker, Wireshark, Metasploit, and Aircrack are the testing applications used by ethical hackers and testers to identify loopholes in both enterprise solutions and networks. In addition, it helps to create a risk matrix, generating a mitigation plan for securing the IT infrastructure from malicious actors.

Example of Penetration Testing Software:

Metasploit

Nessus

Burp Suite

Nmap

Wireshark

Other Types of Application Software based on Availability and Shareability

Custom Application Software

Shareware Application Software

Freeware Application Software

Open Source App Software

Custom Application Software:

Custom Applications Software is designed and developed for a specific set of users or an organization. It is only available to the defined user group, and all the functionalities are embedded according to them. Many

organizations outsource resources to develop an application for their internal use only, and these are not available on the Internet. Only that particular application software companies and digital partners can modify and maintain the codebase as per changing business goals.

Businesses opt for custom software solutions as a long-term investment to increase productivity, improve customer relationships, and streamline their workload with the rapidly growing business.

Shareware Application Software:

Users can access shareware applications after paying a subscription fee to the vendor monthly, quarterly, or annually. For instance, Adobe Photoshop is available only after paying the software vendor. It is freely available to provide a demo to the user for a short period. Most of the time, it is a commercial business solution, which any firm can avail of by paying the authorized company for continuous support.

With the free trial version, users can understand the functionalities and cross-verify them with their business needs. Further, users can cancel the subscription anytime and save their data offline for accessing it anytime.

Freeware Application Software:

As the name implies, this application software is freely available to every user and can be downloaded using a web browser and the internet. The user doesn't have to pay anything to the vendor and can utilize the application as long as he wants. These solutions receive very few updates to ensure that they can run using minimal system specifications.

Freeware applications such as Adobe PDF, MSN Messenger, Google Talk, Microsoft Edge, Google Chrome, and Facebook App are freely distributed to users at no cost.

Open Source App Software:

These kinds of applications are available with their source code to enable the user to integrate external tools, APIs, plugins, and widgets to align with business standards. Apache Web Server, Mozilla Firefox, Libre Office, and Blender are some examples of open-source application software. As a result, their functionality can be impeccably extended without degrading the performance and Quality of Service.

The Purpose of Application Software:

Every application software development type is used for a particular purpose, such as:

Web browsers are used to search the internet, navigate multiple web pages, and download and upload files to web-based solutions.

Video, audio, and image files are viewed and edited with multimedia applications.

Visual Studio, PyCharm, Atom, and Net Beans type of application software is preferred for writing code.

The Solar Winds application is considered to monitor an enterprise's network and IT infrastructure.

Microsoft Suite comprises Word, Excel, and PowerPoint for word processing, making spreadsheets, and creating presentations.

3D Builder and Cisco Packet Trace, a simulation software, provide training to the students.

The main objective of opting for an application for completing a core operation is to save time, automate the task, and reduce the errors in the final output. In addition, organizations use enterprise management systems to optimize collaboration between their internal and external departments. Furthermore, data security is maintained with application software due to embedded authentication, access control, and encryption mechanisms.

Android mobile recovery procedures through coding:

Recovery Mode is an important feature of any electronic device. It is being used when the device is not working properly. Or the device is completely hanged. In such cases, there is only one way to enter into the Recovery mode. Depending upon the problems, there are some solutions provided. Based on the issue, we need to select one solution. This will help to eradicate the issue from the device. Not only laptops & computers, but smartphones also face this type of issue. As smartphones are running with the help of the Android operating system. It can sometimes malfunction.

Sometimes, we need to perform the Recovery mode in smartphones. Roughly using a smartphone can create this type of issue. In such cases, there is no way other than the Recovery mode. If a smartphone goes into the hanged state, we need to perform Recovery mode. As in the latest smartphones, there is no way to open the battery &

restart the device forcefully. In the old day's smartphones, we remove the battery from the device. And again start it. This helps to come out from the severe problems related to smartphones.

Using Recovery Mode On Smartphones:

Step 1: For using Recover mode on a smartphone, we need to first shut down the smartphone. We have to press the Power key. This will help to switch off the phone.

Step 2: Then we need to start the phone again. But at this time, we need to enter the Recover mode of the phone. For that purpose, we need to press the Power Button, Volume Up Button & Home Button. We have to press these three buttons at the same time. We need to keep it pressed until the screen doesn't glow up. Pressing these three buttons simultaneously will help us to enter the Recovery mode.

Note: For some latest smartphones, there are not any Home Button available. The Home Button is only available when the mobile is switched on. So, for those mobiles, pressing only the Power Button & the Volume Up button is enough. This can open the Recovery mode of the smartphone.

Step 3: Now, inside the Recovery mode, there will be a lot of options available. Depending upon the issues related to the phone, the user needs to choose the option correctly. Here, to go to the proper option, we need to use the Volume Button. This will help to navigate there. The touch screen facility will not work here. For selecting the option, we need to press the Power Button.

Step 4: Now, getting out of this screen, we need to use the option 'Reboot System Now. This option will only restart the devices without making any changes or harm to the device.

Here, we also discuss the two most important options in the Recovery Mode. These two options are mostly used by the users. All other options are not advised to use. Those other options will cause damage to the device.

Windows Phone Device Recovery: A How-to Guide

During the course of Flighting, there may from time to time be bumps in the road. Although our hope is to minimize these bumps, testing new software comes with a unique set of experiences.

If you encounter turbulence during a Flight and need to recover your phone to a good state, this guide will help you on the path to restoring your device.

There are three ways to assist a device that is not functioning as expected:

Restart / Reboot

Hard reset

Recovery via the Windows Device Recovery Tool (WDRT)

Restart / Reboot:

If your device ends up in an undesired state, completing a restart is the first step to try. Often time unexpected issues can be resolved by simply rebooting the device.

This can be done one of three ways:

Press and hold the Power key, then swipe down when prompted

Press and hold both Power and Volume Down for 10 seconds

Remove the battery from the device, re-insert the battery, power the device on

A restart does not erase any user data, files, photos, etc. Completing this action reboots the phone and can clear up device hangs, app crashes, failures to open/launch apps, and so forth. There are no changes made to the OS via this action.

Hard Reset / Factory Reset:

Depending on what has occurred with your device, a simple reboot may not be the solution. In more extreme cases it may be necessary to do a full reset of the device to recover back to a usable state.

It is important to note that a hard reset (also known as a factory reset) will erase all data on the device. This includes call logs, text messages, emails, applications, app data, photos/videos saved to the internal device memory, etc. If you'd like to restore as much of this information as possible post-reset, you'll want to ensure you've taken a device backup. Steps to complete a backup can be found here.

There are two primary methods to complete this type of reset:

If your device boots into the OS, navigate the following path:

Settings > System > About > Reset your phone

You will be prompted to confirm that you want to complete a full reset

If your device has an SD card inserted, you will be prompted to optionally erase the content of the SD card (this is optional)

Follow all on-screen prompts and the reset will begin

If your device is completely unresponsive, is stuck in a boot loop, or otherwise won't boot into the OS as expected, you may use the following steps to complete a full reset:

Power the device off

Press the Power key briefly to boot the device

Immediately press and hold the Volume Down key

When an exclamation point (!) appears on the screen, release Volume Down

Press the following keys in this order:

Volume Up

Volume Down

Power Key

Volume Down

The device will then initiate the full reset process

Again, remember that using this type of reset will erase all data from the device. Please ensure that you have a device backup available if you wish to restore your user data after the reset.

Windows Device Recovery Tool (WDRT):

(aka: Rolling back to prior OS version)

If your device ends up in a state that cannot be resolved by completing a soft reset or a hard/factory reset, you may need to use the WDRT tool to recover your device. Using this tool will restore your device back to the most recently available Windows Phone OS version that was published for your device. This tool should be used as a final means of recovery for devices that were not fixed by either of the previous reset methods, or if you want to remove Windows 10 flights from your device and return to the most recently published Retail image available for your phone.

To recover your phone using the Windows Device Recovery Tool, complete the following steps:

Download and install the WDRT tool to your PC.

Ensure that your device has a full charge if possible. A minimum of 50% charge is required.

Open the WDRT software on your PC

Connect the affected device to your PC via an appropriate USB cable:

If your device is detected appropriately, click the phone option as displayed.

If your device is not detected, choose "My device was not detected" and follow the appropriate on-screen prompts.

If using this option and the WDRT tool seems to "hang", disconnect the phone from the USB cable, wait ~10 seconds, and reconnect.

If disconnecting the device does not work, you may need to reboot your PC to re-enumerate the connected peripherals.

The WDRT will check your device for available Firmware version and OS version:

The tool may say "You have the latest available software version". This is referencing the firmware on the device.

This is expected. You can view the Operating system version and see the version that is available on the WDRT server (highlighted in red below).

Click Reinstall software. The WDRT will download the appropriate software package and then begin the recovery process. Ensure the device remains connected via USB during this entire process. Removal of the device during the flashing process may render it permanently inoperable.

Once the recovery image has flashed to the device, it will reboot and prompt you to complete setup. The device is now fully recovered.

Troubleshooting WDRT Concerns:

In some circumstances where the device OS fails to initialize or the bootloader has been impacted, the WDRT tool may have difficulty recognizing the device, even when using the "My device was not detected" steps as noted above. If this occurs, you will see the following message in the WDRT tool:

Please follow these steps as listed. Leave the device connected via USB and complete a forced reboot using the Power and Volume down key combination. This will trigger a reboot and the WDRT should catch the device as it begins the reboot. In some circumstances you may need to reboot the device more than once for the WDRT to connect to the device.

If this does not work, you will need to force the device into flashing mode. To put the device into this mode, complete the following steps:

Disconnect the device from the USB cable

Power the device off

Press and release the Power key

As soon as the device vibrates, press and hold the Volume Up key

The device will show a lightning bolt and gear icon on the screen

Reconnect the device to the PC via USB cable

This should allow the device to be recognized by the WDRT tool

If none of the above steps allow for recovery via the WDRT tool, your device may have an issue that cannot be resolved by re-flashing software to the device. Please start a new thread in the Insider forum to work through any additional troubleshooting.

Techniques of crack password code of windows and android mobile phone:

Crack Windows 10 Password:

Method 1. Crack Windows 10 Password via CMD

Method 2. Crack Windows 10 Password via Super Administrator Account

Method 3. Use Third-Party Software

Method 4. Have an Administrator Change It

Method 1. Crack Windows 10 Password via CMD:

If your PC has another account and you remember its password, you can log in to Windows via this account and then crack Windows 10 password by following the steps below:

Press the "Windows + R" keys to open the Run

In the Run box, type "cmd" and press Enter to open the Command Prompt

Type "net user" and press Enter. The PC will list all user accounts.

Type "net user username *" and press Enter. Please note that the username should be accurately the same as the account whose password is forgotten by you. The command will offer you the option to set a new password for the account.

Enter a new password and press Enter. Enter it again and press Enter. If all things go well, you can log in to the account using the new password. If you get an error message or access is denied, it means that you do not have sufficient permissions to change the password for this account.

If you don't have another account, you can crack Windows 10 password by following the steps below:

Make a Windows installation USB drive and boot the PC from it.

Click Repair your computer on the Windows Install interface and then navigate to Troubleshoot > Advanced options > Command Prompt.

Execute the command "copy d:windowssystem32cmd.exe d:windowssystem32osk.exe".

Type "yes" to confirm the overwrite option.

Reboot the PC, click on Ease of Application (middle one) in the right bottom corner of the login screen, and then choose the On-Screen Keyboard option.

Use the "net user" commands to crack Windows 10 password.

Method 2. Crack Windows 10 Password via Super Administrator Account:

Super Administrator Account (SAC) is a hidden feature on Windows 10 to reset the login password. Here is the guide on how to use it:

Turn on the PC and wait till the login screen appears.

Press the Shift key almost 7 to 8 times till the Super Administrator Account appears.

When SAC appears, you just log in, go to Control Panel, choose "User Profiles", and select the User Name for which you want to reset the password.

Modify your password but make sure to log in next time from your main Administrator Account.

Method 3. Use Third-Party Software:

If the above methods don't work, you can try some Windows 10 password crackers, for example, 4WinKey, WinGeeker, etc. You can try them.

If you want to remove the Windows 10 password permanently, you can refer to this post:

Method 4. Have an Administrator Change It:

If you share your computer with someone else and that person have administrator-level access, you can ask him to reset the Vista password for you. Here is the guide:

Log in Windows Vista with the administrator account.

Open Control Panel.

Click the User Accounts

Select Manage another account.

Select the account that you want to change the password for.

Click the Change the password

Enter a new password for the user to change the password.

But in most cases, you're the only user of the computer and the Windows Vista password reset process may be more complicated.

Crack password Android mobile phone:

Part 1. How to Unlock Forgotten Pattern on Android Without Losing Data

Part 2. How to Bypass A Pattern Lock on Android with Google Account

Part 3. How to Break Pattern Lock on Android with Android Device Manager(ADM)

Part 4. How to Unlock Pattern Lock on Android with Find My Mobile

Part 5. How to Hack Android Pattern Lock with ADB

Part 6. How to Crack Android Pattern Lock with Safe Mode Boot

Part 7. How to Remove Pattern Lock on Android via Factory Reset

Part 1. How to Unlock Forgotten Pattern on Android Without Losing Data

If you want to unlock forgotten pattern without losing data, the tool is required here is dr.fone - Screen Unlock (Android). This program is an amazing lock screen remover that helps users in clearing their lock screens without altering any data. Plus, it not only remove pattern lock from Android but also bypass lock like PIN, password, fingerprint lock, etc. on Android phone or tablet without data loss.

What's more, there is a benefit of a free trial that comes with this tool. So you can take a free trial to check whether your device is supported or not.

dr.fone - Screen Unlock (Android)

Lock Screen Remover in a Few Clicks, No Data Loss

Remove 4 types of lock screens like pattern, PIN, password, or even fingerprint with just one click.

Privacy and data will be fully secured while using this tool and no data loss during the unlocking process.

No requirement for professional technical skills for every user.

100% safe and easy to use.

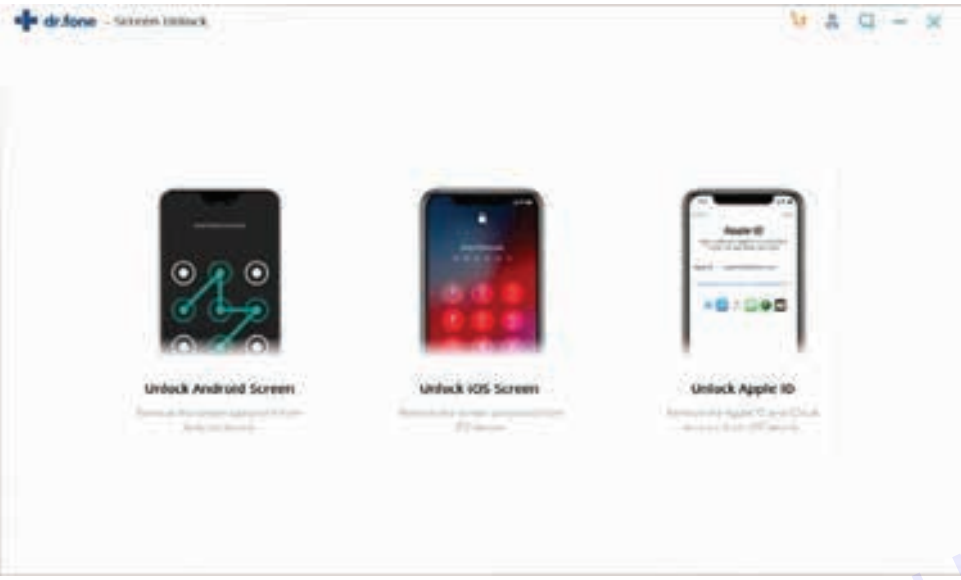
Tutorial on How to Remove Pattern Password from Android using dr.fone.

Step 1:Run the dr.fone - Screen Unlock (Android):

The initial step to be taken is to download dr.fone - Screen Unlock (Android) from here on your PC. Install and launch it afterward. When you'll launch, an interface will come with options as shown in the image. All you need to do is to click on "Lock Screen Removal".

Step 2: Plug-in Device and Enter Download Mode:

Now, connect the device to your computer using a USB cable and you'll see an interface that requires you to select the detailed info about your device, like brand, phone name, model, etc. Just choose the right one according to your own device, and hit "Next".



Now, a pop-up window will appear, and you need to confirm the settings in the above step by typing "Confirm" in the blank area.

Step 3: Enter Download Mode on Android:

Now, proceed to enter the download mode by following the steps given below.

Firstly, power off your phone

Secondly, keep pressing the "Power", "Volume Down" and "Home" buttons at the same time.

And lastly, press the "Volume Up" button and you will enter the download mode.

Step 4: Remove Pattern Lock from Android:

The above step was important to perform because it will assist you in downloading the suitable recovery package for your device in this step. When you enter the download mode, the program will automatically get the recovery package and start the process of unlocking Android pattern lock. You only need to wait until your phone is rebooted.

Part 2: How to Bypass A Pattern Lock on Android with Google Account:

A yet another way to bypass your screen pattern lock is via Google Account. Yes, with the help of a preconfigured Google account to your device, you can easily crack pattern lock on And and without any data loss. Sounds good, right? But there is a problem, this method only works on devices with Android version 4.4 or lower. Now, check your device's OS and make sure that your device must have active wireless or cellular data connection.

Step 1. Make any random attempts on your screen pattern 5 times. This will trigger to "Forgot Pattern" button visible on the screen. Hit the "Forgot Pattern" button when you see it.

Step 2. From the upcoming window, you will be asked to punch in the credentials of your Google Account which is already configured with your device. Punch the details carefully and correctly. Lastly, hit "Sign in". Your device will then validate the credentials and upon success, will reset the pattern screen lock enabling you to use your device normally

Part 3. How to Break Pattern Lock on Android with ADM (Android Device Manager):

Another way by which you can learn how to hack Android pattern lock is when you use ADM that stands for Android Device Manager. The steps are:

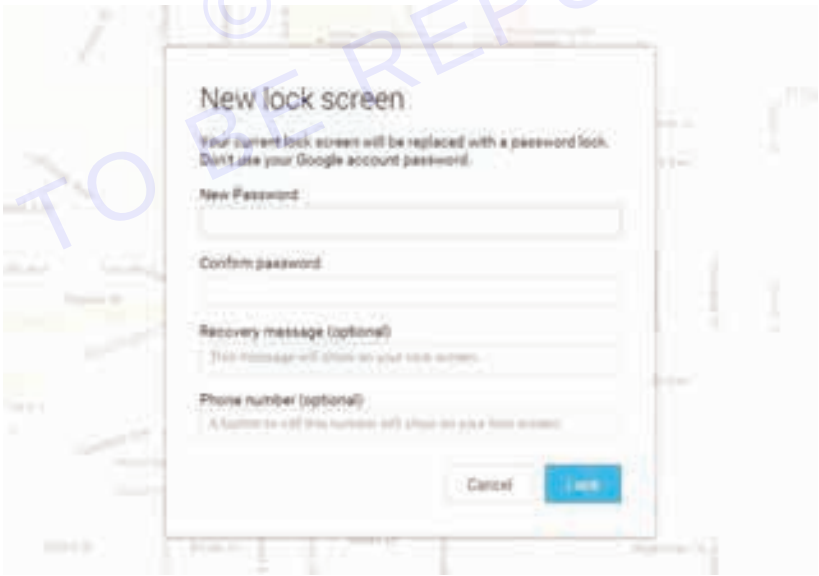
Step 1. Begin with http://www.google.com/android/devicemanager on PC and sign in with the Google account. It should be the same account that you use in the device that is presently locked.

Step 2. Select your device and from the main interface, hit on the "Lock" option.

Step 3. As soon as you click, you will receive a pop-up window as shown in the image. This will prompt you to type in the new password to replace the pattern you forgot.

Step 4. Now, confirm the password by entering it again and then hitting the "Lock" button. In the end, take your device and type the same password you've entered just now. Within a few minutes, you will be able to access your device.

See a Comprehensive Guide on Unlock Pattern lock on Android here.



Part 4. How to Unlock Android Pattern Lock with Find My Mobile App (Only Works for Samsung):

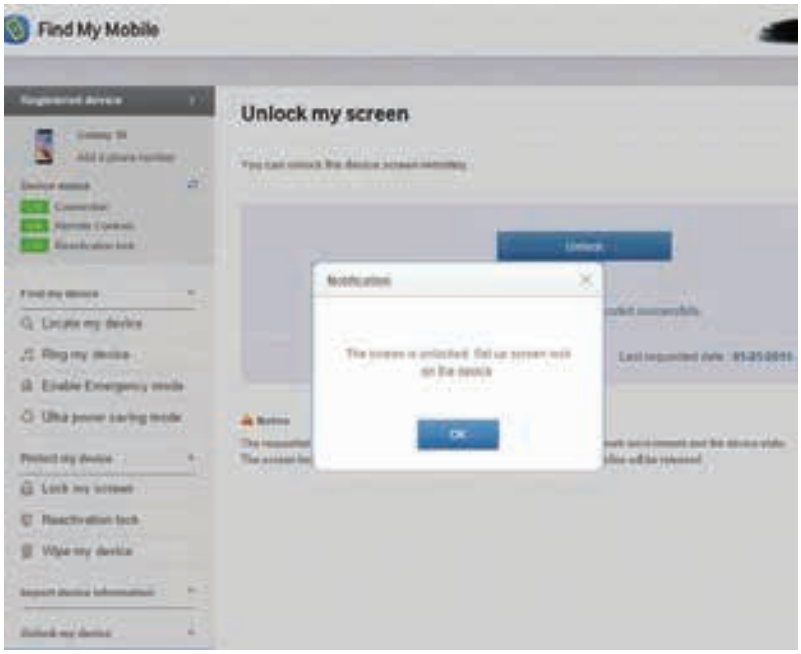
Find My Mobile is a service provided by Samsung to its users' comfort in situations when they are unable to find their mobile or forgotten their password or pattern lock and more. Let's now uncover the step guide tutorial about how to remove pattern lock on Samsung using the popular Samsung's Find My Mobile feature.

Step 1. Using your registered Samsung Account, log into the official link of Find My Mobile

Step 2. Now, locate the "Unlock my Device" tab in the left sidebar menu and hit on it.

Step 3. The website will then try to communicate with your device via the internet. Upon successful communication, you'll be able to notice a button that says "Unlock". Hit on it to remove the pattern lock of your device.

Step 4. That's about it! Your guide on how to hack Android pattern lock with Find My Mobile comes to an end and you can now access your device just like normal.



Part 5. dr.fone - How to Hack Pattern Lock on Android with ADB Command:

This could be the solution to your problem of how to crack pattern lock in Android. If you are a bit tech-savvy and understand the commands then this method is certainly the easiest for you because a bit of coding is involved to get through the lock screen pattern of your Android device.

Well, every method does have some sort of pre-requisites, right? And so is with this method as well. You must have "USB Debugging" enabled on your device and also, should have granted appropriate permissions to the PC with which you are going to connect your device and crack pattern lock via ADB. If you are able to meet these high requirements then this is going to be just a two-step pattern lock breaker.

Step 1. Start by connecting your Samsung smartphone to the PC using the data cable supplied with your device. Now, press and hold the "windows" key along with the letter "R" and a "Run" box will pop on your screen. You can now let go of the buttons and now punch in "cmd" in the text area available and push "OK".

Step 2. Next, the Command Prompt window will come up and you now have to punch in command in it. Make sure, the provided command is typed exactly the way it is, and then hit the "Enter" key on your keyboard.

Step 3. Reboot your device and you'll notice your lock screen pattern is gone. But wait, it's temporary, make sure to reset your pattern lock before rebooting your device again.

Part 6. How to Crack Android Screen Pattern Lock with Safe Mode Boot:

We have the Safe Mode boot method to unlock the pattern screen lock of your device. But the only drawback of this app is that it works for third-party lock screen apps only. Here is how to boot into safe mode.

Step 1. Hold down the Power key only, for a couple of seconds. The Power menu will pop up on the screen, now push and hold the "Power Off" option.

Step 2. A prompt will come up next asking you to boot up your device in safe mode. Push "OK" and let your device boot into safe mode. You'll notice your third-party pattern lock screen app is disabled temporarily until you're in safe mode.

Step 3. Now, either you can uninstall the third-party lock screen app or reset its data and then reboot your device. The lock screen app will no longer be there.

Part 7. How to Remove Pattern Lock on Android via Factory Reset:

Most of the users find the first solution to the question "how to bypass or hack Android pattern lock" is the factory reset. Well! They are not wrong but using this method you may end up losing your data. So, this method is useful if the storage is not so useful to you and you can afford to lose it. Here is how to bypass pattern lock step guide.

Step 1. Firstly, turn off your phone and press the “Volume Up + Home + Power” buttons simultaneously to boot up your device. Keep pressing them until you get the boot animation of the device.

Step 2. After this, you will receive some options from which you are required to choose “Wipe data/factory reset” with the help of volume buttons. Then, tap the “Power” button to confirm.

Step 3. In the last, pick the “Delete all user data” option and click the “Power” button once again. When finished, reboot your device.

Procedure of reboot (windows and android):

How to Reboot a Windows 11, 10, or 8 Computer

The “normal” way to reboot a computer running Windows 11/10/8 is through the Start menu:

Open the Start menu.

Select the power icon at the bottom (Windows 11/10) or top (Windows 8) of the screen.

Select Restart.

Using the Power User Menu:

This second method is a little faster and doesn’t require the full Start menu:

Open the Power User Menu by pressing the Win (Windows) key and X. Another way to get there is by right-clicking the Start button.

Go to Shut down or sign out.

Select Restart.

The Windows 8 Start screen functions differently from the Start menus in other versions of Windows. Install a Windows 8 Start menu replacement to return the Start screen to a legacy-looking menu and have easier access to the restart option.

How to Reboot a Windows 7, Vista, or XP Computer:

The quickest way to reboot Windows 7, Windows Vista, or Windows XP is through the Start menu:

Open the Start menu from the taskbar.

In Windows 7 and Vista, select the small arrow to the right of the Shut down button.

In Windows XP, select Shut Down or Turn Off Computer.

Choose Restart.

Reboot an Android Smartphone or Tablet:

Press-and-hold the Power button, or Power + Volume Up, to find the power off menu.

Alternatively, to force a reboot, hold that button(s) until it restarts on its own.

Press the Power Button:

Press-and-hold the power button for a few seconds. It’s usually on the right side of the device.

A menu will appear with the Power off option. The latest Android version might offer other options, including Restart, which is a better option.

Some devices work a little differently. For example, the latest Pixel phones show the power off menu when you press the Power + Volume Up keys at the same time.

Do a Hard Reboot:

Even when the Android operating system can’t display the power down menu, you can perform a hard reboot, also known as a hard restart. Not every Android device is programmed to do a hard reboot the same way.

Many devices reboot when you hold down the power button. However, it may take 10 to 20 seconds before it’s triggered.

If that doesn’t work, try holding down both the Power and Volume Up buttons for up to 20 seconds. After that, the screen will go black, signaling that the device has powered down.

Note:Factory resetting an Android device is very different from rebooting one. Learn more about reboot vs reset to see which option is best for you.

Overview of BTS,MTS:

BTS: BTS(Base Transceiver Station) and MTS (Mobile Telephone Switching Office) are key components in cellular networks, facilitating communication between mobile devices and the wider telecommunications infrastructure. Here's an overview of each:

BTS (Base Transceiver Station):

Function: The BTS is a critical component of the radio access network (RAN) in cellular networks. Its primary function is to transmit and receive radio signals to and from mobile devices within its coverage area.

Transmission: The BTS communicates with mobile devices via radio waves using various frequency bands allocated for cellular communication. It transmits voice, data, and control signals to mobile devices and receives signals from them.

Coverage Area: Each BTS covers a specific geographical area, often referred to as a cell. Multiple BTSs are strategically deployed to provide coverage across a wider area, forming a cellular network.

Components: The BTS consists of various components, including transceivers, antennas, amplifiers, power supplies, and control units. These components work together to ensure reliable communication between mobile devices and the network.

Connection to Network Core: The BTS is connected to the mobile switching center (MSC) or base station controller (BSC) in the network core through backhaul links, such as optical fibers or microwave links. This connection facilitates the routing of calls and data between mobile devices and the wider telecommunications network.

MTS (Mobile Telephone Switching Office):

Function: The MTS, also known as the mobile switching center (MSC), is a central component of the core network in cellular networks. Its primary function is to route calls and data between mobile devices within the network and external networks, such as the public switched telephone network (PSTN) and the internet.

Call Routing: When a call is initiated from a mobile device, the MTS routes the call to the destination device or network based on the dialed number and other routing information. It manages call setup, teardown, and handovers between different cells and BTSs.

Data Routing: In addition to voice calls, the MTS also handles the routing of data traffic, including SMS (Short Message Service), MMS (Multimedia Messaging Service), and packet data for internet access.

Subscriber Management: The MTS maintains subscriber databases containing information about registered mobile devices, subscriber profiles, service subscriptions, and billing information. It ensures accurate billing and subscriber authentication for network access.

Interconnection: The MTS establishes and manages connections with other MSCs, PSTN switches, and external networks to facilitate inter-network communication and roaming services for mobile subscribers.

In summary, BTSs and MTSs are essential components of cellular networks, enabling communication between mobile devices and the wider telecommunications infrastructure. While BTSs handle radio transmission and reception at the cell level, MTSs manage call routing, data traffic, and subscriber management at the core network level.

Testing various parts and components used in mobile phones is an essential aspect of hardware repair

Here's an overview of common parts and components and how they can be tested:

Battery: Check battery health using diagnostic tools or built-in battery health features on the phone. Measure battery voltage using a multimeter to ensure it's within the expected range.

Test battery capacity by discharging and recharging it fully and measuring the time it takes to deplete.

Display (LCD/AMOLED): Visually inspect the display for any physical damage, dead pixels, or discoloration. Test touch functionality by swiping and tapping across the screen.

Use diagnostic tools to check for display abnormalities, such as color shifts or uneven brightness.

Touchscreen/Digitizer: Test touch sensitivity and accuracy by tapping various areas of the screen.

Use diagnostic tools to check for dead zones or unresponsive areas on the touchscreen.

Verify that multitouch gestures (e.g., pinch-to-zoom) are functioning correctly.

Charging Port/Connector: Inspect the charging port for debris, damage, or corrosion.Test charging functionality using different cables and chargers to rule out issues with accessories.

Measure voltage and current at the charging port using a multimeter to ensure proper charging.

Audio Components (Speakers, Microphones, Headphone Jack):

Test audio output by playing music or making a phone call.

Use diagnostic tools to check for audio distortion, crackling, or muted channels.

Verify microphone functionality by recording audio or making voice calls.

Camera (Front and Rear): Test camera functionality by capturing photos and videos. Check for focus issues, lens scratches, or sensor defects.

Use diagnostic tools to assess camera performance, such as exposure, white balance, and autofocus.

Buttons (Power, Volume, Home):

Test button responsiveness by pressing each button multiple times.

Use diagnostic tools to detect button presses and ensure proper functionality.

Inspect buttons for physical damage or stuck positions.

Sensors (Proximity, Accelerometer, Gyroscope):

Test sensor functionality using diagnostic apps or built-in sensor test features.

Verify that sensors respond to changes in orientation, movement, and proximity.

Calibrate sensors if necessary to improve accuracy and performance.

Motherboard/Logic Board:

Inspect the motherboard for physical damage, corrosion, or burnt components.

Test continuity and voltage levels across critical components using a multimeter.

Use diagnostic tools to identify faulty components or circuitry and troubleshoot issues.

Connectivity (Wi-Fi, Bluetooth, GPS):

Test connectivity by connecting to Wi-Fi networks, Bluetooth devices, and GPS satellites.

Verify signal strength and stability for each connectivity option.

Use diagnostic tools to diagnose connectivity issues and troubleshoot network problems.

Recognize and Troubleshoot common handset problems like hanging issues, camera problems

Reasons for a hanging phone: A lot of credit goes to your phone handling habits. Check some key habits that can lead to a hanging phone:

Running too many apps at the same time: Having too many applications open and running in the background can put a strain on the phone's resources and cause it to hang.

Leaving apps running in the background: If you don't close apps when you're finished using them, they will continue to run in the background and use up resources, leading to a hanging phone.

Ignoring software updates: Keeping your phone's software up-to-date is important because it ensures that the device is optimized and free of bugs that can cause it to hang.

Overloading the phone with media files: Storing too many photos, videos, and other media files on your phone can take up valuable storage space and slow down the device, leading to a hanging phone.

Using the phone while it's charging: Using your phone while it's charging can generate heat and cause the device to hang.

By avoiding these habits and practicing good phone maintenance, you can help reduce the likelihood of your phone hanging and improve its overall performance.

Some technical reasons why your phone start hanging.

Outdated operating system: If your phone's operating system is outdated, it may not be able to handle the demands of newer apps and features, leading to hanging.

Malware or virus: Malware or a virus on your phone can slow down performance and cause the device to hang.

Hardware issues: In some cases, hardware issues such as a damaged battery, a failing processor, or a damaged RAM module can cause the phone to hang.

Poorly designed apps: Apps that are not optimized for the phone's hardware can cause the device to hang.

Overheating: If the phone gets too hot, it may hang or shut down to protect the device and its components.

Camera problems:

Blurry pictures can be a frustrating experience. Blurriness often occurs due to shaky hands or low-light conditions. Sometimes it happens because of your camera's inability to focus correctly. There are some solutions to resolve this such as ensuring stable hands and good lighting.

Camera App Crashes:

A camera app crash can interrupt capturing those special moments. These crashes may happen because of software glitches or incompatible apps. To fix this start by closing the app and restarting your phone.

Black Screen or No Image Capture:

A black screen or inability to capture images can be alarming. It's often due to a software glitch or a malfunctioning camera hardware. To troubleshoot restart your device or perform a soft reset.

Poor Low-Light Performance:

Low light conditions can challenge even the best smartphone cameras. The tiny camera sensors struggle in such situations. To improve low-light photography consider using the flash or enabling Night Mode. You can also invest in external lighting sources for better results.

Overexposed or Underexposed Photos:

Photos that are too bright or too dark can be disappointing. Incorrect camera settings or lighting conditions are often the culprits. To balance exposure use the HDR mode or manually adjust exposure settings. Be mindful of lighting conditions for better results.

Video Recordings Have No Sound:

Have you ever recorded a video and realized later that there's no sound? It's like watching a silent movie – something's missing. Sometimes your phone might mute the audio while recording and you might only notice it when you're back home. It's frustrating.

Front Camera Problems:

Front camera issues can affect selfies and video calls. Poor quality or inaccurate colors might result from low-quality sensors or software bugs. Adjust camera settings avoid excessive use of beauty mode and ensure good lighting to enhance front camera performance.

Camera App Closes Unexpectedly:

Experiencing the camera app unexpectedly closing can be incredibly frustrating. When you're ready to capture a special moment the app shuts down. This unexpected glitch can disrupt your plans and leave you without the photos or videos you intended to take. Let's explore the potential reasons behind this issue and find straightforward solutions to get your camera app back on track.

Red eye in flash photos:

Dealing with the red-eye effect in flash photos can be frustrating. It happens when the flash of your phone's camera reflects off the subject's eyes resulting in an unnatural red or orange glow in the photo. This unexpected

appearance can spoil an otherwise great shot especially when you revisit the image later. Although this issue is less common nowadays due to improved camera technology it can still pop up in specific lighting situations.

Study various radiation levels of smartphone.

Radiation Emissions of Popular Smartphones:

Smartphones have become an integral part of our everyday lives. From work and school to daily tasks, these handheld devices have brought everything into the palm of our hands.

Most people spend 5-6 hours on their phones each day. And, given that our phones emit a tiny amount of radiation, we're exposing ourselves to radiation for hours each day.

But different phones emit different amounts of radiation.

Radiation and SAR Values of Smartphones:

Smartphones and other mobile devices emit tiny amounts of radiofrequency (RF) radiation. Humans can absorb this radiation when the smartphone is being used or is lying dormant anywhere near their bodies.

The parameter used to measure phone radiation emissions is the Specific Absorption Rate (SAR). It is the unit of measurement that represents the quantity of electromagnetic energy absorbed by the body when using a mobile device.

The Council of the European Union has set radiation standards for cell phones at 2 watts per kilogram, measured over the 10 grams of tissue that is absorbing the most signal.

SAR values are calculated at the ear (speaking on the phone) and at the body (kept in your pocket). For the purposes of this article, we've used the former calculations.

Smartphones With the Highest Levels of Radiation Emissions:

The Motorola Edge has the highest radiation emission with a SAR value of 1.79 watts of radiation per kilogram. That's significantly higher than most other smartphone models in the market today and close to the limits set by the EU for cellphones.

Coming in second is the Axon 11 5G by ZTE with 1.59, followed by the OnePlus 6T at a close third with 1.55 W/kg. The Sony Experia AX2 Plus with 1.41 and the Google Pixel 3 XL and 3A XL at 1.39 round out the top five.

Smartphones With the Lowest Levels of Radiation Emissions:

The smartphone with the lowest SAR value is the ZTE Blade V10, with 0.13 watts of radiation per kilogram.

Mobile devices by Samsung carry some of the least radiation risks. The company has four phones considered to be the best in the category. The Galaxy Note 10+ is the best model in their line-up, emitting a meager 0.19 watts per kilogram.

Study compliance standards for mobile phones in india.

BIS Standards for Mobile Devices:

Smartphones are an essential part of everyone's lives, and life would be much harder without them. More than 4 million people in India use smartphones, and in order to sell the product freely, one must obtain the BIS certificate for Smart Phone Import. All smartphones have been registered under Indian Standard IS 13252's BIS CRS Registration Scheme (Part 1). This product cannot be imported into or marketed in the Indian consumer market without a BIS Registration.

Characteristics for BIS Certification for Mobiles:

The following are the few characteristics of BIS Certification for Mobile:

1 Manufacturer:

The manufacturer of the applied product is the sole party eligible for a BIS license. The license is not available to traders, retailers, or other licensees. If the manufacturer doesn't have a liaison office in India, they can nonetheless represent them there. However, the maker is the only one whose name is on the license.

2 Manufacturer Address:

The manufacturer is given a license for a specific site address. A new license must be requested whenever the manufacturer's address changes. Alternatively, different licenses are requested through BIS if the company uses more than one manufacturing address to produce the same product.

3 Product Type:

A manufacturer must submit a separate licensing application for each product category if he produces more than one product. For instance, a business that produces both adapters and mobile phones must submit two separate applications to BIS.

4 Brand:

A producer or OEM must submit a separate licensing application to BIS if they produce the same item for multiple brands. For instance, a business that produces batteries for both Brand A and Brand B must submit two separate license applications to the department.

Schemes for BIS certification of Mobile devices

For mobile device BIS certification, three schemes are applicable:

Institution of Indian Standards (ISI):

This standard denotes that the product has met a number of safety requirements set out by the BIS. ISI marks alert consumers to unsafe goods and stops the sale of dangerous products from reaching the market.

Scheme for Foreign Manufacturer Certification (FMCS):

All producers must now possess the FMCS certificate in order to sell their goods in the Indian market, according to the BIS Act of 2016[1] and the BIS guidelines of 2018. This is done to guarantee that imported items meet the requirements imposed by the government.

Mandatory Registration Program (CRS):

All electronic products must comply with a certification known as a mandatory Registration Scheme. Therefore, BIS certification for mobiles is also required. The program encouraging manufacturers to produce dependable and high-quality products was introduced by the Ministry of Electronics and Information Technology.

Documents needed for BIS Certification for Mobile.

The following are the documents needed for BIS Certification for Mobile:

A copy of the BIS application form submitted online

A letter of authorization from the company's CEO

A letter of authorization from the brand owner or a copy of the trademark registration.

Documents pertaining to the products' test results

English and the local language should also be provided on the business license unit.

Certificate of origin for a country (In case of FMCS)

For overseas manufacturers, an affidavit for authorized Indian representatives is necessary.

The Authorized Indian Representatives' photo identification

A diagram of the manufacturing facility's layout

The product's instructions

The procedure for BIS Certification for Mobile

The following are the steps for BIS Certification for Mobile:

Step-1

Application submission: The manufacturer (the applicant) must go to the BIS website. Establishing a User id and password is the first step. To submit an application for BIS for mobile phones, the applicant must log into the portal.

Step 2

Test Request: Strict testing requirements must be met for the product. The applicant must submit a request for product sample testing.

Step 3

The product will be tested: The officials will go to the factory and choose random samples. Only labs that are registered with the BIS should conduct the testing.

Step-4

Submit the application along with the test report: The application must have all the necessary information filled in by the manufacturer. Include the aforementioned files along with the BIS lab's most recent test results reports.

Step 5:

Application scrutiny: After the application is filed, BIS authorities will review and double-check the information provided by the manufacturer and will approve the test results that are included in the paperwork.

Step 6

Certificate granted: The BIS will award the certificate for mobile phones if the product's test results deem it suitable for circulation and the application's details comply with the standards.

Mobile phone hardware troubleshooting procedure

Fixing hardware problems is not been easy and takes a lot of time to consume rather than software problems, it is because when it comes to software handling you don't really need to open or dismantle a mobile phone handset, because only few of them really need to. In most cases like this, many among mobile phones technician focus on software handling like especially unlocking, for it less time consuming and more flexible to do with. This is been true that mobile phone technicians were separated into two specialties, like Hardware expert and Software expert, that is what the term they called it; It because mobile phones is a combination of software and hardware mechanism.

But there are also many mobile phones masters that can manage and do both hardware and software specialty and skills. They gained this knowledge by years of experience, and not only that they also earned much more income rather than to those staying at one particular specialty.

Now, here is the basic step by step repair procedure on hardware troubleshooting on mobile phones. Various mobile phones have different circuits and components or parts layouts and designs. First thing you must learn and be familiar with is, how each circuit components or parts is being mounted, connected, assembled or designed.

First step in handling troubleshooting procedure.

1 **Visualization Checkup-** Before proceeding to anything always consider the fact that a mobile phones handset is fragile object. Check and have take a look around every inch of the handsets package and layout, In this manner you can identify if the handset is in repairable condition, something like checking the whole printed circuit board components and parts, if it is free from dust, corrosion, bended, breakage etc.

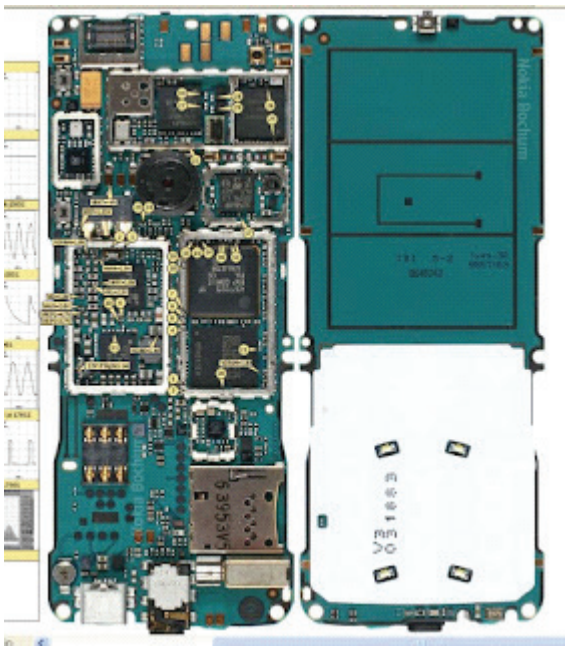
2 **Know the Phones Status -** Ask the the user or the costumer about the phones history before the problem occurs. Letting know the phones history like accidentally soaked into a liquids or water, dropped, throwned and etc.

   In this manner you can get an idea where to start or begin with.

3 **Do Software Check up -** Use a certain flashing device for that particular handset product to be able to read logs, logs is a reading of mobile phones firmware programmed and installed unto it. This is a big help for most advance mobile technician this days, A logs reading can help you where the faulty line or parts occurs. If you are not familiar about how to read logs you can ask to that certain flashing device product supporters and creator.

   You can do flash, reformat at first hand if found something wrong with the mobile phones firmware. If all methods of software already done and nothing happens, proceed to hardware troubleshooting.

4 **Analyze The Circuit -** After dismantling and do visualization check up,be patient and take your time to analyze the whole circuits layout, and think of a step by step plan procedure in your mind where or how to begin with. A Special Operation Procedure is good way and a reliable source of idea within yourself, not only by enhancing your skills but you are also practicing a self discipline method.



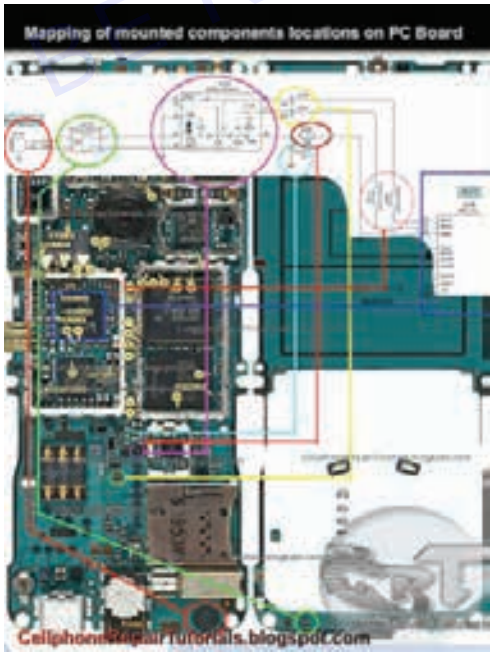
Now lets take one example of basic hardware troubleshooting methods in one particular mobile phone handsets. In this simple way you can then manage how to troubleshoot or been able on finding faulty parts or components within a mobile phone circuitry.

An example here is Nokia 6300, now assuming that this handset having a faulty microphone or mouthpiece.

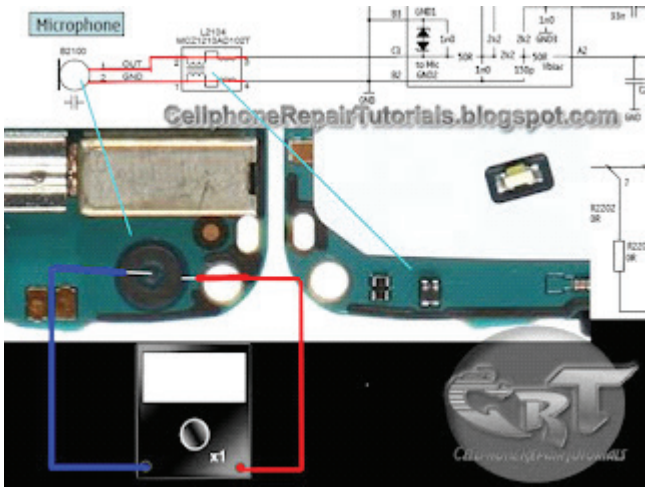
Do the basic procedures mentioned above, assuming that you are familiar with the Mouthpiece or microphone circuit, and already know how to check a microphone or mouthpiece component.

you can now do this step below;

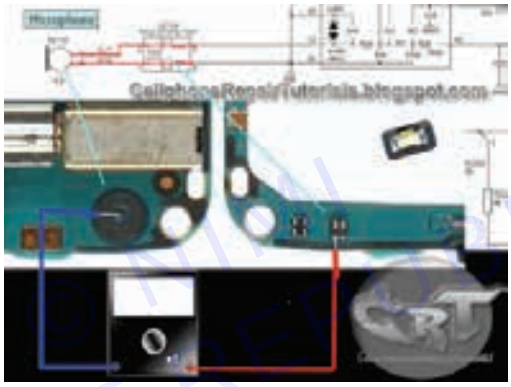
1 Find any available schematic diagram and locate the microphone circuit layout on it. Remember where each parts and components location and do a mapping like this.



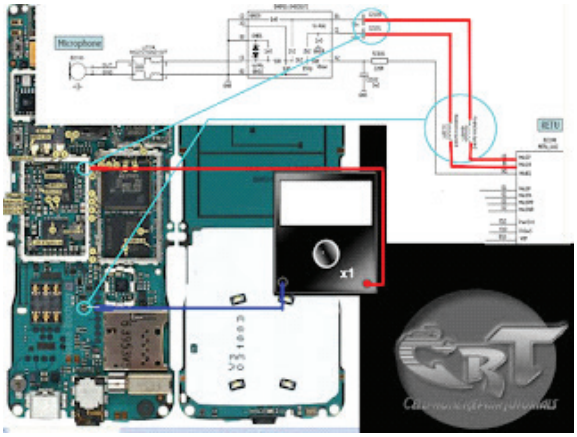
2 Use a multi-tester and check the pads for a short circuit, this is not always happen but it is also unpredictable to a mobile phones short circuit might occurs, you are not checking the outer mounted components but the internal lines with it. Just set the tester to x1 resistance value, I preferred analog multitester in this lesson for it is cheaper to purchase rather than the digital. Now connect both test probe to the inner and outer layer of the mouthpiece terminal pads, then do it again in opposite manner, a short circuit have both readings closer to zero ohms.



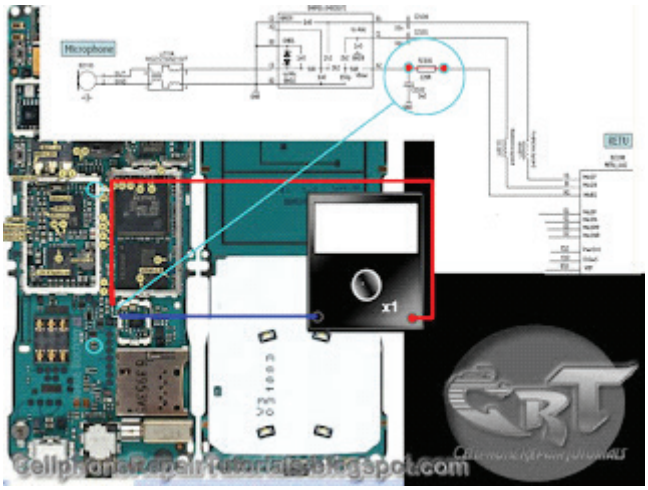
3 Trace the line paths between the first or the closest component connected to each terminal pads.The circuit diagram shows that there are coil filter in both lines, connect the tester across each coil terminal leds, your not just checking the lines here but also checking the the coil as well.



4 Now the next step is to leave behind the line paths between the coil to the EMI-Filter for it is uncheckable beyond that paths for the EMI- filter is an IC. you need to remove it first before you can check on that lines, which will be done later at the last steps of procedures. Now next to move on to the opening lines and component where the test probe can connect with, the two filter capacitors and both coils which are an open path where you can connect the test probe on it. now connect or attach both probes at the end of each line indicated in red.

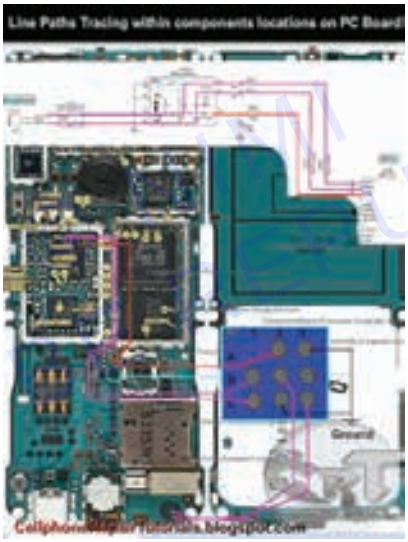


5 Now check the remaining open path which is the Resistor, you can't check the line paths on those area for it ends up connected to Retu IC. So just then proceed to check its resistance value instead.



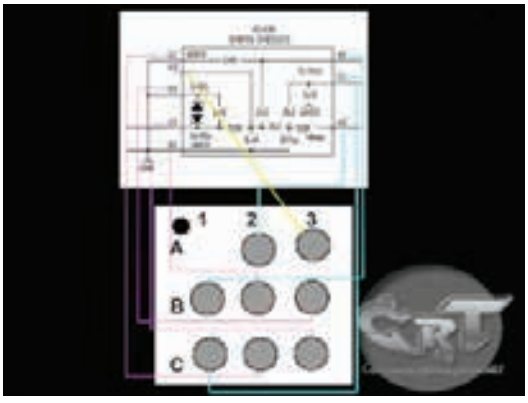
6 If all those mentioned lines above is all in good condition you may now proceed to suspect the EMI-Fiter is having a problem or faulty. You then now remove it from the Printed circuit board then do a line check up from the mouthpiece terminal to that EMI-filter terminal bumps where it is being connected.

You can refer to the schematic diagram for each terminal specification. You may now can check the IC itself by analyzing the internal circuitry inside it. I advice just replace a good and working one if not so sure about.



It this step is most complicated job to do with, specially for beginners.This is one of advance troubleshooters skills. If found all of those line paths and components above were in good conditions. The last part is to work a power management IC itself for the audio codec circuit is also within that chips.

Now, if the last and final suspected parts is the chips, you must need to rework it, Reheating it the first will do and might as well also work. But if the problem still remain, Reworking it is the best advice that suites out.



Reasons for a hanging phone:

A lot of credit goes to your phone handling habits. Check some key habits that can lead to a hanging phone:

Running too many apps at the same time: Having too many applications open and running in the background can put a strain on the phone's resources and cause it to hang.

Leaving apps running in the background: If you don't close apps when you're finished using them, they will continue to run in the background and use up resources, leading to a hanging phone.

Ignoring software updates: Keeping your phone's software up-to-date is important because it ensures that the device is optimized and free of bugs that can cause it to hang.

Overloading the phone with media files: Storing too many photos, videos, and other media files on your phone can take up valuable storage space and slow down the device, leading to a hanging phone.

Using the phone while it's charging: Using your phone while it's charging can generate heat and cause the device to hang.

By avoiding these habits and practicing good phone maintenance, you can help reduce the likelihood of your phone hanging and improve its overall performance.

Study mobile phone USB charging problem:

The Universal Serial Bus (USB) connection has become the de-facto standard for both charging and data transfers for smart phone devices including Google's Android and Apple's iPhone. To further enhance their functionality, smart phones are equipped with programmable USB hardware and open source operating systems that empower them to alter the default behavior of the end-to-end USB communications. Unfortunately, these new capabilities coupled with the inherent trust that users place on the USB physical connectivity and the lack of any protection mechanisms render USB a insecure link, prone to exploitation. To demonstrate this new avenue of exploitation, we introduce novel attack strategies that exploit the functional capabilities of the USB physical link. In addition, we detail how a sophisticated adversary who has under his control one of the connected devices can subvert the other. This includes attacks where a compromised smart phone poses as a Human Interface Device (HID) and sends keystrokes in order to control the victim host. Moreover, we explain how to boot a smart phone device into USB host mode and take over another phone using a specially crafted cable. Finally, we point out the underlying reasons behind USB exploits and propose potential defense mechanisms that would limit or even prevent such USB borne attacks.

If you're having issues with your removable battery charging or not holding a charge, here are some helpful tips.

Check the charging port for water damage or corrosion.

Check the charging port for bent or broken pins and lint.

Press the Power button (if available) for 3-5 seconds to verify the device doesn't power on.

Remove then re-insert the battery, and ensure it's charged.

Ensure a manufacturer or VZW approved battery charger (included in the box) and USB charger cable are used to avoid extended charging times or other charging issues.

Attempt to power on the device while it's connected to the wall charger.

For proper testing, do not use the USB cable connected to the computer or a car charger.

Verify the device and charger display the appropriate charging/LED indicator.

If the battery is extremely low, the display may remain blank for up to 5 minutes before a low battery image appears. It may take up to 20 minutes before the device powers up.

Attempt to power on the device using an alternate manufacturer-approved charger, if available.

Mobile Phone Touch Sensor problem:

No matter whether your phone touch screen is not working due to physical damage or technical issues, here are the ways and steps you need to follow. Here are the 11 ways to fix the phone screen not responding to touch.

1 Restart Your Phone:

Restarting your device is the first step to perform when your phone touch screen is not working for non-physical damage. Sometimes, a simple restart can solve many issues. Since the touch screen is not responding, you cannot turn your device off from the option on the screen. Here are the steps to follow to restart an Android phone.

Step 1: Press and hold the "Power" button until the device turns off. If you wait for a few seconds only, you will see "Power Off" and "Restart" options on the screen.

Since the entire screen is not responding, it is of no use to you. Hence, you should press and hold the "Power" button as long as required.

Step 2: Wait a few seconds when the device turns off.

Step 3: Press and hold the Power button for the device to get restarted.

2 Remove the Screen Protector or Case:

If you are using a screen protector or a case, it may interfere with touch sensitivity. Try removing them to see if the touch screen works without them. Make sure the screen is clean from dust, dirt, or any other debris, Use a soft, lint-free cloth to gently wipe the screen. It's a easy way to clean your device if a reboot doesn't do the trick.

3 Dry out Your Cell Phone:

If your phone gets wet or accidentally drops into water, your phone screen will become unresponsive. You can try drying the phone in this case, which sometimes solves the problem.

If your phone drops into water, take it out immediately. You will need to remove all the removable parts of the device. Use alcohol to wash your device to remove dirt and minerals. Keep your device parts in a sealed packet of rice. The process dries off the device parts. Afterwards, place them outside to dry off to the extreme and see if the problem is solved later.

4 Upgrade Your Operating System:

If there is a new operating system, updating it may solve the issue of 'touch screen of phone not working.' Please make sure that your phone is connected to a stable Wi-Fi network before updating your phone. Then go to your phone's settings menu and look for "Software Update" or a similar option. Tap it to check for available updates. If an update is available, your phone will prompt you to download it. Ensure your phone has enough battery, or connect it to a charger. Follow the on-screen instructions to complete the update.

After installing the update, it may require a restart to finalize the process. Restarting your phone is recommended to ensure all changes take effect.

5 Remove the SIM Card:

In some cases, hardware failure may cause the touch screen to stop responding, such as SIM cards and memory cards, please try removing them and inserting them later. Be sure to turn off the power completely and unplug the device first.

6 Optimize Device Performance:

Improving your phone's performance with the Device Care feature may solve the issue. But, the feature is only available on Samsung Galaxy devices. It scans for wasted storage space and identifies potential issues. To optimize your device, go to Settings > Battery and device care > Optimize now.

7 Adjust Touch Sensitivity:

The exact steps may vary slightly depending on the device model and version of the operating system. Let's take the steps of Samsung and iPhone as examples.

For Samsung Galaxy device, please go to Settings > Display or Display & Brightness > Touch Sensitivity or Touch Calibration, then follow the on-screen instructions to calibrate or adjust the touch sensitivity as desired.

If you are facing issues with an unresponsive or inaccurate touch screen on your iPhone (6S to XS), it could be related to the sensitivity of the 3D Touch feature. To resolve this problem, you will need to make some adjustments. Please head to Go to Settings > Accessibility > Touch > 3D & Haptic Touch, then follow the on-screen instructions to adjust the touch sensitivity as desired. If the screen continues to be inaccurate or unresponsive, you can try turning off the 3D Touch feature.

8 Turn Off Special Feature or Developer Mode:

Running some special features like Talk Back or gestures may cause your phone screen not to respond. If you have enabled them, follow the steps to turn them off. For the Talk Back feature, simply go to Settings > Accessibility > Talk Back and tap the switch. For the gestures feature, just go ahead to Settings gt; Advanced features gt; Motions, and Gestures and tap all the switches.

The developer mode allows users to customize settings and remove certain limitations that are restricted. When you turn on Developer Options, certain Android devices start malfunctioning. If your touch screen is not functioning properly after turning on Developer Options recently, you should turn off Developer Options. Here are the steps to follow.

Step 1: Open Settings apps on your Android devices.

Step 2: Go to the System option, which is generally available at the bottom.

Step 3: Tap on Developer Options. You can understand if the option is turned on.

Step 4: You should turn off Developer options by toggling it off.

Step 5: You should restart your device and see if the Android touch screen randomly stops working.

9 Turn On Safe Mode:

Whenever you suspect that the issue on your device is due to software and apps, you should enter into Safe mode. In Safe mode, the device works with the basic and essential software and hardware support. If your touch screen works in safe mode, you can rest assured that it is a problem with some app or program you downloaded. Start with recently downloaded apps and go from there.

You can take the below steps to turn on safe mode.

Step 1: Press and hold the Power button for some time to restart your device.

Step 2: Keep holding the Power button. When the manufacturer logo appears, release the Power button.

Step 3: Immediately after you release the Power button, press and hold the Volume Down button.

Step 4: Once your phone enters safe mode, you will see the Safe Mode label in the bottom-left corner.

10 Reset Device to Factory Settings:

When uninstalling the recently installed apps does not solve the problem, you can perform a factory reset. It will restore your device to its initial state when you unbox the device. It means all the installed apps and the changes made to settings will be gone. All the phone data will be erased, including any malware present on your device that could be causing the issue.

Concept of ultrasonic cleaning:

Ultrasonic cleaning uses high-frequency, high-intensity sound waves in a liquid to facilitate or enhance the removal of foreign contaminants from surfaces submerged in an ultrasonically activated liquid. Ultrasonic technology has more recently been used in a growing number of applications involving chemical processes and surface conditioning, which, although outside the classic definition of cleaning, use basically the same techniques. Demands for increased cleanliness have driven the development of increasingly sophisticated technology in the field, particularly within the past decade. Today it is possible to customize ultrasonic waves to optimize effects in a wide range of applications, as described by Puskas and Piazza (2000). Recent developments in ultrasonic washing of textiles also have occurred (see the Appendix).

Ultrasonic cleaning is a technology unique in its ability to remove contaminants that other technologies cannot remove and in its ability to effectively clean areas that are not accessible using other technologies. Competing technologies include spray washing, turbulation, agitation, and brushing, among others. In general, these technologies are “line of sight” in nature; that is, there must be direct access to the contaminated surface for them to be effective. In all of these cases the physical energy is delivered indirectly. In a spray system, for example, the energy for the spray stream is imparted by a pump. Pressurized liquid is delivered to a nozzle, which increases the stream’s velocity and directs it toward the surface to be cleaned. Cleaning is achieved by the impact of the high-velocity stream with thesurface being cleaned. Not only is energy lost during each step of the process, but only that energy in the portion of the stream that ultimately impacts the cleaning target provides benefit; the rest is lost. Sprays are not capable of reaching areas hidden from direct access of the spray nozzle to the surface.

Cleaning blind holes with spray technology, for example, can only benefit from a flushing action because the spray creates a pressure differential across the hole opening to force liquid in to and out of the hole.

Another technology, brushing, is similarly limited in that any surface the brush bristle is not able to reach will not be cleaned. In a world where surface geometry of many parts is measured in nanometers, brushes are unable to reach all surfaces of the part to be cleaned.

Ultrasonic cleaning technology, unlike those described above, is able to penetrate and clean any surface that can be reached by a sound-conducting liquid. This means that blind holes, thread roots, parts with complex geometry, minute surface contours, and a number of otherwise impossible cleaning tasks can be easily accomplished using ultrasonic cleaning technology.

I Introduction to SMD Rework Station

A Definition and Purpose:

An SMD (Surface Mount Device) rework station is a specialized tool used in the electronics industry for repairing and reworking electronic components on printed circuit boards (PCBs) that employ surface mount technology. Unlike traditional through-hole components, SMDs are smaller, more compact, and soldered directly onto the surface of the PCB. This design offers several advantages, including space efficiency and better signal performance, but it also presents challenges when it comes to repairs and replacements.

SMD rework stations are designed to address these challenges by providing a controlled and precise way to remove, replace, and re-solder SMD components. These stations typically include features like temperature-controlled hot air rework tools, soldering irons, and preheating platforms, all of which are crucial for achieving reliable solder joints and preventing damage to delicate components.

B Importance in Electronics Repairs:

The importance of SMD rework stations in the field of electronics repairs cannot be overstated. With the rapid advancement of technology, electronics are becoming increasingly compact and intricate, making it essential to have tools that allow for precise repairs. SMD components are commonly found in a wide range of devices, from smartphones and laptops to medical equipment and automotive electronics.

When these SMD components malfunction due to manufacturing defects, wear and tear, or even accidental damage, an SMD rework station becomes indispensable. It enables technicians to remove faulty components without damaging the surrounding circuitry, replace them with new components, and re-solder them to restore the device's functionality. This process helps extend the lifespan of electronic devices and reduces the need for complete replacements, which can be costly and environmentally wasteful.

II Understanding Surface Mount Devices (SMDs)

A Explanation of SMD Components:

Surface Mount Devices, commonly referred to as SMD components, are a type of electronic component that is designed to be soldered directly onto the surface of a printed circuit board (PCB). Unlike traditional through-hole components, which have leads that pass through holes in the PCB and are soldered on the opposite side, SMD components are mounted directly onto the board's surface using solder paste and reflow soldering techniques.

SMD components come in various shapes and sizes, including resistors, capacitors, diodes, transistors, integrated circuits (ICs), and more. These components are designed to be compact, lightweight, and suitable for high-density circuit designs, which has become a necessity as electronics continue to shrink in size while becoming more powerful.

B Differences from Through-Hole Components:

The key distinction between SMD components and through-hole components lies in their mounting and soldering methods. Through-hole components are larger and require holes to be drilled through the PCB for their leads to pass through, making them suitable for manual soldering. On the other hand, SMD components are smaller and are directly soldered onto the PCB's surface, allowing for automated assembly and improved space utilization.

SMD components have a number of advantages, such as better thermal and electrical performance due to shorter connection paths, reduced manufacturing costs through automated assembly processes, and the ability to create more compact and lightweight devices.

C Common Applications:

SMD components are found in a wide range of electronic devices, from consumer electronics to industrial equipment. Their compact size and efficiency make them particularly well-suited for modern electronics.

Some common applications of SMD components include:

Consumer Electronics: SMD components are prevalent in devices such as smartphones, tablets, laptops, televisions, and digital cameras. Their small size contributes to the sleek and lightweight designs of these devices.

Automotive Electronics: SMD components play a vital role in the automotive industry, powering everything from engine control units (ECUs) and infotainment systems to safety features and sensors.

Medical Devices: Medical equipment often utilizes SMD components for their reliability and precision. They can be found in devices like MRI machines, pacemakers, and blood glucose monitors.

Communication Systems: SMD components are essential in communication equipment like routers, modems, and wireless devices, enabling seamless connectivity.

Industrial Automation: SMD components are used in industrial automation systems for tasks like control, monitoring, and data processing.

Aerospace and Defense: SMD components are employed in aircraft avionics, satellites, and military equipment, where reliability and performance are critical.

III Key Components of an SMD Rework Station

A Hot Air Rework Tool:

1 Function and Operation

The hot air rework tool is one of the core components of an SMD rework station and is indispensable for removing and reworking SMD components. This tool uses a focused stream of heated air to soften solder joints, allowing for the careful removal or placement of components on the PCB. The hot air rework tool is particularly crucial for preventing damage to both the delicate components and the PCB itself.

During component removal, the hot air is directed at the solder joints, heating them to the point where the solder becomes molten. This allows the component to be gently lifted off the PCB. Similarly, during component placement, the tool helps melt the solder paste on the PCB pads, ensuring a secure connection when the new component is placed and the solder solidifies upon cooling.

2 Temperature and Airflow Control:

Temperature and airflow control are vital features of the hot air rework tool. Different components and PCB materials require specific temperature profiles to avoid overheating or damaging the surrounding components. Many SMD rework stations offer adjustable temperature settings to accommodate various needs. Additionally, adjustable airflow helps control the rate at which the solder joints heat up and prevents overheating.

When using the hot air rework tool, it's important to follow manufacturer guidelines and recommendations for temperature and airflow settings. The ability to fine-tune these parameters ensures precise and controlled rework operations, reducing the risk of errors and ensuring successful repairs.

B Soldering Iron or Preheater.

1 Role in SMD Rework:

Apart from the hot air rework tool, an SMD rework station may also include a soldering iron or a preheater as additional components.

The soldering iron serves the purpose of localized soldering and desoldering. It's particularly useful for touch-up soldering, where minor repairs or adjustments need to be made to solder joints after the component has been placed. This iron allows for targeted heating and soldering on specific points of the PCB.

Alternatively, a preheater is employed to warm up the entire PCB evenly before using the hot air rework tool. Preheating helps in preventing thermal shock to the PCB and components during rework operations. It ensures that the PCB is at a consistent temperature, making the solder joints easier to work with and reducing the risk of damage due to sudden temperature changes.

2 Temperature Settings:

For soldering irons and preheaters, precise temperature control is paramount. Different solder alloys and component types require specific temperatures to achieve reliable solder joints. Most soldering irons and preheaters allow you to adjust the temperature according to the needs of the particular component you're working with.

BGA Components and Their Soldering Technologies in SMT Assembly.

Classifications and Properties of BGA Components

- **Classifications of BGA Components:**

Based on different packaging materials, BGA components can be classified into the following types: PBGA (plastic ball grid array), CBGA (ceramic ball grid array), CCGA (ceramic column grid array), TBGA (tape ball grid array) and CSP (chip-scale package.

- **Properties of BGA Components**

The leading properties BGA components hold include:

a I/O lead pitch is so large that more I/O count can be held within the same area.

b Higher packaging reliability, lower defect rate of solder joints and higher reliability of solder joints.

c Alignment of QFP (quad flat package) chips is usually achieved by visual observation carried out by operators and it's difficult for alignment and soldering. However, it's easier to implement alignment and soldering on BGA components due to relatively large pin pitch.

d It's easier to carry out solder paste printing through stencil on BGA components.

e BGA pins are steady with better flatness than QFP package because flatness error can be automatically compensated between chip and PCB (printed circuit board) after solder ball melting.

f During soldering process, tension between solder joints will lead to high self-alignment that allows mounting precision error of 50%.

g Featuring excellent electrical properties, BGA components make it possible to obtain excellent frequency merits.

h BGA components perform better in terms of thermal dissipation.

Naturally, apart from advantages, BGA components also feature disadvantage. One leading disadvantage is that it's difficult to inspect quality of solder joints, which depends on AXI (automated X-ray inspection) and AOI (automated optical inspection) equipment that are capable of observing solder ball collapse. Of course, inspection cost and difficulty rise as well.

Storage and Application Environment of BGA Components:

BGA components are a type of highly humidity and thermal-sensitive components, so they should be stored in the dry environment with constant temperature. Moreover, operators should rigorously conform to operation technology process to stop components from bad effect prior to assembly. Generally speaking, the optimal storage environment for BGA components is within the temperature range from 20°C to 25°C with humidity less than 10%RH. Furthermore, they should best be stored by nitrogen gas.

Generally, after BGA component packages are opened, they should never be exposed to the air for long time during assembly and soldering process to stop components from leading to soldering quality reduction due to their low quality. Once packages of BGA components are opened, they have to be used up within 8 hours in the operation environment of ≤30°C/60%RH. When components are stored in nitrogen, application time can be prolonged to some extent.

It's extremely common to see that BGA components fail to be used up once their packages are opened during SMT (surface mount technology) assembly. BGA components have to be baked prior to their applications next time to capture their excellent solderability. Baking temperature usually maintains at 125°C. Relationship between baking time and package thickness can be summarized in below table.

BGA Component Soldering Technologies:

BGA component assembly technologies are fundamentally compatible with SMT. Leading soldering phases come as solder paste printing on pad array by stencil and BGA components alignment to pad array, reflow soldering of BGA components. In the rest of this article, a brief introduction will be provided on PBGA soldering process.

- **Solder Paste Printing:**

Solder paste quality plays a key role in affecting soldering quality. The following aspects should be considered when selecting solder paste: excellent printability, excellent solderability and less contaminant.

Particle diameter of solder paste should be compatible with lead pitch of components. Generally, the smaller lead pitch is, the smaller solder paste particle diameter, the better printing quality will be. But it's never that simple as solder paste with larger particle diameter leads to higher soldering quality than that with smaller particle diameter. Therefore, comprehensive considerations should be taken when determining solder paste. Because BGA components feature fine pitch, it's suitable to select solder paste with particle diameter below 45μm to guarantee excellent printing effect and soldering effect.

- **Component Mounting:**

The essential aim of mounting is to get each solder balls on BGA components aligned with each pad on PCB board. Because BGA component pins are too short to be easily seen by naked eyes, specialized equipment should be used for accurate alignment. Up to now, primary equipment for accurate alignment includes BGA/CSP rework station and chip mounter among which precision of chip mounter reaches approximately 0.001mm. With mirror recognition leveraged, BGA components can be accurately mounted on pad array on circuit board.

- **Reflow Soldering:**

Reflow soldering is the most difficult-controlled phase in BGA assembly process, so optimal reflow soldering curve achievement is a key element contributing to excellent BGA soldering. Reflow soldering curve contains four phases: preheating, soaking, reflow and cooling. Temperature and time of the four phases can be respectively set and modified so that optimal soldering result can be acquired.

- **BGA Rework:**

BGA rework after soldering is carried out on a BGA rework station that can solder and rework independently on a BGA chip without affecting adjacent components. Therefore, a hot air reflow nozzle with suitable size can be selected to cover BGA chip for the convenience of soldering.

BGA Component Soldering Quality Inspection:

BGA as a short form of ball grid array packaging contain solder balls under components and quality of solder balls can hardly be known without specific inspection devices. Visual inspection alone fails to acquire soldering quality of solder joints. Up to now, inspection devices for BGA soldering quality inspection are X-ray inspection devices that are classified into two categories: 2D and 5D.

IC Reballing and installation:

IC Reballing is a process that uses solder paste and a dedicated stencil printer to place solder paste onto all of the pads on the circuit board. The ICs, resistors, capacitors or diodes are then removed from the old PCB and placed on top of the new solder paste using tweezers or forceps. The new component is placed on the solder paste covered pad and pressed down firmly onto it. This is repeated until all of the pads have been replaced with new components. Power is applied to the circuit board and then the resistors, capacitors and diodes are tested. If everything checks out then the board is returned to the user for use.

Rebalancing is a process that is used to repair BGA balls that have cracked or been missing for some time. BGA balls are typically used on motherboards and in place of solder pads on IC sockets. They are designed to be hot-soldered into place but over time they may become loosened or damaged. This can result in instability and intermittent operation of the socket so it needs to be repaired as soon as possible.

Reball a circuit board:

The first step in reballing is to remove the defective component from the circuit board. This can be done using a soldering iron, tweezers or forceps. The old solder is then removed using a desoldering braid or wick. A new BGA reballing station is used to place the new BGA component on the circuit board using a solder paste stencil and laser head. The new BGA component is then soldered onto the circuit board. The new component is tested and then the circuit board is returned to the customer.

The process of reballing BGA chip is as follows:

1 First remove all of the old ICs, resistors, capacitors and diodes from the PCB.

2 Clean the PCB with Acetone or Isopropyl Alcohol and allow it to dry.

3 Reball the ICs, resistors, capacitors and diodes by placing them on a BGA Reballing Station. Press down firmly onto the solder balls with your fingers and apply power. The ICs, resistors, capacitors or diodes should be tested for operation and then returned to the PCB.

4 Using tweezers or forceps, place the new BGA ICs, resistors, capacitors or diodes onto the solder balls. The BGA chips are placed directly onto the solder balls or on top of a new substrate. Once in place they should be pressed down firmly and then power applied again.

5 Wipe away any excess solder paste with a sponge using Acetone or Isopropyl Alcohol. Remove any excess liquid with a cloth and allow to dry.

6 Using a magnifying glass, check the solder balls for solder bridges. If you find any then they should be removed with a solder wick.

7 The final step is to use a multimeter to test all of the new components and make sure that they are functioning properly.

Concept of power failure of mobile phone and process to solve it (dead handsets)

A Dead mobile phone is a hand set that does not get switched ON.

How Does a Mobile Cell Phone Gets Dead

If the mobile phone gets dropped down on the floor or on some hard surface.

If the mobile phone gets wet or is dropped in rain or water.

Mobile Cell Phone Dead Problem and Solution – How to Repair a Dead Mobile Cell Phone

Remove the battery and see if it gets charged or not. Check voltage using a Multimeter. Voltage must be above 3.7 Volt. Use a Battery Booster to Boost the Power of the Battery and Charge it again.

Check Battery Point and Battery Connector. Clean Battery Point and Battery Connector to remove any carbon deposits.

Resold or change the Battery Connector.

Insert charger and se if the “Battery Charging” appears on not. If there is icon of “Battery Charging” but the mobile phone does not gets switched ON then check ON / OFF Switch. Voltage of ON / OFF Switch must be 2.5 to 3.5 Volt (DC). Clean or change the ON / OFF Switch. Check track of ON / OFF Switch and Jumper if required.

If the charging icon is not there then check voltage of ON / OFF Switch. If the voltage is between 2.5 to 3.7 Volts DC, then RELOAD Software in the Phone (Software Flashing).

If the phone does not gets switched ON even after reloading software then Heat the C.P.U, Power IC and Flash IC.

If there is no voltage on the ON / OFF Switch then check track of the ON / OFF Switch. Jumper if required.

If the problem is not solved then heat, Reball or change the Power IC and CPU to fix the problem.

Keep the Multimeter on Buzzer Mode and Check +_ and – of the Battery Connector. If there is Buzzer Sound then the Set is short. If there is short at the Battery Connector then clean the PCB with thinner. Heat the PCB.

If this does not fix the set dead problem then remove the PFO and check for short. If there is short then replace the PFO.

Remove the charging connector and check for shorting. If there is short then change the connector.

Remove the charging IC and check for shorting. Change if required.

Remove the Bluetooth IC and check for shorting. Replace if required.

Remove the Power IC and check for shorting. Replace with a new one if required.

Remove the CPU and check for shorting. Replace if required.

Remove all the Big Electrolytic Capacitors and check one by one. Replace capacitors if required.

Note:

Some mobile phones get dead if the RTC (Real Time Clock) is faulty. This happens mostly in China Mobile Phones. Change the RTC to fix the problem.

If the mobile phone gets hang after reloading software then change the RTC.

If the set is still dead then check by replacing the 26 MHz Crystal Oscillator.

MODULE 16 : CCTV: Closed Circuit Television

LESSON 146 - 154 : CCTV: Closed Circuit Television

Objectives

At the end of this lesson you shall be able to:

- state the benefits of CCTV
- state various types of CCTV.

CCTV stands for Closed Circuit Television. It is also known as video surveillance. It is a system where all the elements, like video cameras, display monitors, and recording devices, are directly connected. It is used to monitor a sensitive area (A particular area which needs continuous observation and where there is no one to watch all the time). It is very helpful to prevent crime because it monitors all the activities and records them. It is also used for traffic monitoring by detecting congestion and noticing accidents.

CCTV uses wired or wireless transmission to send the signals or broadcasts to the monitor or recording device. It can transmit video, audio or both. Advanced CCTV cameras also have night vision capabilities to record low-light images. The CCTV signals are not publicly distributed but are monitored for security purposes.

Places where CCTVs are generally installed:

Banks

Shops and multiplexes

Casinos

City Roads and Highways

Building and Residential Apartments

Corporate Houses

Government Offices and Buildings

Airports and Railway Stations

Industrial plants etc.

The first CCTV was installed at Test Stand VII in Peenemunde in, Germany. It was installed by Siemens AG. The credit for the technological design and installation of this system goes to German engineer Walter Bruch.

Benefits of CCTV:

CCTV systems are a great deterrent to thieves. Once a thief realizes that he is under the surveillance of CCTV, he will prefer to go somewhere else.

It reduces the fear of crime.

It facilitates remote monitoring.

It increases business efficiency and improves profitability.

It can be used as the best option for home security.

It also increases the risks for shoplifters.

CCTV footage provides valuable assistance to the police in investigating crimes

Different Types of CCTV Cameras and Specifications:

We are going to take a brief look at a few of those types:

Dome CCTV

Bullet CCTV

C-Mount CCTV

PTZ Pan-tilt CCTV

Day/Night CCTV

Infrared CCTV

IP CCTV

Wireless CCTV

HD CCTV

1 Dome CCTV:

The dome cameras are named such for the case in which the camera is placed. The greatest advantage of this CCTV is that no one understands the direction the camera points for their dome structure.

Benefits:

Easy to install

Ideal for indoor and outdoor

Resistant to vandal

360 rotation covers every angle

Perfect for:

Shops and restaurants

Hotels and homes

Cash counters

2 Bullet CCTV:

The design of these surveillance devices is such that they are visible from a distance. Generally, they are found to be cylindrically shaped and efficient in capturing long distances. Bullets are ideal for outdoors since they can endure heat, dust, dirt, and water.

Benefits:

Resistant to all types of weather and environment

Visible from long distances and it acts as a deterrent

Able to capture a view from a long distance

The sturdy casing protects the camera from all attacks

Perfect for:

Industrial usages

Property management and farmlands

Any outdoor application

3 C-Mount CCTV:

C-Mount is an advanced model of bullet CCTV. They are ideal for people who want to capture adaptable views. The surveillance gadget has detachable lenses that you can switch on for monitoring different distances. Unlike the bullet models, they are bulky and thus easily visible from a distance, acting as a deterrent to criminals.

Benefits:

Can capture distance beyond 40 feet with alterable lenses

Properly visible to all from long distances

The sturdy casing safeguards the camera from the odd environment

Ideal for outdoor usage

Perfect for:

Widely popular in logistics industries

Food and manufacturing industries also prefer them

Any place with odd temperatures and fluctuations

4 PTZ Pan-tilt CCTV:

The pan-tilt or zoom camera helps you monitor and have full control of everything recorded. You can turn the camera to the left or the right using a button. Even zoom in and out, tilt up or down. These devices perfectly fit your needs when you have security personal monitoring live on the field.

Benefits:

Close focus on the subject through optical zoom

Tilt and pan mode to get a 360-degree view

Recognition of facial features since the resolution is high

Personalized live viewing

Perfect for:

Ideal for remote viewing

Best for business premises

Great for museums

Entry and exit gates of high-security zones

5 Day/Night CCTV:

The specialty of day/night cameras is that they can record clear images irrespective of the light in their nearby environment. They are specially built for effective operation in obscure light conditions. There are extra sensitive imaging chips that make this possible.

Benefits:

Low light recording yet clear capture

Both color and black and white recording

Functions effectively irrespective of sunlight, reflections, or glare

Tough casing for better camera protection

Perfect for:

Business premises with 24 x 7 recording

Any outdoor monitoring at any place

6 Infrared CCTV:

As the name suggests, this CCTV is induced with infrared technology to capture videos. The camera works perfectly in any pitch-black condition. However, infrared cameras are expensive as they can record in the dark. People or companies with vital requirements for night recording can opt for this model.

Benefits:

Crystal clear recording in dark and black surroundings

Equipped with an infrared cut filter that captures videos in the daytime, even in very light conditions

Repellent to dust, fog, and smoke, this perfect capturing images always

Captures color images for day and black and white for night

Perfect for:

The best option for recordings during the night

Ideal for banks, manufacturing units, farms

Any high-security place that requires night recording

7 IP CCTV:

Also known as network cameras, these vigilance devices can share live footage. The live capturing can be accessed across any place around the globe through the internet. However, the bandwidth of the footage remains compressed to make the online version reliable. The archived videos can be reserved on NVRs for viewing at a later time.

Benefits:

Recording can be obtained from any place across the globe

Footage can be archived

Straightforward installation since no computer station or coaxial cable is required.

Requires very little maintenance

Perfect for:

Business sites whose owners are away from the site

Residential surveillance while outstation as footage can be accessed from a smartphone, PC, or Laptop.

8 Wireless CCTV:

Wireless models stay very neat and do not require much time to be installed. The appearance of the camera becomes much didn't, and you can fix it at any location. You can get various Wireless CCTV camera types for your home and office.

Benefits:

Fast installation when compared with other CCTV

Tidy appearance with very less fittings

You can view captured footage anywhere as images are transmitted over the internet

Easy to access archived footage and store them

Perfect for:

Security room, presentation halls

Well-furnished places

Any place that requires a tidy look

9 HD CCTV:

As the name suggests, it has a very clear picture resolution, which remains unparalleled compared with others.

Benefits:

Perfect and precise picture capturing

No compromise on clarity even when zoomed

You can get HD cameras on models of bullet and done

Easy to identify people in the footage

Perfect for:

Places prone to theft

High-security zones

Whatever your CCTV camera dimensions, do remember the different types while buying your model. You can get the ideal one as per your requirements.

CCTV setup and its Components:

A Standard CCTV Surveillance System Consists of These 7 Components:

A typical CCTV system consists of seven parts. Each is crucial for the system's function, but some play a more critical role than others.

1 Camera:

The camera is the central part of a CCTV security system. You can choose from two types.

Internet protocol: IP cameras use the internet to send and receive footage and are compatible with most devices. As a result, they're a convenient option for most organizations.

Analog: Though analog cameras are becoming less common, many legacy systems still use them. However, they're likely to be incompatible with more modern tech.

Security cameras come in various configurations.

Bullet: Bullet-shaped cameras often come with bulkier housing to provide extra lens protection. They are more visible than dome cameras, which can deter some threats.

Dome: Dome cameras look like upside-down half-spheres. They often feature tinted glass, which keeps the lens orientation hidden.

C-mount: Because C-mount cameras are more rugged, they're excellent for outdoor applications. They also feature detachable lenses, so you can change the monitoring distance as needed.

Pan-tilt-zoom: PTZ cameras allow you to point your lens at specific objects in the camera's field of vision.

The camera system your facility needs primarily depends on what areas you want to monitor. For example, C-mount and bullet cameras are best for outdoor environments, while dome cameras are often best for indoor spaces.

2 Monitoring Stations:

At the monitoring station, operators use software-equipped computer monitors to review camera feeds. You may only need a few monitors, or a whole room. Your monitoring station configuration will depend on your system as a whole. You can easily add and remove monitors any time your needs change.

Real-time CCTV streaming apps allow you to take your monitoring station on the go. Many modern systems make apps for mobile devices and laptop computers to provide extra flexibility. Using these apps, you can watch live video feeds, review historical footage and store video data for future use.

3 Video Recording Systems:

The video recorder processes and store the footage from the IP cameras. The earliest CCTV used VCRs for this purpose. Since recording technology is obsolete, here are the two types of video recorders in use today.

Digital video recorders: A DVR records digital video to a storage device, such as a disk drive or SD card.

Network video recorders: Most systems using IP cameras opt for the easy integration and compatibility of NVR. Though NVRs cost more, they're often worth the higher price tag because you can use them with better cameras. Meanwhile, recent NVRs have been developed to provide all-in-one solutions that simplify your video surveillance system for entry-level applications in a plug-and-play format.

Additionally, video surveillance workstations provide reliable delivery points for security recorders. They take some of the burden off the NVR, enabling better recording and video management. As a result, they're advantageous for modern recording systems.

4 Supporting Accessories:

Supporting accessories such as cables and routers are essential for creating a functional system.

Commercial-grade camera cable is essential for connecting your cameras to your recording device. RG59 Siamese coaxial cable is the most common option for commercial CCTV systems due to its EMI shielding and multiple cabling capabilities.

Ideally, purchasing cable you can cut down to size and attach connectors to ensure your system is the proper size to deliver high-quality performance for your facility.

If you opt for a wireless system, you'll also need to purchase a router. Here are some essential considerations for choosing a router.

Your budget: There's a router for almost every price point, so you should be able to find one within your budget that has all the features you need.

Compatibility with your ISP: Though most routers are compatible with any ISP, it's still worthwhile to check before making an investment.

Range of coverage: Choose a router that will provide a solid connection to surveillance cameras all over your property. If needed, you can use multiple routers or Wi-Fi extenders to expand coverage.

Wireless protocol: The wireless protocol number indicates the router's throughput and range. Choosing a newer Wi-Fi standard can provide the network speed and coverage you need to support your facility.

5 Video Recording Storage Devices:

Storage hardware is one of the most critical components of a CCTV security system. Standard hard drives, such as those found in computers, are unsuitable for video storage systems, which collect enormous quantities of video data.

High-performance CCTV storage devices enable you to record, store and replay videos on demand from all connected feeds. Look for solutions that offer data protection capabilities, as they'll help you ensure your data is always accessible and safe from harm.

6 Power Supply:

The power supply is another critical part of a CCTV system. A wired power-over-Ethernet security camera enables you to transfer power and data from a camera to a server using the same cable.

Consider these options for organizing your power supply.

Power supply box: Most commercial security systems opt for power supply boxes to keep all their cabling neat and organized. Power supply boxes also provide individual surge protection for each camera in your system, reducing the need for additional complexity.

Individual transformers: CCTV systems for smaller facilities may want to consider using individual transformers to power each camera, such as in residential camera systems. However, if your facility needs more than a handful of IP cameras, this solution can quickly spiral into a disorganized mess.

You'll also need to decide whether you'll connect your system to AC or DC power. While 12VDC is the most common choice for commercial facilities, 24VAC is typically the better choice for larger facilities because AC power can travel faster than DC with fewer power drops.

7 Video Management Software:

An integrated VMS is the linchpin to your video surveillance system. A VMS collects and stores video from your IP cameras, consolidating all the input into a single pane of glass.

In this way, your VMS is a simple solution for managing and overseeing your entire system. From one interface, you can gather, store and retrieve all your live and recorded footage, enabling you to remain compliant with government regulations and reducing complexities within your organization.

Your options vary based on whether you choose DVR or NVR technology. To ensure optimal function, you'll want to choose a VMS solution that integrates smoothly with the other elements of your IP CCTV video surveillance system.

Digital Video Recorder (DVR):

A Digital Video Recorder (DVR) records video to local storage devices, most commonly a hard drive. DVR can record analog video sources on-site or capture video from a digital source. DVRs can be connected to analog cameras via coaxial cables, enabling them to be accessed remotely. DVRs offer enhanced functionality like the ability to search recordings for events, or sort by time and date. DVRs can be configured to automatically replace older footage once storage becomes full.

DVR Hardware Features:

Mountable in a server rack

Can include multiple source inputs (coaxial/optical)

External monitor output

I/O connection for tilt pan zoom (PTZ) camera

Event notification from security devices

Notification for connectivity issues

DVR Software Features:

Image capture by the user or triggered by an event

Set resolution of recording by the user or by an event

H.264 Video compression for higher resolution at lower bandwidth

Video analytics such as dwell time, the direction of movement, and motion tracking

Alarm, event, and time search functions

Multi-channel audio recordings

Archived footage

DVRs are limited to the physical number of input channels and are not upgradable. This makes them best suited for small businesses or home security systems. Network Video Recording (NVR) is a cloud-based video surveillance recording solution that can be upgraded at any time. Analog limitations mean DVR record is much lower quality than a network solution and also the video is always stored locally versus in the cloud.

How Do DVR Security Systems Work?

[Digital video recorders] connect to analog cameras via coaxial cables and contain internal hard drives and encoding software; this means all footage is processed and stored locally. Let's look at the main features to get a better sense of how these systems work.

Connects Directly to Cameras: As DVR systems don't operate wirelessly, each camera must be connected individually to the device using cables.

Operates on a Closed Circuit: DVR camera systems aren't connected to a network in the same way that other modern surveillance systems are; they operate like conventional CCTV solutions.

Captures Analog Pictures: Digital video recorders are primarily intended to be used with analog cameras, though companies with existing systems can easily upgrade and replace this hardware with better quality versions as needed.

Processes Video Data at the Recorder: DVR systems use an encoder, which ensures the images captured by a camera are recorded and sent to an enterprise's chosen storage destination.

Stores Footage on a Hard Drive: DVR systems rely entirely on on-premises data storage, meaning they must be configured to a server or PC.

Pros and Cons of DVR Security Systems:

Though DVR video surveillance seems outdated because—unlike other technological solutions—it doesn't require an internet connection, these security camera systems have still evolved throughout the years. And as with any technological device, DVR camera systems come with their own set of benefits and challenges.

Benefits of DVR Camera Systems:

Cost-Effective Set Up: Compared to NVR, cloud, and hybrid cloud systems, DVRs are an affordable security solution for small businesses. Costs do vary depending on the number of cameras required and whether or not professional help is needed for installation, but there are initial savings due to the fact that DVR systems integrate with lower quality cameras.

Secure Connections: Since no internet connection is needed in order for analog DVR camera systems to work, they can be set up almost anywhere, including remote locations—provided there's a power source. This lack of network connectivity also helps to eliminate the risk of security systems being hacked, making for a secure surveillance solution.

Instant Access: DVR systems are hardwired—they connect directly to CCTV cameras. This means video is instantly stored on a hard drive and is easily accessible. So long as surveillance staff are onsite, they can watch footage as soon as it's been recorded.

Special Features: Though DVRs might not appear to be the most advanced security camera solution, they can be configured with a range of different features. Motion detection and time stamping capabilities, for example, means surveillance staff no longer have to work round-the-clock or sift through hours of footage to find a specific incident.

Challenges of DVR Camera Systems:

Minimal Flexibility: Given that DVR systems need to be located close to a power source, businesses sometimes have limited options for installing them onsite. Because DVR security recorders do not make use of network connections, footage also has to be reviewed wherever the storage device is located.

Maintenance Fees: If a DVR malfunctions, it's a hardware issue—not a software issue—and can therefore be very expensive to fix or replace.

Clunky Wiring: Unlike NVR systems, which can be configured wirelessly, all security camera DVR solutions require coaxial cable connections. In addition to not supporting audio, these cables are large and therefore hard to install in tight spaces and are unable to supply power (DVR systems transmit signals only). This means extra wires are always needed to ensure the cameras can operate.

Low Image Quality: Although DVR camera systems are cheaper than other security options, they output a much lower picture quality than hi-res cloud and hybrid cloud cameras. Business owners and surveillance teams will need to determine whether the cost savings are worth sacrificing picture clarity.

Storage Capacity: DVR camera systems cannot connect to the internet, via ethernet cables or wifi. And because of that, storage capacity is much lower than systems that can make use of cloud storage, like NVR camera systems do.

MODULE 17 : Home theatre

LESSON 155 - 159 : Home theatre

Objectives

At the end of this exercise you shall be able to

- identify the occupational safety devices.
- interpret the different types of safety devices.

Introduction

A home theater system is a setup designed to replicate the experience of a commercial cinema within the comfort of your own home. It typically consists of a large-screen television or projector, surround sound speakers, an audio/video receiver, and various media sources like Blu-ray players, streaming devices, or gaming consoles. The goal is to create an immersive audiovisual experience for enjoying movies, TV shows, music, and gaming in high fidelity and cinematic quality.

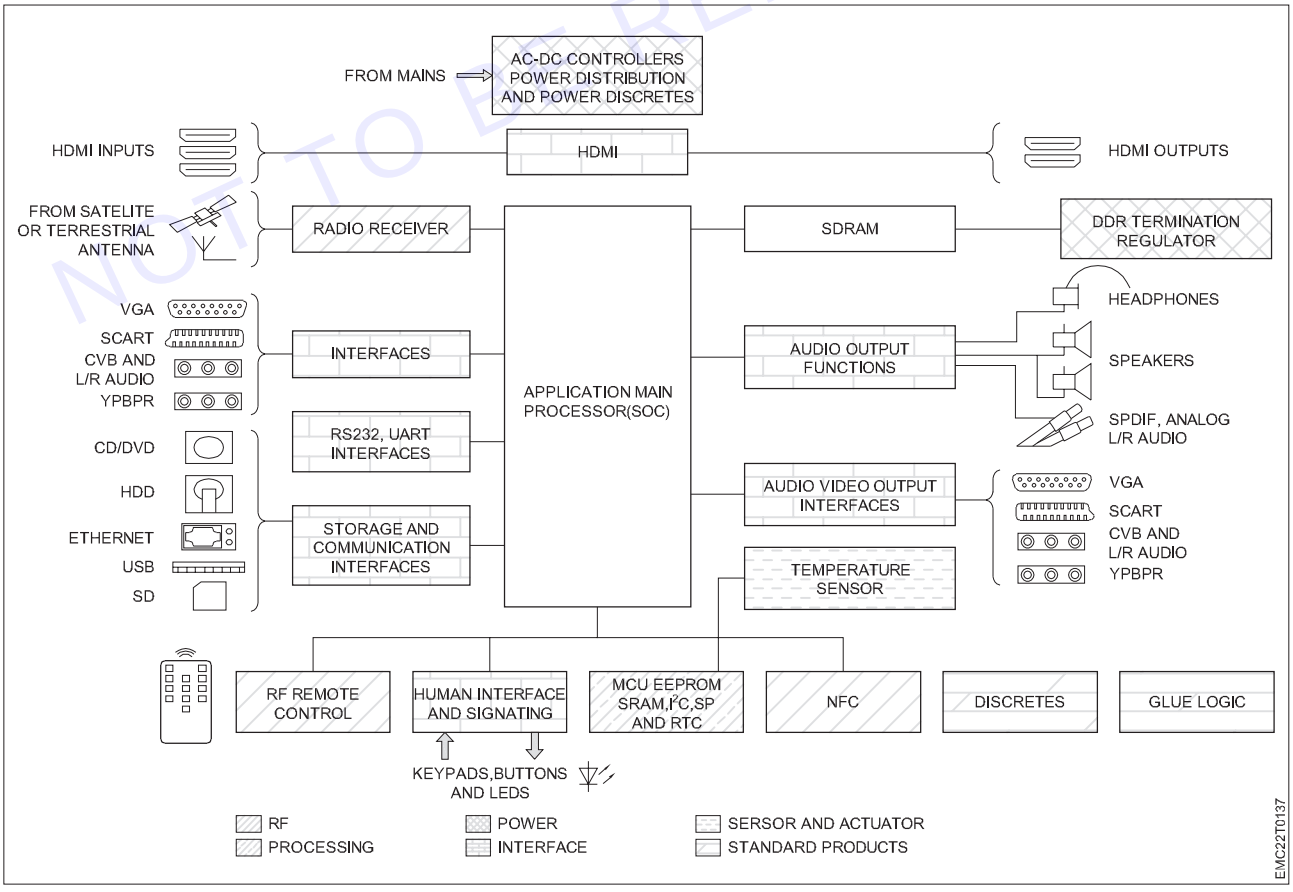
Surround sound system

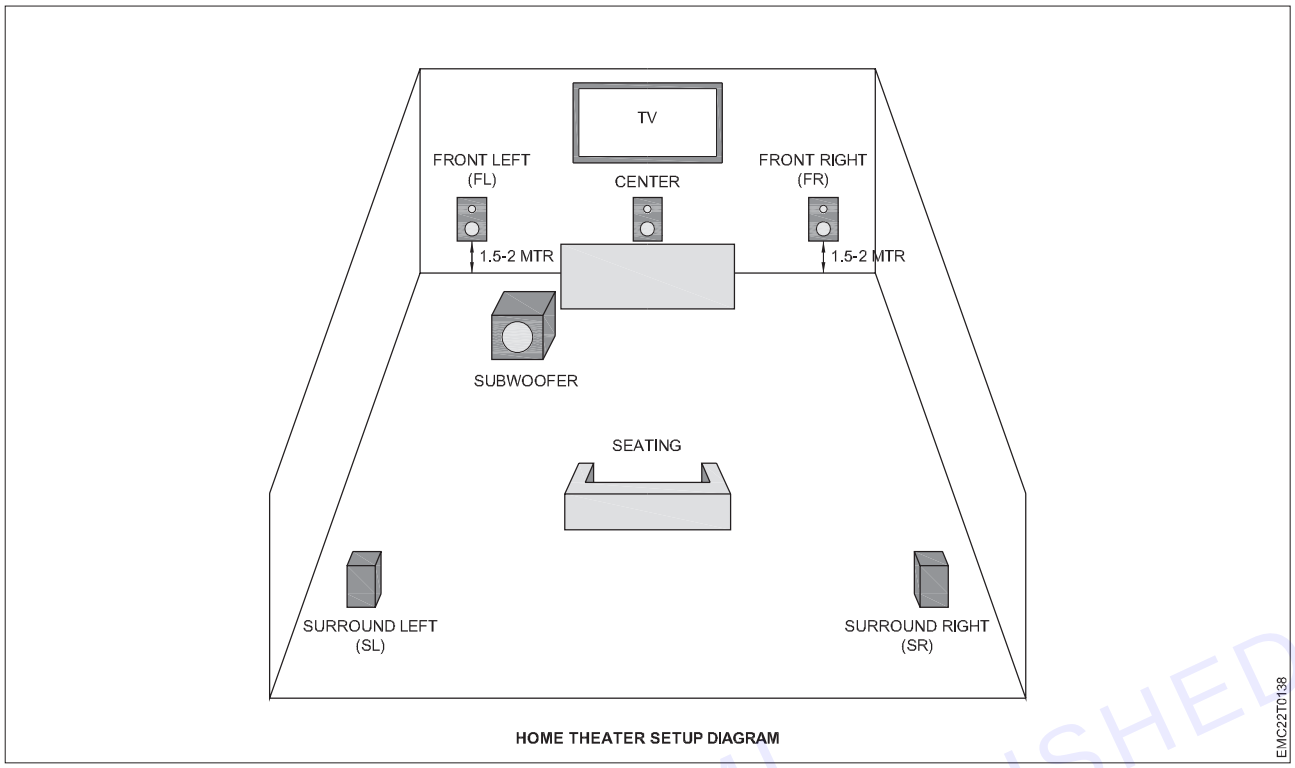
We get that not everyone enjoys actually seeing where their sound is coming from. That's why in-wall and in-ceiling speaker options are popular alternatives. There are even in-wall subwoofers! Once they're installed, they're hidden behind a grille, giving you a clean look across the board. You can check out our article on in-wall and in-ceiling speaker installation to learn more about what's involved.

Basic component

A basic component of a home theater system is a television or a projector/screen for displaying audiovisual content. Other essential components include a sound system (such as speakers and a receiver), media players (such as Blu-ray players, streaming devices, or gaming consoles), and cables/connectors to connect everything together.

Block diagram





HOME THEATER SETUP DIAGRAM

Working

How does surround sound work

Let's dive into how surround sound works in your home theatre system, giving you that immersive movie experience right in your living room. The key to understanding home theatre acoustics lies in three main elements:

The strategic placement of left and right speakers to create a sound field

Accurate synchronization of audio with the visuals to enhance the realism

The use of Dolby Atmos sound technology for three-dimensional audio effect

The surround sound system employs multiple speakers that project sound from different directions, including sound coming from the front. Each speaker outputs specific sounds at precise moments, creating a multidimensional auditory environment. With Dolby Atmos, sounds are not just around you, they're above too. Mastering these elements will elevate your home theatre experience to new heights.

What do you need to create surround sound

To create surround sound in your own space, you'll need a few essential components: multiple speakers, a receiver or amplifier, and a proper layout plan. It's key to understand that the number of speakers corresponds to the channels in your home system. A 5.1 system, for instance, includes five speakers and one subwoofer. Placement of these components significantly impacts your home theatre acoustics. Front speakers should align with your TV, the center speaker directly underneath, and the rear speakers should be placed behind your main seating area. The subwoofer, responsible for low-frequency sounds, can be placed anywhere in the room. An amplifier or receiver is necessary to process and distribute the sound signals to the speakers. With these elements, you can create surround sound that truly envelops you. For Dolby Atmos, it is common for Wavetrain Cinemas to be using 16-24 channels of audio processing. The most common systems are 7.1.4 (7 bed channels in the horizontal plane, 1 LFE bass channel & 4 Atmos height channels).

MODULE 18 : Domestic appliances

LESSON 160 - 179 : Domestic appliances

Objectives

At the end of this exercise you shall be able to

- state various domestic appliances their types & uses.

Microwave Oven

A microwave oven (also commonly referred to as a microwave) is an electric oven that heats and cooks food by exposing it to electromagnetic radiation in the microwave frequency range.

micro wave cooking has some bad effects as written below- Microwaves Create Carcinogens In Food Microwaves Destroy Breast Milk And Vitamin B-12 Microwaves Can Change Your Heart Rate.

Different types of Microwave Oven:

Diving into the world of kitchen appliances can be overwhelming, especially when it comes to selecting the right microwave oven types for your cooking needs. From the basic models designed for heating and defrosting to those equipped with advanced features for baking and grilling, there's a microwave out there for every type of chef.

Solo Microwave Ovens:

The foundation of the microwave oven types, solo microwaves are ideal for basic kitchen tasks such as reheating leftovers, thawing frozen foods, and making popcorn. They are simple, affordable, and perfect for individuals or families that primarily use their microwave for reheating.

Grill Microwave Ovens:

Adding to the capabilities of solo microwaves, grill microwave ovens include a grilling feature that allows you to grill vegetables, fish, and meats. This type is suitable for those who enjoy the occasional grilled meal but do not want to invest in a full-sized grill. The oven grill function provides a nice sear and crispness to foods, enhancing flavour and texture.

Convection Microwave Ovens:

These microwaves are the all-rounders of the kitchen. By combining microwave energy with a convection oven, they can cook food quickly while also browning and crisping it just like a traditional oven. This type is perfect for those who love to bake, roast, and grill but have limited space or budget for multiple appliances. The convection feature circulates hot air around the food, ensuring even cooking and browning.

OTG Microwaves:

OTG (Oven, Toaster, Grill) microwaves are not microwaves in the traditional sense but are often grouped with microwave ovens due to their compact size and multiple functionalities. They excel in baking, toasting, and grilling, making them ideal for culinary enthusiasts who enjoy preparing a wide range of dishes. An OTG is perfect for baking cakes, bread, pizzas, and grilling meats to perfection.

Combination Microwave Ovens:

These units provide the ultimate flexibility by combining microwave, convection, and grill functions in one appliance. You can start cooking a dish using the microwave function for speed, then switch to convection or grill to finish with a crispy top. This type is ideal for those who enjoy experimenting with different cooking methods but have limited kitchen space.

Inverter Microwave Ovens:

Inverter technology allows these microwaves to deliver continuous cooking power at varying levels, which means more evenly cooked food, improved texture, and faster cooking times. This technology is particularly beneficial for delicate foods that can easily overcook, such as fish and vegetables, ensuring they remain tender and flavorful.

Built-in Microwave Ovens:

For a sleek and integrated kitchen design, built-in microwaves are the go-to choice. They can be installed into cabinetry or a wall, saving valuable counter space. While they can come in solo, grill, or convection types, their primary appeal lies in their ability to blend seamlessly into your kitchen's aesthetic.

Countertop Microwave Ovens:

The versatility and ease of installation of countertop microwaves make them a popular choice among many households. They are available in various sizes and power capacities, accommodating different cooking needs and kitchen spaces. From dorm rooms to family kitchens, there's a countertop microwave for every setting.

Commercial Microwave Ovens:

Designed for the rigorous demands of professional kitchens, commercial microwaves are built to withstand heavy use. They feature higher wattage for faster cooking times and larger capacities to handle bulk food items, essential for restaurants, cafeterias, and catering businesses.

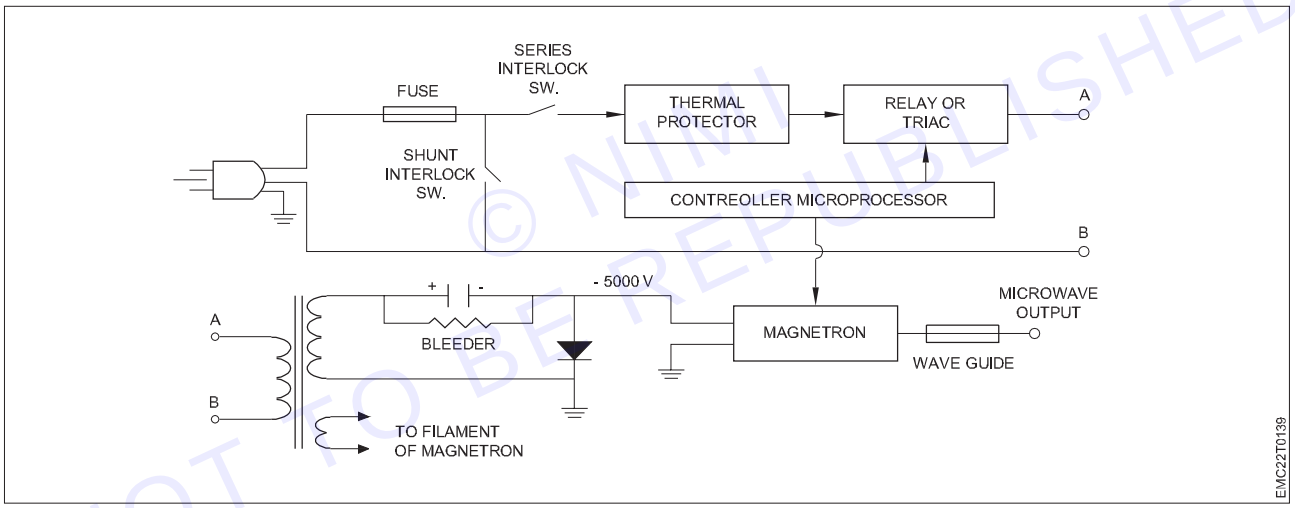
Compact Microwave Ovens:

Space-saving and convenient, compact microwaves are designed for places where kitchen space is at a premium. Despite their small size, they are still powerful enough for basic tasks like reheating and defrosting, making them perfect for small apartments, dormitories, or as an additional microwave in a busy kitchen.

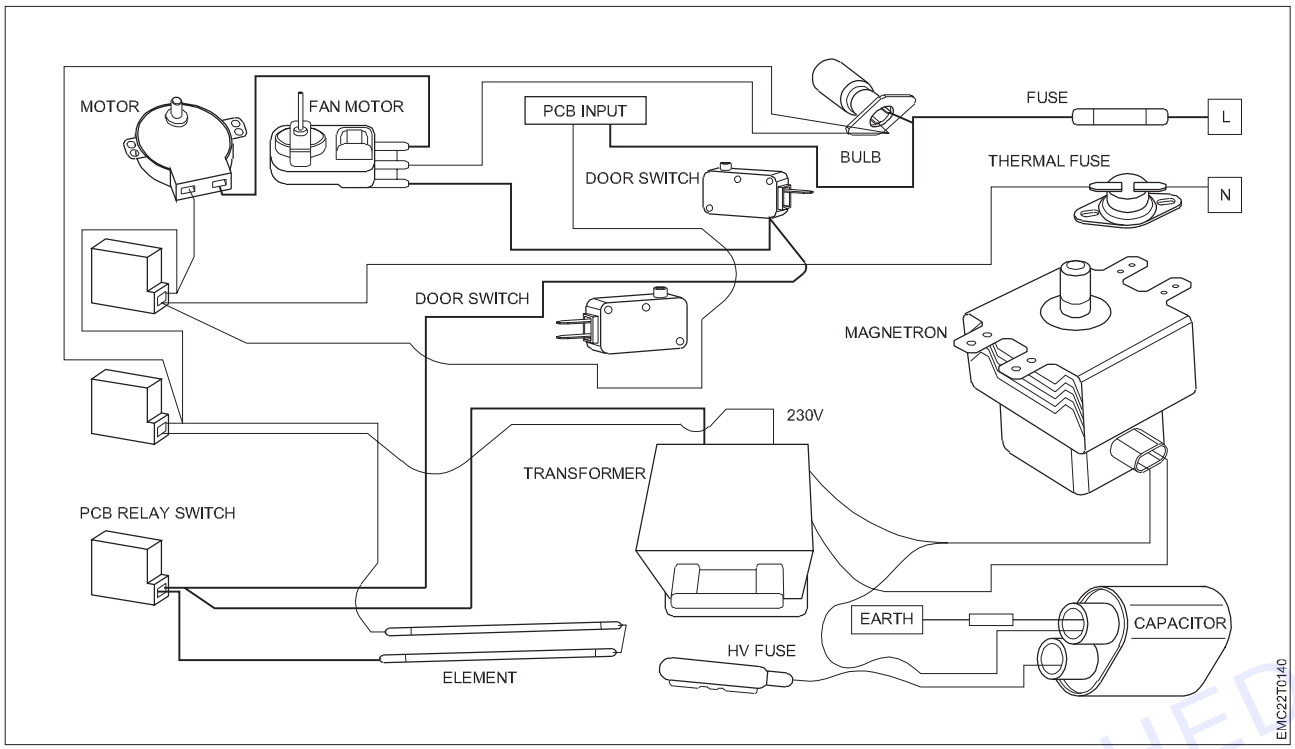
Microwave oven block diagram

The block diagram of a microwave oven is given below .

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



In the wiring of a high-voltage unit for a microwave oven through which a high-voltage transformer, a magnetron, a high-voltage capacitor, and a high-voltage diode are electrically connected with one another, the microwave oven having a wire, leading to the magnetron from the high-voltage transformer, making a ...



Washing Machine:

Mechanical washing machines appeared in the early 1800s, although they were all hand-powered. Early models cleaned clothes by rubbing them, while later models cleaned clothes by moving them through water. Steam-powered commercial washers appeared in the 1850s, but home washing machines remained entirely hand-powered until the early 1900s, when several companies started making electric machines. The Automatic Electric Washer Company and Hurley Machine Corporation both began selling electric washers in 1907, while Maytag offered an electric wringer washer in 1911. In 1947, Bendix offered the first fully automatic washing machine, and by 1953 spin-dry machines overtook the wringer types in popularity.

The last wringer washer manufactured in the United States was made in June of 1990 at Speed Queen's plant in Ripon, Wisconsin. The major U.S. manufacturers today are General Electric, Maytag (Montgomery Ward), Speed Queen (Amana and Montgomery Ward), Whirlpool (Kenmore), and White Consolidated (Frigidaire and Westinghouse).

Many models with many varying features are now available; however, with a few exceptions, only the controls are different. The only difference between the washer in your home and the top-load washers in the laundromat is the ruggedness of construction.

The washing machine operates by a motor, which is connected to the agitator through a unit called a transmission. The motor and transmission are near the bottom of the machine, while the agitator extends up through the middle of the machine. The transmission is similar to the transmission in your automobile in that it changes the speed and direction of the agitator. In one direction (agitate), the transmission changes the rotation of the agitator and spin tub—the inside tub with small holes in it—into a back-and-forth motion. When the motor is reversed by the controls (spin), the transmission locks up and the agitator, transmission, and spin tub all rotate as a unit. Without the transmission changing the speed or direction, the unit uses centrifugal force to remove as much water from the clothes as possible. The motor is also connected to a pump. When the motor is moving in the spin direction, the pump removes the water from the tub and discards it through the drain pipe.

Models designed for use in other countries offer different features. One component required on all models sold in England (and possibly soon in the rest of Europe) is called the lid lock. Normally when the lid is raised the washer must stop for safety reasons. However, in England, when the washer is operating the lid must be locked closed.

Parts of washing machine:

Since each washing machine comes with its own design and features, some of the parts will vary between your machine. But get to know your washer with some common parts you can find in your machine.

Water pump: This circulates the water through the machine, rotating in two directions. It's used for circulating the water through the wash cycle and also for draining the water during the spin cycle.

Water inlet control valve: This is located near the water inlet point, which is opens and closes automatically when you load the clothes, depending on how much water is required.

Drum: Did you know that washing machines actually have two tubs? The one you see where the clothes are loaded is the inner drum, which moves around the washing machine and is perforated with holes to allow the water in and out. The outer tub contains the inner drum and the water, stopping it from leaking into the rest of the machine and supports the inner drum.

Agitator or paddles. This is located inside the tub of the washing machine and helps perform the cleaning of the clothes. Most fully-automatic washing machines have these paddles on the rotating inner drum which is controlled by a rotating disc, whereas semi-automatic washing machinesuse an agitator that rotates within the machine to produce a current in the machine. Either way, these are designed to move the clothes around during the wash to allow the detergent to work and remove dirt particles and soiling from your clothes, helping the clothes rub together while washing.

Washing machine motor. This is combined with the agitator or the disc that turns the drum, it produces a rotator motion. This is basically the mechanism that gets your machine going.

Drain pipe. All the dirty water from your washing is expelled from the machine via the drain pipe.

Printed circuit board (PCB). This is where you'll find mainly the electronics that operate the machine from electrical components to circuits. These can be programmed and help operate the machine, acting as the artificial intelligence for the washing machine, sometimes even deciding on the time needed for rinsing or washing.

Timer. This helps set the wash time for your clothes, which can be set manually or automatically.

Heating element. This heats the water up in the washing machine to the desired temperature.

Different types of washing machine :

There are four main washing machine types available. Each offers the user something different, so keep reading to find out the pros and cons of each type, in order to choose the right one for you.

Top-loading washing machines:

Top-loading washing machines are generally considered more convenient than their front-loading counterparts, particularly for those with mobility issues. There is no need to bend down while you load and unload laundry. In addition to this, top-loading washers can have a larger capacity and can be fitted into a tighter space, as they don't require space for the door to swing open while you crouch. If you have a traditional London apartment, this feature can be very useful.

Other top-loading washing machine characteristics include:

Can add clothes mid-cycle

Often a more budget-friendly option

Top loaders can be harsh on clothes

Front-loading washing machines:

Front-loading washing machines are more efficient than top-loaders, as they use less water and electricity. Often, these laundry machines have a greater variety of cleaning options and features than their top-loading cousins.

More front-loading machine features include:

Less wear and tear on your clothes

Cleans laundry more efficiently

Accommodates more fabric types and stain levels

Often slightly more expensive than top-loaders

Integrated washing machines:

A 'stow away unit' is a fantastic option for anyone who is looking for a seamless, modern aesthetic. In general, this would utilise a front-loading washing machine, with a few key differences. Most importantly, the washing machine should fit into the cabinetry or walls of your home and will blend in with the features that surround it.

Other key features of integrated washing machines include:

Subtly merge into your kitchen, bathroom or laundry room aesthetic

Ability to utilise your exact preference for a washing machine, load capacity and style without the appearance affecting your space

Washer dryer combo:

Washer dryers allow you to utilise your space optimally while also getting your clothes dry in the damp UK winters. They are slightly less efficient than their single-function counterparts, but the addition of the dryer capacity makes this worthwhile for many. There are a few types of washers and dryers that offer greater functionality for users.

Here are a few more washer dryer characteristics:

Take up less space than two separate machines

Can be built-in to your kitchen, laundry room or bathroom

Are often less efficient for either purpose

washing machine techniques

How a washing machine works: step-by-step

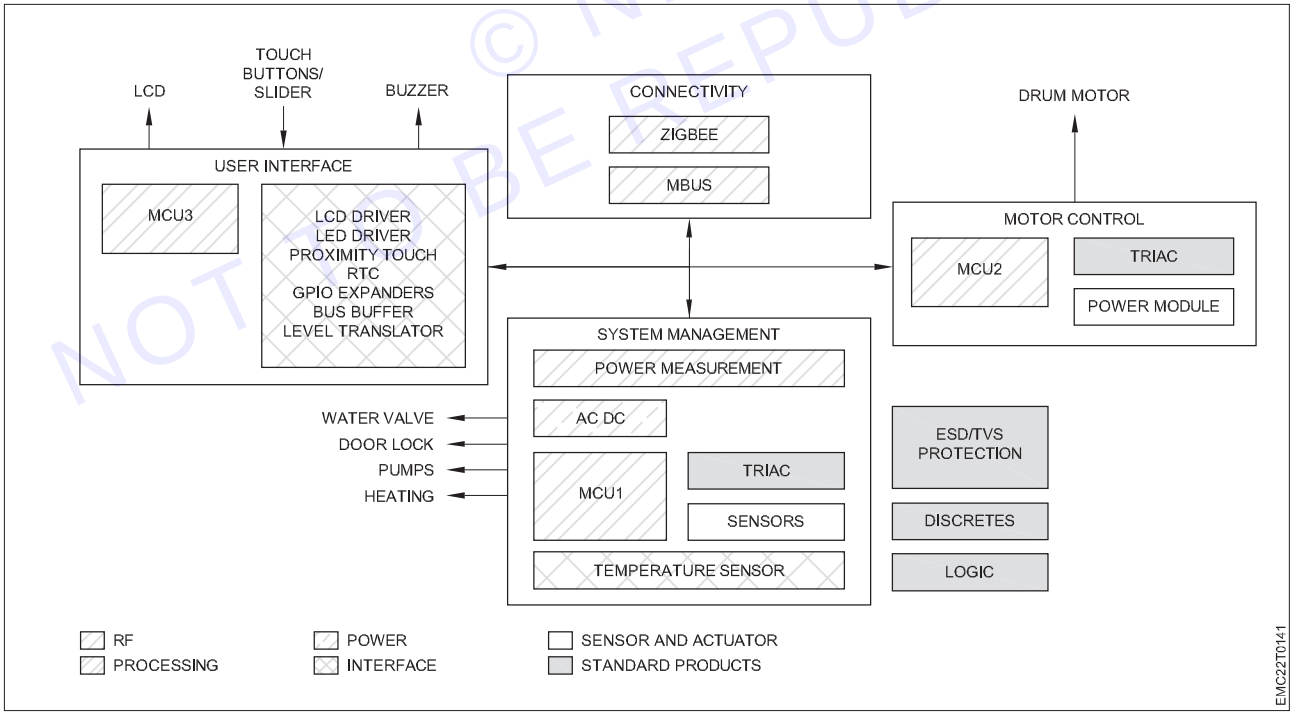
Wash cycle begins. Once you load your laundry inside the washer drum, close the washer door or lid and select a cycle and water temperature to begin the wash cycle.

Load sensing.

Washer spins and agitates laundry.

Drain and rinse cycle.

Drain and spin cycle.



Block diagram of washing machine:

Semi-automatic and fully automatic washing machine:

Semi-automatic washing machine:

Semi-automatic washing machines, as the name suggests, are partially automated, and require some level of manual assistance. You have to supervise the washing process and when clothes are washed, you have to manually transfer the load from the washer into the drying tub. The semi-automatic washing machin1es come in top load form only.

Fully automatic washing machine:

Unlike the semi-automatic one, a fully automatic washing machine doesn't require manual work. You just have to load the clothes and feed the washing program to the machine. The machine takes care of the rest. It washes and dries the clothes in the same tub. Fully automatic washing machines come in two categories – front load and top load.

High-end fully automatic washing machines are engineered with excellent wash programs and multiple functions such as soak, pre-soak, rinse and pre-rinse.

Washing machines typically have several types of timers:

1 **Cycle Timer:** Controls the duration of each washing cycle.
2 **Delay Timer:** Allows you to set a delay before the washing cycle starts.
3 **Program Timer:** Selects the specific washing program (e.g., normal, delicate, heavy - duty).
4 **Spin Timer:** Determines the duration of the spin cycle.
5 **Rinse Timer:** Controls the length of the rinse cycle.

These timers work together to ensure efficient and effective washing of clothes.

Power supply in washing machine :

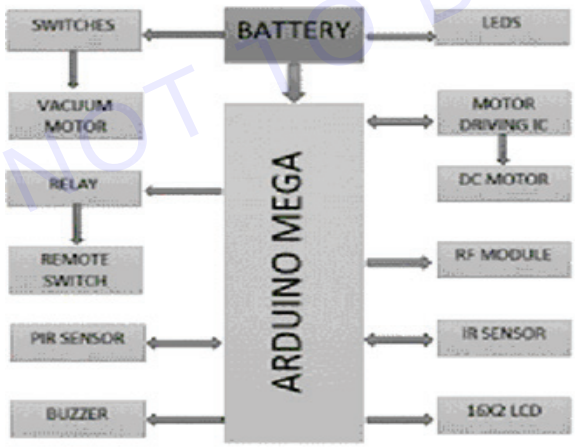
A conventional power supply system of a washing machine is realized through a power cord 100 which is connected to a source of power whose voltage is either 110 V or 220 V for household use, a power switch 101 that has one end connected to the power cord 100, and is turned on or off in order to either supply power.

Vacuum cleaner:

A vacuum cleaner, also known simply as a vacuum, or a hoover, is a device that uses suction in order to remove dirt and other substances from floors, upholstery, draperies, and other surfaces. It is generally electrically driven.

The vacuum cleaner is nothing but an electric device that makes use of an air pump to suck up dirt and dust from the floor and other surfaces. The type of cleaning you do will determine the suitable vacuum cleaner you will need, as there are many options available to choose from. You will have the best cleaning experience with vacuum cleaners, whether you use them at home or commercial place.

Block Diagram Of Vacuum Cleaner:



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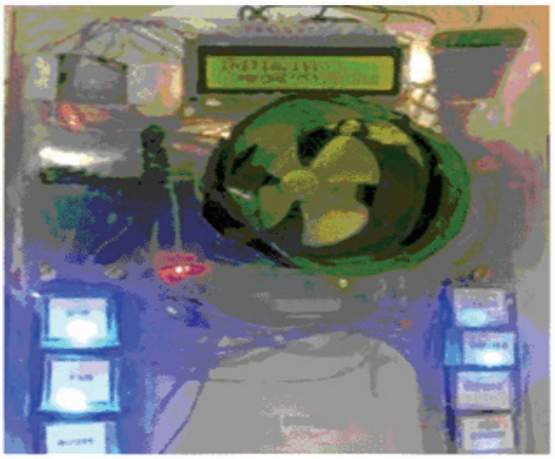
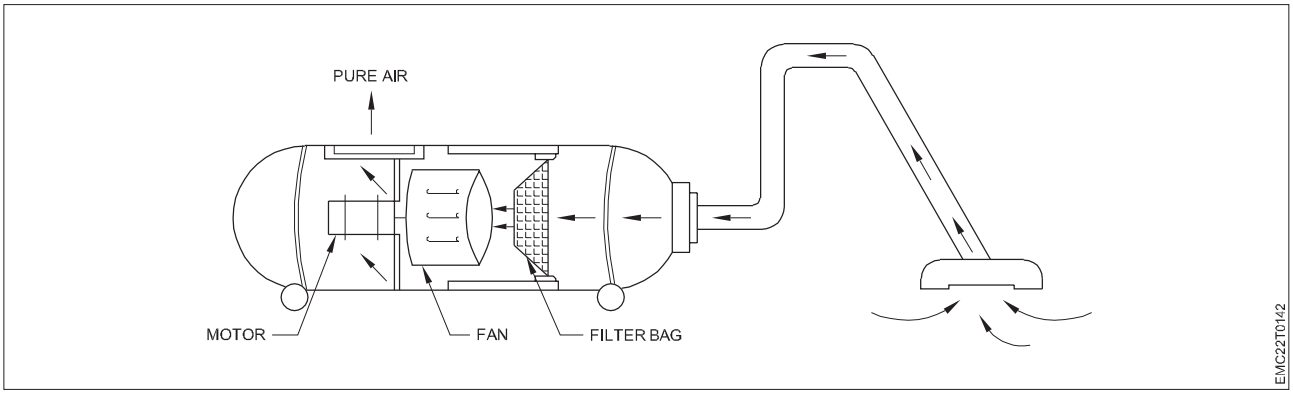


(b)

Working principle of the vacuum cleaner:

Materials flow from one location to another when a pressure difference is created between two locations. This phenomenon is the basic working principle of an ideal vacuum cleaner. When a centrifugal fan rotates it makes the air to flow by adding it external kinetic energy. Air is sucked from behind and pushed forward with pressure and so negative pressure it creates behind the fan. An ideal vacuum cleaner has such centrifugal fan in it connected to a motor. This unit has suction and discharge connections, on the suction side filter bag is fitted before the hose connection. The discharge has another air purifier filter and opened to the atmosphere. When the electric power is given the motor rotates and so the centrifugal fan. Air from the suction side is sucked into the unit, along with

the air all air born particles, cat allergen, mist, dirt, and small solid particles are carried to the suction filter. They are trapped in the filter and dirt free air is pushed out from the discharge opening



Types Of Vacuum Cleaners:

There are five types of vacuum cleaners:

1 Upright vacuum cleaner:

An upright model is one of the earliest, most commonly seen and most popular vacuum cleaners.

It has a tilt and push, easy to understand ergonomic design. The brush is motor driven and clears up dirt through suction.

It is ideal and most powerful for cleaning large carpeted surfaces. It has a sensor that sucks the debris from carpet strands effectively.

It also has a different setting for cleaning of bare floors where the brush roll is turned off.

It provides height adjustment and attachments are sometimes required to reach tight corners.

It is heavy to push and pull.

2 Stick vacuum cleaner:

A stick model is slender, lightweight and used for quick cleaning. It is in the shape of a broom and has a basic design which makes it easy to store.

The motor is located along with the stick and performs light suction.

This type is good for maneuvering around furniture and narrow spaces. It can be used for cleaning small carpet areas and hardwood floors. It is ideal for cleaning the kitchen and bathroom.

It also has a different setting for cleaning bare floors where the brush roll is turned off.

It can convert into a handheld vacuum and has lesser attachments. There are dirt cups instead of bags.

It is not very powerful and not suitable for deep cleaning. It might have a shorter battery life compared to other types.

3 Canister vacuum cleaner:

A canister type has a long wand attached to a cylinder-like device by a retractable suction hose. It is powered by a motor and has a receptacle that collects dust.

It can clean several surfaces- bare hard floors, carpeted areas, wooden floors, tiles, cars, stairs, walls, ceiling, corners and upholstery- furniture, curtains, etc.

It has many attachments and is on the costlier side as it can operate on a variety of surfaces.

It is bulkier than other models for storage purposes.

4 Handheld vacuum cleaner:

It is a small, portable and light vacuum cleaner, suitable for on-the-go cleaning. It can be held in one hand.

It is available in different designs- some are with a cord, some are cordless. Some consist of a rotating brush and some are without it.

It is sometimes used with an upright model. It is used for cleaning tight areas that are too small or are too difficult to reach like car interiors, tables, stairs and corners.

It is good for cleaning crumbs and spills, getting rid of fine dirt like hair from upholstery and cleaning up after children and pets.

It is cheaper than other models.

It is not comparable to a full-size vacuum and doesn't function for general floor cleaning.

5 Robotic vacuum cleaner:

It is an automatic kind of vacuum cleaner powered by a sensor. It involves little effort as it doesn't require maneuvering.

The settings are chosen and the instructions are input through a remote control, after which, it can clean without supervision.

It is useful for cleaning corners, tiles, carpets and wood surfaces.

It is compact, doesn't need a cleaner bag and creates less noise.

It is always cordless, which means it has to be charged time and again.

Since it is automatic, it cleans very well and in less time. Hence, it commands a higher price than other types of models.

Parts of Vacuum Cleaner :

A vacuum cleaner is a sophisticated cleaning tool composed of various essential components working in harmony. From the powerful suction mechanism of the motor to the precision of brush rollers, each part plays a crucial role in achieving a spotless home. Let's delve into the essential vacuum cleaner with parts names:

Motor:

The heartbeat of your vacuum cleaner, the motor powers the suction mechanism, driving its efficiency and performance.

Filter:

Acting as the lungs of the vacuum, filters are pivotal in maintaining clean air output by trapping dust, allergens, and pet dander during the cleaning process.

Brushes and Rollers:

These parts of vacuum cleaner housekeeping are responsible for agitating and lifting dirt and debris from different surfaces, ensuring a thorough cleaning experience.

Hose and Wand:

Providing flexibility and reach, the hose and wand extend the vacuum's range, allowing you to access corners, crevices, and elevated surfaces with ease.

Dustbin/Bag:

The final destination for collected dirt, the dustbin or bag is where the vacuum stores the debris during the cleaning process.

Understanding these fundamental vacuum cleaner parts names empowers you to use your vacuum cleaner effectively, troubleshoot potential issues, and perform regular maintenance to keep your cleaning machine performing at its best. Regularly replacing vacuum cleaner spare parts as needed ensures longevity and peak performance.

Advantages of Vacuum Cleaner:

Vacuum Cleaner Saves Time and Energy:

Cleaning with vacuum cleaner is not only hygiene but also it more secure than cleaning manually using broom. Vacuum cleaners capable to clean within tens of minutes whereas manually cleaning takes approximately hours. With vacuum cleaner, you can achieve the purpose of thorough cleaning within the shortest time possible. They are fast and easy to use. Additionally, you only need less effort and energy to handle vacuum cleaner.

Easy to use

Installing, usage of vacuum cleaner is quite easy. Just plug into electricity socket and let move on the floor, anywhere you want to clean.

Removes allergen from breathing air:

Vacuum cleaner are equipped with HEPA or other type of filters which blocks, removes air borne disease causing germs, bacteria and viruses present in your home.

Removes pet hair:

Vacuum cleaners are expert in removing pet hair which are stuck in piles of carpet. Due to high suction power vacuum cleaner removes pet hair as well as bad odors from carpet.

Vacuum cleaner comes with advanced features:

Vacuum cleaners of nowadays have series of sophisticated features that you cannot even envisage. When you have vacuum .cleaner with sophisticated features, cleaning will be easy for you. Furthermore, with vacuum cleaners with advanced features, you will always get the benefit of having automatic surface revealing sensor to ascertain and work effectively.

Vacuum cleaner is a low cost tool:

Due to the fact that vacuum cleaner is a low cost tool; you will always get advancement towards any term. Therefore, you can always obtain the advantage of saving time and energy by spending less. The average cost of vacuum cleaner varies depending on the size and the type you want for your cleaning. You can get good vacuum cleaner in range rupees 5,000 to 10,000 rupees in India. Eureka Forbes, Euro Clean, Karcher, Black and Decker and Bissell are trending, well known vacuum cleaner manufactures in India.

Discern the quantity of dirt and set settings:

You will get the benefit of setting up the available alternatives robotically, if you buy the robotic vacuum cleaner. In addition, the vacuum cleaner will become aware of the amount of dirt and work accordingly. As a result, you are not expected to operate the machine physically in order to do the cleaning of your home for you.

Clean your home even when you are away:

The robotic vacuum cleaners will clean your home, even when you are not at home. Thanks to their advanced features that can make them work robotically.

Disadvantages of Vacuum Cleaner:

Heavy to lift:

Vacuum cleaners are bulky, cumbersome machine that often hard to move around the home. Moreover, in case of upright vacuum cleaner it almost impossible to move up and down stairs. Vacuum cleaner was manufactured in a fairly large size, although not heavy. Moving and storing of this device will require a big place.

Running electricity bill:

Depending on the vacuum cleaner model uses hundreds to thousands watts of electricity. Absolutely, if you are using vacuum cleaner, your electricity bill starts running.

No Reusable dustbin bags:

You have to buy reusable dustbin bags when you want to clean your home or other places because some vacuum cleaners don't offer them.

Application of vacuum cleaner motor in vacuum cleaner:

Electric motors are commonly used in a wide range of applications, including vacuum cleaner.

The electric motor is a crucial component of the vacuum cleaner, providing the suction power necessary to effectively clean floors and other surfaces. Vacuum cleaners have come a long way since their invention in the late 19th century, and today's models use a variety of motor types and designs to achieve high levels of performance and efficiency.

The most common type of motor used in vacuum cleaners is the universal motor, which can operate on both AC and DC power. This versatility makes the universal motor a popular choice for vacuum cleaners, as it can be used with a wide range of electrical power sources. Another advantage of the universal motor is its high power-to-weight ratio, which allows for a compact and lightweight design that. is easy to handle and maneuver.

Another type of motor used in vacuum cleaners is the brushless DC motor, which is more energy-efficient and has a longer lifespan than the universal motor. Brushless DC motors use electronic commutation instead of brushes to control the current flow, reducing wear and tear and increasing reliability. This type of motor is also more efficient than the universal motor, as it produces less heat and requires less energy to operate.

The motor design of a vacuum cleaner can have a significant impact on its overall performance and efficiency. For example, a motor with high air flow and high speed can provide strong suction power, while a low-speed motor can produce more torque and be better suited for heavy-duty cleaning tasks. Vacuum cleaners with powerful motors are typically more expensive, but they can clean more effectively and require less effort on the part of the user.

In addition to the type and design of the motor, the size of the motor can also affect the performance of the vacuum cleaner. Smaller motors are more energy-efficient, but they may not have the suction power of larger motors. Larger motors, on the other hand, can provide more suction power but may be more energy-intensive and less efficient.

The electric motor is also an important factor in determining the noise level of a vacuum cleaner. Vacuum cleaners with high-speed motors can produce a significant amount of noise, making them less suitable for use in quiet or densely populated areas. To reduce noise levels, some vacuum cleaners use insulated motors or sound-absorbing materials, while others use low-speed motors or low-noise fans.

Electric circuit and power supply:

Creating a detailed circuit diagram for a vacuum cleaner's electronic circuit would require specific information about the vacuum cleaner model and its internal components. However, I can provide a simplified overview of the key components typically found in such a circuit:

1 **Power Supply:** This section includes components such as a transformer or power converter to step down the voltage from the mains power supply to a suitable level for the vacuum cleaner's operation.

2 **Power Switch:** This is a simple on/off switch that controls the flow of electricity to the rest of the circuit.

3 **Motor Controller:** This component regulates the speed and direction of the vacuum cleaner's motor. It may include features like variable speed control or reversing functionality.

4 **Safety Features:** These can include fuses, thermal cutoff switches, or overcurrent protection devices to prevent damage to the vacuum cleaner or ensure user safety.

5 **Sensors (Optional):** Some vacuum cleaners may include electronic sensors for tasks such as detecting obstructions, measuring airflow, or controlling automatic features like height adjustment.

Keep in mind that the specific layout and components of the circuit can vary greatly depending on the design and features of the vacuum cleaner.

Mixer Grinder

A mixer grinder is a compact portable electrical machine that is used for mixing and grinding grains.

Generally, the mixer grinder is designed to operate with a 230V AC supply. The internal parts of a mixer grinder as below,

Universal Series Motor

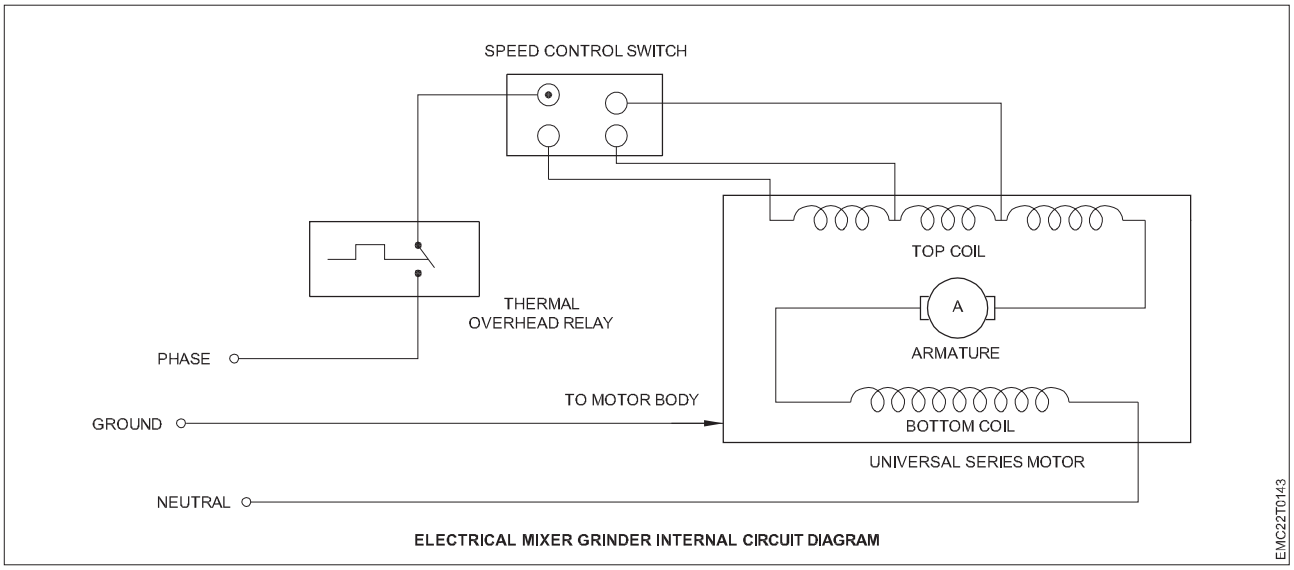
Three Position Speed Control Rotary Switch

Thermal Overload Relay or overload switch

Indicator Light

Power Switch

Mixer Grinder Internal Circuit Diagram:



ELECTRICAL MIXER GRINDER INTERNAL CIRCUIT DIAGRAM

Universal Series Motor:

Universal series motors are those which are designed to operate with both AC and DC supply.

Here the word 'series' used because its field windings are connected in series with the armature winding.

In the above circuit diagram, you can also see there are two series windings. One of these is tapped in three positions. And those tappings are connected to the speed control switch. So this arrangement is for speed control of the motor. So we can obtain three different speeds(low, medium, high) by rotating the switch. Also, you can see the mixer grinder motor connection below.

Thermal Overload Relay or overload switch:

A thermal Overload Relay or overload switch is used to protect the device from overload or overcurrent fault. If the motor draws overcurrent due to any internal fault, or improper use, the overload relay will automatically disconnect the power supply to the motor. As the mixer grinder is a home appliance, so the thermal overload relay is very helpful to prevent accidents such as burning of motor, fire, and melting due to over current. The overload switch also helps to turn off the motor if you run it for a long time. After fully cool down it will be got automatically turned on. You can see the mixer grinder overload switch connection diagram below.

Three-Position Rotary Switch:

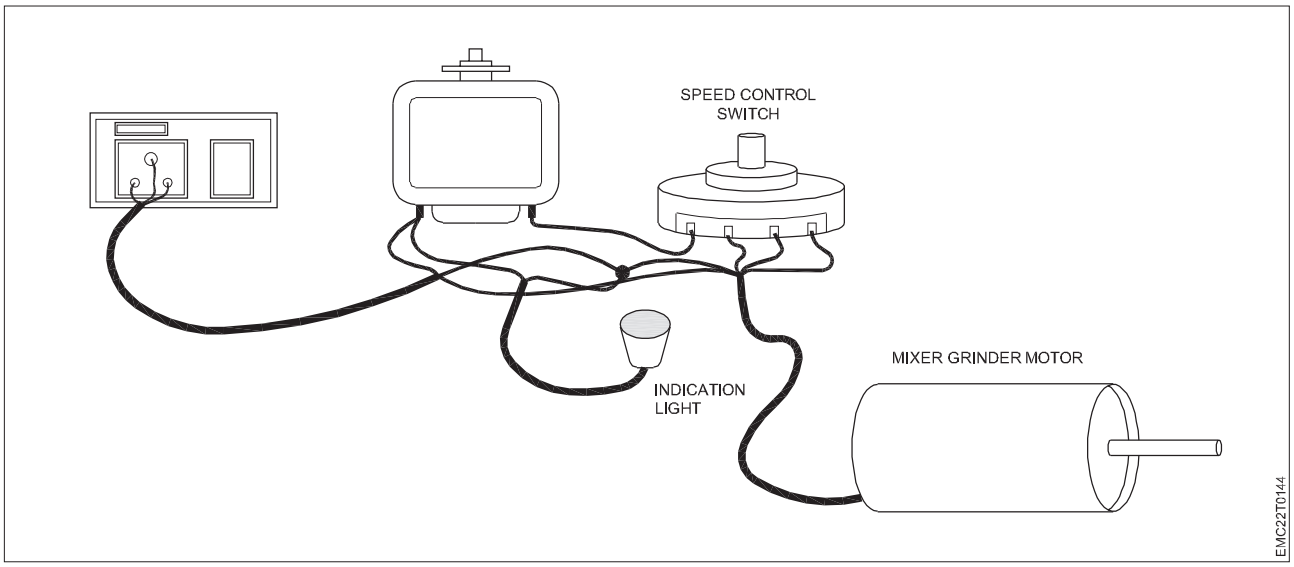
It has a total of four terminals. The first one is the input terminal and the other three are output terminals where the terminals of the motor are to be connected. You can see the mixer grinder rotary switch connection diagram below.

Power Switch:

Most of the mixer grinders have the function to switch on and off in their speed control switch but some mixer grinders come with a separate power switch to on and off.

Mixer Grinder Connection Diagram:

Here, you can see the connection diagram of the Mixer Grinder below.



So, here you can see there is a total of five terminals of the motor. The red, yellow, and blue are connected to the speed control switch. Rest, two terminals are neutral and ground. The thermal overload relay is connected in series with the speed control switch. The indicator light is connected across the phase and neutral. So when the power supply is available, it will glow.

Mixer:

A mixer is a kitchen appliance used to combine, beat, whip, or blend ingredients together. It typically consists of a motorized base with beaters, whisks, or paddles that rotate to thoroughly mix ingredients. Mixers are commonly used for tasks such as baking (for mixing cake batter or dough), cooking (for blending sauces or dressings), and preparing beverages (for mixing drinks or shakes). They come in various types, including hand mixers and stand mixers, each offering different levels of power and convenience for culinary tasks.

Grinder:

A grinder is a kitchen appliance or tool used to grind, crush, or pulverize ingredients into smaller particles or powders. It typically consists of a motorized base with sharp blades

or grinding mechanisms that rotate to break down food items. Grinders are commonly used for tasks such as grinding spices, chopping vegetables, making nut butter, or crushing grains. They come in various types, including spice grinders, coffee grinders, food processors with grinding attachments, and specialized meat grinders. Grinders provide convenience and efficiency in food preparation by reducing ingredients to the desired consistency or texture.

Various part and function of mixer & grinder

A mixer/grinder typically consists of several parts and functions:

1 **Motor:** Powers the appliance and drives the blades.

2 **Blades:** Grind, mix, and blend ingredients. There can be different types of blades for various functions, like grinding, chopping, or mixing.

3 **Jars:** Containers where ingredients are placed for processing. Usually, there are different-sized jars for different purposes, like grinding spices, making chutneys, or blending smoothies.

4 **Lid with Locking Mechanism:** Covers the jar securely during operation to prevent spillage.

5 **Control Panel:** Interface for selecting different speeds, settings, or functions. It may include buttons or knobs for power, speed, pulse, etc.

6 **Speed Settings:** Allow the user to adjust the speed of the blades according to the requirement of the recipe.

7 **Pulse Function:** Provides short bursts of power for precise control over processing.

8 **Safety Features:** Overload protection, safety lock mechanisms, and non-slip feet ensure safe operation.

9 **Cord Storage:** Some models have compartments to store the power cord neatly when not in use.

10 **Base/Chassis:** Provides stability and houses the motor.

Each part and function work together to make the mixer/grinder versatile and efficient for various kitchen tasks.

Working Principle Of Mixer Grinders:

Mixer grinders are the most common kitchen gadget that is used almost every single day. Buy juicer mixer grinders online from the leading brand Polar.

If there is one item in the kitchen that you cannot live without is a mixer grinder. Indian cuisine gets its taste from the freshness of the spices mixed, powdered, and grinded. Whether you need to make a chutney for your dosa, or a healthy green smoothie for breakfast, mixer grinders are the sole warriors. Thus, this versatile powerhouse should definitely be on your kitchen appliances online shopping list if you still do not have one.

All of us are familiar with mixer grinders and their power in the kitchen. But do you know how it works? It consists of blades, a jar, the gasket or seal ring, housing, jar nut, and the jar lid. The best mixer grinders in India will have premium quality machine parts that will guarantee a good performance.

A Short Know-How Of The Working Of Mixer Grinders:

When you start the mixer grinder, the mortar begins to turn the blades.

The spinning of the blades sets the food particles in a circular motion.

The circular swirling motion of the mixture creates a vacuum at the center

The central vacuum displaces the contents toward the axis while the whirling motion forces them up on the sides.

This helps the ingredients to turn into a smooth paste and a great consistency.

Advantages of mixer grinder:

- **Versatile cooking:**

A mixer grinder is a revolutionary appliance that helps in versatile cooking. Several types of dishes can be prepared with the help of mixers. Any liquid item can be whisked and whipped. Any vegetable can be sliced and chopped. All types of batter can be made with it. Any kneading can be done with it. From breakfast to dinner, numerous items can be prepared with this single appliance.

- **Different type of speed:**

Most of the mixers available in the market come with varying speed settings. Depending upon your needs, the speed can be adjusted. The only part of the user is to set the correct speed for items, and all the other work is automatically done by the machine.

- **Efficient and easy use:**

The energy and power used by the machine are positively less. Starting from chopping, mixing, kneading, all the tasks can be done without any arm or hand pain. The mixer grinders provide great convenience and comfort for the users. If you use the conventional hand grinder, then the effort spent on it is high, but with the mixer grinders, everything is easier.

- **Effortless handling:**

The mixer grinders are user-friendly. Any user can understand how to use and work a mixer grinder. The control panel is easy to understand and operate.

- **Price and affordability:**

Mixer grinders are available from low to high price range. You can easily find a mixer grinder that fits your budget.

Disadvantages of mixer grinder:

- **Can be noisy:**

Most of the mixer grinders are noisy and loud. When using a mixer, other sounds in the room cannot be heard. The noise can have a negative impact as it can disturb your mind. If the noise of your mixer grinder is very high, then there may be some fault in the motor.

- **Sharp blades:**

The mixer grinder should be used with alertness. If you use it without any caution, there are possibilities of injuring your hands. These blades can be dangerous; therefore, you have to keep the jar away from children and pets.

- **Repair and maintenance:**

If there is any fault in the mixer, then the repairing cost can be very high. Some parts of the mixer grinders are very expensive. It can also be difficult to maintain as dirt and food items easily get stuck in the bottom.

Application of Mixer Grinders:

One of the primary uses of mixer grinders is to grind spices. Indian cuisine is known for its use of spices, and having a mixer grinder in your kitchen can make the task of grinding spices much easier and faster. Mixer grinders are also used for making chutneys, which are an integral part of Indian cuisine. From coriander and mint chutneys to tomato and onion chutneys, a mixer grinder can help you prepare these condiments with ease.

Another popular use of mixer grinders is for blending fruits and vegetables to make smoothies and shakes. This is especially useful for those who want to include more fruits and vegetables in their diet but do not have the time to chop and blend them manually. Mixer grinders can also be used for preparing the batter for dosas and idlis, which are a staple in South Indian cuisine.

Overload Protection in Mixer Grinders

Overload Protection is a crucial feature in Mixer Grinders that prevents the motor from getting damaged due to excessive load or overheating. It automatically shuts off the motor when it detects an overload, ensuring the longevity and durability of the appliance. This feature is especially useful when grinding tough ingredients or using the mixer grinder for an extended period.

Benefits of Overload Protection in Mixer Grinders

Having an overload protection feature in your Mixer Grinder offers several advantages. It safeguards the motor from burning out, saving you from costly repairs or replacements. It also enhances the overall lifespan of the appliance, ensuring reliable performance for years. With overload protection, you can confidently use your mixer grinder without worrying about overheating or excessive strain on the motor, making it a valuable addition to your kitchen appliances.

Electric Iron:

An electric iron is a household appliance used to remove creases or wrinkles of the clothes by the combination of heat and pressure. After turning it on, a flat triangular soleplate is pressed on the clothes to make them smooth and flat.

An electric iron is an application of heating effect of current. Current is taken from the power supply which heats up the coil inside the iron, and this heat is then transferred to the soleplate due to the conduction, and when it's rubbed on clothes, small strings of clothes stretch to go flat.

An electric iron might not remove creases when it's too cold, and cloth might burn when it's too hot, so there is a range of temperature in which an electric iron operates effectively. Domestic irons generally range in operating temperature from between 250 °F (121 °C) to 360 °F (182 °C).

Working:

When a current is passed through the heating element which is placed between the sole plate and pressure plate, the element gets heated up and transfers its heat to the sole plate through conduction and in-turn the sole plate also gets heated up. Now to remove the wrinkles in clothing, we should apply heat and pressure. Heat is formed due to the coil and when we press the clothes with iron, the wrinkles are removed. For maintaining the optimum temperature, a thermostat is used along with pilot lamp which serves as an indicator.

Types of Electric clothes irons:

There are basically two types of an electric iron which are given below.

Automatic:

1 It's thermostat switch to regulate the heat to a predetermined value. When the predetermined value of the temperature is reached, the thermostat switch automatically disconnects the electricity supply and reconnects the same when iron starts cooling down.

2 It has pilot lamp to indicate. It will glow if the temperature is under predetermined value, otherwise not glow.

3 Cost is high.

4 As the temperature is controlled automatically through thermostatic switch, the risk of burning the cloth is minimized.

Non-Automatic:

1 It does not contain thermostat switch. Thus temperature is not regulated.

2 User has to switch ON or OFF the supply to iron according to the heat requirement.

3 There is no pilot lamp to point out the temperature condition whether it is within the limit or not.

4 Cost is low.

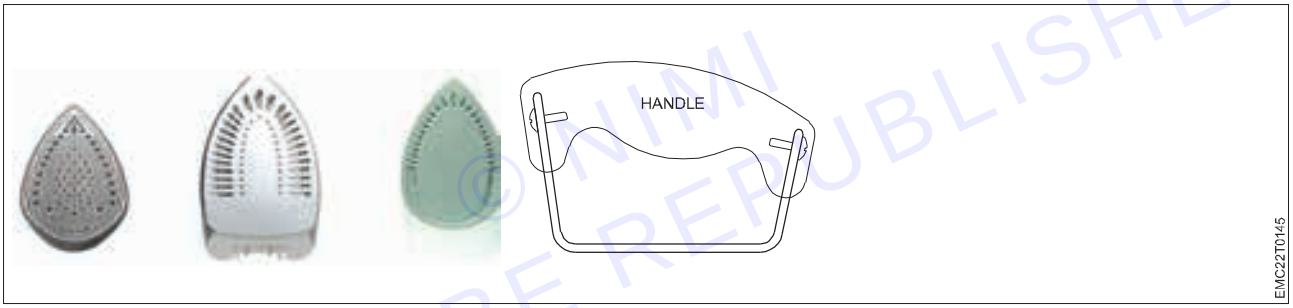
5 Overheat might burn the cloth. Thus more care is needed.

Automatic electric irons are more common as compared to non-automatic due to their safety benefits.

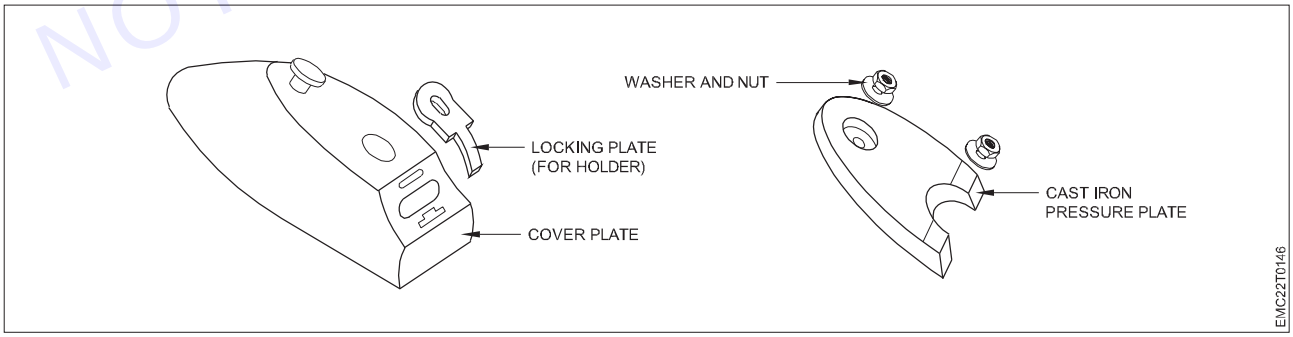
Components of an electric iron:

An electric clothes irons have following common parts:

1 **Handle:** The handle of an electric iron is made with plastic or wood. The reason is that these materials are insulators, current doesn't pass through them, so person who touch the handle while ironing would be saved to get shocked. It's attached to the cover plate with the aid of screws.



2 **Sole plate:** Soleplate, also called the hot plate, is the thick and flat triangular shaped surface made of aluminum that forms the base over which the electric iron is built up. Aluminum allows corrosion not to occur. It is polished, layered with a non-stick material making it stainless. It's the part of an electric iron which comes in contact with clothes while ironing.The base plate holds the pressure plate and cover plate in position.

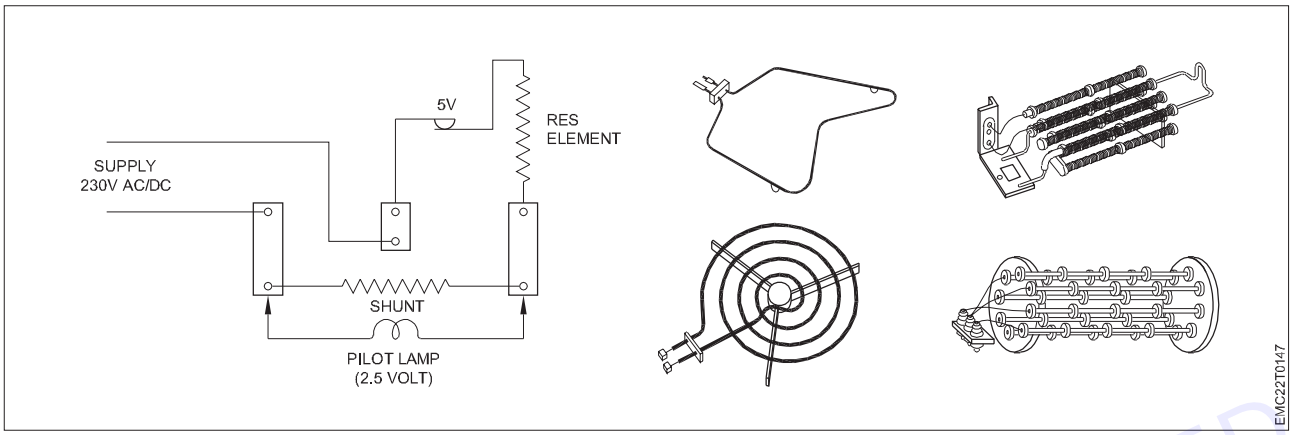


3 **Cover Plate:**The cover plate is made of thin sheet of iron. It is placed on top of the base plate and it covers all the internal parts of the iron. The handle and connector are only attached to the cover plate.

4 **Pressure Plate:**This plate is generally called the top plate as it follows the shape of sole plate. The pressure plate has some holes through which the studs form the base plate passes through. We should tighten the nuts on the studs in such a way that the pressure plate and sole plate are pressed tight against each other. In some iron, the pressure plate is heavy and made of cast iron while in some other cases, it is a thin sheet of steel, about Ό cm thick.

5 **Pilot Lamp:** The pilot lamp is housed on the cover plate of the electric iron.One end of the pilot lamp is connected to supply, while the other end is connected to the heating element. A shunt resistance is provided across the pilot lamp which assists in providing a voltage drop. The shunt is designed to provide a voltage drop of 2-5 volts.

6 **Heating Element:**Most heating elements are made with a nickel-chromium wire, having both tensile strength and high resistance to current flow. The resistance and voltage can be measured with a multimeter to verify if the element is functioning properly. Heating elements are available in many sizes and shapes.

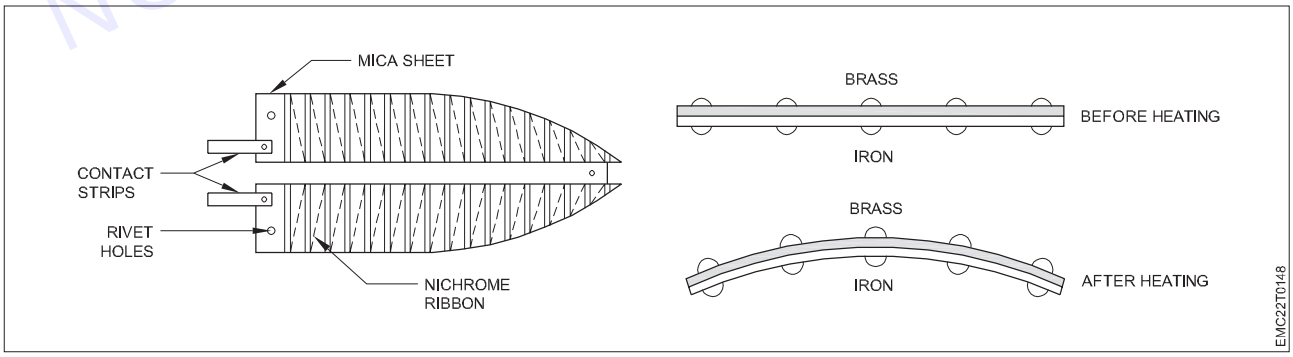


In an electric iron, the heating element is present between the sole plate and pressure plate. It is pressed hard between the two plates. The heating element consists of nichrome wire wound around a sheet of mica. The two ends of the nichrome wire are connected to the contact strips. The contact strips are connected to the terminals of the iron. There are two reasons for which mica is chosen in the heating material. Mica is a very good insulating material. Besides that mica can also withstand very high temperatures. The entire assembly of mica sheet, nichrome wire and contact strips are riveted together resulting in a mechanically sound and robust construction. There is an asbestos sheet, which separates and thermally insulates the top plate from the heating element.

7 **Thermostat:**Thermostat is an important component of an electric iron that regulates its temperature. The word thermostat is very common due to its usefulness in many home appliances that deals with temperature control. The word thermostat is a combination of two words 'Thermo' (heat) and 'statis'(status quo or constant).The main function of thermostat is to keep heat constant in a given setting.

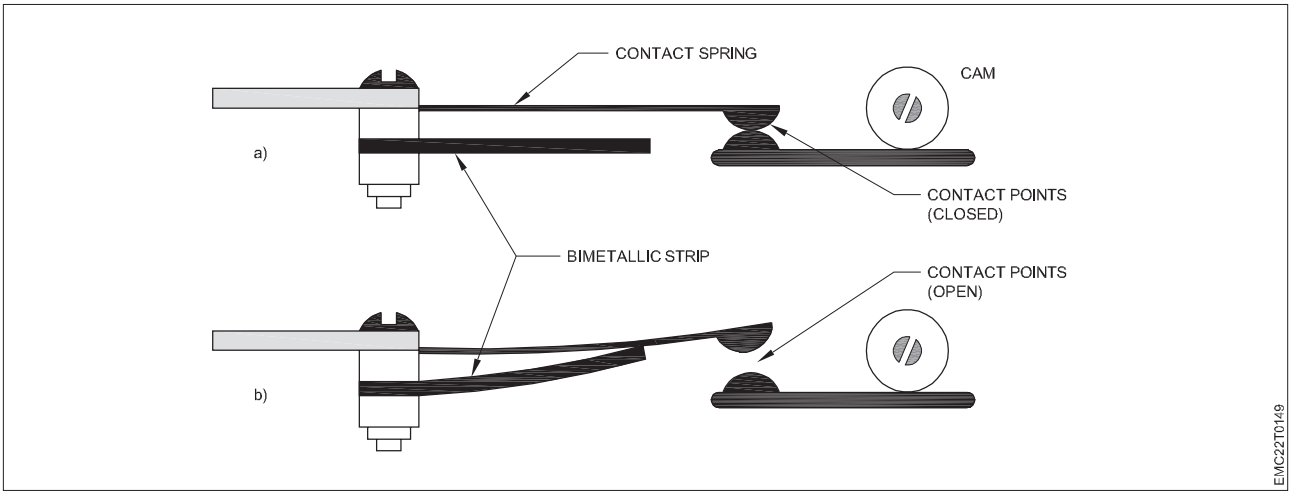
The main function of thermostat in an electric iron is to make sure that the iron doesn't get too hot if it is left unattended to for a period of time. The mechanism work as follows.

When electric current is passed through a coil in an electric iron, the coil becomes very hot. Through conduction the heat is transferred to the flat base plate of the electric iron which is used to iron our clothes .



8 **Bimetallic Strip:**The thermostat in iron makes use of bimetallic strip. This bimetallic strip is made up of two different types of metals (Brass and iron) with different coefficient of expansion bonded together. Therefore, in the presence of heat, the bimetallic strip expands differently. The metallic strip is connected to a contact spring through small pins.

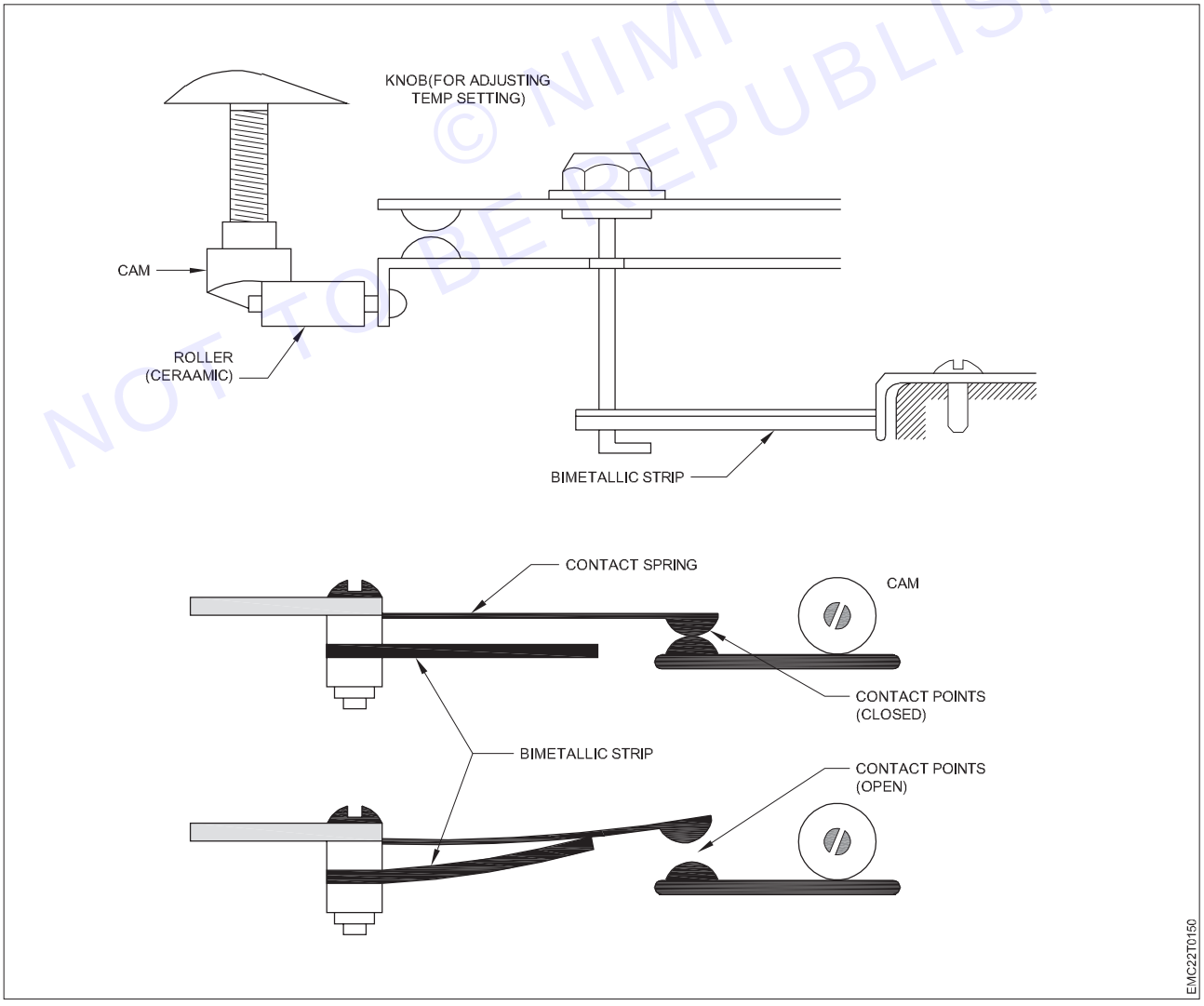
The bimetallic strip remains in physical contact with the contact point at moderate temperature. However, at a temperature of the iron above a certain limit, the strip tends to bend towards the metal with lower coefficient of expansion. At this point, the strip stops to be physically connected to the contact point and current stops flowing because of opening of the circuit.

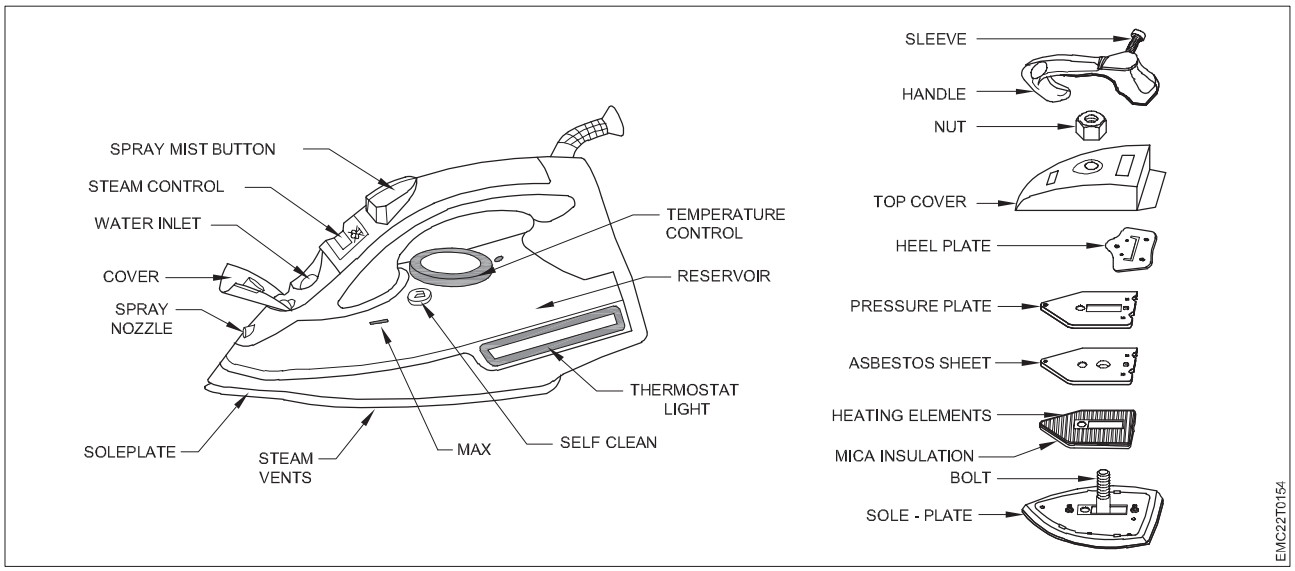


(a) when the iron is at normal temperature (b) When the iron becomes too hot

As far as the circuit remains open, the temperature of the iron continues to reduce, then the strip goes back to its original position and current begins to flow again. This cycle continues until the power supply is being switched off from the main electricity source. This is the main reason why your iron tends to power on and off on its own when connected to electric source.

8 **Capacitor:** The thermostat helps in maintaining the temperature within limits. But frequent making and breaking of circuit damages the contact points and it may also result in interference with radio reception. To avoid this, a capacitor of certain range is connected across the two contact points.





Reverse Osmosis

The process of reverse osmosis can remove different types of dissolved and suspended chemical species as well as biological ones' alike bacteria from water. This process is useful in both industrial processes and the production of potable water. The result is that the solute is retained on the pressurized side of the membrane and the pure solvent is passed to the other side. In particular, this membrane does not allow large molecules or ions through the holes. Though it allows smaller components of the solution, for instance, solvent molecules like water H2O to pass through it freely.

In normal osmosis, the solvent naturally moves from an area of low solute concentration through a membrane, to an area of high solute concentration. Basically, it goes from high water potential to low water potential. The driving force for the movement of the solvent is because of the reduction in the Gibbs free energy of the system when the difference in solvent concentration on either side of a membrane is reduced.

By reducing it generates osmotic pressure due to the solvent moving into the more concentrated solution. By applying an external pressure to reverse the natural flow of solvent is actually reverse osmosis. The process is similar to other membrane technology applications ever in use.

Reverse Osmosis Principle:

Reverse osmosis works by reversing the accurate principle of osmosis. The salt solution is subjected to pressure against the semi-permeable membrane. Remember that the applied pressure is greater than the osmotic pressure. Thereby, the molecules move easily from a highly concentrated solution to a less concentrated solution.

Reverse osmosis differs from filtration as if the mechanism of fluid flow is by osmosis across a membrane. The removal process in membrane filtration is straining, or size exclusion. Here, the holes are approximately 0.01 micrometres or larger. Thus, the process of osmosis can theoretically get perfect efficiency regardless of parameters such as the solution's pressure and solution's concentration.

Drinking Water Purification by Reverse Osmosis:

Reverse osmosis is most commonly in use in drinking water purification from seawater, removing the salt and other sewage materials from the water molecules.

Generally, household drinking water purification systems, including a process of reverse osmosis. It is commonly in use for improving water for drinking and cooking.

Such systems typically include a number of steps as follows:

A sediment filter traps particles such as rust and calcium carbonate.

Optionally, it has a second sediment filter with smaller pores.

It contains an activated carbon filter to trap organic chemicals and chlorine, this will attack and degrade some types of thin-film composite membrane.

A reverse osmosis filter, which is a thin-film composite membrane

An ultraviolet lamp is in use for sterilizing any microbes that can escape filtering by the reverse osmosis membrane

Also, a second carbon filter to capture those chemicals that are not removed by the reverse osmosis membrane

Portable Reverse Osmosis Water Processors:

Portable reverse osmosis water processors are made for personal water purification. To work properly, the water feeding to these units are under some pressure of 280 kPa (40 psi) or greater is the norm. Portable reverse osmosis water processors are in use by people who live in rural areas as if without clean water. This is the water that is far away from the city's water pipes.

Rural people filter river or ocean water themselves, as the device is easy to filter the water. Many travellers on long boating, fishing, or island camping trips, or in countries where the local water supply is polluted or substandard. The use of reverse osmosis water processors is coupled with one or more ultraviolet sterilizers.

Advantages of reverse osmosis:

Reverse osmosis is the best method for water softening. As a matter of fact. It performs two functioning that is water softening and water purification.

No ion particles are allowed to enter through the semipermeable membrane.

Maintenance is done when the machine is still operational.

It is easy to adapt and efficient in its working for filtration purpose.

Disadvantages of reverse osmosis:

A lot of energy is requiring for the entire process of reverse osmosis filtration.

There is a lot of pressure needed so that deionization can occur for further filtration.

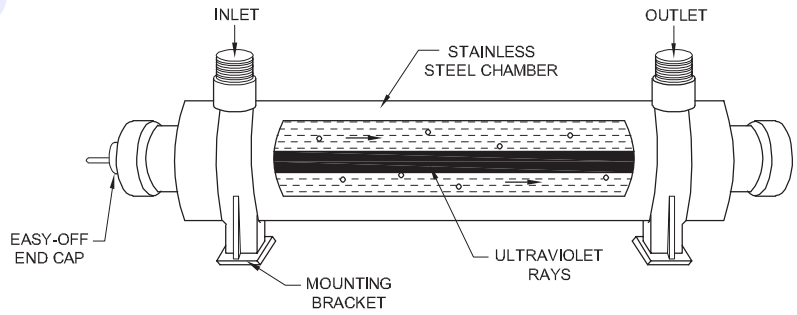
During the process, the water might become acidic because it has been deionised of all its mineral content.

It is not advisable to drink water from the process because naturally, the water must have some minerals that help in the functioning and malnutrition of the body.

UV water purifier:

A UV water purifier kills the microbiologically unsafe water with UV light. Whenever the water is exposed to the rays, it disrupts the DNA of microorganisms. Due to this disruption, the living organisms cannot replicate themselves and make us sick if we drink that water. UV water purifiers are safe and effective.

Fig 1



Working:

Ultraviolet or UV energy is found in the electromagnetic spectrum between visible light and x-rays and can best be described as invisible radiation. In order to kill microorganisms, the UV rays must actually strike the cell. UV energy penetrates the outer cell membrane, passes through the cell body and disrupts its DNA preventing reproduction. UV treatment does not alter water chemically; nothing is being added except energy. The sterilized microorganisms are not removed from the water. UV disinfection does not remove dissolved organics, inorganics or particles in the

water. The degree of inactivation by ultraviolet radiation is directly related to the UV dose applied to the water. The dosage, a product of UV light intensity and exposure time, is measured in microwatt second per square centimeter (µws/cm2). The accompanying table lists dosage requirements to destroy common microorganisms. Most UV units are designed to provide a dosage greater than 30,000 µws/cm2 after one year of continuous operation. Notice that UV does not effectively disinfect some organisms (most molds, protozoa, and cysts of Giardia lamblia and Cryptosporidium) since they require a higher dose

Advantages:

1 It helps in the destruction of 99.99% of microorganisms.

2 It is eco-friendly because it does not leave any by-products after the treatment.

3 It is cost-effective and user-friendly since the only lamp and sleeve have to be replaced annually. Apart from it, hardly any maintenance is required by the UV water purifiers.

4 It is chemical-free, and there is no change in the taste and color of the water.

5 Water purification through UV rays is a quick process since the water flows through the system without a holding tank or reaction times.

Disadvantages:

1 It does not help in the removal of contaminants. UV deactivates only the living microorganisms. Therefore, a prefiltration of particles is necessary.

2 The UV lamps heat the water if the cleaner is not in use.

3 A UV system requires the power supply;y to run. Hence, an undisrupted power supply is necessary for the functioning of a UV water purifier.

Different Types of Water Purifiers

1 Activated carbon water purifier:

Pesticides and other potentially harmful organic compounds are removed from water by activated carbon in water purifiers. Chemicals that give water a foul taste are also removed by activated carbon in water filters. Consequently, having an activated carbon water filter purifier is an excellent idea for drinking water.

However, it cannot remove pollutants such as fluorides, nitrates, sodium, and microscopic organisms like parasites and bacteria.

2 Sediment filter water purifier:

The more advanced water purifiers use sediment cartridge filters as the first in a series of several filters. A sediment filter's main function is to remove bigger solid particles from water, such as mud, dirt, sludge, and other similar solid particles.

3 Gravity-based water purifiers:

Gravity-based water purifiers use many filtration techniques to produce clean water. Many people in India utilize cheap gravity water filters. The primary benefits of gravity water purifiers are their low cost and ability to operate without electricity.

As the name suggests, gravity water purifiers use gravitational forces to drive water through various filter cartridge parts. However, gravity filters have a very slow flow rate—almost drop by drop into the storage tank below—through their filters.

4 UV purifier:

A UV water purifier is a water filter that employs UV or Ultraviolet light to kill germs, bacteria, protozoa, cysts, and other organisms in the water.

By projecting powerful UV or ultraviolet rays on the bacteria in the water, UV water purifiers kill them. The UV Ultraviolet rays penetrate bacteria, viruses, and cyst cells and stop them from reproducing. Without it, these organisms can't reproduce and eventually die.

The UV water purifier light kills up to 99.99% of bacteria in water, making it a relatively simple but effective method. In the kitchen, a typical UV water filter will consume around the same amount of electricity as a 40-watt light bulb.

The UV water purifier can be connected to an inverter or UPS to function even when there isn't an electrical supply.

The issue with UV water purification is that although the germs are killed, their bodies are still present in the water. The smallest particles of bacteria, viruses, and germs are completely eliminated from the water by an RO water purifier.

5 UF water purifier:

Ultra-Filter is referred to as UF. In comparison to RO membranes, UF membranes have larger holes. Water with dissolved salts cannot be removed by UF. The primary benefit of UF water purifiers is their ability to totally eliminate all germs from water, even the tiniest viruses, without the need for energy.

In order to ensure that you always have healthy tap water free of chemical contaminants, a UF water purifier is the best water purifier for tap water in large cities. This is so that even the tiniest of germs, and viruses, may be removed from water using a UF water purifier.

The UF water purifier's drawback is that it cannot remove dissolved particles from water. Therefore, it should only be used with water from public sources, such as wells, ponds, rivers, and waters collected from the rain, if you are absolutely certain that the total dissolved solids (TDS) are within the acceptable range and that no toxic dissolved impurities, such as arsenic, heavy metals, or nitrates, are present. The best course of action is to get a RO water purifier if you are unsure of the number of dissolved solids in the water.

6 RO water purifier:

Among water purification membranes, RO has the tiniest pores and is capable of removing all dissolved salts from water. As a result, water that has been purified by a RO membrane does not contain any dissolved salts, making it nearly as pure as distilled water.

The benefit of a RO or reverse osmosis water filter is that it eliminates dangerous compounds like arsenic, heavy metals, nitrates, salts, and other contaminants in addition to all germs and viruses, even the smallest ones. In fact, before bottling the water, manufacturers of bottled water utilize RO to cleanse the water.

Because a RO membrane filters out all the bacteria and parasites in the water, Reverse Osmosis, or RO, water purifiers are far superior to UV water purifiers. Additionally, it cleanses the water of any dangerous substances, including heavy metals. On the other hand, a UV purifier just has a strong light inside that emits UV radiation to eliminate any parasites and germs. The water you drink still contains the remains of these dead microorganisms.

Finally, RO purifiers improve the water's flavor and aroma. The RO purifier is a sure investment in health given the contaminants in water.

7 RO+UV+UF water purifier:

When a water purifier is described as RO+UV+UF, it signifies that it uses three different types of water purification techniques. The procedures of Reverse Osmosis, Ultra Violet, and UltraFiltration are all integrated into a water purifier with RO+UV+UF.

For example, the Livpure RO combines all three processes to purify your water. The purifier performs best with hard water, water that contains high amounts of TDS, and water that contains heavy metals. You may pass your household water through the RO Livpure filter and drink with confidence, regardless of whether it originates from a municipal corporation, borewell, or another source.

This purifier eliminates all types of contaminants, including dissolved salts, heavy metals, bacteria, viruses, chemicals, etc. Additionally, it doesn't affect the water's naturally important minerals. Only the excess minerals are removed by the Livpure water purifier (which can be harmful to health).

The built-in mineralizer replenishes your water with necessary minerals like calcium, magnesium, zinc, copper, and more to guarantee that it has the right mineral levels.

Different components of water purifier

Sediment Pre-Filter:

The sediment cartridge is the first filter stage in all RO systems.

Sediment filters trap sand, dirt, dust, rust, and other debris in a drinking water supply. This particulate matter could clog the reverse osmosis membrane surface and reduce its lifespan if not removed.

Carbon Filter:

The are usually two carbon filters in a reverse osmosis filter system:

A second-stage carbon filter, which removes chemicals like chlorine (most city water utilities provide chlorinated water supplies).

A carbon polishing filter, which is installed after the RO membrane and gives water a final polish.

Reverse Osmosis Membrane:

The RO membrane, or semipermeable membrane, is a key part of any RO system.

Semipermeable membranes use membrane separation to remove virtually all inorganic and organic substances, including chemicals, metals, microorganisms, minerals, and salts.

RO membranes are usually the third stage in an RO unit and have a 2-year average lifespan.

Other Parts:

Water Supply Connector:

The water supply adapter or connector connects the under-sink or whole house cold water supply to the RO system. The adapter should make it possible to connect the RO unit to different-sized water supply lines.

Shut-Off Valve:

A shut-off valve is used in an RO system that has a water chamber or storage tank.

The role of the shut-off valve is to prevent unnecessary draining when the tank is full.

Check Valve:

Again, in RO systems with a water tank, the check valve is needed to prevent high-pressure purified water from back-flowing into the RO system, potentially damaging the membrane.

The check valve is usually installed directly after (downstream of) the semipermeable membrane.

Drinking Water Faucet:

Most under-sink RO systems come with their own dedicated faucet.

This faucet is lead-free and free from any other metals and substances that could leach back into RO purified water, which is empty of impurities and more susceptible to recontamination.

Optional Components:

There are a few components of a reverse osmosis system that are sold as optional add-ons. It's often worth paying the extra cost for these components.

Water Storage Tank:

RO water storage tanks aren't technically an optional component – if you buy a tank-based RO system, you will need to install the tank.

Remineralization Filter:

Many RO water filters now come with an optional remineralization filter. Reverse osmosis removes up to 99.99% of all dissolved solids in water, including healthy minerals and salts like calcium, magnesium, zinc, sodium, and potassium.

Pressure Booster Pump:

A pressure booster pump is an optional add-on for homes that don't have a high enough feed pressure to install a reverse osmosis water filter system.

The ideal water pressure for a reverse osmosis system is 60 PSI, and water pressure below 40 PSI won't provide enough force to send water through the numerous filter stages. A pressure booster pump increases water pressure to a suitable level for RO performance.

Pressure Regulator:

On the other end, high water pressure could damage the pre-filter housings in an RO system, and a pressure regulator is used to protect these housings from water hammer.

Frequently occurring fault in water purifier:

1 Water Leakage:

One of the most frequent water purifier problems is concerned with water leakage. If you notice a pool of water beneath an RO, do not get intimidated. Most often than not it might be due to the loose connections of pipe connectors.

To fix this, the faulty connection needs to be refitted properly or sometimes even replaced. If the leakage is in the membrane, the O ring (the soft rubber ring that stops water from seeping into other parts), might be damaged and would need replacement. It is a good idea to seek professional help if you notice any sort of water leakage in your RO water purifier.

2 RO not working:

If your RO does not give any water output and the storage tank is nearly empty, it can be quite frustrating. First off, check if the switch button is turned on properly and that you have an electricity supply. In case both these are positive, the fault may be with the power supply connector. In this case, it is prudent to seek professional help.

If the power indicator is in the 'on' mode and the water supply is not resumed, check if the water supply valve is turned off. If so, turn it on and check if the RO water filter is working properly.

3 Bad odor and disagreeable taste of water:

In its natural state, the RO water filter, do not give off foul-smelling or tasting water. If you experience either of these two conditions with your RO water purifier, it may be due to the presence of chlorine in the water. This is most commonly due to the filters not working properly. To avoid this, it is recommended that you change the filters yearly.

4 Auto shut-off feature not working:

In normal cases when the water stocking tank of the RO water purifier gets filled over the designated levels, it stops all cleaning activities and shuts itself off. In case this feature is faulty, the machine continues to operate, and the water will begin to seep out of the crevices and begin to leak out. In such cases, a professional should be called in to fix this flaw, immediately.

Strange noises:

If you hear unusual-sounding noises coming out of your RO water filter, especially after replacing the membranes, it could be due to the air being pushed out of the system or due to a sudden change in the water pressure. If the noise does not subside in a while, it might be a good idea to call a technician to check if the tubes are properly connected and to ensure that the water tank's valve is properly closed. They might also need to replace the RO pump, as with constant use, it can become noisy.

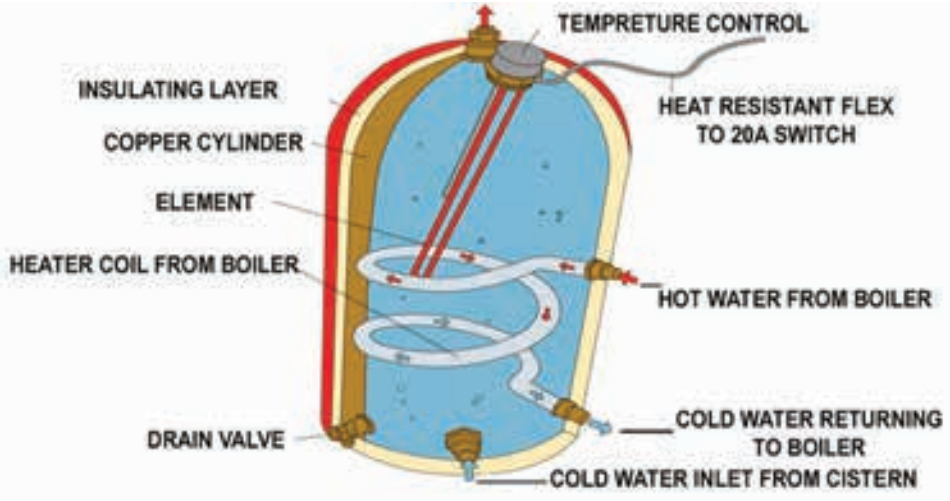
6 Low water output or water tank takes a long time to fill:

The filter in your RO water purifier is designed to filter out all sorts of impurities. In the process, some of the contaminants may get stuck to its surface, blocking the proper flow of water through it. If the filters are not cleaned frequently, this can even form a patina-like layer on the membrane. This is especially common in areas where the water quality is very bad. The solution to this problem is to check your filters and get them cleaned or replaced consistently.

Immersion heater:

Immersion heaters are electric heating elements that are found inside hot- water cylinders and designed to heat water. They act a little like a kettle and heat the surrounding water in the cylinder.

Block Diagram of Immersion Heater:



The direct heat transfer of this type of heater allows liquids to achieve the desired temperature rapidly. Heaters, which are made of tubing bundles, can be fixed on the side of a container or submerged in its contents. Their heating coils deliver heat to the contents of the container, which are distributed throughout the container.

Working Process Of Immersion Heater:

These heaters have an electrically resistant heating element encased in a sheath. When the heating element is turned on, it heats its enclosing jacket, which in turn heats the sheath, which in turn heats the liquid. The conductivity of the jacket and sheath determines its effectiveness. There are two immersion heaters direct and indirect that heat liquids in different ways.

Direct Immersion:

It is put directly into the liquid at the top or through a side fitting. Its heating element comes into touch with the to-be-heated fluid. When it's in place, it's turned on, and electricity flows through the heating element into the liquid.

Indirect Immersion:

It is immersed in liquid after being placed into a pipe with a closed end. The heating element heats the air within the pipe, resulting in an oven effect that heats the liquid. An indirect immersion has the advantage and purpose of not coming into direct contact with the fluid, which prevents contamination and corrosion.

Moreover, the time required to heat a substance is determined by the quantity and power level of the heater. They are intended to heat specific sorts of materials.

Parts of an Immersion Heater:

When examining an immersion heater, there are certain elements that have to be closely observed. They include:

Sheath material

Power density

Wattage

Enclosure

Temperature range

Heating element

Each of these factors are discussed below.

Sheath Material:

The most important consideration regarding the sheath is the material or fluid that will be in direct contact with it since different sheath materials react differently to certain liquids. The chart below is a short guide regarding sheath materials. Immersion heater manufacturers provide charts regarding sheathing regarding which ones are appropriate for certain applications.

The selection of the correct sheath material is critical since its failure can lead to extremely serious issues. The most common type of failure is corrosion, and no immersion heater manufacturer provides a warranty against corrosion.

Sheath Materials Selection Chart

Sheath Material	Max Sheath Temperature	Max WSI	Application
Copper	350°F	55	Clean water, water solutions non-corrosive to copper, boilers, cooling towers.
Steel	750°F	22	Immersion in oils, alkaline cleaning solutions, tars and asphalt, wax, petroleum, heat transfer mediums.
304 Stainless Steel	1200°F	30	Process water, Corrosive liquids, food processing equipment, soap, soluble cutting oils, hospital equipment.
Incoloy	1500°F	40	Air heating, radiant heating, cleaning and degreasing solutions, plating & pickling solutions, corrosive liquids, air or gas.

Power Density:

The power density of an immersion heater has to be calculated to fit the liquid. Incorrect power density can scorch the liquid and create excess heat build up in the heater. A key factor is the ability of the liquid to remove heat from the immersion heaters heating element, which determines the proper density.

Water removes power density from a heating element very quickly and can have a higher power density. Crude oil and molasses do not remove heat and require a lower power density, which can be seen in the power density chart below.

Typical liquid density

Compound	Density, kg/m^3
Drilling Mud	1500-2000
Water	1000
Diesel	860
Gasoline	725
Liquid Petroleum Gas (LPG)	550
Liquefied Natural Gas (LNG)	460

Wattage:

The next factor is to determine if the heater has the capability of delivering enough heat to create the necessary temperature, which is decided by its wattage. There are three parts for factoring wattage:

Startup:

This requires the greatest amount of wattage and is dependent on the method of heating such as conduction, convection, or radiation as well as the type of heater.

Operation:

When the immersion heater has achieved start up, the amount of wattage required should remain constant and maintain continual heat flow.

Heat loss:

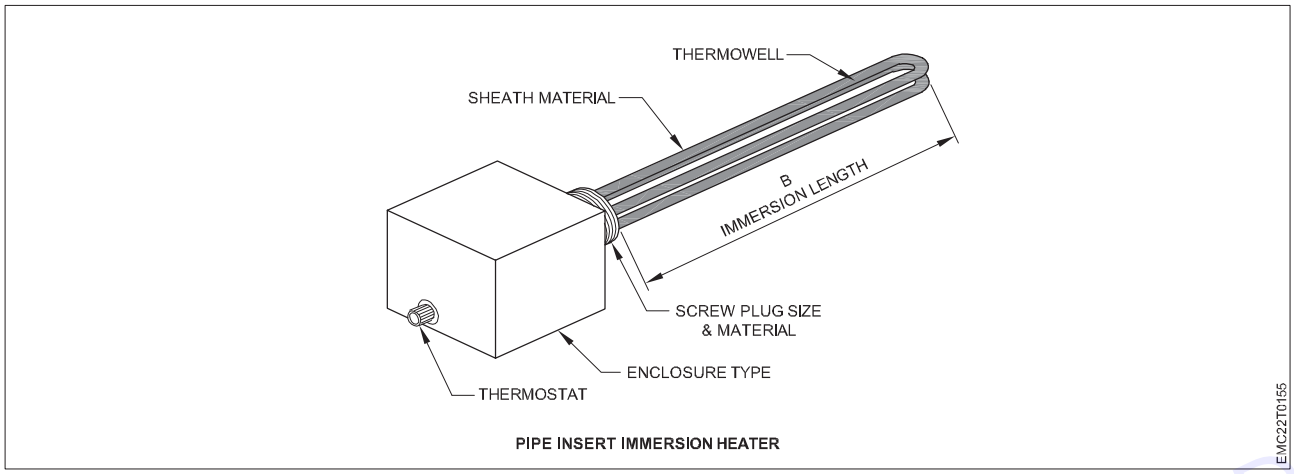
Heat loss has to be factored into the operation of any heating device. In the case of an immersion heater, the enclosure for the liquid, the type of heater, and type of liquid determine the amount of heat loss, which can increase the required amount of wattage.

These three factors are influenced by the material, mass to be heated, temperature difference, and how much time it takes to reach the desired temperature.

Enclosures:

Immersion heater enclosures, casings, have normally been made from aluminum since the middle of the 20th Century. Plastic enclosures have become more popular because of plastic's moldability but have been of inferior quality. Most manufacturers have continued to use aluminum for its mechanical and thermal resistance.

For larger immersion heaters for uses such as atomic power plants, heavier denser metals are required.



PIPE INSERT IMMERSION HEATER

The dark blue section in the above image is the enclosure that contains the wiring for the pictured pipe insert, indirect immersion heater.

Temperature Range:

The temperature range for immersion heaters is dependent on how it will be used. Most industrial heaters are designed to heat water to around 900°F or 482°C. Depending on application requirements, the amount of heat will remain constant. Two key factors in the amount of heat produced are the voltage supply and resistance.

Heating Element:

The heating element of an immersion heater is made of a combination of nickel and chrome, known as nichrome, with refractory metals tungsten, molybdenum, or tantalum, encased in stainless steel or titanium. The majority of heating elements are insulated with magnesium as a filler between the heating element and sheath.

The composition of heating elements can vary depending on the material to be heated. Low alloy steels are used for heating elements that are designed to heat oil or gas. Below is an immersion heater with a stainless steel heating element for the brewing process.

Insulation in immersion heater:

Insulation resistance is a key parameter for any electric heater to operate safely. All Watlow® heaters undergo insulation resistance testing before leaving the manufacturing facilities. However, during shipping and storage, the mineral insulation (magnesium oxide or MgO) material used in metal sheath heaters can absorb moisture rendering the heater unusable until the moisture is purged from the heater.

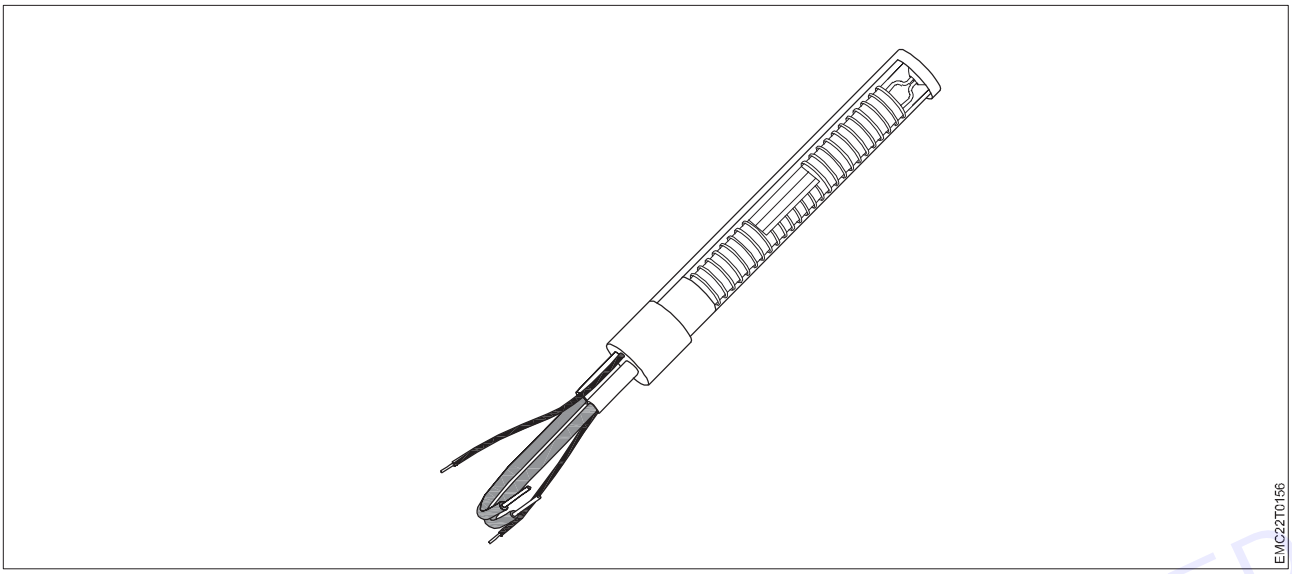
Moisture impacts the functionality and performance of mineral insulated heaters and increases the likelihood of a short-to-ground episode. Although all heaters should have their insulation resistance tested before installation, heaters held in storage for long periods of time or used in high humidity regions are especially vulnerable to absorbing moisture from the ambient environment and should, therefore, always be tested before use. When too much moisture has been absorbed from the surrounding atmospheric humidity, the heater can become "wet" and must be purged of all moisture prior to use.

An insulation resistance test, or megohm test, is required to determine the quality of the insulation within the heating elements. This test is easy to perform and should be completed before putting any electric heater into service. This critical step will help avoid the installation of a "wet heater" that will have a higher chance of causing damage or shorting out.

Insulation Resistance:

For an electric heater to work correctly, current needs to flow directly through the coil wires within the heating element and not be able to short to the outer sheath through the absorbed moisture. The greater a heater's

insulation resistance, the greater the heater's ability to handle the voltage and operate correctly. As current travels through the heating element, low insulation resistance can allow the voltage to arc across the dielectric material and ground out to the sheath, which can destroy the heater or cause broader system damage.



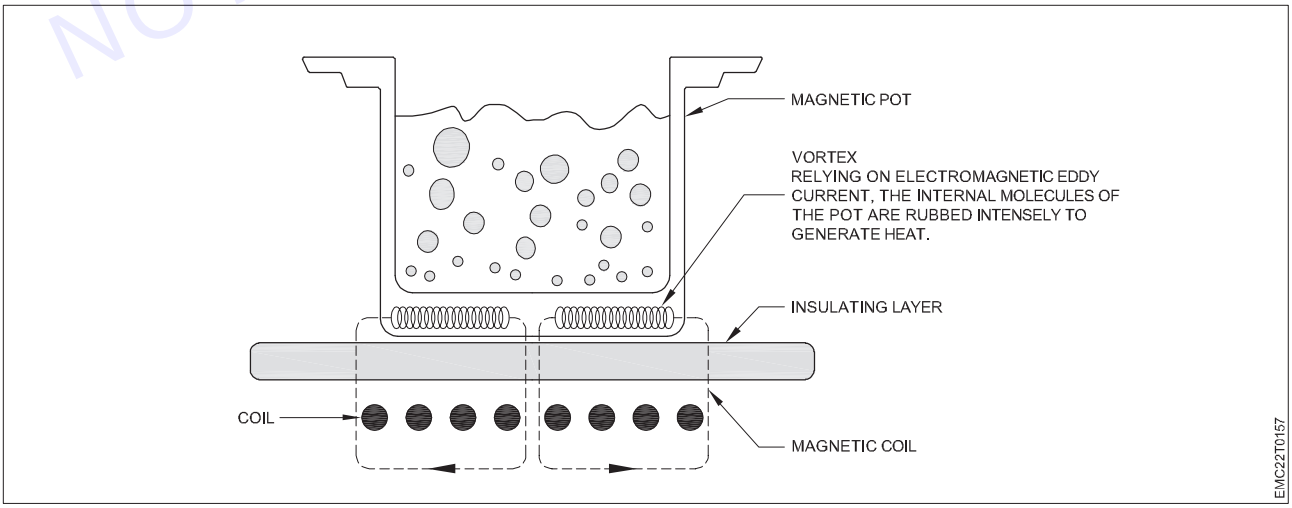
Magnesium oxide (MgO) is typically used as a dielectric material to insulate the element wire from the heating surface or outer sheath. As long as the insulation resistance of the MgO remains high, the heater can function correctly.

While MgO is an excellent high-temperature insulator, it also is hygroscopic, meaning that it likes water and actively draws moisture out of the surrounding atmosphere, effectively lowering the insulation resistance. If too much moisture is present when the heater is fully powered up, the current will find the shortest path out by arcing to the sheath and shorting out the heater.

A heater arcing and grounding out can have a range of consequences, from a nuisance trip of a breaker to an explosive event. Depending on the voltage and type of material being heated, a short to ground can result in a more significant explosive event generating damage, injury or even death, so understanding how to perform a megohm test properly is essential to safe operation.

Working Principle of Commercial Induction Cook :

Without an open fire, how does the induction cooker heat food? If the induction cooker is still like some unbelievable scientific mystery for you, let's find out the working principle of it together



The induction stove works on the principle of electromagnetism, which is a new thermal energy technique. The surface of the induction stove is usually glass-ceramic, and a coil made of copper wire is installed underneath the glass-ceramic.

When the high-frequency alternating current goes to the coil, it will generate a certain range of magnetic fields. This magnetic field range can generally reach the top of the glass-ceramic within 3cm height. The internal molecules of the bottom of the pot or pan rub intensely through the induction of the magnetic field so that the vessel itself generates thermal energy.

Compared to traditional gas stoves and electronic stoves, which use a burner or heating element to heat indirectly and deliver the heat to the food in a radiation range, the induction cooker is better, which can reduce the wastage of heat energy, thereby keeping the kitchen cool. It is crucial for smaller kitchens or sites struggling with high temperatures.

In other words, if we use an induction cooker, the heat source would be the cookware itself, it heats the food directly, so less heat emits to the surrounding air, and cooking is faster. According to our experiments, the thermal energy utilization rates of gas stoves, electric stoves, and induction cookers are different, respectively 40%, 74%, and 90%.

It means better temperature controllability and less cooking time with the induction. “This is a physical reaction that happened in an instant,” says Mr. Chen, the product development manager of the Lestov factory.

As for the range of temperature, the induction cooker has a wide variation, and the boiling time is far lesser than that of the electric stove or the gas stove. Besides, the surface of the burner remains cool, so you don’t have to be concerned about burning your hands if you touch the surface of the burner by accident.

You can even put a paper towel between the induction burner and a boiling pan. You will find that the pan gets hot, but the surface of the burner is as cool as usual. Because the pan will be inducted by the electromagnetic, but the paper will not.

Advantages of Commercial Induction Cooktops:

Regarding the advantages of the induction cooker: Firstly, it is easy to clean. Since the cooktop itself is not hot, it is easy to clean. Turn off the power first, then clean it with cleaning cream and then with a soft cleaning pad or cloth. Secondly, the new induction cooker has time control or temperature control to prevent the food from burning or over-cooking, and the bottom of the pot is evenly heated.

When the set time is up, it will automatically shut down, but the gas and electronic stoves have no function in this regard. Furthermore, the induction cooker has a built-in protection system. The equipment will automatically shut down once overheating, overvoltage or overcurrent occurs.

Through 18 years of experience and continuous innovation, Lestov commercial induction hob manufacturer has released a series of smart induction cookers in 2020, which can not only achieve time setting and temperature control on the same equipment but also preset and memorize several different menus. For example, for menu number one, you can preset a value for a temperature of 180 degrees for two minutes according to food cooking requests.

For menu number two, you can set the temperature to 100 degrees to cook for ten minutes for another dish, and so on. Once the menus are preset on the equipment, you don’t need so many executive chefs, even an apprentice can operate it, which greatly reduces the labor cost.

Study of different features of machine:

While induction cooking is not new, it has recently grown in popularity because the cost of this technology has become more affordable. Induction cooktops are also safer to use than any other cooking method, are more energy-efficient, provide precise temperature control, and complement popular kitchen designs trending today. But in my opinion, those are only a few reasons why induction cooktops are a must-have. Check out some interesting facts from the experts.

Pure Design:

An Elle Dıcor article, The Biggest Kitchen Design Trends for 2019, stated, “We will continue to see integrated appliances.. Induction cooktops continue to be increasingly popular because of their seamless look. You no longer need to see appliances sticking out everywhere anymore, and that’s the new face of luxury.”

Trending:

According to the 2019 Home Design Trends Survey done by the American Institute of Architects, induction cooking appliances continue to be on the list of popular kitchen features and products.

Precise Temperature Control:

A review by Good Housekeeping stated, “Electric cooktops take much time to heat up and cool down, and it’s difficult to hit a precise temperature with gas ranges. But with induction, you’re afforded super precise temperature control, which allows for more controlled cooking.”

Boost of Power:

Some induction cooktop models have a “power boost” mode to increase the power up to 50 percent in individual cooking zones for those times when you want the pasta water to come up to a boil more quickly.

Individual Timers:

Like any stovetop, you “turn on” a burner or a zone. Some induction cooktop models have individual timers for each cooking zone. Imagine a recipe indicates that a sauce should simmer for 10 minutes, and you could set the cooking zone to “simmer” and a timer to just that zone to “10 minutes,” and when it is done, the cooking zone will turn off automatically. At the same time, another burner could be set for the rice to cook over medium heat for precisely the time needed.

Because only the area that the pot is placed on heats up, the surface around the pot remains cool to the touch making it less likely for spills to “bake on” the surface. Compared to stovetops with an open flame or radiant coil, the smooth glass surface is easier to clean.

It’s Magnetic!

The induction technology automatically detects when magnetic cookware is placed in the cooking zone of the cooktop surface, and an electromagnetic field located below the glass-ceramic cooktop transfers current (heat) directly to the cookware. Induction skips the need to heat a burner, such as an electric coil increasing the overall heating efficiency.

Advanced Safety Features:

Easiest to Clean:

Look for an induction cooktop with advanced safety features such as:

Cookware must be present for a cooking zone to turn on, so you won’t accidentally turn it on, or leave it on after you remove the pan.

All cooktop controls can be locked-down to prevent the activation of any sensor key, except for the Lock keypad.

A residual heat indicator for each cooking zone lets you know if a cooking zone is still hot.

Auto Power Shutdown has cooking zones countdown and turns themselves off after 120 minutes.

Safer Than Any Other Cooking Method:

The safety of children and seniors around the stovetop is always of great concern, but mitigating stove fires should be top-of-mind for all cooks. In addition to the advanced safety features listed above, because only the pan gets hot during cooking, it is less likely that clothing would be ignited if it comes into contact to the cooktop. To read more information about fire safety check out the following resource: In the Home Cooking Fire Mitigation: Technology Assessment report published by The Fire Protection Research Foundation stated the following:

Better for the Planet:

U.S. Department of Energy tested the energy efficiencies of four conventional cooking tops with induction coming out on top at 73.59 percent, electric coil resistance at 71.87 percent, smooth electric resistance surface at 67.72 percent, and gas ranked surprisingly far below at 43.94 percent. And using induction cooktops is better for the environment.

In July 2019, in a first for California and the nation, Berkeley, CA, City Council passed a historic ordinance requiring that new buildings be built all-electric beginning Jan. 1, 2020. The “All-Electric Building Ordinance” means that no gas hook-ups will be installed in new houses, apartments, or commercial buildings. Soon after Berkeley passed its ordinance, many other California cities followed suit, and the effort is spreading to other parts of the country, all the way to Massachusetts.

ADA Compliant Induction Cooktops:

To be considered ADA compliant, an induction cooktop must meet the following requirements:

The maximum high forward reach for controls and operating mechanisms is 48-inches; maximum low forward reach is 15-inches.

Controls and operating mechanisms must be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate controls shall be no more than 5 pounds.

If cooktops have knee spaces underneath, they shall be insulated or otherwise protected on the exposed surfaces to prevent burns, abrasions, or electrical shock.

The location of controls for cooktops shall not require reaching across burners.

Types of induction tubes:

Ultra Flex has provided many manufacturers in the Tube and Pipe industry with induction heating solutions. Induction heating provides quick, concentrated heat on focused areas which increases productivity, repeatability, and saves on operation time and cost.

Induction heating is successfully applied for common processes such as brazing, annealing, pre/post-heating. Some processes require multi zone heat treatment. Our patented SmartPower modular induction heating system allows customers to save on space, energy and helps optimize equipment costs by providing multiple, independently controlled induction coils connected to a single power supply.

How Induction Heating is used in Tube & Pipe Industry:

Induction brazing and soldering of tube assemblies

Preheating of pipes before welding and before bending

Post heating and stress relieving of weldments

Curing of coating and coating repair for the oil pipelines

Induction bonding of plastic pipes with metal inserts

Induction forming of steel tubes and pipes

Hardening and tempering of tubes and pipe ends

Tube annealing and bright annealing

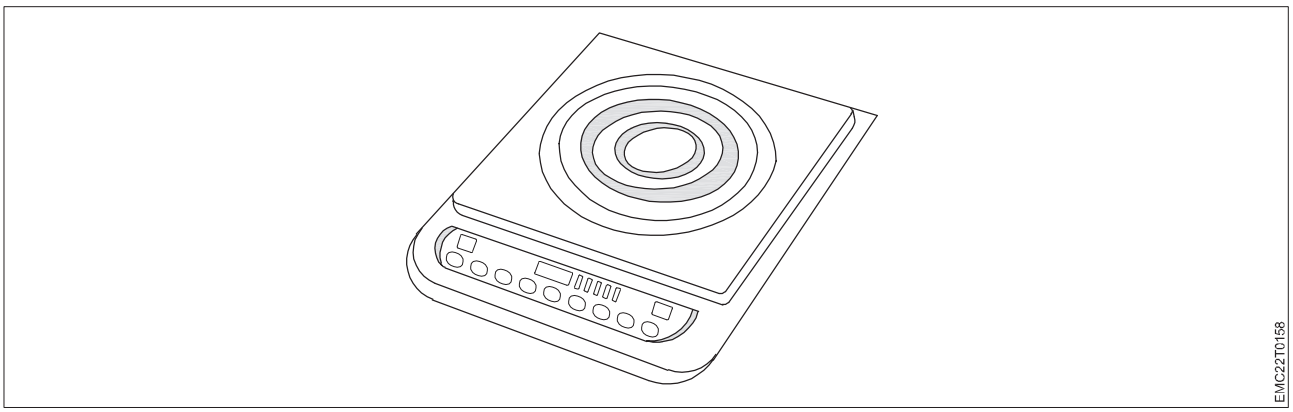
Different component of induction cooktop:

The main components of usual induction cookers are the glass plate, bottom cover, LED display, PCB, induction coil, fan, power cord and plug, and power supply. All induction cooker parts contribute to an accurate and efficient induction cooking, thus if one of them is broken it will not work properly, or worst will not turn on at all.

There are induction cooker fixings that are modular or can be accomplished by the user alone; however, there are also issues that need to be repaired by experts. In essence, who to repair it depends on the problem and how knowledgeable the repairer is.

Therefore, it is important to be familiar with the induction cookers components, for it will be useful when one of them is not working. Any damaged part of it can be replaced by a new one. And, some manufacturers produce only the parts of the induction cookers which are available on the market.

With this, we will provide you with a brief explanation of the basic components of an induction cooker.



Glass Plate:

Let us start with the glass plate. This part is the top surface of the induction cooker which generally is made of glass. The button or touch control signs and text are printed on it. The glass plate is what makes the induction cooker easy to clean and looks sleek.

LED Display and PCB:

A light-emitting diode display (LED Display) of an induction cooker is a panel display that produces light when there is a current flow in it. It allows the user to regulate the induction cooker through its control panel that is connected to the PCB. There are induction cookers that have button control and others have touch control.

The Printed Circuit Board or the PCB is the one that processes the functions asked by the user. It works as the brain of the induction cooker. The PCB itself has various small components. Part of it is the led driver which is attached to the back of the panel display and is linked to the PCB. All other small parts functions are as essential as the major parts.

Power Supply:

The power supply of an induction hob is the device that supplies electrical power to the hob by converting the electric current to the right voltage and frequency. The power supply has input and output connections; the power input receives the current from an electric power source while the output sends the current to the electrical load.

The power supply of an induction cooker is very specific with its power range, such as the voltage and frequency. With this, the power range of the power supply must be compatible with the power source wherein the standard range is between 220 V to 240 V with 50 to 60 frequencies.

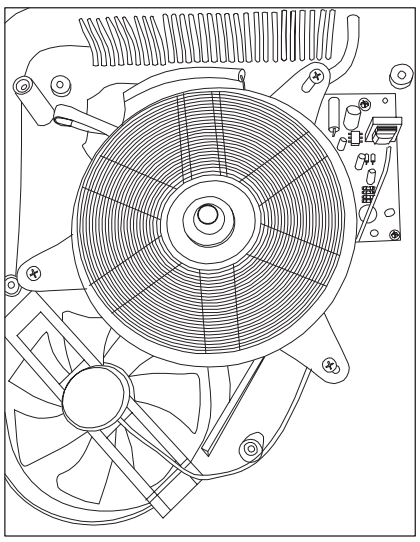
Fan:

The fan functions as the cooling system of the induction cooker. It balances the heat when it is too hot. It also makes the heat residues dissipate after its usage. The details of the fan depend on the hob's interior structure.

Coil

The coil is the unique component of the induction cookers. It is the key to creating a magnetic field, with the electric field, that transfers to the cookware.

Through induction, the electrical energy is transferred to the cookware from the coil. The coil is attached below the induction panel. In the center of it is the temperature sensor, which also has two temperature components.



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Bottom Cover:

Most of the bottom covers are made of plastic, but others are metal and crystal plates. This is used to protect the internal structure of the induction cooker and to form the external design.

Power Cord and Plug:

The power cord and plug are used to connect the induction cooker to the electric power source. The plug used is based on the outlet used by the region as outlets vary by region.

Conclusion:

There are various components of the induction cookers which all play essential functions. These are the glass plate, bottom cover, LED display, PCB, induction coil, fan, power cord and plug, and power supply. If any of the parts are broken, the induction hob will not work properly or will not function at all. Therefore, it is necessary to replace the broken induction cooker parts with a new one.

Fault identification in induction cooking:

The first and one of the most frustrating categories of induction cooktop issues is heating problems. A stovetop serves one function, so when it can't perform that function, it's important to get to the bottom of it fast.

Here are some of the most common causes of induction cooktop heating problems:

Incompatible cookware: Induction stovetops use magnetic waves to rapidly heat your cookware to a specific temperature. Despite mostly being made of metal, not all cookware is magnetic enough to function on an induction stove. If your cookware is aluminum, copper, or ceramic, it may not function well, if at all, with your stove.

Power cycling: This is a normal but often confusing operation that induction cooktops do. Essentially, when a particular internal temperature is reached, the cooktop automatically cuts power to the induction coils. The burner usually resumes function after two minutes. This typically happens when you run the burner on high for an extended period of time.

Improperly positioned cookware: Because induction stovetops use magnetic coils to heat up your cookware, rather than direct heat, they are more particular about cookware placement than gas and standard electric stoves. If your cookware is too large or placed far off the center of the coil, it won't heat up as quickly. A general rule of thumb is to place all cookware in the center of the burner and to use cookware that is the same size or slightly smaller than the size of the burner.

Damaged burner: Like any cooktop, your burners can experience functionality issues as a result of standard wear. If you cannot seem to get it to function, contact an appliance repair professional to handle the repair.

Locked cooktop: Most induction cooktops have a control lock setting that prevents the stove from being used while activated. If you turned it on by accident and can't turn it off, consult your user's manual or research your model online to see how to deactivate it. Usually, it can be turned off by holding the power button, a button with a key or lock symbol, or a button labeled "P" or "L."

Unexpected Noises:

Many of us know the stressful experience of hearing a new noise emanating from our cars while driving, but we tend not to expect that from a kitchen appliance. Much like a vehicle, though, an unexpected sound coming from your cooktop is rarely a sign of something good.

Here are a few common causes of a noisy induction cooktop:

Fan issue: Induction cooktops contain fans that keep the rest of the components cool while the oven or burners are in use. If you notice that the fans are louder than usual, contact a professional appliance repair service to fix your cooktop. Leaving it alone can cause the fan to break, which could compromise the whole appliance.

Vibrating Cooktop: A vibrating pot or pan is nothing to worry about, but if the whole cooktop shakes, that's another story. Typically, this has to do with the glass cover being ineffectively fastened. Check the fastenings and make sure it's sealed down tight. Even luxury brands can experience this issue.

Uneven Surface: Cooktops, especially induction cooktops, need to be perfectly level to operate efficiently. If your cooktop isn't fully level, it can rock your pots and pans around, causing the glass to chip.

Control Panel Issues: Control panel issues are among the more frustrating induction cooktop problems. Everything else about the cooktop may be mechanically sound, but if you can't press the buttons, it won't perform its primary function.

Here are some of the main control panel issues and how you can identify them:

Circuit board issue: Electronics are very particular, and they can break unexpectedly. A circuit board problem requires a replacement from a professional. The best way to avoid frying your circuit board is to always turn off the heat before removing your cookware from the burner.

Co**oktop does not receive power:** If nothing on your cooktop is working, it may be a power supply issue. If you're lucky, resetting the circuit breaker will resolve the issue. Make sure to check both the plug and circuit breaker before calling in a professional.

Heat sinking in induction cooktop:

Standard Cooking Efficiency Test Procedures It is important to follow a standard test procedure when evaluating efficient products so that their performance can be compared with other devices in an unbiased way. The primary test procedure for measuring the efficiency of consumer cooking appliances in the U.S. is specified by the Department of Energy (DOE) (US National Archives and Records Administration 2012). In its procedure, DOE specifies the heating of a solid aluminum test block on maximum power until its temperature has increased by 144° F (80° C). At this point, power is reduced to 25% ±5% of maximum and held for 15 minutes. Cooking efficiency is calculated as the ratio of thermal energy absorbed by the block divided by the energy consumed by the device as it heated th block. Because this procedure specifies that an aluminum test block be used as the cooking load, it cannot be applied to induction cooking products. To address this limitation, DOE proposed an amendment to its test procedure in 2013 that would allow induction technology to be tested alongside conventional cooking technologies. The proposal specifies that a "hybrid test block" composed of two pieces be used in place of the aluminum test block. The body of the test block would remain aluminum, but the aluminum block would fit inside of a base made of ferromagnetic stainless steel. This two-piece block would be used in testing all cooking technologies, including conventional electric and gas. Apart from DOE's test procedure, two test procedures used by the food service industry provide an alternate method for evaluation the efficiency of cooking appliances. One of these test procedures is specified by the American Society for Testing and Materials (ASTM) in its standard F1521, which is applicable to both gas and electric ranges and cooktops (ASTM 2012). The cooking efficiency component of this test procedure calls for the heating of 20 pounds (9.07 kg) of water in a 13" (33 cm) aluminum stock pot. The water is heated from 70° to 200° F (21° to 93° C), with efficiency calculated as the change in thermal energy of the water divided by the energy consumption of the device.

MODULE 19 : PLC & Electronic pneumatic

LESSON 180 - 187 : PLC

Objectives

At the end of this exercise you shall be able to

- state about PLC
- state the design, working principle & application of PLC.

Introduction

PLC is a digital computer used for automation of electromechanical processes in plants. The PLC is designed for multiple inputs and outputs arrangements, so we can get the data from the sensors, work with it and command the actuators.

Evolution of control technology

The first Programmable Logic Controller (PLC) was developed by a group of engineers at General Motors in 1968, when the company were looking for an alternative to replace complex relay control systems. The new control system had to meet the following requirements:

- Simple programming
- Program changes without system intervention (no internal rewiring)
- Smaller, cheaper and more reliable than corresponding relay control systems
- Simple, low cost maintenance

The function of an input module is to convert incoming signals into signals that can be processed by the PLC, and to pass those signals to the central control unit. The reverse task is performed by an output module. This converts the PLC signal into signals suitable to operate and invoke the plant actuators. The actual processing of the signals is undertaken in the central control unit and with respect to the program stored in the memory.

Advantages of PLCs

PLC features can be concluded in the following:

They are rugged, withstand industrial environment, such as heat, humidity,

mechanical shocks and vibrations

In a PLC based system we can easily identify the exact location of the fault by simply seeing on the system monitor but where as in conventional relay systems it is difficult to identify the fault location.

If we want to modify any changes in circuit , in PLC based systems we can easily modify the circuit by just changing the ladder diagram circuit and upload it to the system, but in an over relay based systems it is very difficult to modify the circuit we had to replace it with new one.

Power consumption by a PLC based system is very less compared to relay based systems.

A multiple devices like (alarms, motor, sensors, pressure gauge , etc..) can be install in a single PLC system but whereas in relay based system it is not possible to get all the devices all in one system we need to combine them separately.

Some PLC can be connected to HMI (Human Machine Interfaces) where we can simply operate the device from the motor terminal by a small display unit it is not possible in relay based systems.

In PLC any complex logics can be built easily by having some system knowledge but in conventional relay system it is difficult to have a very complex logics.

The fault clearance in PLC is very easy and it is maintenance free.

It can work at any temperatures with ease.

The basic procedure for programming PLC.

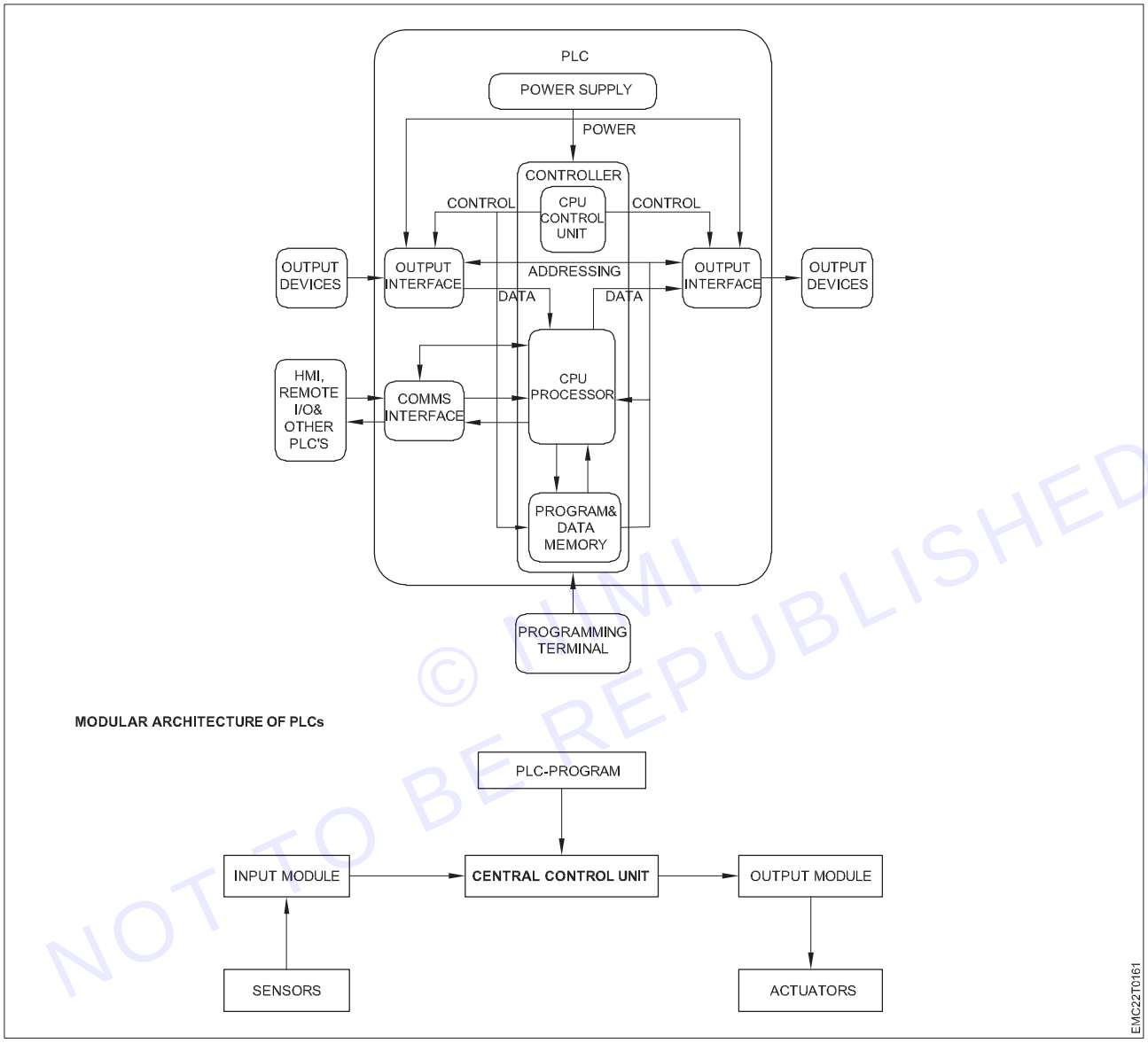
Designing the solution to the automation task

Creating a project

Configuring the hardware

Creating a program

Transferring the program to the CPU and debugging



Types of Modular PLCs

Small PLC

Medium-sized PLC

Large PLC

Small PLC:- Small PLC is a mini-sized PLC that is designed as compact and robust unit mounted or placed beside the equipment to be controlled This type of PLC is used for replacing hard-wired relay logics, counters, timers, etc.

Medium-sized PLC:-It is mostly used PLC in industries which allows Many plug-in modules that are mounted on backplane of the system .

Large PLCs:- Large PLCs are used wherein complex process control functions are required. Mostly, these PLCs are used in supervisory control and data acquisition (SCADA) systems, larger plants, distributed control system, etc.

How PLC works ?

A programmable controller has a user programmable memory that reads input conditions and sets output conditions to control a machine or process through the control program stored in the memory. PLC system consists of three division:-

Input section – Input section consists of push-buttons, switches and sensors which are connected to specific addresses in the program. They transfer address information to the processing section.

Processing section – The microprocessor receives the input signal from input section and execute the information in the software program and sends the processed signals to output section.

Output section – Takes the signal from processing section and modify the signal from the processor to operate output devices connected to specific output addresses.

Modules of PLCs

It is built with several components that are plugged into a common rack or bus with extendable I/O capabilities.

It contains power supply module, CPU and other I/O modules that are plugged together in the same rack, which are from same manufacturers or from other manufacturers

These modular PLCs come in different sizes with variable power supply computing capabilities, I/O connectivity etc.

PLC is essentially a microcomputer consisting of hardware and software. The major components are

1 Power Supply module

2 Input module

3 Central processing unit

4 Output modules

5 Software

1 Power supply module:

Usually input output modules require 24V DC and processor require 5V DC. Usually power supply is integral part of PLC. Power supply units convert 120/230 V AC line voltage to standard supply 24 VDC or 5V DC using standard rectifier circuits

2 Input module

Input devices include push buttons, sensors, potentiometers, pressure switches. The function of the input module is to covert high voltages from input devices to low level logic voltages that the CPU uses internally for processing. Input module can process both analog input and digital input. Digital inputs are more preferred in Industry.

Analog Input module :-Analog input module is used to convert analog signal form analog devices like temperature sensors, pressure sensors etc. to digital signals using ADC (Analogto digital convertor).Analog signal is varying voltage in the range of 0-12 V or current in the range of 5-20 mA. These values of current or voltage is converted into integer value (say16 bit word)

3 Central processing unit

The central processing unit controls and processes all operations within the PLC and hence called brain of the PLC. The CPU can perform various arithmetic and data manipulation function with the local and remotely located Input/output sections. Further, the processor can perform many communication functions it needs to interface with a personal computer, remote Input/Output, other PLCs and peripheral devices Functions of CPU are :

A It receives Input from various sensing devices and switches

B It executes the user program

C It makes various decisions to control the operation of the equipment or process

D It can perform various arithmetic and data manipulation functions

E It delivers corresponding output signals to various load control devices such as relay coils and solenoids

4 Output module

Output devices include contactor coils, solenoid coils, lamps, etc. Output module amplifies the low-Level logic signals generated by the CPU and pass these modified signals to the final control elements to operate the output devices.

5 Software

PLC consists of two parts: Operating systems and user program. The PLC operating system provides effective

support ranging from the creation of project structure to the creation of user programs. The OS system is accessed through a graphical user interface window (also known as main window). The main window contains all the functions needed to set up a project , configure the hardware , write and test programs. User program can be written in any standard PLC programming language like ladder diagram or statement list While processing a PLC program, the CPU scans and executes the main program cyclically; A program scan cycle consists of sequential operations that include input scan, program scan, and output scan. In the input scan, the CPU updates the process image input table, in the output scan; the CPU updates the process image output table. After the completion of each scan cycle, the CPU returns to the beginning of the next cycle and again repeats the cycle. The time taken to scan one program is called scan-Cycle time.

Addressing /programming of plc

Addressing:-

Addressing is the most important concept to understand when learning PLCs. Addressing is how we make a correlation between the field devices controlled by the PLC, and the data that is stored in the PLCs memory. If you cannot address a point or group of points in the PLCs memory, then you cannot control the field device associated with that point. The easiest way to approach understanding the addressing used in the Allen Bradley PLC-5 is to view all addresses from the processors point of view. By this, we mean that in order for a real device in the field, such as a relay, to be operated by the PLC, the PLC must first have a record of that point in its memory. That point can then be accessed by the PLC.

Chassis

Hardware assembly (physical rack) that houses devices such as I/O modules, adapter modules, processor modules, and power supplies. Chassis are available in six sizes: 4-, 8-, 12-, and 16-slot.Talk Page

Group

An I/O addressing unit consisting of one input and one output word (16 bits each) of the data table. Depending on the density of the I/O module and the addressing mode used, some of the bits in a group maybe unused. The group number is included in I/O addresses in the position represented with agin the format:I:rrg/xx.Talk Page

Rack

An I/O addressing unit that corresponds to eight input image table words and eight output image table words(8 groups). A rack is a logical entity not to be confused with the physical chassis. 8 groups = 1 full rack, 6groups = rack, 4 groups = rack, 2 groups = rack. The rack number is included in I/O addresses in the position represented with an “rr” in the format: I:rrg/xx.Talk Page

Slot

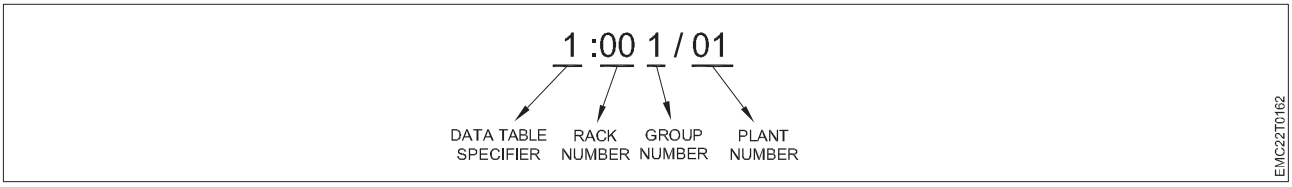
A location in a chassis for installing a module. The number of physical slots per group determines the addressing mode.

Elements

Data files are made up of individual data blocks called “Elements” or “Structures”. Each element is composed of “words”, and each word is composed of “bits”. Elements are comprised of from 1 to 56 words, depending on the instruction. Most instructions you will encounter will have from one to three words to an element. An example of an element level address is T4:0T4:0 indicates the first timer (0) in the default timer file (T4). Each timer is comprised of three (3) 16 bit words. When you say T4:0, you are referring to all three of these words as a group.

Rack Addressing Rules

Addressing to a rack is just assigning a physical slot in the chassis to a logical word in the processor. Rack addressing involves only data tables 0 and 1, the output and input data tables. The type of addressing shown is called Single slot addressing and is the most common type of addressing used in Allen Bradley PLCs. To review the rules for rack addressing, use the following while referring to the previous figure on PLC 5 Racks.: A rack is a logical term that defines 8 words in the processor input data table and 8 words in the processor output data table. These words are numbered 0-7.Each logical rack can store 128 bits of information in its input rack and 128 bits in its output rack. (8words per rack x 16 bits per word=128 bits of data storage)In single slot addressing, each physical slot is addressed to one input word and also to one output word. This makes it possible to put either an Input module or an output module in any slot. The number of logical racks determines how many points a particular model of PLC can address. This number is fixed for any particular processor and cannot be changed. Rack addressing is always in the format shown in Figure



Programming:-

There are various approaches for entering the program into PLC they are:-

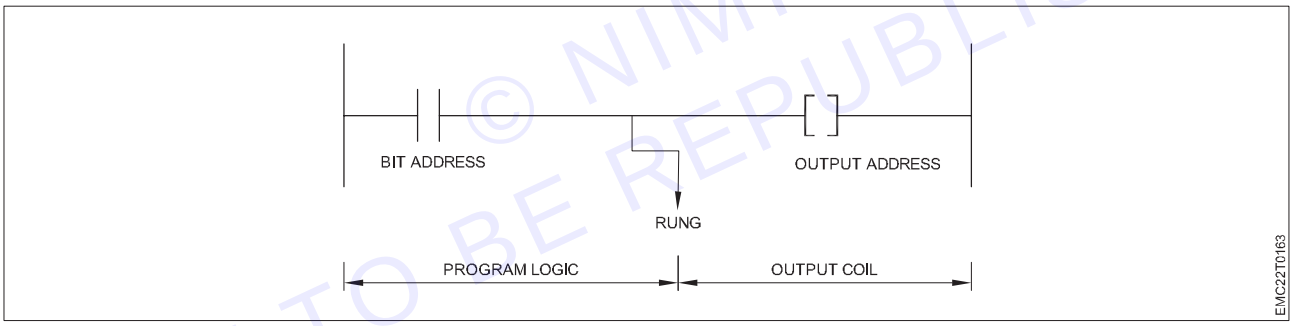
1 Ladder diagram based

2 Low level based on Boolean expressions

3 Functional blocks

4 High level language

Most of the programming methods used today for PLC are based on the ladder logic diagram. Therefore the concept of ladder diagram is explained in the following sections. The PLC programming based on the use of ladder diagram involves writing a program in a similar manner to drawing a switching circuit. The ladder logic diagram is converted into PLC ladder diagram by using the conventions of PLC ladder diagram constructions. This method requires the use of simple keyboard and CRT with minimum graphic capability to display the symbols, representing components and their inter relationship in the ladder logic diagram. The components are of two types, contact and coils. Contacts are used to represent input switches, relay contacts and similar elements. Coils are used to represent load such as solenoids, relays, timers, counters etc. The programmer inputs the ladder diagram rung by rung into the PLC memory with the CRT displaying the results for verification. The ladder diagram has two vertical sides (also called rungs) see fig.1.1.



The left side line represent line with a positive voltage and right side represent a line with zero voltage. Between these two sides are the horizontal rungs for the assumed power flow. The symbols representing the various program elements are placed on the rungs in order to realize the required control task.

There are five program elements/operations commonly used in PLC ladder diagram they are

1 PLC Bit logic operations

2 Timer Operations

3 Counter operations

4 Comparison operations

5 Arithmetic operations

1 PLC bit logic operations : Some important programming elements for bit logic operations are

a NO contact b NC contact c Coil

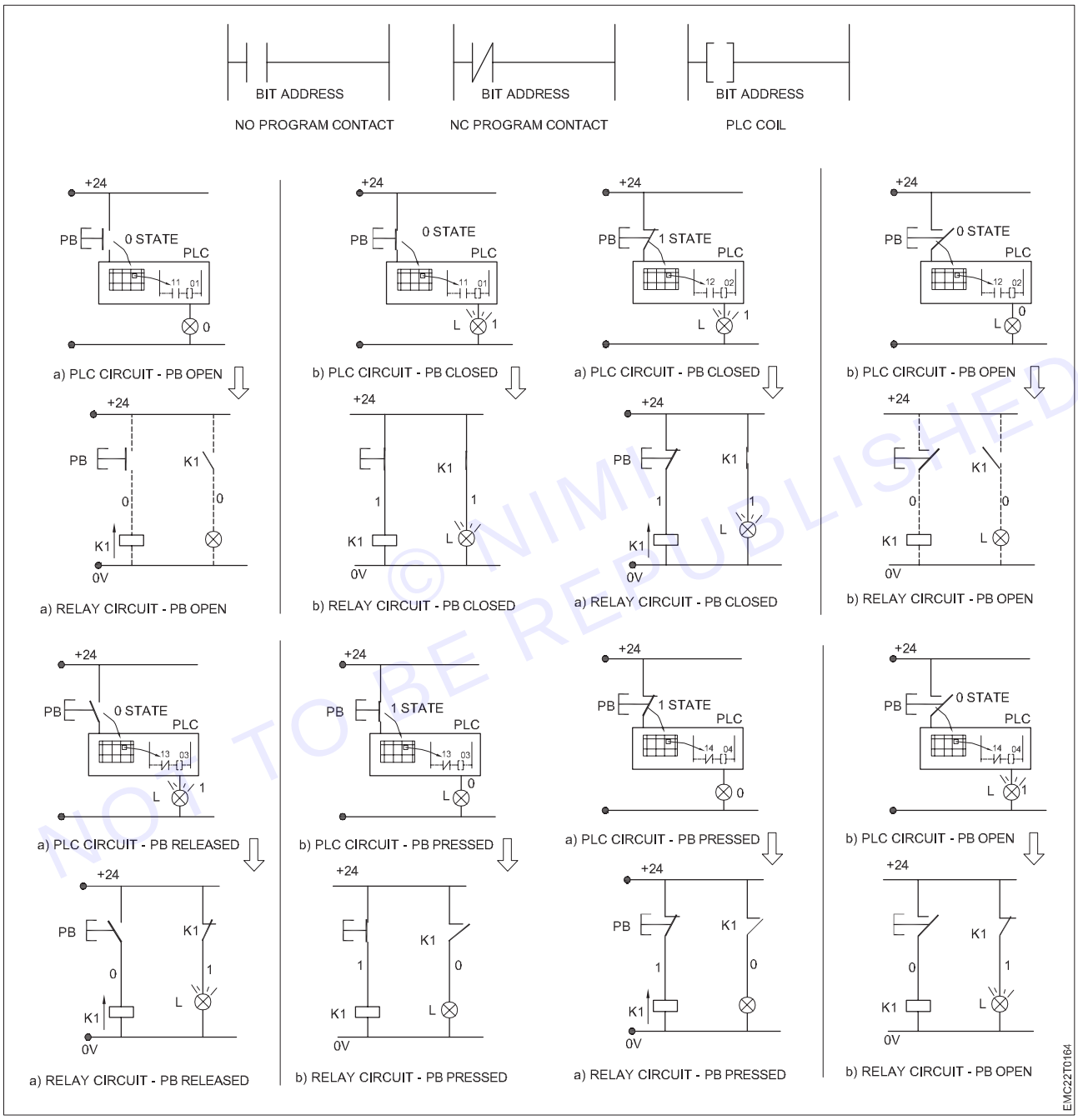
Each of these elements can be selected from the program window. NO and NC elements should not be confused with the hardware NO and NC contacts of switching devices.

NO Contact of PLC:

The PLC representation of NO contact is given in Figure1.2. This contact scans for the signal state ON (1) at the specified bit address. Power flows through NO contact if the scanned bit address has a signal state ON (1). This contact is used for scanning the signal state of input devices or output devices or other internal program elements.

NC contact of PLC

The PLC representation of NC contact is given in Figure 1.3. This contact scans for the signal state OFF (0) at the specified bit address. Power flows through NC contact if the scanned address has a signal state OFF (0). This contact is used for scanning the signal state of input devices or output devices or other internal program elements. Figure 1.4 Shows PLC circuit with NC contact position using NO push button. Figure 1.5 Shows PLC circuit with NC contact position using NC push button

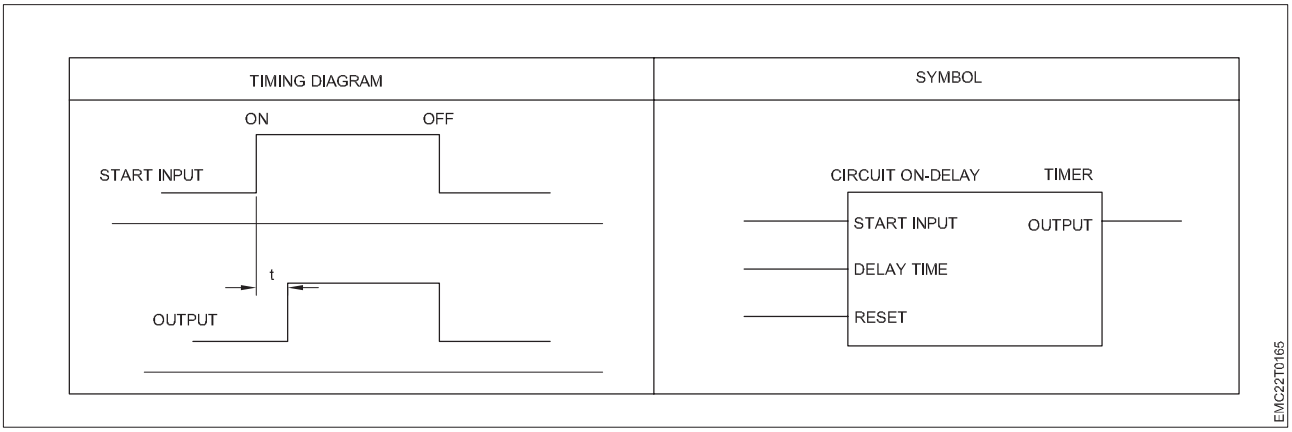


PLC TIMERS

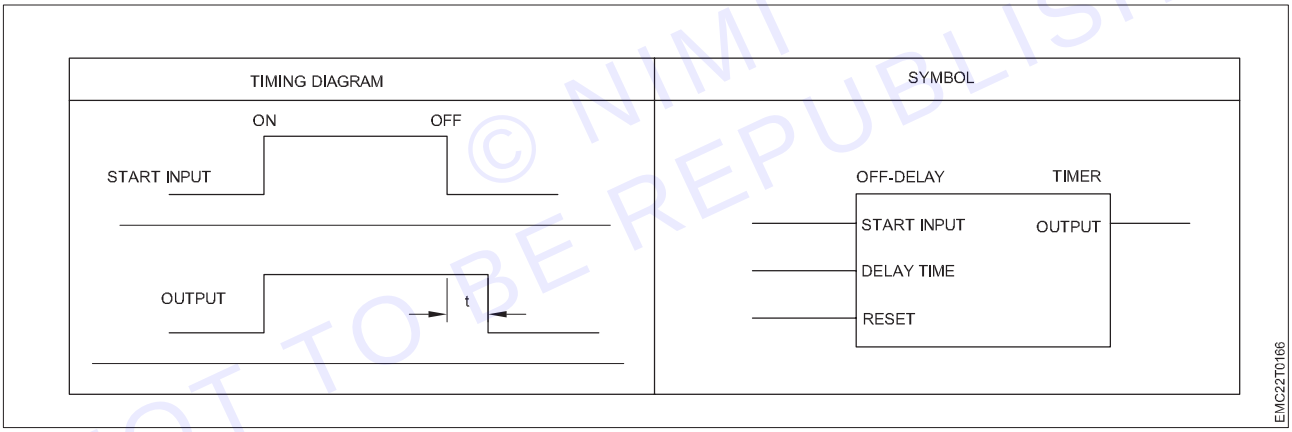
Many control tasks require the programming of time. For example, cylinder 2 is to extend, if the cylinder 1 is retracted- but only after a delay of few seconds. The timers of a PLC are realised in the form of software modules and are based on the generation of digital timing. Memory space is allocated in system memory to store the values of the delay time. The representation of the timer address varies from manufacturer to manufacturer. For sake of understanding we shall as T1, T2for timer addresses. The typical number of timers available in commercial PLC are 64, 128, 256 , 512 or even more. To explicitly reset timer, an RLO of 1 has to be applied at the reset port.

There are two types of timer:-

PLC on delay timer : The timer will be ON state when it receives a start input signal and the signal state of output changes to 0 from 1 , when preset timing is reached. The signal state of the output changes from 0 to 1 when preset time has been reached with reference to change of RLO(Result of logic operation) from 0 to 1(ON) at the start input .Functional diagram Is shown in Figure 1.6

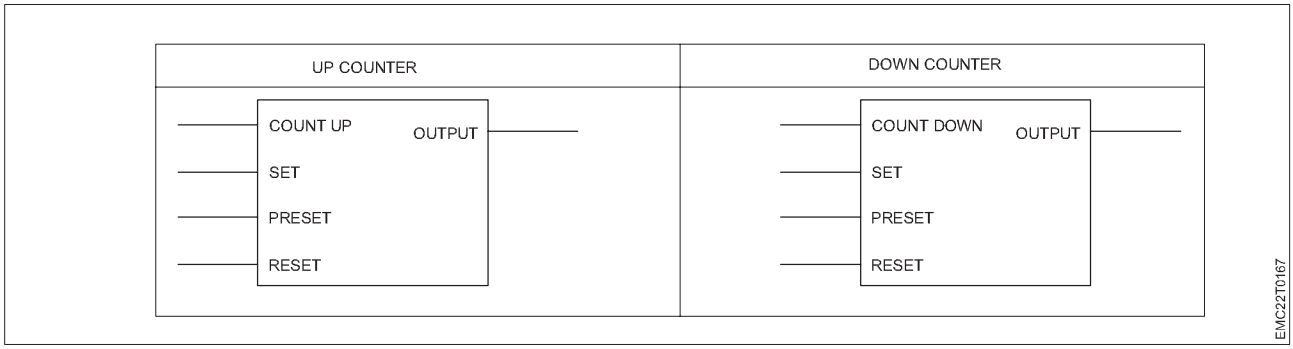


PLC off delay timer : The timer will be ON state when it receives a start input signal and The signal state of output changes to 1 from 0 , when preset timing is reached. The signal state of theoutput changes from 1 to 0 when preset time has been reached with reference to change of RLO from 1 to 0(OFF) at the start input. Functional diagram is shown in Figure 1.7.



PLC counters

Counters are used to detect pieces numbers and events. Controllers frequently need to operate with counters in practice. For example: a counter in circuit is required if exactly 20 identical components are to be conveyed to a conveyor belt via a sorting device. There are two basic counter types a) Count Up b) Count down When the input to count up counter goes true the accumulator value will increase by 1 (no matter how long the input is true). If the accumulator value reaches the preset value the counter bit will be set. A count down counter will decrease the accumulator value until the preset value is reached. Symbols are shown in Figure 1.8



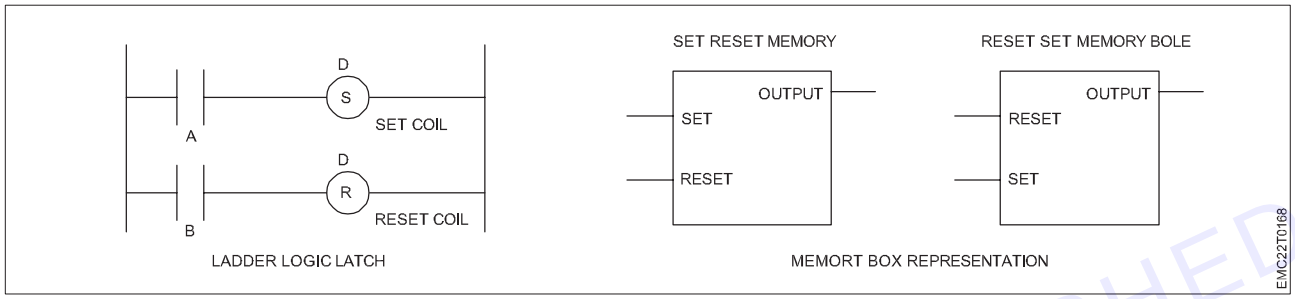
Counter parameters

Accumulative value(ACC)-number of false to true transitions that have Occurred since the counter was last reset

Preset value(PRE)- Specifies the value that the counter must reach, before The controller sets the done bit. When the accumulator value becomes equal To or greater than the preset value, the done status bit is set. This can be Used to control an output device

PLC memory elements

Memory elements are used to store intermediate values. Memory function are achieved using flags (bit memory locations) and system memory. Specified bit memory can be set or reset using a set coil. A latch in ladder logic uses one instruction to latch and a second instruction to unlatch, as shown in Figure 1.9. The output with an S inside will turn the output D on when the input A becomes true. D will stay on even if A turns off. Output D will turn off if input B becomes true and output with a R inside becomes True.



Both set coil and reset coil can be combined in one box as shown in Figure 1.10. Following instructions are to be followed while writing a program for memory function

Setting up a memory location

Resetting up a memory location

The memory address locations vary from manufacturer to manufacturer. For sake of simplicity

We shall use M1, M2 …To represent memory. Number of bit memories available in PLC for memory are 1024, 2048 8192 and more. If the power flows either momentarily or continuously to the set coil, the specified memory address is set to signal state 1. If power flows momentarily or continuously to the reset coil , the corresponding memory address is reset to signal state 0. If there is no power in the set input or reset input, the memory address remains unaffected. The output of the memory function can be accessed through either NO or NC program element.

Set and reset functions are combined in one memory box as shown in Figure 1.10. They can be further classified into two categories

a Memory box with set priority

b Memory box with reset priority

The functions of a memory box are similar to the memory coils. In the memory box with set priority, the associated memory address is set when signal state 1 appears simultaneously at both the set and reset inputs. In the memory box with reset priority, the associated memory address is reset when signal state 1 appears simultaneously at both reset and set inputs.

Wiring of field devices to various module in PLC:-

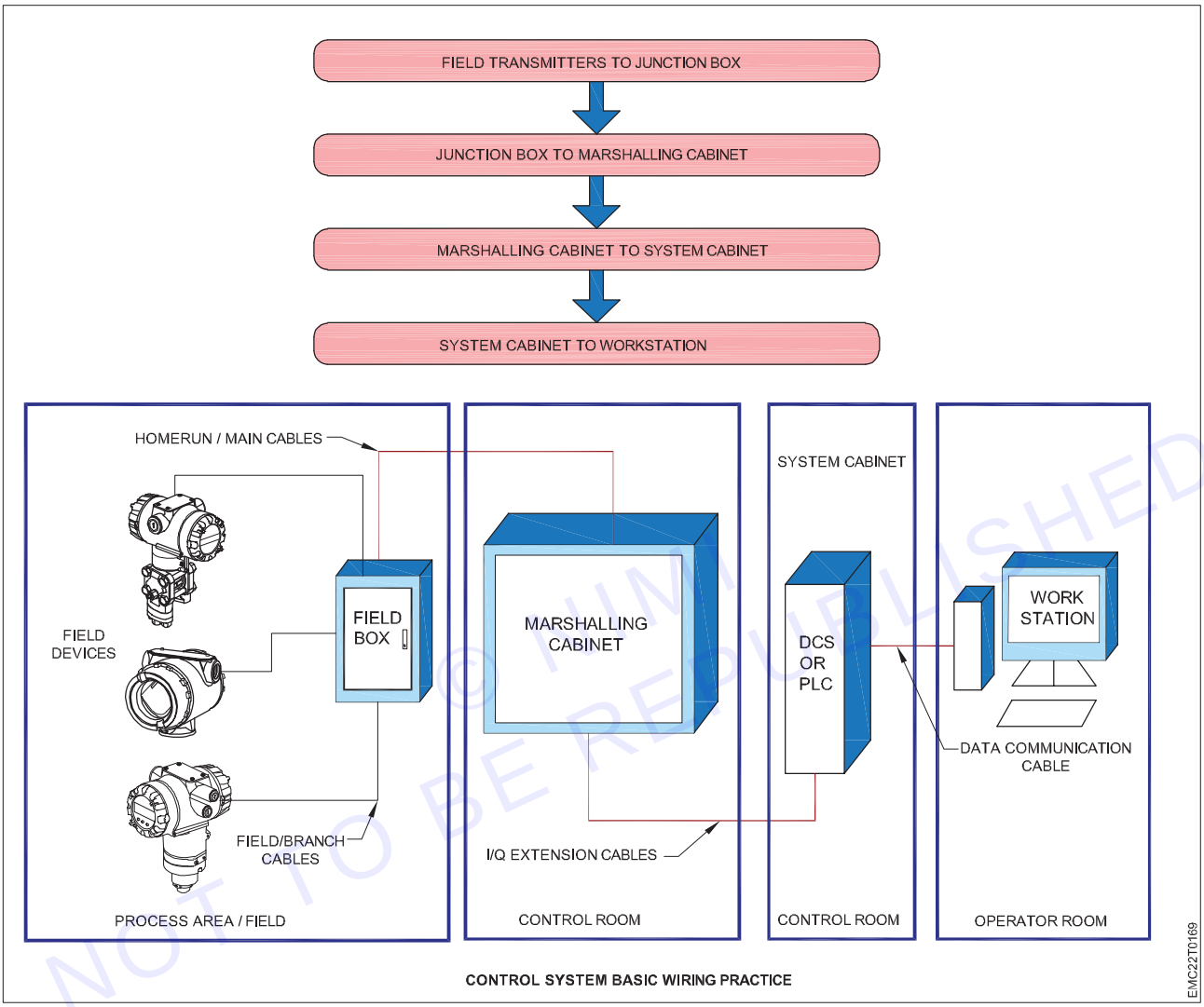
A programmable logic controller is an industrial computer control system that monitors the input device continuously and it takes a decision based upon the custom program to control the state of output devices.

During the wiring of PLC, the wire size is an important factor. One or more conductors can be accepted by the input-output terminal of a particular wire size we need to check that if the wire is the proper size and is correct gauge so that it can handle the maximum possible current.

Wiring interlocks need a good understanding of the logic to be implemented as well as the electrical standards that need to be implemented to fulfill it. So, it is said the one who is a master in designing and understanding electrical wiring logic and interlock can easily.

The PLC panel consists of the main breaker switch, bus bar, circuit breakers, relays, contactors, PLC, fuses, SMPS, terminal boards, utility sockets, and earthing points. A typical cabling scheme that collects and distributes signals to and from the field devices.

A Field Junction Box Is used to concentrate the signals into multi-conductor homerun cables or main cables.



CONTROL SYSTEM BASIC WIRING PRACTICE

Wiring of PLC include below system:-

The homerun cables then terminate in a remote or marshalling cabinet where the signals are marshalled (reorganized) as necessary to efficiently terminate at the I/O interface of the DCS or PLC system

LESSON 188 - 198 : Electronic pnuematic

Objectives

At the end of this exercise you shall be able to

- state various types of pneumatic actuator & their priciple.

Pneumatic Actuator is a device that converts the energy of compressed air or gas into mechanical motion. Here, depending on the motion obtained by the actuator, the actuator can be rotary or linear type. “Pneumatic actuators are known to be a highly reliable, efficient and safe source of motion control.”

A pneumatic actuator diagram is given below showing different configurations-

Figure- Pneumatic Actuators

Pneumatic actuator Valve

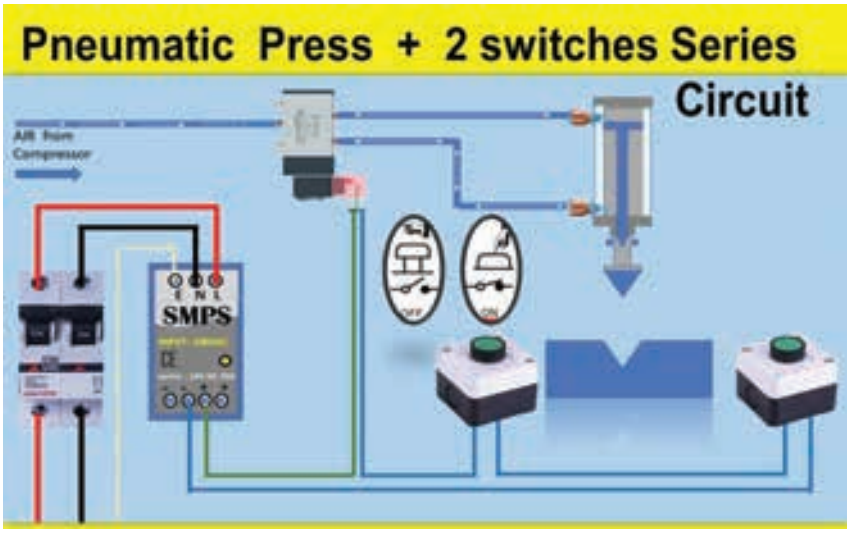
A pneumatic actuator converts pneumatic energy into mechanical energy which controls a final control element such as a control valve according to the received control signal. The pneumatic actuator used to operate the control valve is called pneumatic actuator valve. Normally in industries, pneumatic systems use air pressure of (80 to 100) PSI for their operation. Actuator valves primarily consist of a diaphragm or a piston surrounded by a metallic enclosure and a stem attached to the diaphragm or piston which can be connected to the valve stem through a coupling. They can have either a single pneumatic signal port with a spring return mechanism which is referred to as a single acting actuator or it can have a double pneumatic signal port which is referred to as a double acting actuator. Apart from this, according to the valve type, linear or rotary actuator is connected. The diagram of a simple pneumatic actuator valve is shown below-

Push button switches

- Momentary push buttons return to their unactuated position when they are released.
- Maintained (or mechanically latched) push buttons has a latching mechanism to hold it in the selected position.
- The contact of the push buttons, distinguished according to their functions,
- Normally open (NO) type
- Normally closed (NC) type
- Change over (CO) type.

Normally open type

- In the NO type, the contacts are open in the normal position, inhibiting the energy flow through them.
- But in the actuated position, the contacts are close



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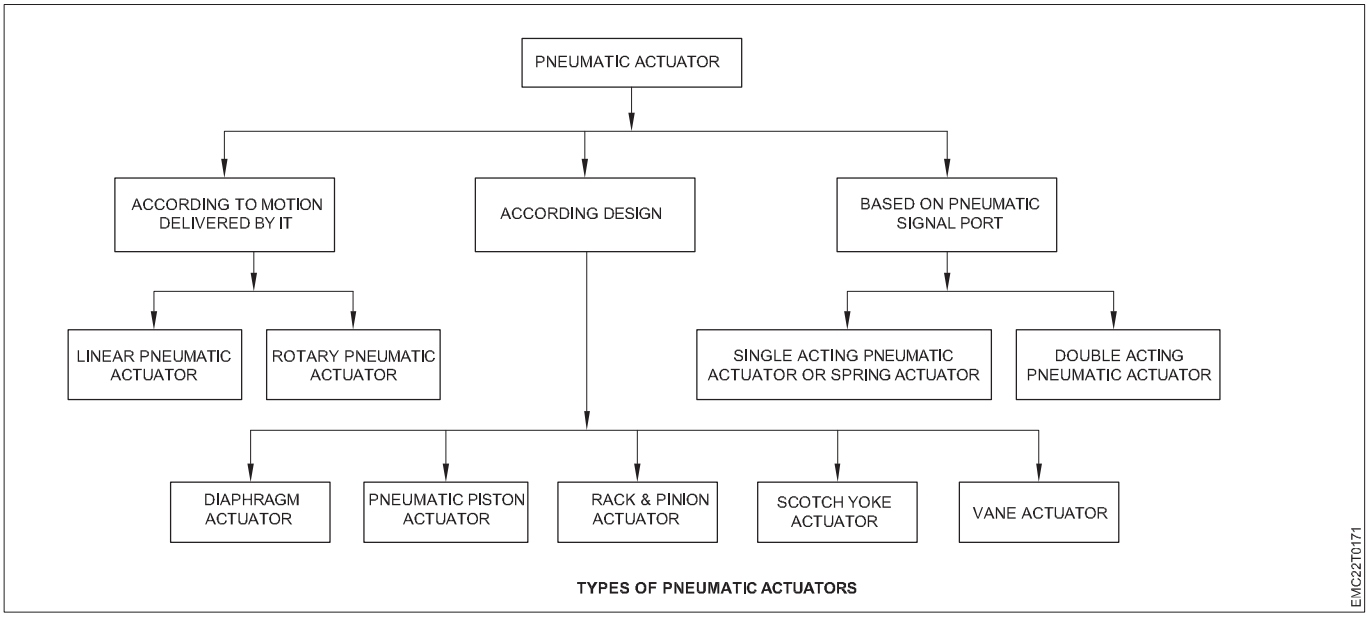
Pneumatic Actuator Valve

Figure-
Pneumatic actuator valve

Types of pneumatic actuators

The pneumatic actuator uses the energy of compressed air for its operation. They can be classified as described below-



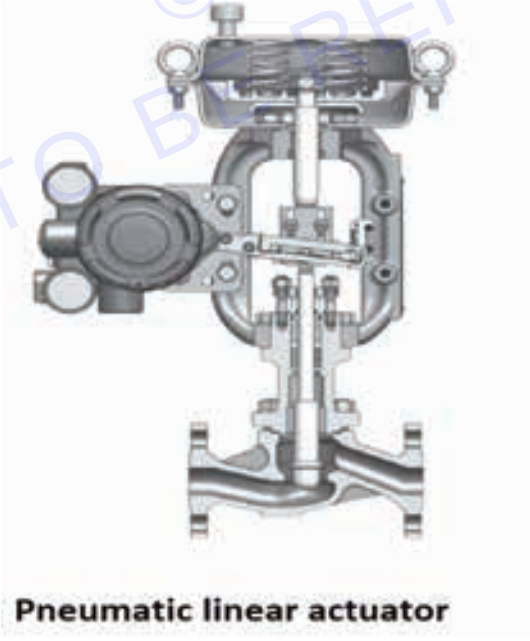
TYPES OF PNEUMATIC ACTUATORS

Types of pneumatic actuators

Pneumatic linear actuator

When a pneumatic actuator provides linear motion in response to controlled air pressure applied to it, it is called a pneumatic linear actuator. Mostly such actuators are used for fluid flow applications in globe valves and also to precisely regulate gate valves. The diagram of linear actuator with globe valve application is shown below-

Pneumatic linear actuator



Pneumatic linear actuator

Pneumatic rotary actuator

When pneumatic actuators provide rotary motion in response to controlled air pressure applied to it, it is called pneumatic rotary actuator. Typically the rotary actuator can turn 90 degrees (quarter turn) during full scale movement. These are used to operate ball valve, butterfly valve. A diagram for pneumatic actuator with ball valve and butterfly valve application is shown below-

Pneumatic rotary actuator with ball valve and butterfly valve

Diaphragm actuator

Diaphragm actuator is pneumatic actuator which uses a supply of compressed air and is normally used to operate control valves such as globe valve, butterfly valve according to the received control signal. Normally it is used to adjust the fluid to regulate some process variables, such as pressure, fluid level, temperature, flow rate etc. They are used in process industries, oil and gas industry, refineries. A diagram for a simple diaphragm actuator with its parts/components is shown below-

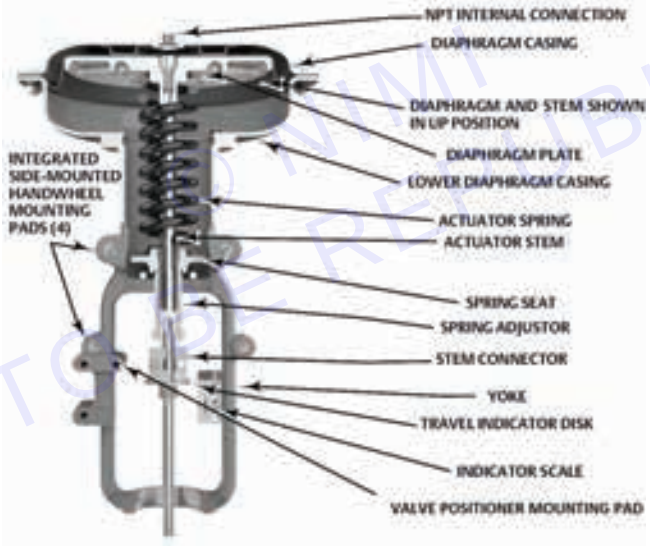


FIGURE- PARTS OF A DIAPHRAGM ACTUATOR

Diaphragm actuator

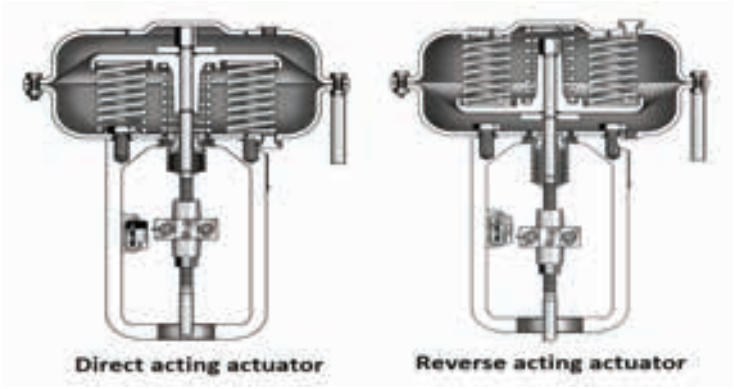
A pneumatic actuator basically consists of a rubber diaphragm with a spring return mechanism enclosed in a metal casing. When a controlled air pressure is applied to the signal port (at one end of the diaphragm), the diaphragm expands and spring compression occurs and hence the actuator stem travels.

Diaphragm actuators are available in single acting types because air is only supplied to one side of the diaphragm, and they can be either direct acting (spring-to-retract) or reverse acting (spring-to-extend). Two possible configurations exist—"direct acting" (spring-to-retract) and "reverse acting" (spring-to-extend).

Direct Acting and reverse acting

In direct action, air enters from the top area of the diaphragm (at the input port) and pushes the diaphragm down against the spring. Direct-acting types are suitable for air-to-close (ATC) and fail-open (FO) applications.

In reverse action, the air supply port is located below the diaphragm which pushes the diaphragm upward against the spring. Most control valve actuators are reverse-acting types as they offer fail safe modes in the form of air to open and fail closed (FC) positions.



Pneumatic piston actuator

A pneumatic actuator is a device that converts the energy of compressed air into motion according to an applied control signal. When using a diaphragm actuator, there is a shorter stroke length and smaller thrust range due to the diaphragm. To achieve a larger stroke length and higher thrust, we use a sealed

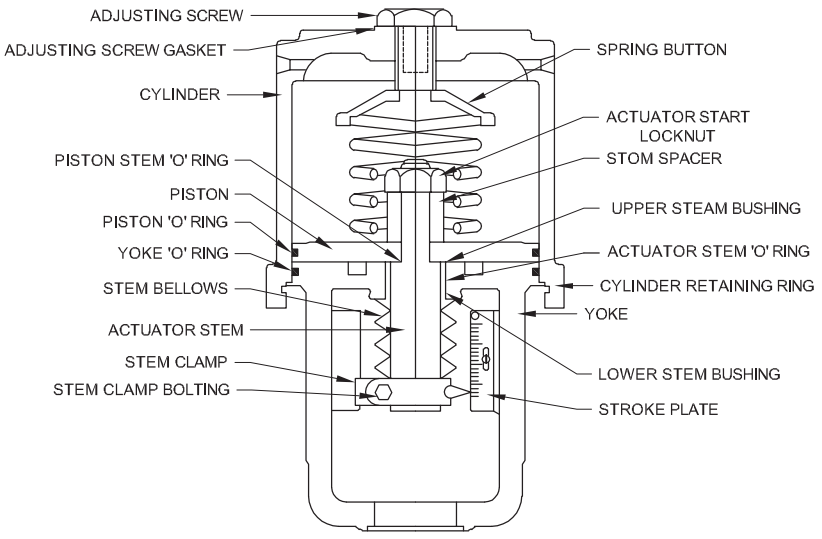
piston enclosed in a metal cylinder. Here the desired stroke length can be obtained by changing the length of the cylinder and the desired thrust can be obtained by changing the internal diameter of the cylinder. The piston actuator can be either signal acting type with one signal port with a spring return mechanism or double acting type with two air ports available. Piston cylinders are used for large stroke applications (such as damper actuator). The diagram of 2 different configurations of piston actuator is shown below-

Piston Actuator

A diagram showing various parts and components is shown below-

Parts of a piston actuator

- PISTON CYLINDER
  - CYLINDER & RETAINING RING
  - PISTON
  - PISTON O-RING
  - PISTON STEM O-RING
  - SPRING
  - SPRING BUTTON
- ACTUATOR STEM
- STEM CLAMP
- ACTUATOR STEM LOCKNUT
- UPPER STEM BUSHING
- LOWER STEM BUSHING
- ACTUATOR STEM O-RING
- YOKE
- YOKE O-RING
- STEM BELLOWS
- ADJUSTING SCREW
- ADJUSTING SCREW GASKET
- STROKE PLATE



PARTS OF A PISTON ACTUATOR

Rack and pinion actuator

Another type of pneumatic actuator is rack and pinion actuator which is used mostly for on-off application (i.e. to open and close the valve) of quarter turn valves like Butterfly, Ball, Plug valves & dampers. . “Rack and pinion” is a generic term for a pair of gears that convert linear motion into rotary motion. A linear gear bar called the “rack” engages the teeth on a circular gear called the “pinion”. The linear force applied on the rack will cause rotary motion of the pinion. A figure showing a simple rack and pinion mechanism is given below-

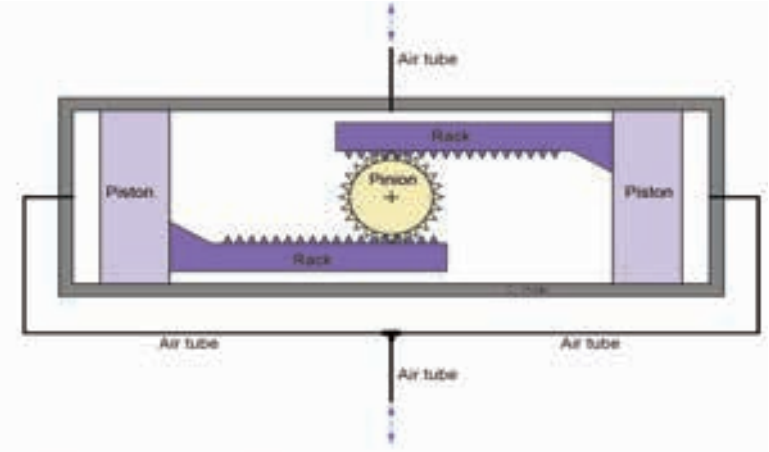


FIGURE- SIMPLE CONSTRUCTION OF A RACK & PINION ACTUATOR

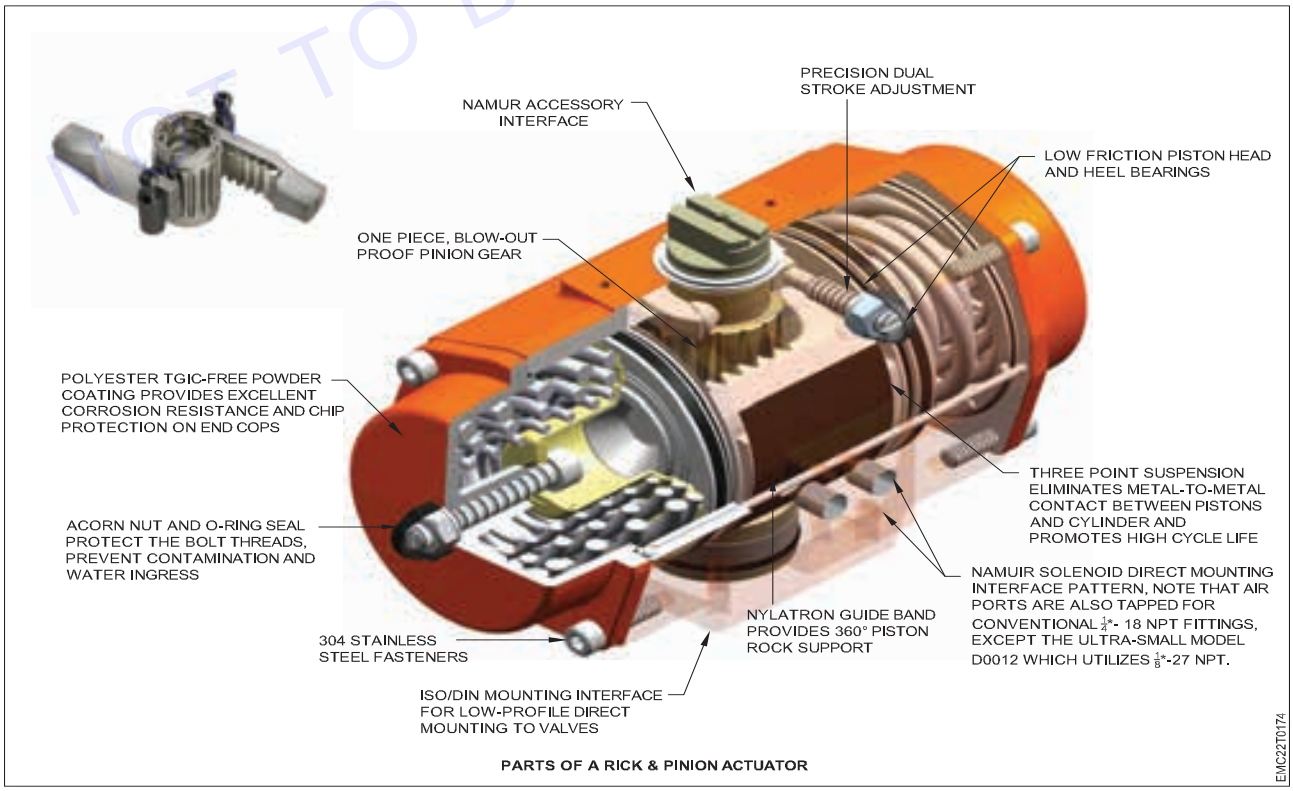
Rack and pinion mechanism

“The rack and pinion mechanism uses two piston-type racks moving in opposite directions to ensure balanced forces on the pinion. normally, pneumatic air pressure is used to power the actuator. By applying pressure on the piston rack, the pinion can be changed to the desired position. The pinion bottom connects to the valve stem to open and close the valve as the pinion turns. These actuators are available in two constructions-

spring return – Mechanical spring return is for fail-safe applications and can be assembled for “fail close” or “fail open” safety function, and

Double acting – Double acting actuators can be used for “fail to lock position” safety function.

Parts of rack and pinion actuator



PARTS OF A RICK & PINION ACTUATOR

Scotch yoke actuator

This actuator uses a Scotch yoke mechanism for its operation and converts linear force into torque to motorize the quarter turn valve. Two configurations are available – "single acting and double acting". Scotch yoke actuator consists of 2 main components – housing containing the yoke mechanism, pressure cylinder containing the piston. In signal acting type, spring also becomes a part of it, where in double acting there is no spring and air pressure is required for both closing and opening. The diagram of Scotch yoke actuator is shown below-

Scotch yoke actuator

Figure- Single acting scotch yoke actuator

Figure- Double acting Scotch yoke actuator

Vane actuator

Vane actuators are basically true rotary pneumatic actuators and do not require converting linear motion to rotary motion. They are used to open, close or modulate quarter-turn valves, dampers, louvers and the inlet guide vane (IGV) of a compressor or turbine as well as for the precise operation of ergonomic lifting equipment. Vane actuators are designed to connect to direct valve devices to transfer shaft movement. The diagram of vane actuator is shown below-

Vane actuator

Single acting actuator or Spring actuator-

In a single acting actuator, control pressure is applied to an inlet port of the actuator to operate/open the valve, and valve closing is determined by the stored energy of the spring. Therefore single acting actuator is also called spring actuator. To close the valve, the applied pressure is reduced proportionally and is directed by spring return / spring release. There are two types of possible actions (without use of air lock relay) –

direct acting actuator (apply pressure to open/close)

reverse actuator (apply pressure to close open/fail open)

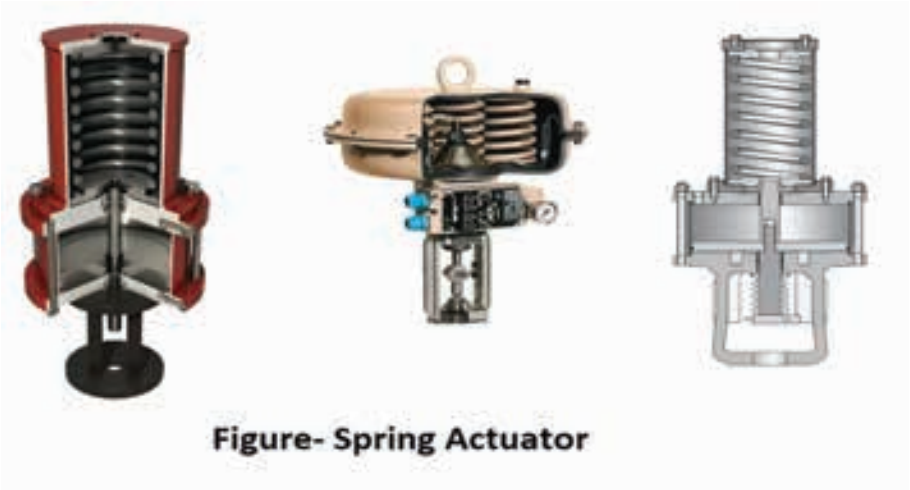


Figure- Spring Actuator

Spring Actuator

When control pressure applied to the actuator is used to open the valve and energy on the spring return used to close the valve safely, it is called a direct acting actuator. The valve closes as a fail safe action in case of direct acting actuator control signal failure. When control pressure applied to the actuator is used to close the valve and energy in the spring return used to open the valve safely, it is called a reverse actuator. Reverse actuator control signal failure results in the valve opening as a fail safe action.

However, lock to lock position can be achieved by installing an air lock relay so that when the control signal fails, the pressure applied to the actuator must be constant to hold/lock the valve in the same position.

Double acting actuator

In double acting actuator, there are two signal ports in such a way that controlled pressure on one port is used to open the valve and controlled pressure on the other port is used to move the valve to close. . Most double acting actuators fail to lock type. However, fail open and fail close conditions can also be achieved by using control valve accessories such as valve positioners and solenoid valves etc.

Pneumatic actuator applications

There is a wide field of applications of pneumatic actuators in process plants and industries. Now a days such actuators are integrated with electronic devices using solenoid valves, positioners, I/P converters etc. to take commands in electrical form directly from the digital controller by manipulating the signal output. Some of their areas of application are as follows-

Chemical plants and refineries ,

Water treatment plants ,

Manufacturing industries ,

Food handling industries,

Electronic Industry ,

Automotive industries ,

Agriculture applications ,

Construction, Coal Mining Equipment , etc.

MODULE 20 : 3-Phase rectifier controlled & uncontrolled

LESSON 199 - 204 : 3-Phase Rectifier controlled & uncontrolled

Objectives

At the end of this lesson you shall be able to

- state working principle of controlled & uncontrolled rectifiers
- state the applications of controlled & uncontrolled rectifiers

High current rectifiers

In high current rectifier SCRs are mainly used in devices where the control of high power, possibly at high voltage, is needed. The ability to switch large currents on and off makes the SCR suitable for use in medium to high-voltage AC power control applications, such as lamp dimming, regulators and motor control.

High Current Rectifiers are used in a variety of industrial applications such as Electroplating, Electro coloring, Magnetization, Hydrogenation, Electro winning, Capacitor Film Formation, Cathode Protection, Anodizing, ED Coating (Painting), Chlorination, Water Treatment, Battery Formation, Electro heating.

Difference between uncontrolled and controlled rectifierts

Controlled rectifiers

A controlled rectifier can control the power fed to the load. It is used to convert AC supply into unidirectional DC supply in an inverter. Controlled rectification is the process of converting AC to direct current (DC) based on the required voltage and current demand. To design the controlled feature, The silicon-controlled rectifier (SCR) is basically a thyristor, a four-layer (P–N–P–N) semiconductor device.

Uncontrolled rectifiers

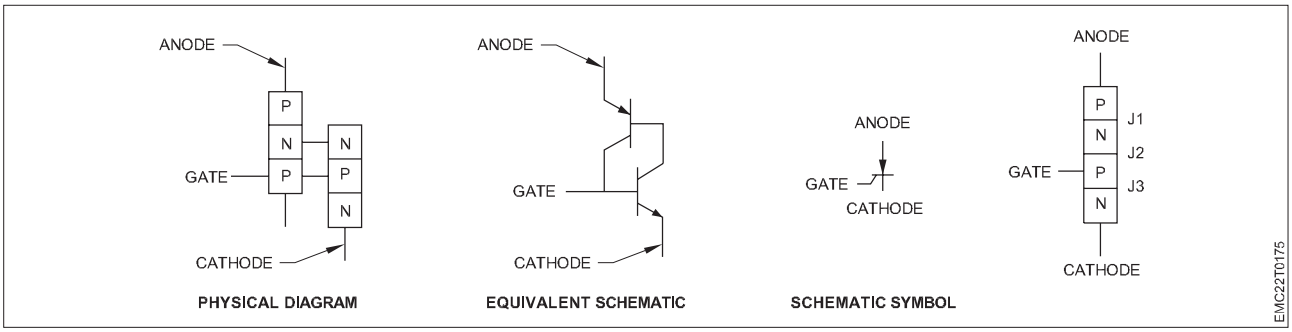
An uncontrolled rectifier is a type of AC to DC converter that provides fixed DC output voltage from a given AC input supply. These rectifiers are used in applications where fixed DC voltage is essential.

Silicon Controlled Rectifier

A silicon controlled rectifier or semiconductor-controlled rectifier is a four-layer solidstate current-controlling device. The name “silicon controlled rectifier” is General Electric’s trade name for a type of thyristor.

SCRs are mainly used in electronic devices that require control of high

Voltage and power. This makes them applicable in medium and high AC power operations such as motor control function.



An SCR conducts when a gate pulse is applied to it, just like a diode. It has four layers of semiconductors that form two structures namely; NPNP or PNPN. In addition, it has three junctions labeled as J1, J2 and J3 and three terminals Anode,Cathode, Gate.

Advantage of SCR

- It can handle large voltage ,current and power.
- The voltage drop across conducting SCR is small .this will reduse the power dissipation in the SCR.
- Easy to turn on
- The operation does not produce harmonics.
- Triggering circuit are simple
- It gives noiseless operation at high efficiency.

Drawbacks of SCR

- It can conduct only in one direction, so it can control power only during the one half cycle of ac.
- SCR can not be used at high frequencies or perform high-speed operation .the maximum frequency of its operation is 400 Hz.
- Gate current can not be negative

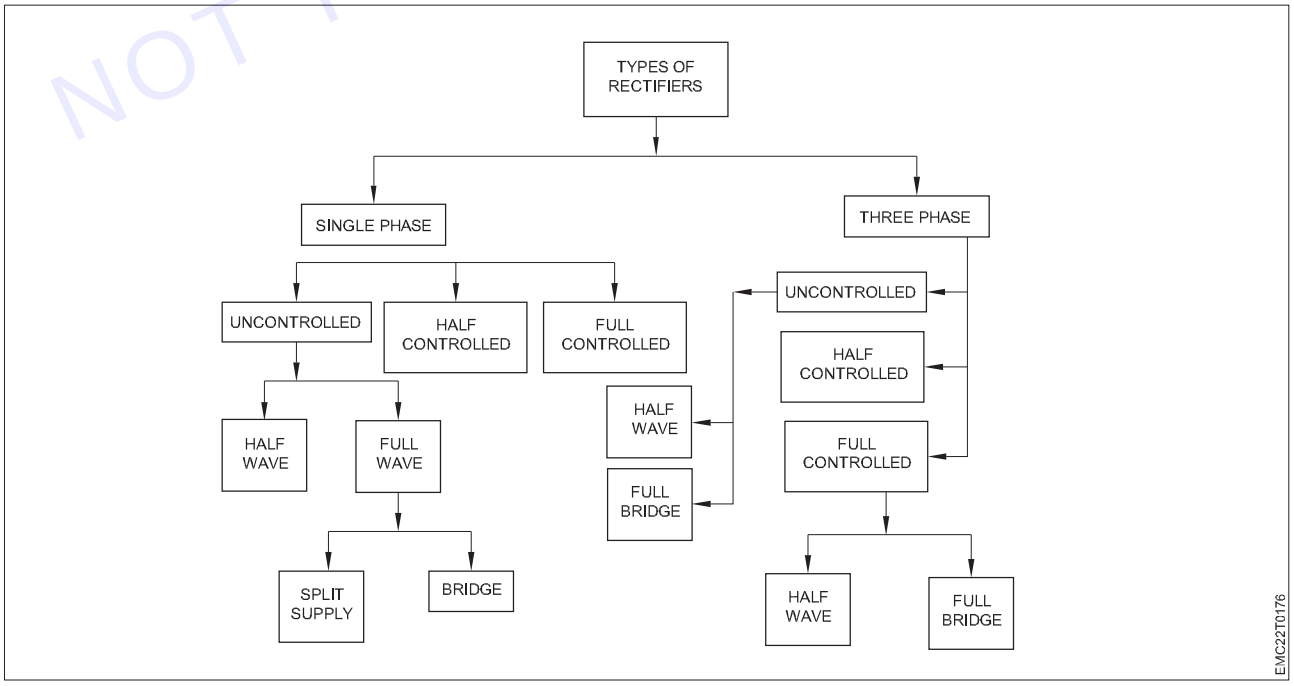
Application

- Controlled rectifiers
- Dc to dc converter or choppers
- Dc to ac converter or inverter ,
- Speed control of dc and ac moter
- fan speed regulators
- AC voltage stabilizers

Phase Controlled Rectifier

Phase-controlled rectifiers are circuits used in power electronics that enable the conversion of AC voltage to DC voltage by regulating the firing angle of thyristors. Thyristors are semiconductor devices that can regulate the flow of current by using a gate signal. Phase-controlled rectifiers are employed in a variety of applications, including motor drives, heating and lighting control, battery chargers, and power supplies for electronic devices.

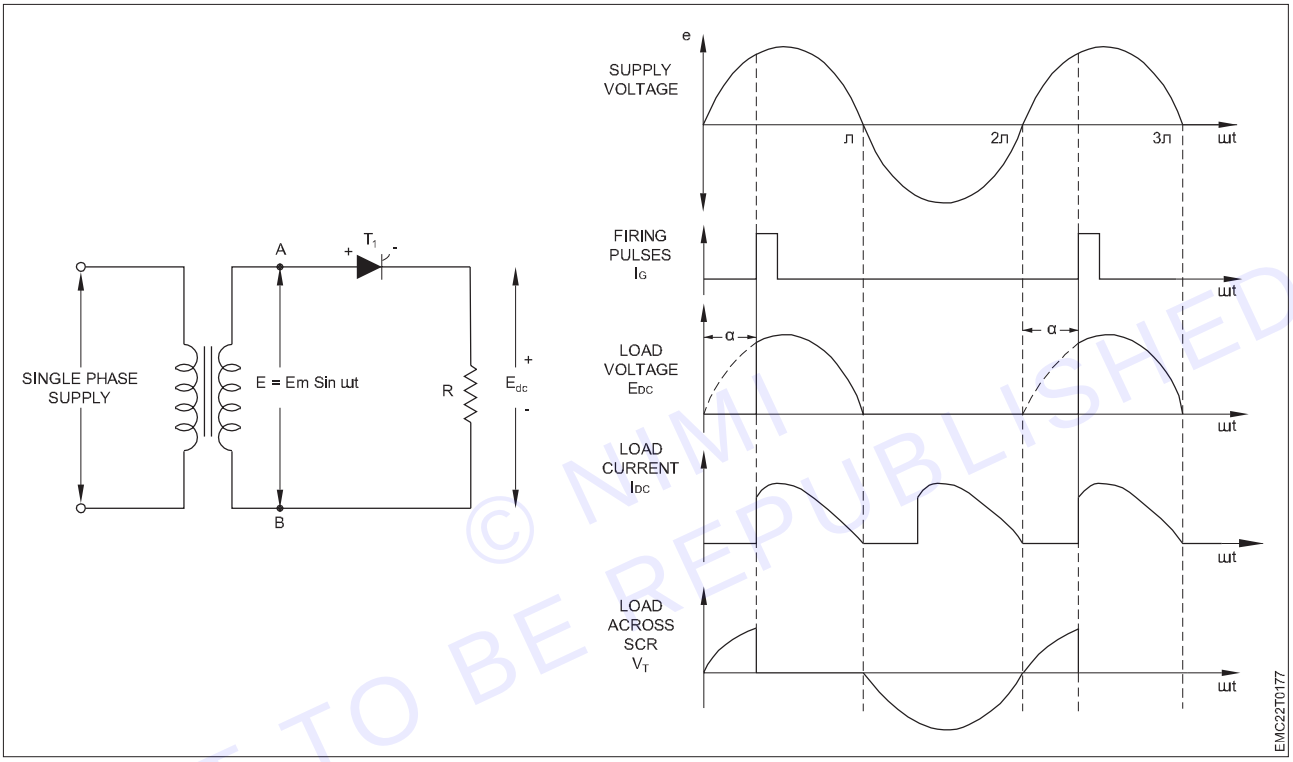
Classification of phase controlled rectifiers



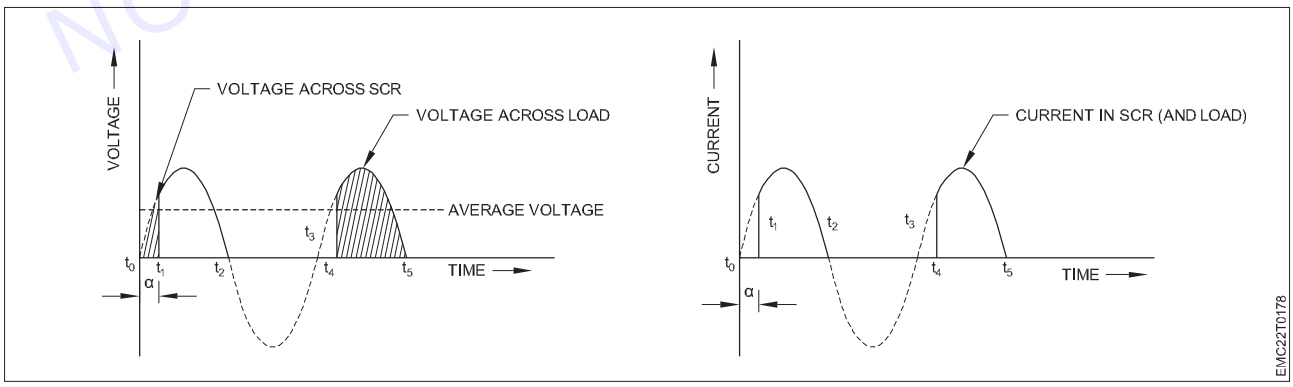
Single phase half wave controlled circuit

Single-phase controlled rectifiers, also known as phase-controlled rectifiers, play a crucial role in power electronics applications. These devices are used to convert alternating current (AC) to direct current (DC) with the ability to control the output voltage. This is achieved by adjusting the firing angle (or phase angle) of thyristors, which are semiconductor devices capable of switching large currents.

A half-wave controlled rectifier utilizes a single thyristor that is connected in series with the load. Once triggered at a specific firing angle during the positive half-cycle of the input AC supply, the thyristor begins to conduct, and the output voltage waveform is determined by the firing angle and the input AC voltage amplitude. By adjusting the firing angle, the average output voltage can be controlled, which affects the amount of power delivered to the load. However, half-wave controlled rectifiers have the disadvantage of using only half of the input AC waveform, resulting in high harmonic distortion and poor power circuit.



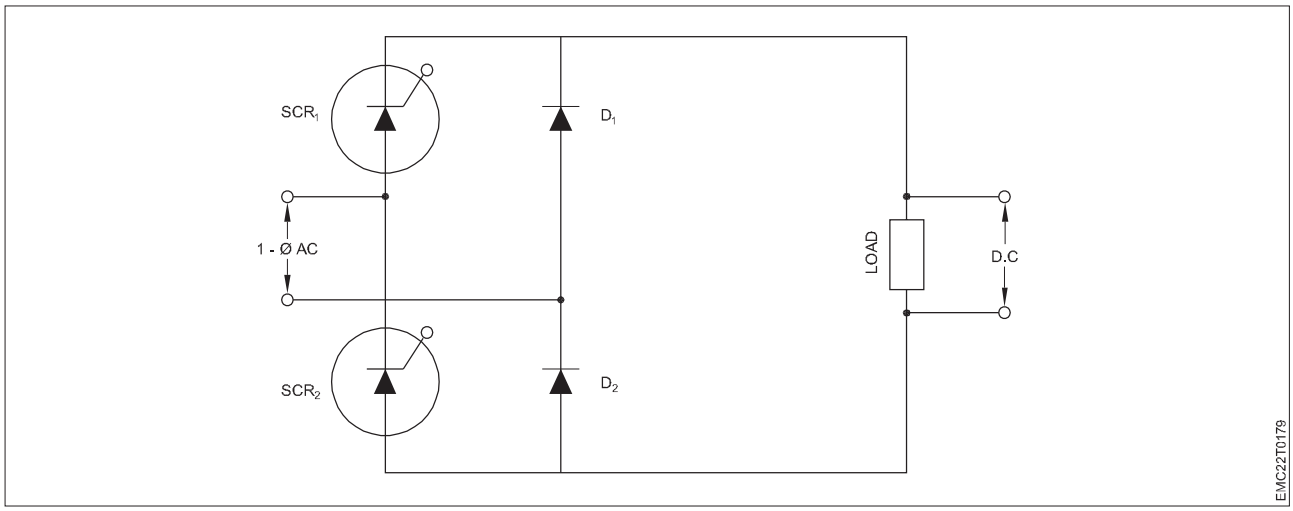
The output voltage can be changed by changing the firing angle α.



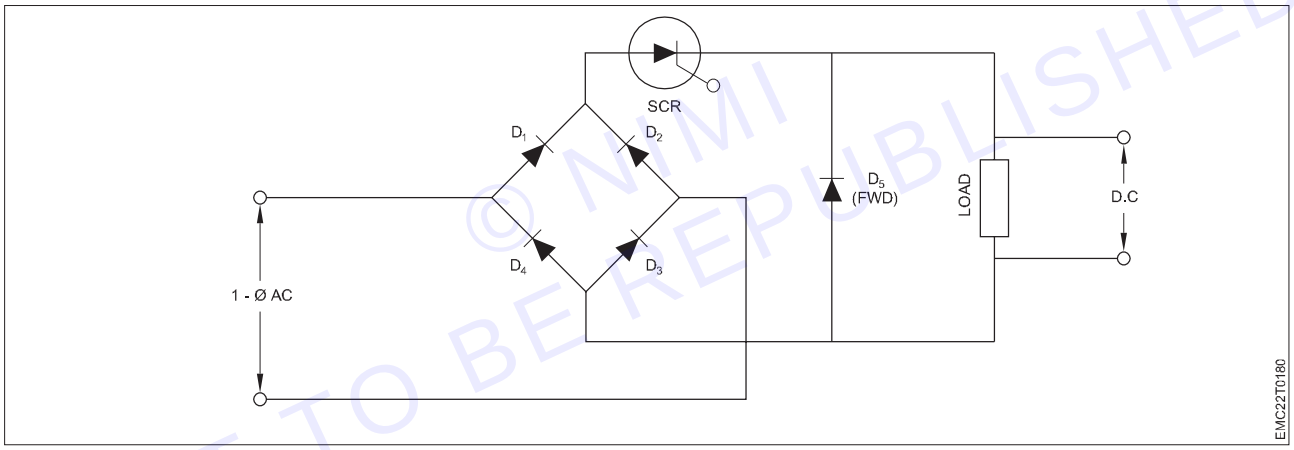
Single phase full wave half controlled bridge

The circuit diagram of single-phase full-wave half-controlled bridge is shown Fig. Two SCRs and two diodes are used in this configuration. Single-phase a.c. supply is used as the input to the bridge. It gives a full-wave rectified d.c. at its output. In the positive half of the input, SCR_1 and D_2 are conducting while in the negative half, SCR_2 and D_1 are conducting and hence full wave rectification is obtained. The positive half of the input can be controlled by SCR_1 when SCR_2 remains idle. In the negative half cycle, SCR, is responsible for the control when SCR_1 is idle. Hence, one half cycle of the input only

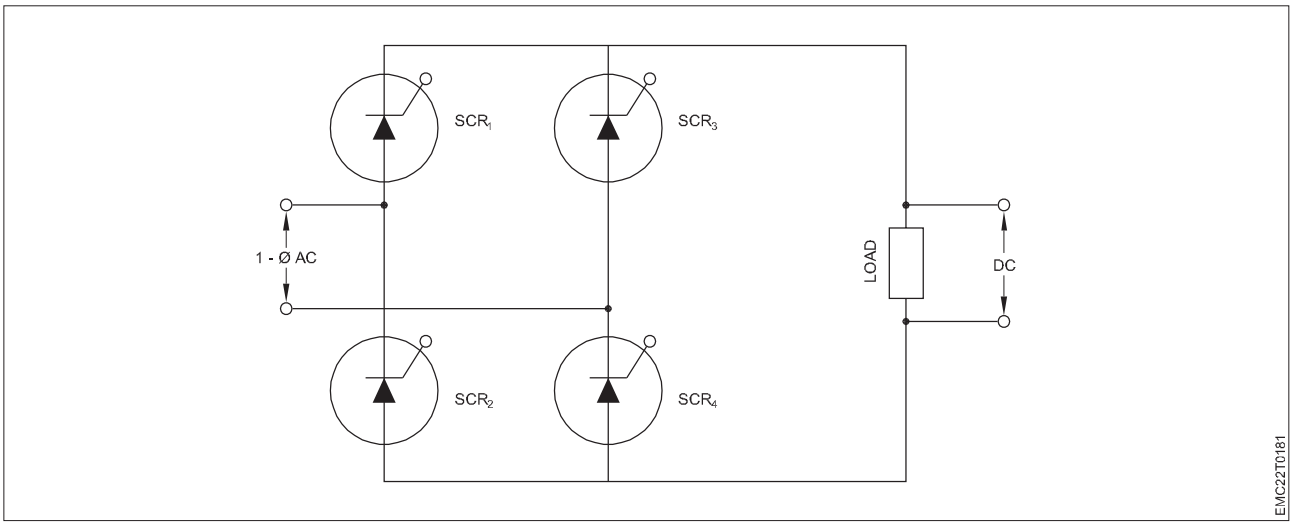
one of the two control devices is operative and so this bridge is called single-phase full- wave half-controlled bridge. In this circuit, freehweeling action (when the load is inductive) is done by the pair of diodes D_1 and D_2. So, there is no need of separate diode for this purpose.



Single Phase Full Wave Fully Controlled Bridge



The circuit diagram of single-phase full-wave fully controlled bridge is shown in Fig. A full- wave bridge rectifier is formed with the help of four diodes D_1, D_2, D_3 and D_4. Only one SCR is used as the control device. D.C. output is available in both the halves of the a.c. input cycle. The d.c. output can be controlled by varying the firing angle of the SCR. Diode D5 is used for freewheeling purpose.

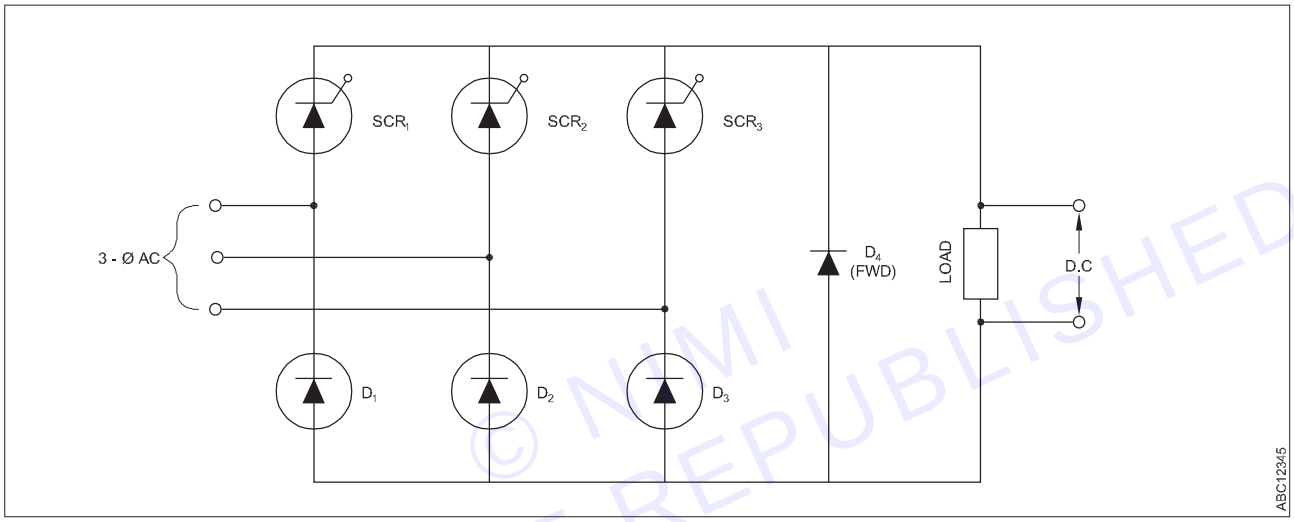


Another arrangement of this bridge is shown in Fig. It uses four SCRs. Here four SCRs i.e. SCR_1, SCR_2, SCR_3 and SCR_4 are used to form the rectifier bridge. In the positive half-cycle of the a.c. input, conduct and in the negative half cycle the other two SCRs i.e. SCR_2 and SCR_3 conduct. So, d.c. output is available in both the halves. Hence, for the positive half cycle, SCR_1 and SCR_4 are responsible for control, while for negative half cycle SCR_2 and SCR_3 are responsible. Therefore, each arm of the bridge is involved in both the halves of the a.c. input and hence it is called fully controlled bridge.

Three- phase Full-wave Half controlled bridge

The circuit diagram of three-phase full-wave half-controlled bridge is shown in Fig.

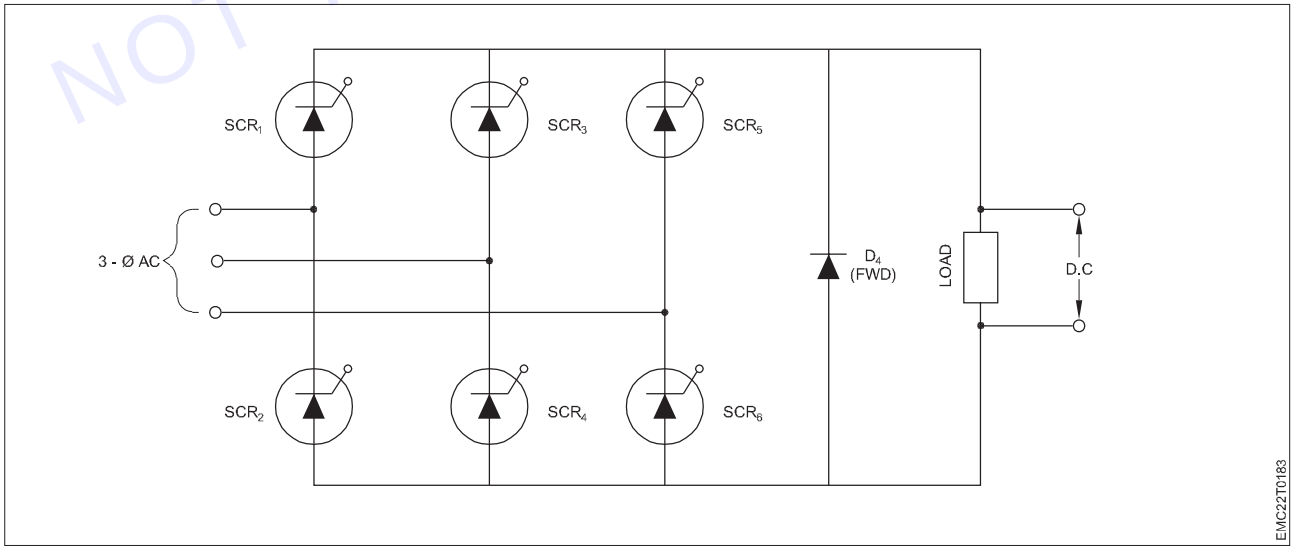
This configuration uses in all the three SCR's (S_1, S_2, S_3) and 3 diodes (D_1, D_2, D_3), with one pair of SCR and diode per phase. In every phase output is available in both the halves of the a.c. input but only one control device is used in both the half cycles and therefore it is called a half controlled full-wave bridge. Diode D_4 is used for freewheeling purposes.



Three phase Full wave Fully Controlled Bridge

In all six SCR`s have been used with a pair per phase to give a full wave fully controlled output.

Diode D is freewheeling diode .



MODULE 21 : Electrical control of AC/DC machines & AC drives

LESSON 205 - 222 : Electrical control of AC/DC machines

Objectives

At the end of this lesson you shall be able to

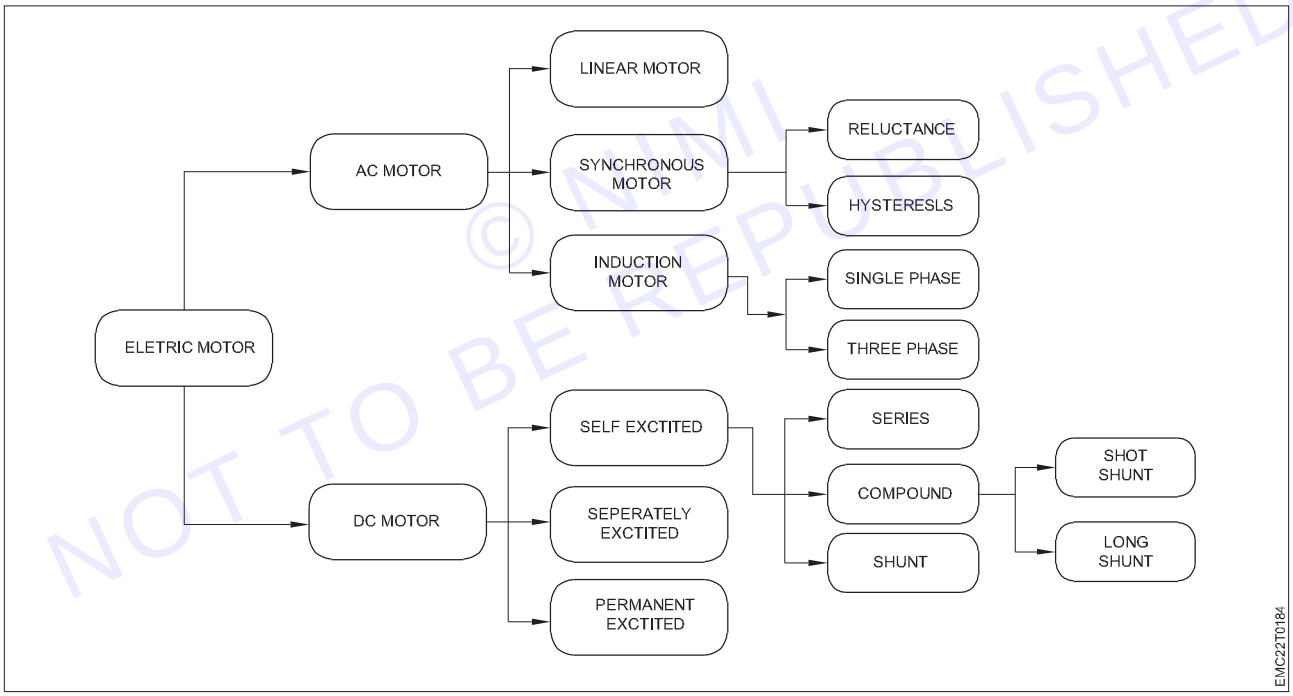
- state construction &b working priciple of AC/DC motors
- state the characteristics, advantages & disadvantages of the DC motors.

Motor

An electric motor is an electro-mechanical machine that converts electrical energy into mechanical energy. Basically, the motor produces the rotational force.

The working principle of the all-electric motor depends on the interaction between the magnetic and electric fields.

An electric motor has two types: the AC motor and the DC motor. Let's see these types of electric motors in detail.



1 AC Motor

The AC motor requires an alternating current to rotate. This motor converts the alternating current into mechanical power using electromagnetic induction. The AC electric motor has two most important parts: the stator and the rotor.

The stator is the stationary part, and the rotor is the rotating part of the ac electric motor. Most AC motors are single-phase or three-phase.

The three-phase AC motor produces bulk power and is mostly used in industry. Single-phase AC motors are used in small power applications. The single-phase AC motor is small in size and used in a variety of services.

Most domestic appliances, such as refrigerators, fans, washing machines, and mixers, use a single-phase AC motor.

2 DC Motor

A motor that converts the DC power into mechanical power is referred to as a DC electric motor. It is operated by a DC current. The basic working principle of a DC motor is that when a current-carrying conductor is placed in a magnetic field, a force exerted on it develops torque.

The DC motor consists of two main parts: the armature and the stator. The rotating part is the armature, and the stationary part is the stator.

Types of AC Electric Motor

AC motors are mainly classified into three types, and they are:

- Synchronous Motor
- Asynchronous or Induction Motor
- Linear Motor

1 Synchronous Motor

The synchronous motor changes the alternating current into mechanical power at the desired frequency. In this motor, the speed of the motor is synchronized with the AC frequency. These motors mainly depend on the three-phase supply. In this, the motor speed is the constant speed at which the motor generates an electromotive force.

There is no air gap available in the speed of the stator current and rotor. So it provides more rotation accuracy. Because of high rotation accuracy, these motors are applicable in automation, robotics, etc

The synchronous motor is segmented into two types

i Reluctance Motor

The motor whose construction is similar to an induction motor and runs like a single-phase synchronous motor is called the reluctance motor.

In this motor, the rotor is like a squirrel cage, and the stator includes sets of windings such as the auxiliary and main windings. To offer a level operation at a stable speed, the auxiliary windings are very useful.

These motors are commonly used in signal generators, recorders, etc., which require proper synchronization.

ii Hysteresis Motor

The hysteresis motor has a uniform air gap and doesn't have any DC excitation system. The rotor of this motor induces hysteresis and eddy current to complete its required task. The working of a motor depends on its construction, whether it is a single-phase or three-phase supply.

These motors provide very smooth operation with stable speed, similar to other synchronous motors. The noise level of this motor is quite small, and due to this reason, they are used in applications where soundproof motors are required like a sound player, audio recorder, etc.

2 Induction Motor

According to rotor construction, there are two types of induction motors. They are squirrel cage induction motors and phase wound induction motors.

On the basis of supply phases, the induction motor is classified into single-phase and three-phase induction motors.

i Squirrel Cage Rotor

The rotor of the motor has the shape of a squirrel cage. In this, the inner component is connected to the output shaft and looks like a cage. This rotor decreases the magnetic locking and the humming sound of the rotor.

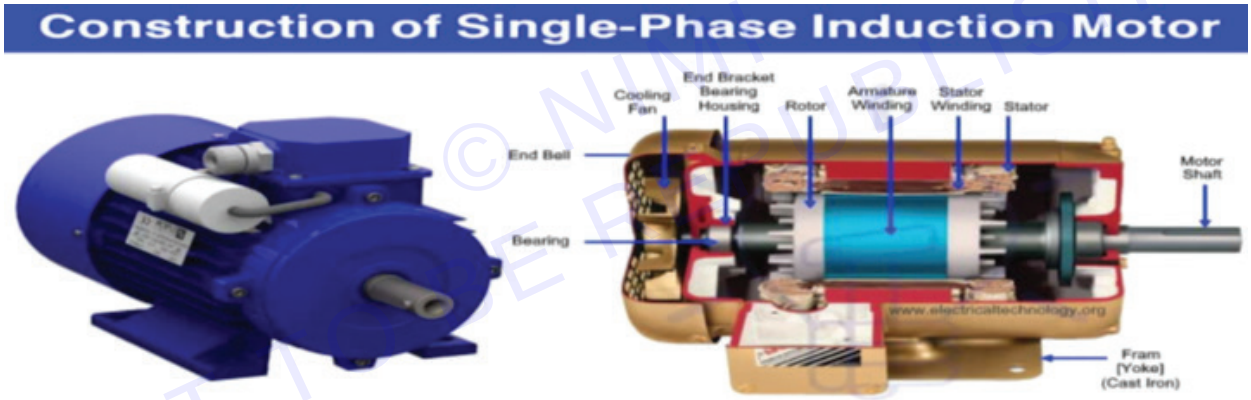
ii Phase Wound Rotor

This rotor is a variation of the three-phase induction motor, which is designed to provide high torque for loads with high inertia while taking very little current. It is also known as slip ring motors.

iii Single-phase induction motor

Construction of Single-Phase Induction Motor

A single phase induction motor is similar to the three phase squirrel cage induction motor except there is single phase two windings (instead of one three phase winding in 3-phase motors) mounted on the stator and the cage winding rotor is placed inside the stator which freely rotates with the help of mounted bearings on the motor shaft.



Similar to a three-phase induction motor, single-phase induction motor also has two main parts;

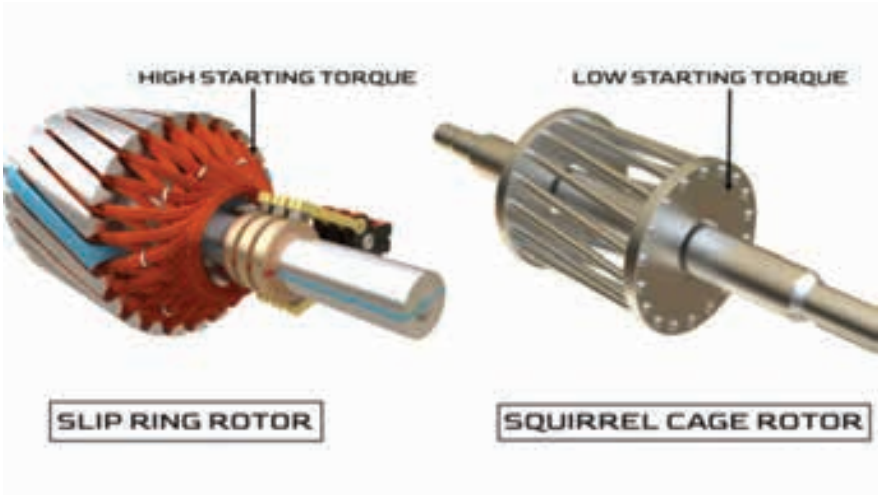
- Stator
- Rotor

Roter

Rotor as the name suggests it is a rotating part of an electrical machine, in which current is induced by transformer action from rotating magnetic field.

Induction motor rotor is of two types

- Squirrel Cage Rotor
- Wound Type Rotor or Slip Ring Type Rotor



Stator

It is the outer body of the motor and consists of outer frame, stator core and windings.

The stator is built up of high-grade alloy steel laminations to reduce eddy current losses. It has three main parts, namely the outer frame, the stator core, and a stator winding.

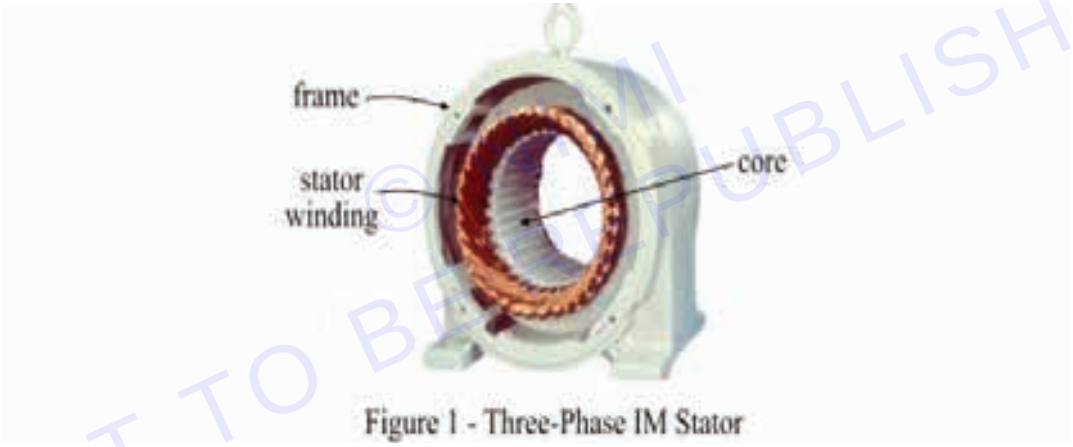


Figure 1 - Three-Phase IM Stator

Working of Single-phase Induction Motor

We know that for the working of any electrical motor whether its AC or DC motor, we require two fluxes as the interaction of these two fluxes produced the required torque.

When we apply a single phase AC supply to the stator winding of single phase induction motor, the alternating current starts flowing through the stator or main winding. This alternating current produces an alternating flux called main flux. This main flux also links with the rotor conductors and hence cut the rotor conductors.

According to the Faraday's law of electromagnetic induction, emf gets induced in the rotor. As the rotor circuit is closed one so, the current starts flowing in the rotor. This current is called the rotor current. This rotor current produces its flux called rotor flux. Since this flux is produced due to the induction principle so, the motor working on this principle got its name as an induction motor. Now there are two fluxes one is main flux, and another is called rotor flux. These two fluxes produce the desired torque which is required by the motor to rotate.

Why Single Phase Induction Motor Is Not Self Starting?

The stator of a single phase induction motor is wound with single phase winding. When the stator is fed with a single phase supply, it produces alternating flux (which alternates along one space axis only). Alternating flux acting on a squirrel cage rotor can not produce rotation, only revolving flux can. That is why a single phase induction motor is not self starting.

How To Make Single Phase Induction Motor Self Starting?

As explained above, single phase induction motor is not self-starting. To make it self-starting, it can be temporarily converted into a two-phase motor while starting. This can be achieved by introducing an additional 'starting winding' also called as auxillary winding.

Hence, stator of a single phase motor has two windings:

i Main winding

ii Starting winding (auxillary winding).

These two windings are connected in parallel across a single phase supply and are spaced 90 electrical degrees apart. Phase difference of 90 degree can be achieved by connecting a capacitor in series with the starting winding.

Hence the motor behaves like a two-phase motor and the stator produces revolving magnetic field which causes rotor to run. Once motor gathers speed, say upto 80 or 90% of its normal speed, the starting winding gets disconnected form the circuit by means of a centrifugal switch, and the motor runs only on main winding.

Starting Methods of Single Phase Induction Motor

Single -phase induction motor doesn't have starting torque, so external circuitry is needed to provide this starting torque. The stator of these motors contains Auxiliary winding for this purpose. The Auxiliary winding is connected in parallel to a capacitor. When the capacitor is turned on, similar to main winding, revolving two magnetic fields of the same magnitude but opposite direction are observed on Auxiliary winding.

From these two magnetic fields of Auxiliary winding, one cancel outs one of the magnetic fields of main winding whereas the other adds up with another magnetic field of main winding. Thus, resulting in a single revolving magnetic field with high magnitude. This produces force in one direction, hence rotating the rotor. Once the rotor starts rotating it rotates even if the capacitor is turned off.

There are different stating methods of single-phase induction motors. Usually, these motors are chosen based on their starting methods. These methods can be classified as

- Split-phase starting.
- Shaded-pole starting.
- Repulsion motor starting
- Reluctance starting

In the split -phase starts, the stator has two types of windings – main winding and Auxiliary winding, connected in parallel. Motors with this type of starting methods are

- Resistor split -phase motors
- Capacitor split -phase motors
- Capacitors start and run motors
- Capacitor-run motor

Applications of Single Phase Induction Motor

These motors find use in fans, refrigerators, Air-conditioners, Vacuum cleaners, washing machines, centrifugal pumps, tools, small farming appliances, blowers etc…

So, basically, we use single phase induction motors in our daily life frequently. These motors are easy to repair.

How to calculate single phase motor speed?

Speed of an induction motor depends on the motor design itself, the synchronous speed determined by the frequency and amount of AC input power poles in the stator.

The higher the number of poles, the slower synchronous speed.Relationship between poles, frequency and speed of synchronous is as follows:

Ns(rpm) = 120 x f /p

Ns = synchronous speed

f = supply frequency

p = number of poles in the stator

Example

a four (4) pole motor is built to operate at 60 Hz and synchronous speed is:

Ns = 120 x f /p

Ns = 120 x 60 / 4

Ns = 1800 rpm

Slip in electric motor

The difference in rotor speed and synchronous speed is known as slip

we can calculate the slip of a motor using the formula:

S = Ns – Nr / Ns x 100%

S = slip

Ns =stator magnetic field speed

Nr = rotor speed (available on the motor name plate)

How to calculate HORSE POWER for motor?

To calculate the total power output of a motor, we can use the formula:

HP = I x V x Eff / 746

I = Ampere

V = voltage

Eff = efficiency (available on the motor name plate)

Example

1 unit single phase motor,240 volt,20 ampere and 85% efficiency

HP = I x V x Eff / 746

HP = 20 x 240 x 85% / 746

HP = 5.5

iv Three-phase Induction Motor

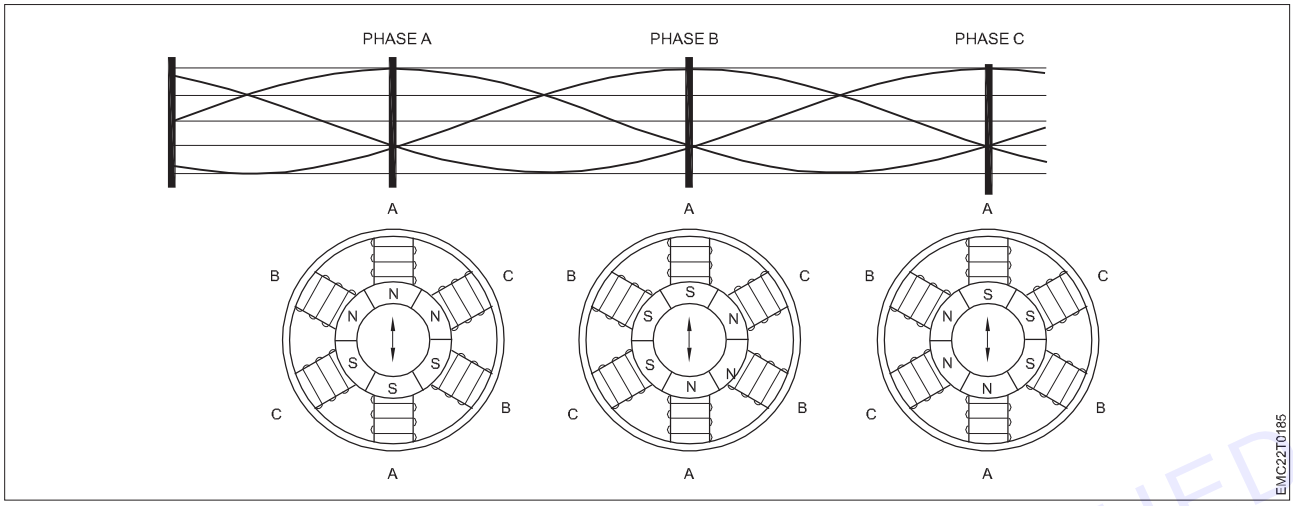
An electrical motor is an electromechanical device that converts electrical energy into mechanical energy. In the case of three-phase AC (Alternating Current) operation, the most widely used motor is a 3 phase induction motor, as this type of motor does not require an additional starting device. These types of motors are known as self-starting induction motors.

To get a good understanding of the working principle of a three-phase induction motor, it's essential to understand the construction of a 3 phase induction motor. A 3 phase induction motor consists of two major parts:

- A stator
- A rotor

Working of Three Phase Induction Motor Production of Rotating Magnetic Field

The stator of the motor consists of overlapping winding offset by an electrical angle of 120o. When we connect the primary winding, or the stator to a 3 phase AC source, it establishes rotating magnetic field which rotates at the synchronous speed.



Secrets Behind the Rotation

According to Faraday's law an emf induced in any circuit is due to the rate of change of magnetic flux linkage through the circuit. As the rotor winding in an induction motor are either closed through an external resistance or directly shorted by end ring, and cut the stator rotating magnetic field, an emf is induced in the rotor copper bar and due to this emf a current flows through the rotor conductor.

Here the relative speed between the rotating flux and static rotor conductor is the cause of current generation; hence as per Lenz's law, the rotor will rotate in the same direction to reduce the cause, i.e., the relative velocity.

Thus from the working principle of three phase induction motor, it may be observed that the rotor speed should not reach the synchronous speed produced by the stator. If the speeds become equal, there would be no such relative speed, so no emf induced in the rotor, and no current would be flowing, and therefore no torque would be generated. Consequently, the rotor cannot reach the synchronous speed. The difference between the stator (synchronous speed) and rotor speeds is called the slip. The rotation of the magnetic field in an induction motor has the advantage that no electrical connections need to be made to the rotor.

Thus the three phase induction motor is:

- Self-starting
- Less armature reaction and brush sparking because of the absence of commutators and brushes that may cause sparks
- Robust in construction
- Economical
- Easier to maintain

Advantages

- **Low Cost:** Induction machines are very cheap when compared to synchronous and DC motors. This is due to the modest design of the induction motor. Therefore, these motors are overwhelmingly preferred for fixed speed applications in industrial applications and for commercial and domestic applications where AC line power can be easily attached.
- **Low Maintenance Cost:** Induction motors are maintenance-free motors unlike dc motors and synchronous motors. The construction of an induction motor is very simple and hence maintenance is also easy, resulting in low maintenance cost.

- **Ease of Operation:** The operation of the induction motor is very simple because there is no electrical connector to the rotor that supply power and current are induced by the movement of the transformer performs on the rotor due to the low resistance of the rotating coils. Induction motors are self-start motors. This can result in reducing the effort needed for maintenance.
- **Speed Variation:** The speed variation of the induction motor is nearly constant. The speed typically varies only by a few percent going from no load to rated load.
- **High Starting Torque:** The starting torque of the induction motor is very high which makes the motor useful for operations where the load is applied before the starting of the motor. 3 phase induction motors will have self-starting torque, unlike synchronous motors. However, single-phase induction motors do not have self-starting torque and are made to rotate using some auxiliaries.
- **Durability:** Another major advantage of an induction motor is that it is durable. This makes it the ideal machine for many uses. This results in the motor running for many years with no cost and maintenance.

All these advantages make induction motor to use in many applications such as industrial, domestic, and in many applications.

Disadvantages

The disadvantages of induction motor include the following.

- Throughout the light load situation, the power factor is extremely less and it draws a huge current. So, the copper loss can be high which decreases the efficiency throughout the light load situation.
- The squirrel cage induction motor's initial torque is not low.
- This is an invariable speed motor and this motor is not applicable where uneven speed needs
- This motor speed control is not easy
- This motor includes a high starting inrush current which will cause a reduction within voltage at the beginning of time.

Applications

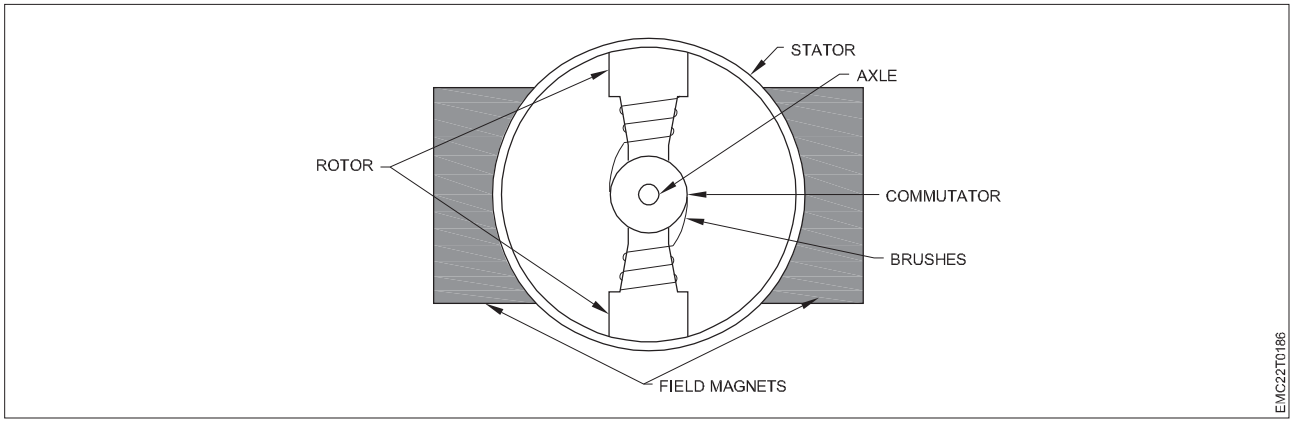
The applications of types of induction motor include the following.

- Lifts
- Cranes
- Hoists
- Large capacity exhaust fans
- Driving lathe machines
- Crushers
- Oil extracting mills
- Textile and etc.

DC Motor

A DC motor is an electric motor that runs on direct current power. In an electric motor, the operation is dependent upon simple electromagnetism. A current-carrying conductor generates a magnetic field, when this is then placed in an external magnetic field, it will encounter a force proportional to the current in the conductor and to the strength of the external magnetic field. It is a device that converts electrical energy to mechanical energy. It works on the fact that a current-carrying conductor placed in a magnetic field experiences a force that causes it to rotate with respect to its original position. Practical DC Motor consists of field windings to provide the magnetic flux and armature which acts as the conductor.

Construction of DC Motor



The armature coil is the rotating part whereas the stationary part is the stator. In this, the armature coil is connected toward the DC supply which includes the brushes as well as the commutators. The main function of the commutator is to convert the AC to DC which is induced in the armature. The flow of current can be supplied by using the brush from the motor's rotary part toward the inactive outside load. The arrangement of the armature can be done in between the two poles of the electromagnet or permanent.

DC Motor Parts

In DC motors, there are different popular designs of motors that are available like a brushless, permanent magnet, series, compound wound, shunt, otherwise stabilized shunt. In general, the parts of dc motor are the same in these popular designs but the whole operation of this is the same. The main parts of dc motor include the following.

- **Stator**

A stationary part like a stator is one of the parts in DC motor parts which includes the field windings. The main function of this is to get the supply.

- **Rotor**

The rotor is the dynamic part of the motor that is used to create the mechanical revolutions of the unit.

- **Brushes**

Brushes using a commutator mainly work as a bridge to fix the stationary electrical circuit toward the rotor.

- **Commutator**

It is a split ring that is designed with copper segments. It is also one of the most essential parts of dc motor.

- **Field Windings**

These windings are made with field coils which are known as copper wires. These windings round approximately the slots carried through the pole shoes.

- **Armature Windings**

The construction of these windings in the DC motor is two types like Lap & Wave.

- **Yoke**

A magnetic frame like a yoke is designed with cast iron or steel sometimes. It works like a guard.

- **Poles**

Poles in the motor include two main parts like the pole core as well as pole shoes. These essential parts are connected together through hydraulic force & are connected to the yoke.

- **Teeth/Slot**

The non-conducting slot liners are frequently jammed among the slot walls as well as coils for safety from scratch, mechanical support & additional electrical insulation. The magnetic material between the slots is called teeth.

Working Principle

An electrical machine that is used to convert the energy from electrical to mechanical is known as a DC motor. The DC motor working principle is that when a current-carrying conductor is located within the magnetic field, then it experiences a mechanical force. This force direction can be decided through Flemming's left-hand rule as well as its magnitude.

If the first finger is extended, the second finger, as well as the left hand's thumb, will be vertical to each other & primary finger signifies the magnetic field's direction, the next finger signifies the current direction & the third finger-like thumb signifies the force direction which is experienced through the conductor.

F = BIL Newtons

Where,

'B' is the magnetic flux density,

'I' is current

'L' is the conductor's length in the magnetic field.

Whenever an armature winding is given toward a DC supply, then the flow of current will be set up within the winding. Field winding or permanent magnets will provide the magnetic field. So, armature conductors will experience a force because of the magnetic field based on the above-stated principle.

The Commutator is designed like sections to attain uni-directional torque or the path of force would have overturned each time once the way of the conductor's movement is upturned within the magnetic field. So, this is the working principle of the DC motor.

Types of DC Motors

In order to appreciate the benefits of DC motors, it is important to understand the various types. Each type of DC motor has beneficial characteristics that must be examined before purchase and use. Two of the main advantages of DC motors over alternating current (AC) motors are how easy they are to install and that they require little maintenance.

DC motors are differentiated by the connections between the field winding and the armature. The field winding can be connected parallel to the armature or connected in a series. In some cases, the connection is both parallel and in a series.

A further distinction of DC motors is how the rotor is powered; it can be brushed or brushless. In brush DC motors, current is applied to the rotor by brushes. In a brushless DC motor, the rotor has a permanent magnet.

Since DC motors are everywhere and used for a wide variety of applications, there is a different type to meet the needs of every application. Regardless of your need for DC motors, it is important to understand each type since they can be found in every aspect of life.

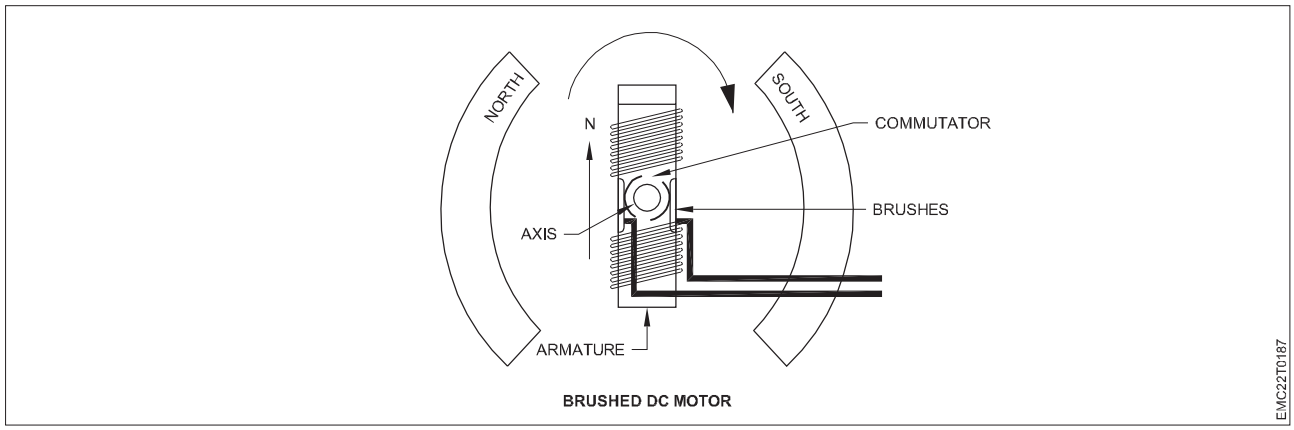
Brushed DC Motor

The magnetic field in a brush DC motor is produced by current sent through a commutator and brush that are connected to the rotor. Brushes are made of carbon and can be separately excited or self excited. The stator is the enclosure that contains the components of the motor and contains the magnetic field. The winding of the coil on the rotor can be in a series or parallel to form either a series wound DC motor or shunt wound DC motor.

The commutator is an electrical switch that reverses the current between the rotor and the external power source. It is a method of applying electrical current to the windings and produces a steady rotating torque by reversing the current direction. The sections of the commutator are attached to the windings on the rotor through a set of contact bars that are set in the shaft of the motor.

There are three main types of DC motors: separately excited, self excited, or permanent magnet. In the separately excited and self excited, an electromagnet is used in the stator structure. With the permanent magnet type, a powerful magnet generates the magnetic field.

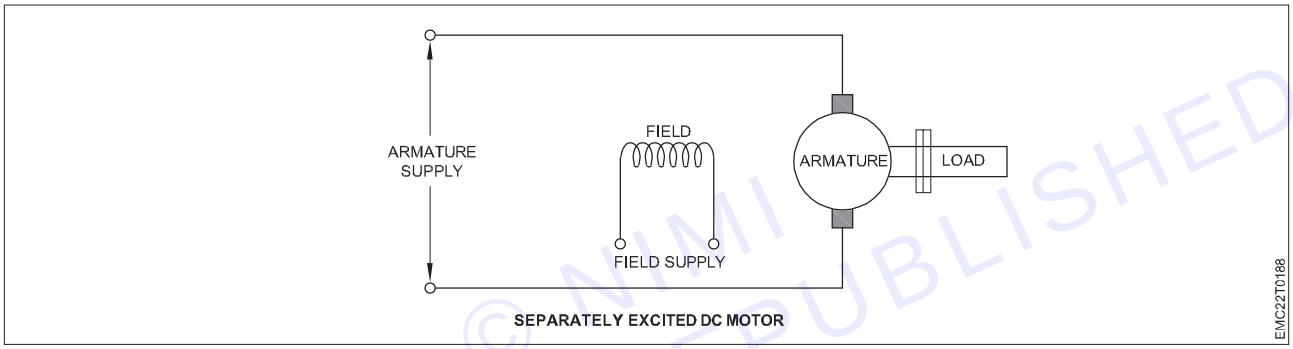
Self excited DC motors are further divided into shunt, series, and compound. The compound excited type is separated into cumulative and differential with short and long shunts in each type.



BRUSHED DC MOTOR

- **Separately Excited DC Motor**

In a separately excited DC motor, the motor has separate electrical supplies to the armature winding and field winding, which are electrically separate from each other. The operations of the armature current and field current do not interfere with each other's actions, but the input power is their total sum.

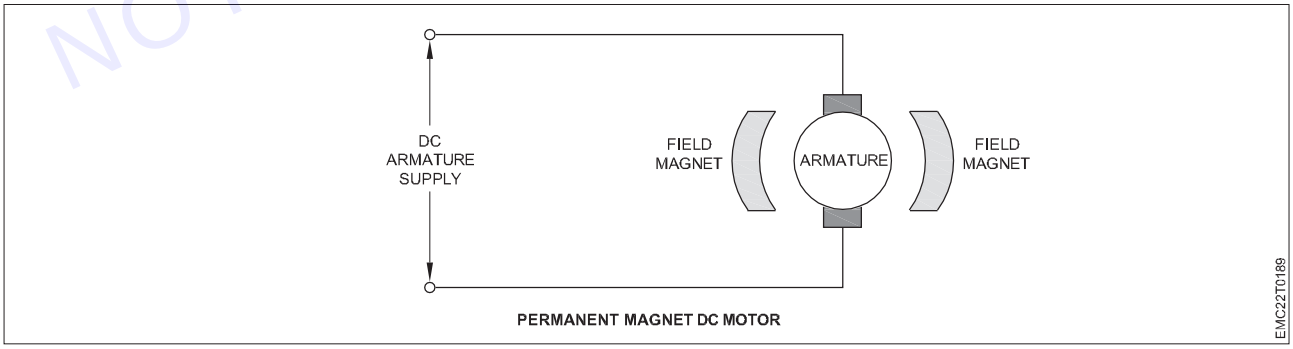


SEPARATELY EXCITED DC MOTOR

Permanent Magnet DC Motor

A permanent magnet DC motor has an armature winding but does not have a field winding. The permanent magnet is mounted on the inner surface of the stator core to produce the magnetic field. It has a regular armature consisting of a commutator and brushes.

Permanent magnet DC motors are smaller and less expensive. They use rare earth magnets such as samarium cobalt or neodymium iron boron.



PERMANENT MAGNET DC MOTOR

Self Excited DC Motor

In self excited DC motors, the field and armature windings are connected and have a single supply source. The connections are parallel or series with parallel made as shunt wound while the series version is series wound.

- **Shunt**

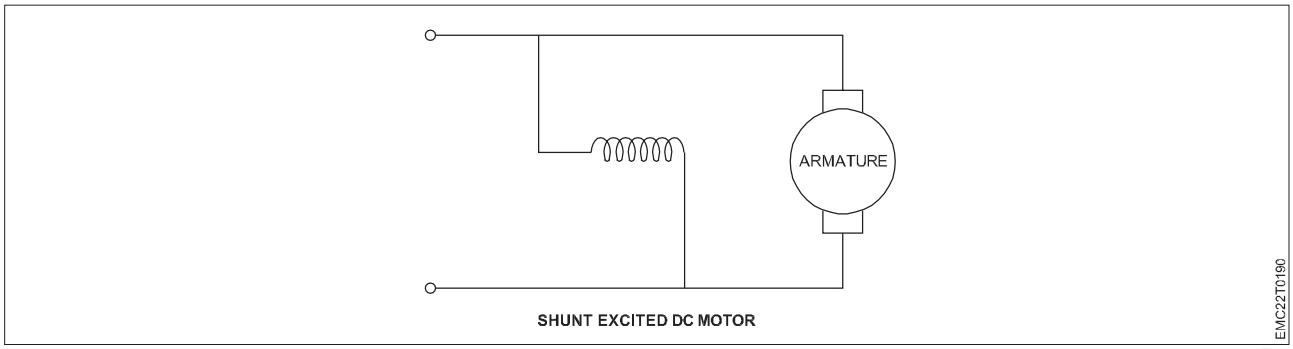
In a shunt wound DC motor, the field and armature windings are connected parallel to each other; this exposes the field winding to terminal voltage. Though the supply is the same, the current for the field and armature windings is different. The speed of a shunt DC motor is constant and does not deviate with varying mechanical loads.

- **Series**

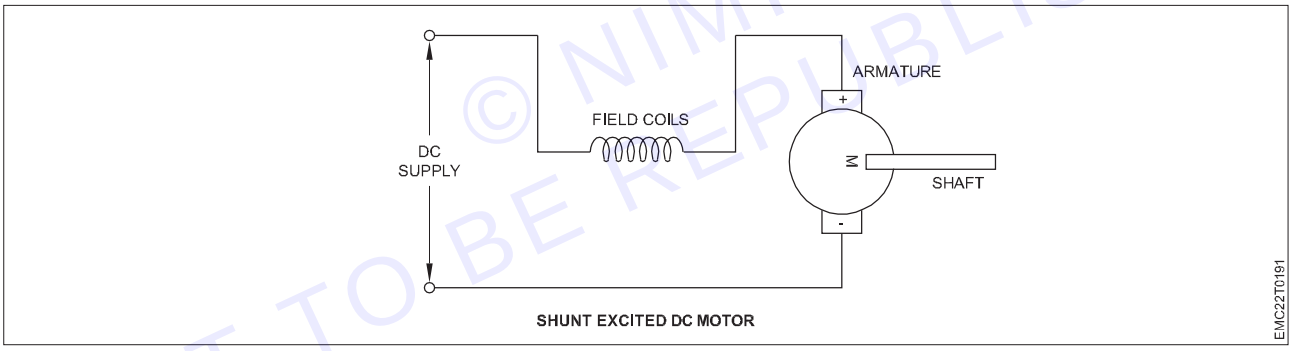
The field and armature winding on a series DC motor are connected to the power supply in a series. The same current flows in the field and armature windings. A series wound motor can work with AC and DC voltage supply, which makes it a universal motor. Series motors always rotate in the same direction regardless of the voltage source. Their speed varies with the mechanical load.

- **Compound**

A compound DC motor uses the features of the series and shunt field windings. The winding for the armature is connected in a series while the winding for the field is a shunt or parallel connection.



Compound DC motors are further divided into cumulative and differential. With cumulative DC motors, the flux of the shunt field helps the flux in the series field. They both move in the same direction while the flux of a differential compound DC motor, for the series and shunt fields, moves in the opposite direction. Cumulative and differential compound DC motors can have long or short shunts; this is based on the shunting of the shunt field winding.



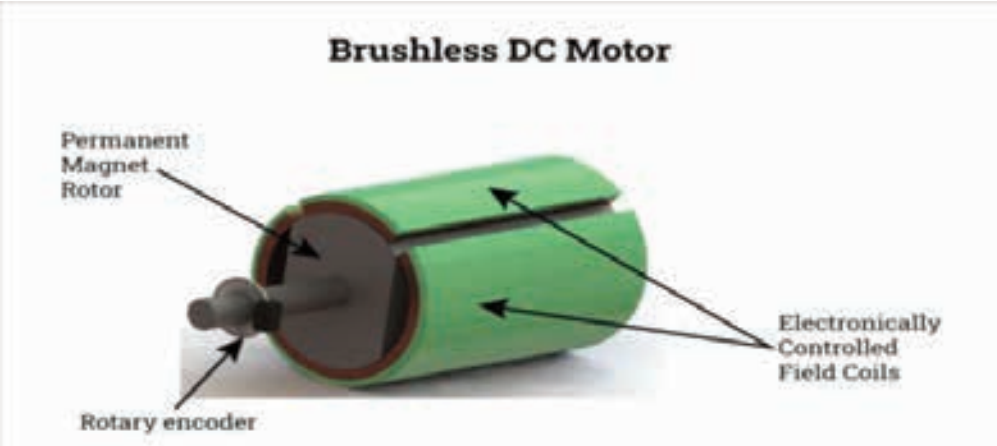
Brushless DC Motor (BLDC)

Brushless DC motors, known as BLDC motors, are a permanent magnet synchronous electric motor driven by direct current and an electronically controlled commutation system, the process of producing rotational torque by changing phase currents. They are also referred to as trapezoidal permanent magnet motors.

The electrical commutation by a BLDC motor is what differentiates it from brushed DC motors that operate by mechanical contact on a rotor. A BLDC motor includes a magnet rotor and a stator with a sequence of coils. The permanent magnet rotates while current carrying conductors are fixed in position.

The armature coils are switched electronically by transistors at the correct rotor position. The created force causes the rotor to rotate. Hall sensors sense the position of the rotor and are placed on the stator. The feedback position of the rotor from the sensors determines when to switch the current of the armature.

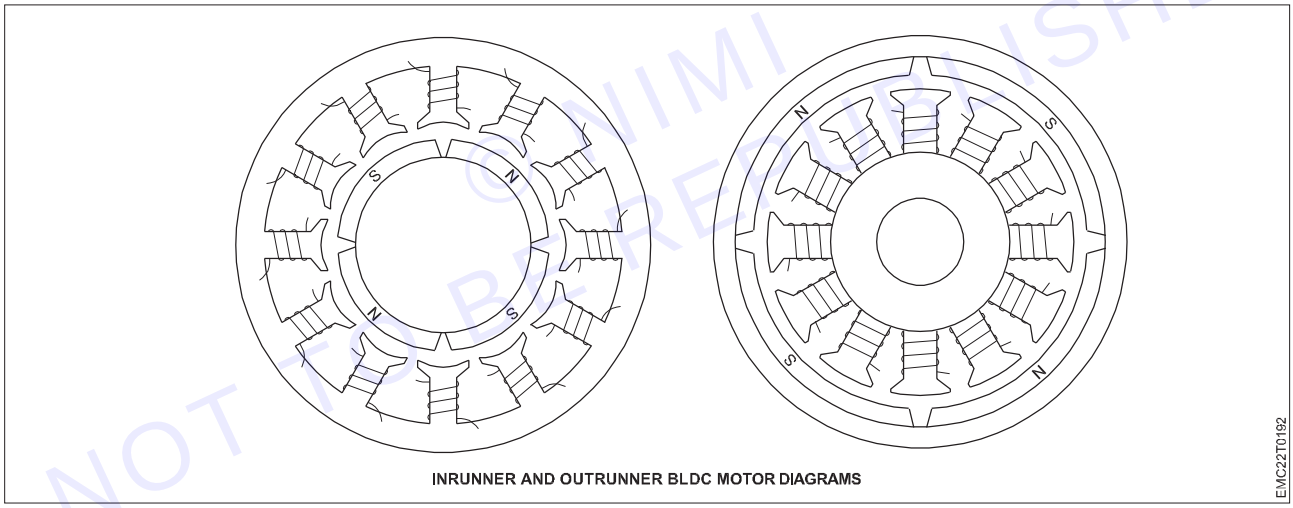
The design of brushless DC motors eliminates the need for brushes and makes BLDC motors quieter and more reliable with an efficiency rating of 85 to 90 percent. The elimination of brushes removes the wear and tear that brushes experience since very little heat is produced by the rotating magnet.



Brushless DC Motor Construction

There are several different configurations of BLDC motors, which vary according to their stator windings that can be single, two, or three phase. The majority of BLDC motors have the three phase design with a permanent magnet rotor. The stator for each type of BLDC motor has the same number of windings.

BLDC motors can be inrunner or outrunner where an inrunner brushless motor has the permanent magnets inside the electromagnets while an outrunner has the permanent magnets outside the electromagnets. The working principle for both designs is the same with different configurations.



INRUNNER AND OUTRUNNER BLDC MOTOR DIAGRAMS

Stator

The stator produces the magnetic force that causes the rotor of a brushless DC motor to spin. It is either inside and surrounded by the rotor or outside enclosing the rotor. The stator is made up of laminated steel stampings stacked together to form a magnetic core. Coils of wire are wound around the core and are connected to the controller.

The pieces of steel of the stator can be slotted or slotless with slotless cores being capable of producing high speed motors because of low inductance, a design that is more expensive since it requires more coil turns.

Rotor

The rotor contains a permanent magnet with two to eight pairs of poles with alternate south and north poles. The magnetic material for the rotor is carefully chosen in order to produce the required magnetic field density. The types of magnets for the rotor can be ferrite or neodymium.

The different core configurations are circular with permanent magnets on the periphery or circular with rectangular magnets.

Hall Sensor

Hall sensors synchronize the stator armature excitation by sensing the position of the rotor. The commutation of BLDC motors is controlled electronically causing the stator windings to be energized in sequence to rotate the rotor. Before a winding can be energized, the Hall sensor identifies the position of the rotor. Most BLDC motors have three Hall sensors that are placed in the stator. Each of the sensors generates a low and high signal when the rotor poles pass near them.

Benefits of BLDC Motor

- Absence of mechanical commutator to avoid wear
- High efficiency
- High speed of operation in loaded and unloaded conditions
- Smaller motor geometry and lighter weight
- Long life
- Higher dynamic response because of low inertia and carrying windings in the stator
- Less electromagnetic interference
- Low noise and quiet operation

Uses for DC Motors

Diesel Electric Locomotives

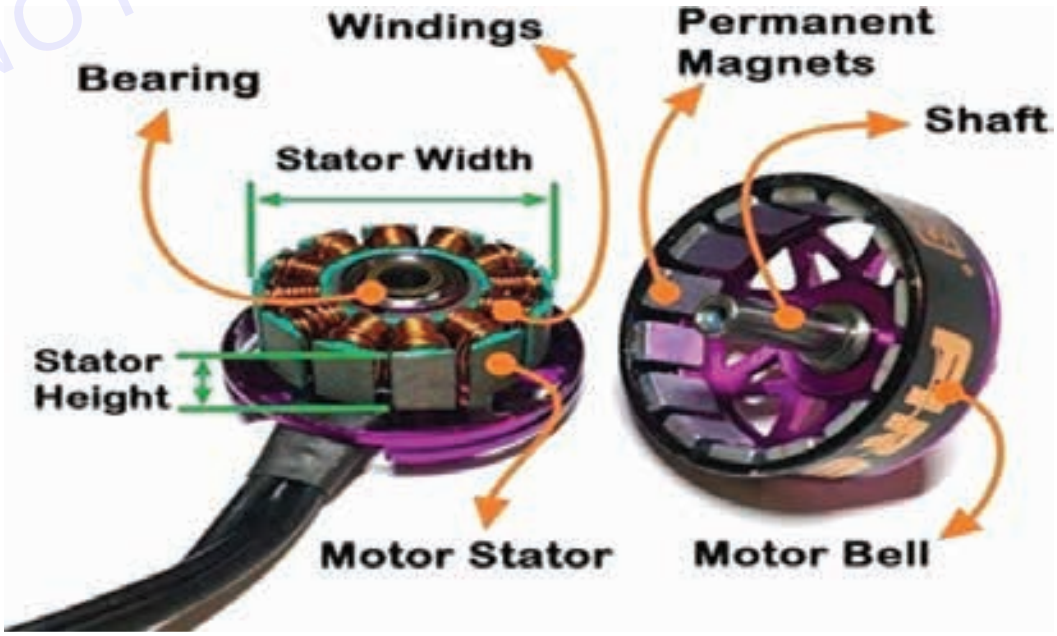
In a diesel electric locomotive, combustion from the diesel engine is converted into rotational energy by the diesel engine, which is coupled with a generator that converts it to electrical energy. The converted electrical energy is fed to DC motors that are coupled with the wheels on the engine.

Electric Vehicles

Brushed DC motors are used in electric vehicles for retracting and positioning electrically powered windows. Since brushed motors tend to wear out rapidly, many electric vehicle applications use brushless motors due to their long life span and noiselessness. Brushless DC motors are used for windshield wipers and CD players. All of the recent hybrid electric vehicles depend on brushless DC motors.

Cranes

In applications with overhauling loads, it is important for the motor to have the ability to hold a full load at zero speed where mechanical brakes may not be required. In those situations, DC motors are the most cost effective and safest option. A major benefit of their use is their size and weight.



Conveyor Systems

Conveyor systems require constant speed and high torque, which makes DC motors an ideal option. As has been found with other applications, DC motors have high torque at start up and even consistent speed. Brushless DC motors are the most commonly used for conveyor applications. They are noiseless and can be easily controlled, a major requirement for conveying systems.

Ceiling Fans

Ceiling fans made with DC motors have become extremely popular. They use less power and have a rapid start up torque. The alternating current in a home or office is easily converted to DC power by a transformer, an effect that decreases the amount of power required by the fan. As with other DC motor applications, brushless DC motors are most commonly used in ceiling fans.

Pump Drives

DC motors have been the main driving force behind pumps for several decades because of their variable speed control, simple control system, high starting torque, and good transient response. For many years, pumping systems depended on brushed DC motors as their primary source of energy. The development of permanent magnet DC motors and brushless DC motors have offered a more beneficial option for pump system operations.

Elevators

In high speed elevators, AC motors are impractical due to their difficulty decelerating and accurately leveling with the floor. These problems are overcome with DC motors because they allow for infinite control of their speed by varying the current supplied to the armature. As with ceiling fans, the operation of a DC motor for elevators depends on changing the incoming AC current to DC current through the use of a transformer.

LESSON 223 - 236 : AC Drives

Objectives

At the end of this lesson you shall be able to

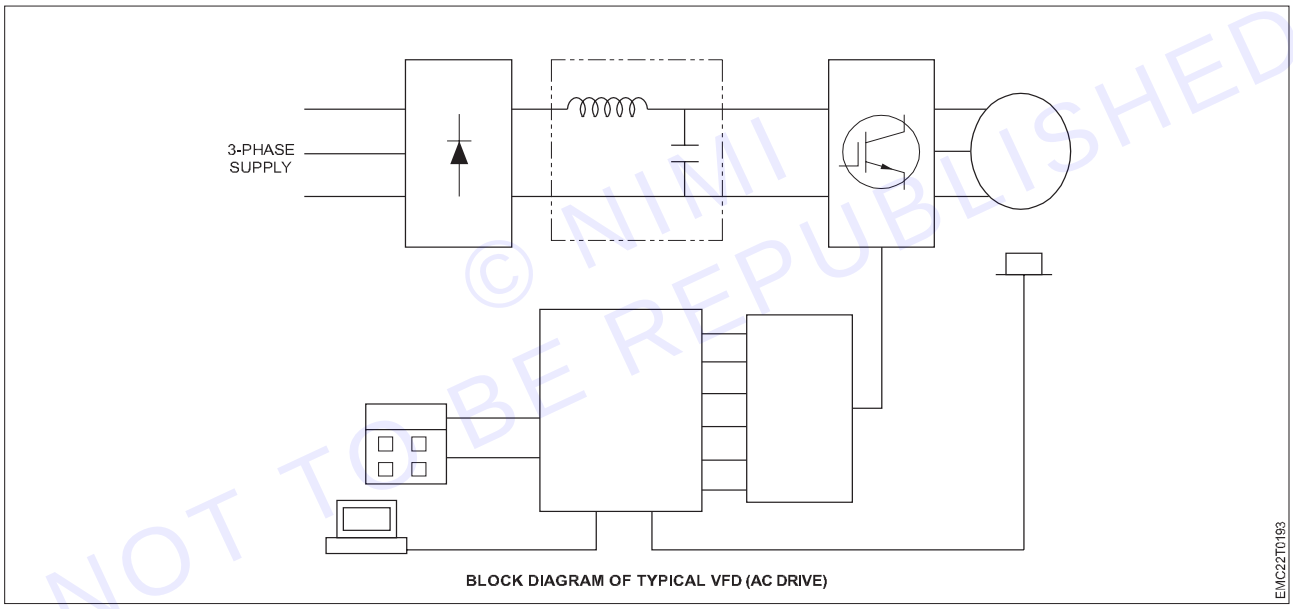
- state the various steps involved in the condition of AC drives
- state the advantages & disadvantages of AC drives.

AC Drive

An AC drive is a device used to control the speed of an AC motor that control loads ranging from pumps and fans to complex machines. An AC drive may control other aspects of an application as well, but that depends on the capabilities of the drive and how it is applied.

AC drives function by converting a constant AC frequency and voltage into a variable frequency and voltage. There are many types of AC drives, but this course focuses on low voltage (less than 1000 VAC) AC drives used with three-phase induction motors, the most common pairing used in industrial applications.

The importance of controlling speed varies with the application, but, for many applications, speed control is critical because it affects many other aspects of a manufacturing process. Many processes require multiple AC drives functioning independently or in coordination. AC drives are also used in non-manufacturing applications, but the basic principles of operation are the same.



BLOCK DIAGRAM OF TYPICAL VFD (AC DRIVE)

Advantage of AC Drives

Lower Energy Costs

- Less Usage
- Reduce Demand
- Improved Power factor

Reduced Maintenance

- Mechanical stress
- Shock loads
- Reduced cavitation

Improved Process control

- Speed control
- Flow control
- Pressure control
- Temperature control
- Acceleration control

- Tension control
- Torque control
- Monitoring

Lower Installation Costs

- Contactors/control relays
- Overload relays
- PID modules
- Control panel complexity

Single-phase rectifier

Single-phase rectifiers for producing d.c. supplies for inverters are usually uncontrolled, i.e. composed of diodes only; the variation of voltage and frequency is carried out by the output stage, usually by pulse width modulation. However, single-phase controlled rectifiers are still employed as variable voltage sources for d.c. servomotors used in control systems. a shows the circuit of a single-phase fully controlled bridge rectifier. The average rectifier output from Appendix B (with m = 2 for single phase) is $2E_p$ (cos α)/π, where E_p is the peak a.c. line voltage and α is the firing-delay angle. The e.m.f. of the motor is considered constant and the net voltage available to drive current through the impedances is the rectifier output voltage shown less the e.m.f. it is assumed that the motor has sufficiently high inductance to maintain current over short intervals when the rectifier's output voltage is negative.

Power flow is therefore from the load to the supply (inversion); this condition can only be maintained if the motor e.m.f. is aiding the flow of current, i.e. generating. If inversion is not required, a simpler 'half-controlled' bridge formed of two SCRs and two diodes may be used.

The waveforms assume that the supply current can reverse instantaneously when there is a change in the SCR conduction pattern. However, presence of inductance in the supply prevents sudden reversal and the result is that the supply voltage is committed for a short interval in supporting the L di/dt in the supply inductance. During this 'overlap' interval, all four devices conduct (the load current rising from zero in one pair and decaying towards zero in the other pair) and the rectifier output voltage is zero. If the a.c. current is i and the d.c. current I_d,

Diagram of single phase rectifier and wave form

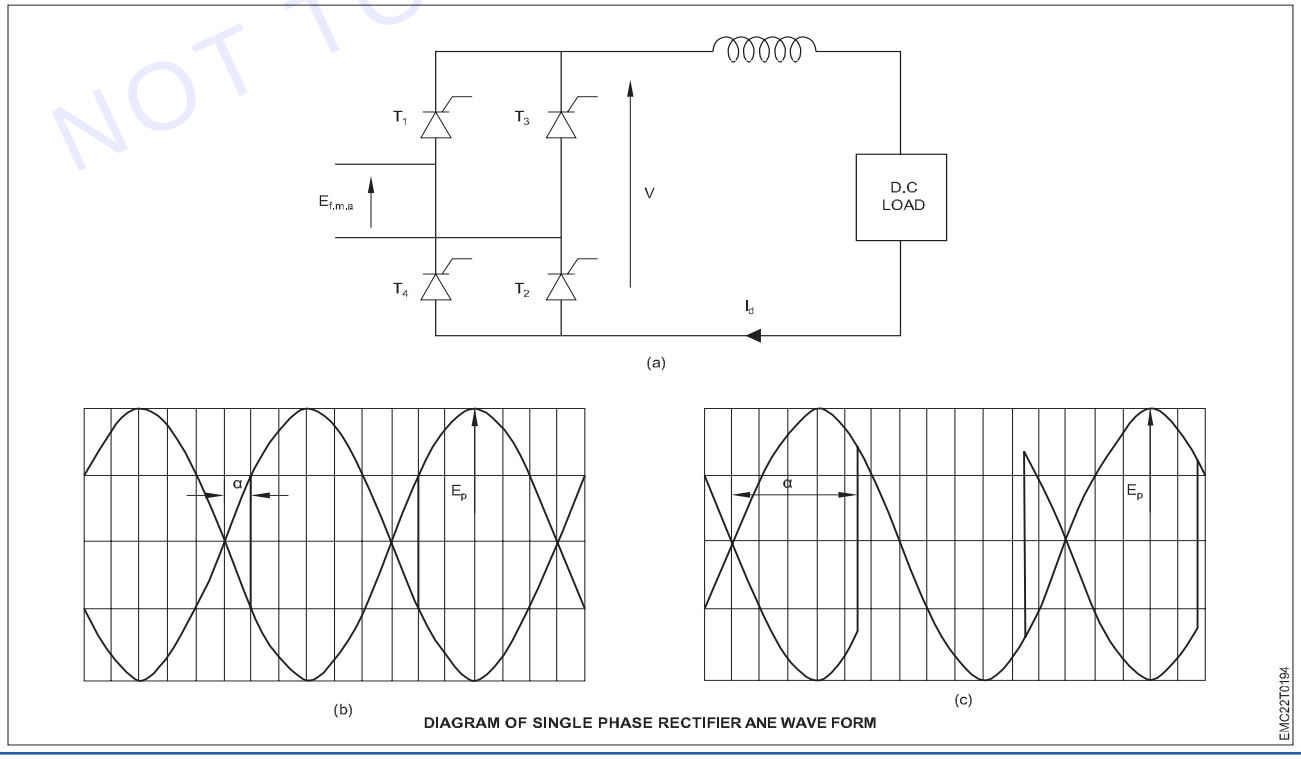


DIAGRAM OF SINGLE PHASE RECTIFIER ANE WAVE FORM

Three Phase Rectification

3-phase rectification is the process of converting a balanced 3-phase power supply into a fixed DC supply using solid state diodes or thyristors

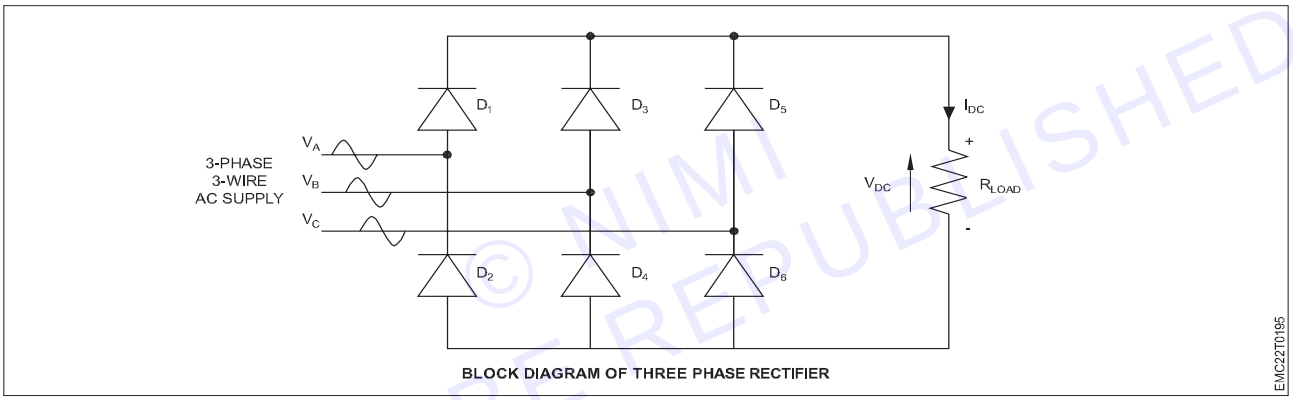
We saw in the previous tutorial that the process of converting an AC input supply into a fixed DC supply is called Rectification with the most popular circuits used to perform this rectification process is one that is based on solid-state semiconductor diodes.

In fact, rectification of alternating voltages is one of the most popular applications of diodes, as diodes are inexpensive, small and robust allowing us to create numerous types of rectifier circuits using either individually connected diodes or with just a single integrated bridge rectifier module.

Single phase supplies such as those in houses and offices are generally 120 Vrms or 240 Vrms phase-to-neutral, also called line-to-neutral (L-N), and nominally of a fixed voltage and frequency producing an alternating voltage or current in the form of a sinusoidal waveform being given the abbreviation of “AC”.

Three-phase rectification, also known as poly-phase rectification circuits are similar to the previous single-phase rectifiers, the difference this time is that we are using three, single-phase supplies connected together that have been produced by one single three-phase generator.

Block diagram of three phase rectifier



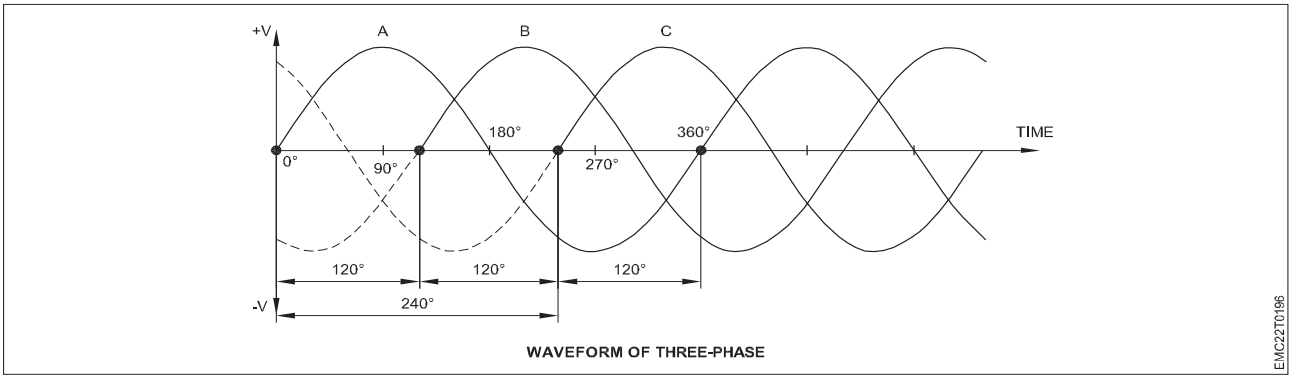
BLOCK DIAGRAM OF THREE PHASE RECTIFIER

Advantage of three phase rectifier

The advantage here is that 3-phase rectification circuits can be used to power many industrial applications such as motor control or battery charging which require higher power requirements than a single-phase rectifier circuit is able to supply.

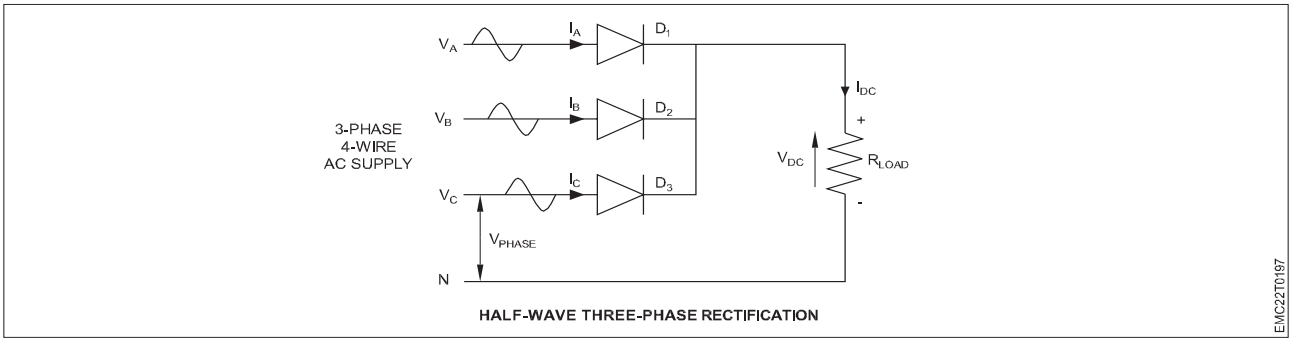
3-phase supplies take this idea one step further by combining together three AC voltages of identical frequency and amplitude with each AC voltage being called a “phase”. These three phases are 120 electrical degrees out-of-phase from each other producing a phase sequence, or phase rotation of: 360o χ 3 = 120° as shown.

Waveform of Three-phase



WAVEFORM OF THREE-PHASE

Half-wave Three-phase Rectification



HALF-WAVE THREE-PHASE RECTIFICATION

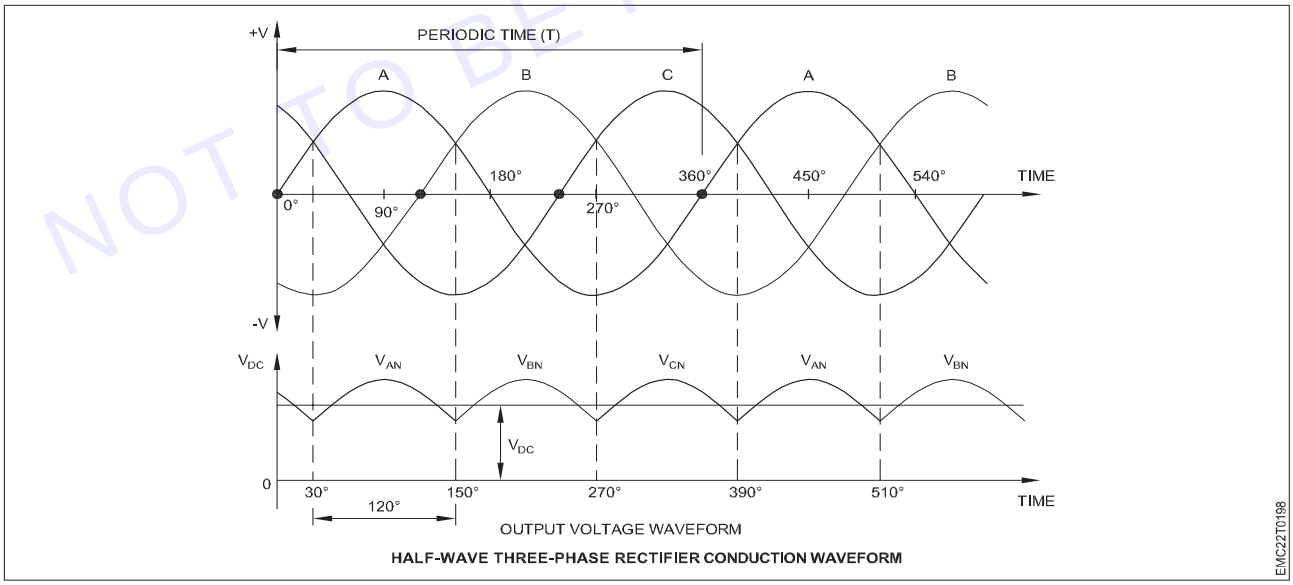
So how does this three-phase half-wave rectifier circuit work. The anode of each diode is connected to one phase of the voltage supply with the cathodes of all three diodes connected together to the same positive point, effectively creating a diode-"OR" type arrangement. This common point becomes the positive (+) terminal for the load while the negative (-) terminal of the load is connected to the neutral (N) of the supply.

Assuming a phase rotation of Red-Yellow-Blue (V_A – V_B – V_C) and the red phase (V_A) starts at 0°. The first diode to conduct will be diode 1 (D_1) as it will have a more positive voltage at its anode than diodes D_2 or D_3. Thus diode D_1 conducts for the positive half-cycle of V_A while D_2 and D_3 are in their reverse-biased state. The neutral wire provides a return path for the load current back to the supply.

120 electrical degrees later, diode 2 (D_2) starts to conduct for the positive half-cycle of V_B (yellow phase). Now its anode becomes more positive than diodes D_1 and D_3 which are both "OFF" because they are reversed-biased. Similarly, 120° later VC (blue phase) starts to increase turning "ON" diode 3 (D_3) as its anode becomes more positive, thus turning "OFF" diodes D_1 and D_2.

Then we can see that for three-phase rectification, whichever diode has a more positive voltage at its anode compared to the other two diodes it will automatically start to conduct, thereby giving a conduction pattern of: D_1 D_2 D_3 as shown.

Half-wave Three-phase Rectifier Conduction Waveform



HALF-WAVE THREE-PHASE RECTIFIER CONDUCTION WAVEFORM

Switching Circuit

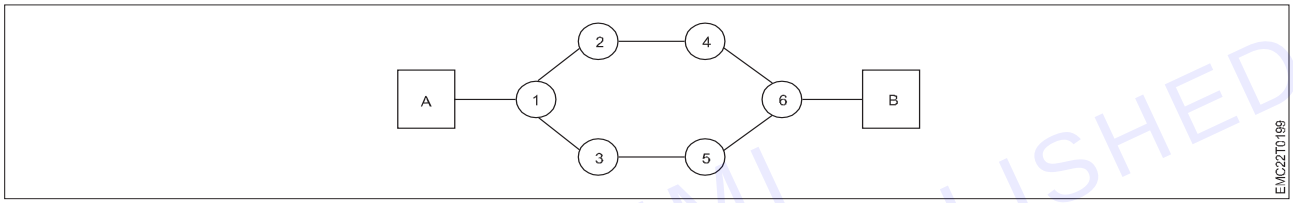
This method of switching establishes a dedicated communication path between the sender and receiver. Here the link is established in physical form between two stations present in the network. The link will be established, maintained and terminated for each communication session. The most common example of circuit switching is the Analog telephone network.

This method of switching provides a constant bit delay and fixed data rate channel between the sender and receiver. The full channel capacity is dedicated for the duration of a connection. When data is to be transferred from sender to receiver, firstly the sender sends a request to the switching station for the establishment of a connection. The receiver replies with an acknowledgment. After receiving the acknowledgment signal the sender starts the data transmission. This switching is commonly used for voice circuits. The public switched telephone network, Datakit, B channel of ISDN, Optical mesh network, etc are some of the examples of circuit-switched networks.

Circuit Switching Diagram

In this type of switching, there is a set of switches connected with physical links. Here once the dedicated path is established between the sender and receiver, it stays the same until one of the users terminates the connection. Fixed data is transmitted and this type of switching is highly used to transfer voice data. The network consists of the switching offices with permanent links between them. Whenever is connection requested the communication links are dedicated to the terminals forming the transmission route. This dedicated link is maintained until the connection is terminated. Other users will be able to use this link only when it is terminated by the sender or receiver.

There are three phases in the establishment of a circuit switching network. They are – circuit establishment, Data transfer and circuit disconnect.



Pulse Width Modulation (PWM) Techniques

Introduction

A common control method in power electronics for managing the output voltage of converters, particularly DC/AC inverters, is pulse width modulation (PWM). The basic concept behind PWM is to adjust the output pulse width in order to regulate the average output voltage. With PWM, a fixed DC input voltage source can produce a sinusoidal output waveform with variable frequency and amplitude.

PWM methodologies in inverters provide fine control over the output voltage waveform in VSIs, enabling accurate voltage regulation as well as current regulation. This is vital for numerous applications where precise voltage control is necessary for top performance, including motor drives, renewable energy systems, and uninterruptible power supplies (UPS).

With the usage of PWM, it is also possible to control the output waveform's harmonic distortions which ultimately leads to improved power quality and lowering system losses. In contrast to the fundamental square-wave modulation techniques, PWM in inverters offers advantages in terms of improved control over output voltage, frequency, and harmonics.

The common PWM methods, as well as their impacts on inverter performance, harmonic content, and distortion, are covered in single-phase inverters and three-phase inverters in the section below.

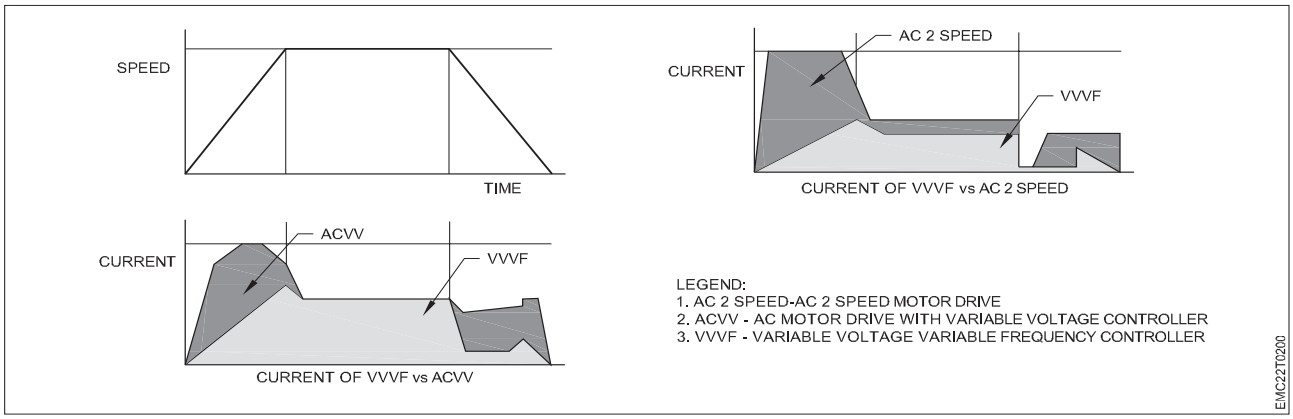
Variable Voltage Variable Frequency (VVVF) Lift Drive

Variable Voltage Variable Frequency (VVVF) Lift Drive employs frequency inverter technology which regulates input voltage and frequency throughout the journey, drawing much less current during acceleration and deceleration.

Operating characteristics of different motor drives

When compared with other modes of drives, one can see that the VVVF drive offers low starting current (approximately 1.8x of the rated current), high power factor (i.e. better efficiency in power supply) with good ride quality and floor leveling. It can reduce motor starting currents by as much as 50 to 80% compared with conventional motor drives. Further, wear and tear of the equipment can also be less during start/stop of the motor by using VVVF motor drive.

One example in Hong Kong using VVVF technology can be found at Po On Market and WSD Staff Quarters at



Kwai Fong. It has been shown that this low noise level drive enables over 40% of energy saving with improved riding comfort.

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One example in Hong Kong using VVVF technology can be found at Po On Market and WSD Staff Quarters at Kwai Fong. It has been shown that this low noise level drive enables over 40% of energy saving with improved riding comfort.

3-Phase Induction Motor

A 3-phase induction motor is an electromechanical energy conversion device which converts 3-phase input electrical power into output mechanical power.

A 3-phase induction motor consists of a stator and a rotor. The stator carries a 3-phase stator winding while the rotor carries a short-circuited winding called rotor winding. The stator winding is supplied from a 3-phase supply. The rotor winding drives its voltage and power from the stator winding through electromagnetic induction and hence the name.

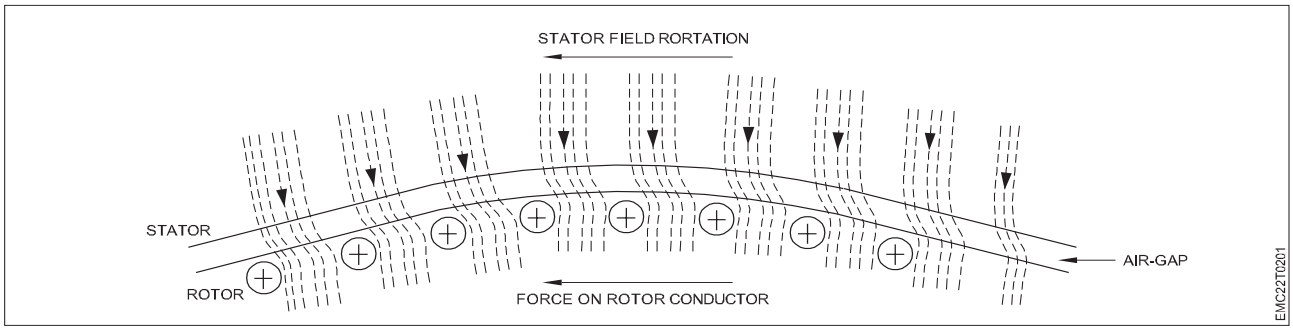
Working Principle of a 3-Phase Induction Motor

The working principle of a 3-phase induction motor can be explained by considering a portion of it as follows:

When the 3-phase stator winding is fed from a balanced 3-phase supply, a rotating magnetic field (RMF) is produced in the motor. This RMF rotates around the stator at synchronous speed which is given by,

SynchronousSpeed,NS=120fPSynchronousSpeed =120

The RMF passes through the air gap and cuts the rotor conductors, which as yet are stationary. Due to the relative motion between the RMF and the stationary rotor conductors, EMFs are induced in the rotor conductors. As the rotor circuit is closed with short-circuit so currents start flowing in the rotor conductors.



Since the current carrying rotor conductors are placed in the magnetic field produced by the stator winding. As a result, the rotor conductors experience mechanical force. The sum of the mechanical forces on all the rotor conductors produce a torque which moves the rotor in the same direction as the rotating magnetic field. Hence, in such a way the three phase input electric power is converted into output mechanical power in a 3-phase induction motor.

Also, according to Lenz's law, the rotor should move in the direction of the stator field, i.e., the direction of rotor currents would be such that they tend to oppose the cause producing them. Here, the cause producing the rotor currents is the relative speed between the RMF and the rotor conductors. Thus to reduce this relative speed, the rotor starts running in the same direction as that of the RMF.

Advantages of Three Phase Induction Motor

Following are the chief advantages of a 3-phase induction motor :

It has simple and rugged construction.

It requires less maintenance.

It has high efficiency and good power factor.

It is less expensive.

It has self-starting torque.

Disadvantages of Three Phase Induction Motor

The disadvantages of a 3-phase induction motor are given as follows:

The 3-phase induction motors are constant speed motors; hence their speed control is very difficult.

3-phase induction motors have poor starting torque and high inrush currents (about 4 to 8 times of the rated current).

They always operate under lagging power factor and during light loads, they operate at very worst power factor (about 0.3 to 0.5 lagging).

PID Controller

A PID (Proportional – Integral – Derivative) controller is an instrument used by control engineers to regulate temperature, flow, pressure, speed, and other process variables in industrial control systems. PID controllers use a control loop feedback mechanism to control process variables and are the most accurate and stable controller.

PID Controller Basics

The purpose of a PID controller is to force feedback to match a setpoint, such as a thermostat, that forces the heating and cooling unit to turn on or off based on a set temperature. PID controllers are best used in systems which have a relatively small mass and those which react quickly to changes in the energy added to the process.

AC Drive Installation

Overview This publication identifies important installation considerations for Allen-Bradley adjustable frequency AC drives. Precautions Qualified Personnel General Reference Materials . Installation Considerations Configure For Non-Solid Grounded Distribution Systems Your drive may contain protective MOVs and common mode capacitors that are referenced to ground. Disconnect these devices from ground when installing the drive on any of the following non-solid grounded distribution systems: Measure Input Impedance Do not install a drive on a

power distribution system that is more than 10 times the drive kVA rating without adding impedance (line reactor or transformer) in front of the drive. ATTENTION: Only qualified personnel familiar with adjustable frequency AC drives and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage. ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the +DC and –DC terminals of the Power Terminal Block. Refer to the product-specific documentation for location. The voltage must be zero.

- AC fed ungrounded
- B phase ground
- Impedance grounded
- Regenerative unit such as common DC bus supply & brake
- High resistive ground
- DC fed from an active converter *PN-73136* PN-73136 Publication DRIVES-IN003A-EN-P - April 2010 Copyright © 2010 Rockwell Automation, Inc.

Measure Line-To-Line Voltages Verify that the drive input voltage has an unbalance that is less that 3%. Ground The Drive Ensure that drive grounding is properly connected as illustrated below. The ground wire return between the motor and the drive must be terminated directly to the drive PE terminal. Shielded cable is recommended but not always needed. Refer to the product-specific documentation for requirements. Protect The Drive Ensure that the proper sized input fuses or circuit breakers are installed prior to applying power to the drive. Verify Your Installation Ensure that all input and output power wiring is correctly wired and securely fastened prior to applying power to the drive. Unbalanced Percent = (Vmax - Vmin) x 100 (Vavg) Vavg = (VAB + VBC + VCA) 3 Where: Vmax = maximum line-to-line RMS voltage Vmin = minimum line-to-line RMS voltage Where: VAB, VBC, VCA = line-to-line voltage

Protect The Drive Ensure that the proper sized input fuses or circuit breakers are installed prior to applying power to the drive. Verify Your Installation Ensure that all input and output power wiring is correctly wired and securely fastened prior to applying power to the drive.

Siemens Micromaster 440 (MM440) Series

The MICROMASTER 440 are frequency inverters for speed and torque control of three-phase motors. The various models available cover the performance range from 120 W to 200 kW (for constant torque (CT), alternatively up to 250kW (for variable torque (VT)). The inverters are microprocessor-controlled and use state-of-the-art Insulated Gate Bipolar Transistor (IGBT) technology. This makes them reliable and versatile. A special pulse-width modulation method with selectable Pulse frequency permits quiet motor operation. Comprehensive protective functions provide excellent inverter and motor protection. With the factory default settings, the MICROMASTER 440 is suitable for many variable speed applications. Using the functionally grouped parameters, the MICROMASTER 440 can adapted to more demanding applications. The MICROMASTER 440 can be used in both 'stand-alone' applications as well as being integrated into 'Automation Systems'.

Variable Frequency Drive

Speed control, since the result is an adjustment of motor speed.

There are many reasons why we may want to adjust this motor speed.

For example, to A variable frequency drive (VFD) is a type of motor controller that drives an electric motor by varying the frequency and voltage of its power supply. The VFD also has the capacity to control ramp-up and ramp-down of the motor during start or stop, respectively.

Even though the drive controls the frequency and voltage of power supplied to the motor, we often refer to this as

Save energy and improve system efficiency

Convert power in hybridization applications

Match the speed of the drive to the process requirements

Match the torque or power of a drive to the process requirements

Improve the working environment

Lower noise levels, for example from fans and pumps

Reduce mechanical stress on machines to extend their lifetime

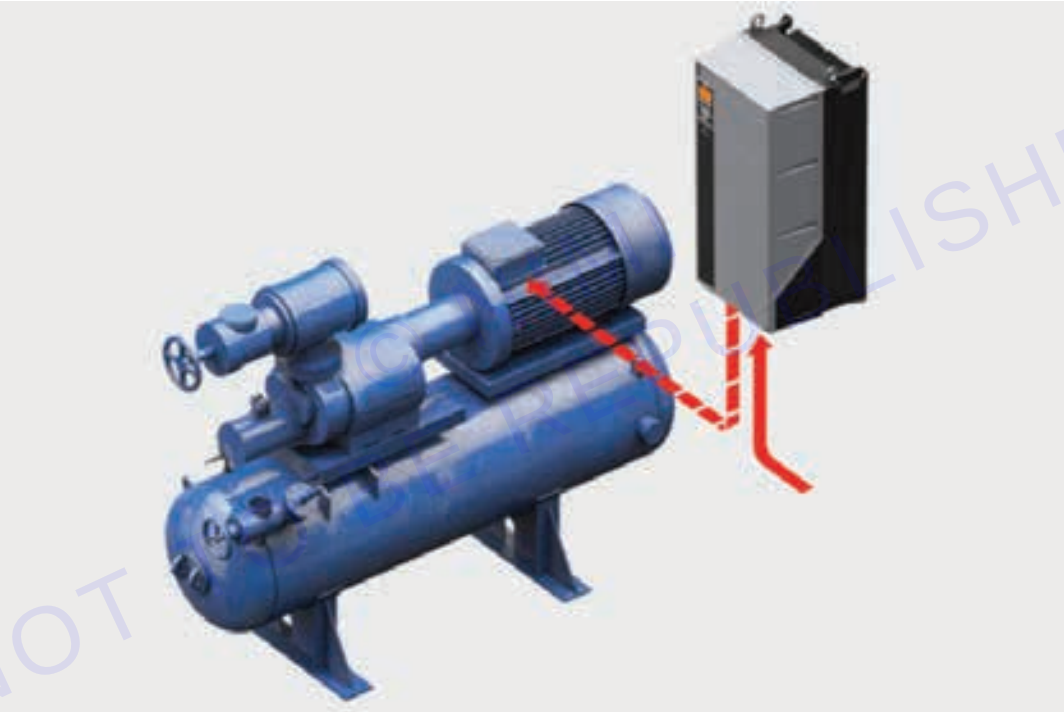
Shave peak consumption to avoid peak-demand prices and reduce the motor size required

In addition, today's drives integrate networking and diagnostic capabilities to better control performance and increase productivity. So, energy savings, intelligent motor control and reduction of peak-current drawn are three great reasons to choose a VFD as the controller in every motor-driven system.

The most common uses of a VFD are for control of fans, pumps and compressors, and these applications account for 75% of all drives operating globally.

Soft starters and across-the-line contactors are other, less sophisticated types of motor controllers. A soft starter is a solid-state device and provides a gentle ramp-up to full speed during startup of an electric motor.

An across-the-line contactor is a type of motor controller that applies the full line voltage to an electric motor.



LESSON 237 - 241 : Servo Motor

Objectives

At the end of this lesson you shall be able to

- state the various steps involved in the condition of servo mechanism
- state the control method of servo motor
- study of servo drive.

Servo Mechanism

A servo mechanism is a closed-loop control system that uses feedback to control the position, velocity, or acceleration of a mechanical system. It typically consists of a motor, a sensor (such as an encoder or potentiometer), and a controller. The sensor provides feedback to the controller, which adjusts the motor's output to achieve the desired position or motion. Servo mechanisms are commonly used in robotics, aerospace systems, and industrial automation for precise control of motion.

Servo Mechanism

Servo Motor

Working principal

A servo motor is a type of rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration. It consists of a motor coupled with a sensor for position feedback, typically a potentiometer or an encoder. This feedback allows the servo motor to adjust its position accurately based on the control signal it receives. Servo motors are widely used in various applications such as robotics, industrial automation, CNC machinery, and remote-controlled vehicles due to their high precision and controllability.

Difference between Motors & Servo Motors

The main difference between a regular motor and a servo motor lies in their control and precision

1 **Control:** Regular motors typically rotate continuously when power is applied and require external control mechanisms (such as motor drivers) to manage speed and direction. Servo motors, on the other hand, incorporate built-in control systems that enable precise positioning and velocity control.

2 **Precision:** Servo motors are designed for high precision applications, allowing accurate control of position, velocity, and acceleration. They typically incorporate feedback mechanisms (like encoders or potentiometers) that provide information about the motor's current position, enabling precise adjustments.

3 **Usage:** Regular motors are commonly used for tasks where simple rotational motion is required, such as driving a fan or a conveyor belt. Servo motors excel in applications that demand precise and controlled motion, such as robotic arms, CNC machines, and camera gimbals.

4 **Cost:** Servo motors tend to be more expensive than regular motors due to their built-in control systems and precision components.

In summary, while both types of motors convert electrical energy into mechanical motion, servo motors offer enhanced control and precision, making them ideal for applications requiring accurate positioning and motion control.

Types of Servo Motor

Servo motors can be classified into various types based on their construction, control method, and application. Here are some common types:

1 DC Servo Motors

These motors operate on DC power and are widely used in applications requiring precise control of position, velocity, or acceleration.

2 AC Servo Motors

These motors are designed to work with AC power and are often used in industrial automation and robotics due to their high torque and speed capabilities.

3 Brushed Servo Motors

These motors use brushes and a commutator to transfer electrical power to the rotor, providing simplicity and ease of control.

4 Brushless Servo Motors

These motors eliminate the need for brushes and commutators, offering improved efficiency, reliability, and maintenance-free operation.

5 Linear Servo Motors

Instead of rotational motion, linear servo motors produce linear motion directly, making them suitable for applications such as CNC machines and high-precision positioning systems.

6 Micro Servo Motors

These are small-sized servo motors commonly used in RC (remote control) models, drones, and small robotic applications.

Industrial Servo Motors

These motors are designed for heavy-duty industrial applications, offering high torque and precision control for tasks such as CNC machining, printing, and packaging.

Hobby Servo Motors

These are low-cost, small-sized servo motors commonly used in hobbyist projects, remote-controlled vehicles, and model airplanes.

AC & DC Brushless Servo Motor & Permanent Magnet Servo Motor Construction & Application

AC and DC brushless servo motors, as well as permanent magnet servo motors, have distinct constructions and applications:

1 AC Brushless Servo Motors

Construction: AC brushless servo motors consist of a stator with windings and a rotor with permanent magnets. They typically use a three-phase system.

Applications: They are commonly used in applications requiring precise control and high torque, such as robotics, CNC machines, and industrial automation.

2 DC Brushless Servo Motors

Construction: DC brushless servo motors also have a stator with windings and a rotor with permanent magnets. However, they are powered by DC voltage and utilize electronic commutation rather than brushes for operation.

Applications: DC brushless servo motors are used in similar applications to AC brushless servo motors but are often preferred in battery-powered devices, drones, and smaller-scale automation systems due to their efficient and compact design.

3 Permanent Magnet Servo Motors

Construction: Permanent magnet servo motors, whether AC or DC, have a rotor with permanent magnets and a stator with windings. These motors can be brushless or brushed, depending on the design.

Applications: Permanent magnet servo motors find applications in a wide range of industries, including aerospace, automotive, robotics, and medical devices. They are favored for their high power density,

Control Method For Servo Motor

There are various methods to control a servo motor

1 **Pulse Width Modulation (PWM):** Most common method where the servo's position is controlled by the duration of a pulse signal sent to it. The width of the pulse determines the position of the servo.

2 **Position Control:** Directly specifying the desired position of the servo motor. This can be achieved using analog or digital control signals.

3 **PID Control:** Using a proportional-integral-derivative (PID) controller to adjust the servo's position based on feedback from sensors, such as encoders or potentiometers, to minimize error between the desired and actual position.

4 **Microcontroller:** Utilizing a microcontroller, such as Arduino or Raspberry Pi, to generate control signals for the servo motor based on user-defined algorithms or commands.

5 **Closed-loop Control:** Combining feedback from sensors with control algorithms to continuously adjust the servo's position for more precise control.

The choice of control method depends on factors such as the application requirements, precision needed, complexity of the system, and available resources.

Study of servo drive

Studying servo drives involves understanding their components, operation principles, control mechanisms, and applications in various industries such as robotics, manufacturing, and automation. Key areas to explore include motor types (e.g., DC, AC), feedback systems (e.g., encoders, resolvers), control algorithms (e.g., PID), communication protocols (e.g., CAN, EtherCAT), and tuning methods for optimal performance. Practical experiments, simulations, and hands-on projects can deepen understanding in this field.