ELECTRONICS EQUIPMENT MAINTENANCE

Syllabus

Unit I Fundamental Troubleshooting Procedures Inside An Electronic Equipment:

Reading Drawings And Diagrams – Block Diagram, Circuit Diagram, Wiring Diagram; Disassembly and reassembly of equipment, Equipment Failures and causes such as poor design, production deficiencies, careless storage and transport, inappropriate operating conditions, Nature of faults, Fault location procedure Fault finding aids – Service and maintenance manuals and instruction manuals, Test and Measuring instruments, special tools Troubleshooting techniques, Approaching components for tests, Grounding systems in Electronic Equipment, Temperature sensitive Intermittent problems Corrective actions, Situations where repairs should not be attempted.

Unit II Passive Components and Their Testing Passive Components-

Resistors, Capacitors, Inductors Failures in fixed resistors, testing of resistors, variable resistors, variable resistors as potentiometers, failures in potentiometers, testing of potentiometers, servicing potentiometers, LDRs and Thermistors Types of capacitors and their performance, Failures in capacitors, testing of capacitors and precautions therein, variable capacitor types, Testing of inductors and inductance measurement

Unit III Testing of Semiconductor Devices

Types of semiconductor devices, Causes of failure in Semiconductor Devices, Types of failure Test procedures for Diodes, special types of Diodes, Bipolar Junction Transistors, Field Effect Transistors, Thyristors Operational Amplifiers, Fault diagnosis in op-amp circuits

Unit IV Logic IC families,

Packages in Digital ICs, IC identification, IC pin-outs, Handling ICs, Digital troubleshooting methods – typical faults, testing digital ICs with pulse generators Logic clip, Logic Probe, Logic Pulser, Logic Current Tracer, Logic Comparator Special consideration for fault diagnosis in digital circuits Handling precautions for ICs sensitive to static electricity Testing flip-flops, counters, registers, multiplexers and demultiplexers, encoders and decoders; Tri-state logic.

Unit V Rework and Repair of Surface Mount Assemblies Surface Mount Technology and surface mount devices Surface Mount Semiconductor packages – SOIC, SOT, LCCC, LGA, BGA, COB, Flatpacks and Quad Packs, Cylindrical Diode Packages, Packaging of Passive Components as SMDs Repairing Surface Mount PCBs, Rework Stations.

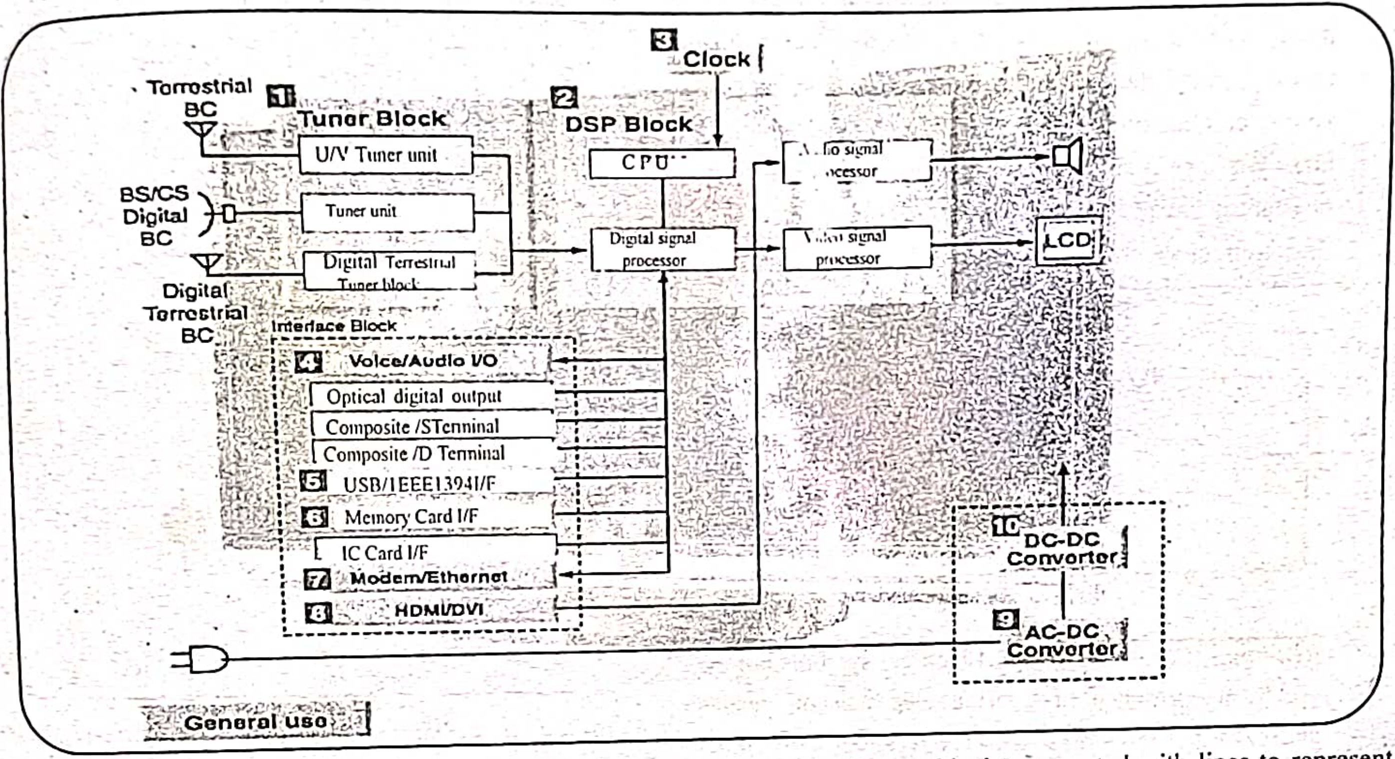
UNIT 01

FUNDAMENTAL TROUBLESHOOTING

QUESTIONS AND ANSWERS

Q1. Explain the block diagram, its importance and Uses of Block Diagrams.

Ans. A block diagram is a drawing illustration of a system whose major parts or components are represented by blocks. These blocks are joined by lines to display the relationship between subsequent blocks.



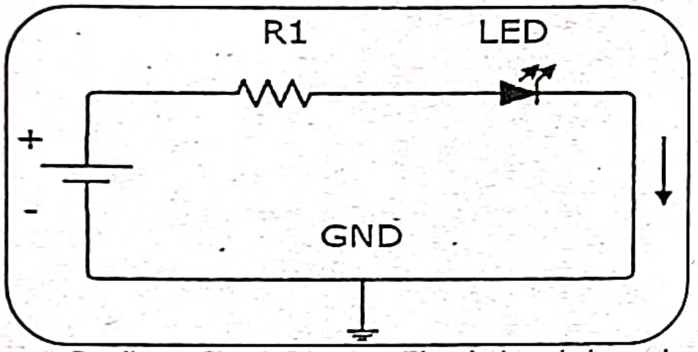
We use block diagrams to visualize the functional view of a system. It uses blocks connected with lines to represent components of a system. With a block diagram, you can easily illustrate the essential parts of a software design or engineering system and depict the data flow in a process flow chart. You can learn everything about a block diagram, including its uses and types. Check out some of its most used examples and learn how to create your block diagram.

Importance of block diagram: A Block Diagram is a fundamental way that hardware and software developers utilize to describe these systems while illustrating their workflows and processes. Electricians, on another hand, need them to represent systems and their shifting, for example, the mechatronic systems in the trucking industry.More often than not, block diagrams are of great assistance when a clear picture of information or control flows is required, besides when a project has a myriad of processes. They make it easier to represent complicated algorithms or flows of details or communication among precise components, for instance, in a mass production facility. Graphically represented project processes are less strenuous to understand than when they are in text form. When you walk into a room with a block diagram, you will be able to easily decipher the system's details, interface, and such as structure aspects. It is all thanks to how the blocks are connected intellectually to one another by lines. Blocks are convenient when designing new processes and upgrading those that already exist.

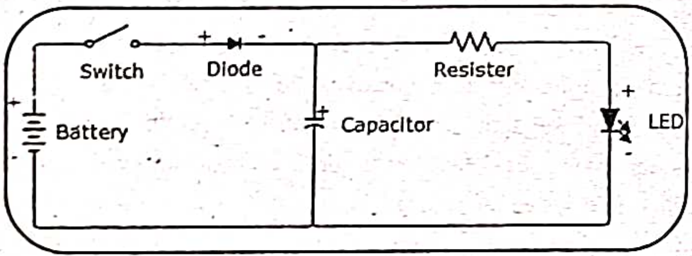
Uses of Block Diagrams: Being simple and easy to understand, Block Diagrams are used in most industries to illustrate functional processes in respective fields. Next, we will look at three most areas that make use of block diagrams.

Q. 2 Describe How to Read and Draw a Circuit Diagram.

Ans. ***Circuit Diagram:*** Circuit diagram is the graphical notation of the electrical circuit. We can also call the circuit diagram as electrical schematic and electrical diagram so doesn't be confused in both. But a question that has been confusing till now is how to draw a circuit diagram? It is very simple, just place the desired electrical symbol in place of electrical components. So as we know that we can't draw the actual component, it is a very hard and time taking process, so to overcome this problem we use the desired electronic symbol in place of components and this makes it easy to draw. We use circuit diagrams to make circuits easily. Through this circuit diagram, you can also plan your circuit that how it works, what to replace, and many more. We have a simple circuit diagram with a battery, resistance, and a LED. So you can see how simple it is to draw a circuit diagram.



Reading a Circuit Diagram: Electrical symbols are the graphical representation of various electrical components and electrical devices. Click here to know more about Electrical Symbols Look at this simple circuit diagram

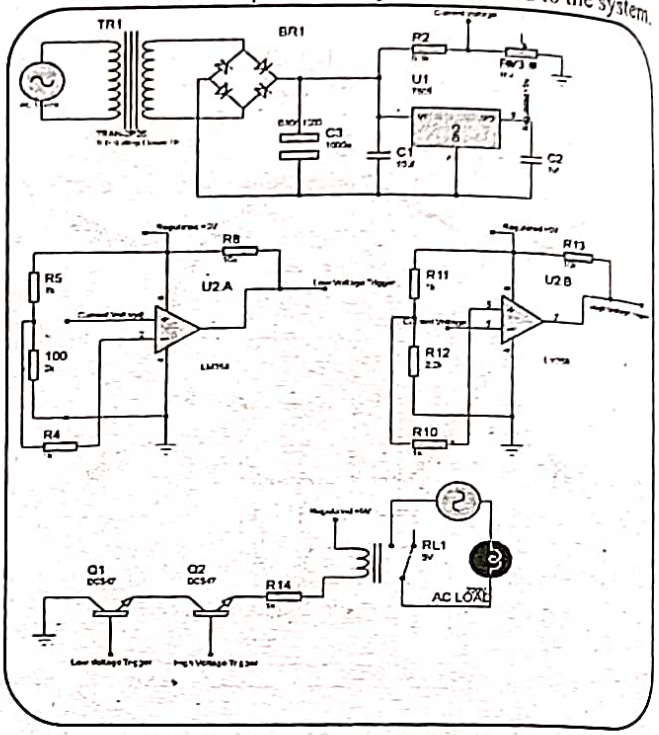


Let's read the upper diagram, here you see a Battery symbol which is the power source of the circuit. On the positive end of the battery, we connect a switch to on and off the supply in the circuit. A diode is connected to one side of the switch to protect the power source. A capacitor is added to the negative side of the diode and to the ground of the circuit. Here we connect a resistance to protect the LED from overcurrent in the circuit.

Q3. Explain wiring diagram and draw the symbol for Standard Wiring Diagram.

Or, How to Draw a Circuit Diagram and draw the symbol for standard wiring diagram.

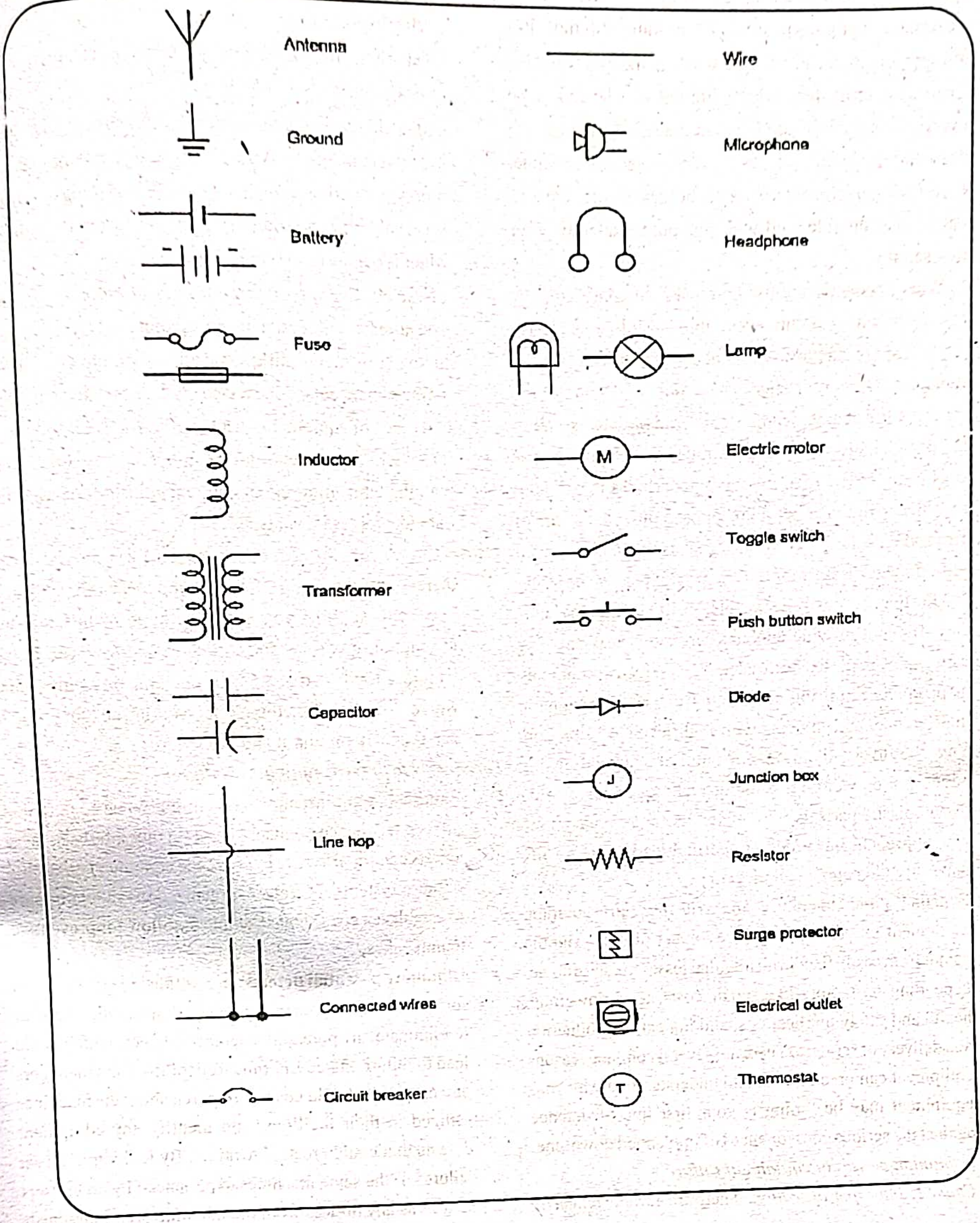
Ans. ***Wiring Diagram:*** A wiring diagram is a simple visual representation of the physical connections and physical layout of an electrical system or circuit. It shows how the electrical wires are interconnected and can also show where fixtures and components may be connected to the system.



Draw a Circuit Diagram: SmartDraw comes with pre-made wiring diagram templates. Customize hundreds of electrical symbols and quickly drop them into your wiring diagram. Special control handles around each symbol allow you to quickly resize or rotate them as necessary. To draw a wire, simply click on the Draw Lines option on the left hand side of the drawing area. If you right click on a line, you can change the line's color or thickness and add or remove arrowheads as necessary. Drag a symbol onto the line and it will insert itself and snap into place. Once connected, it will remain connected even if you move the wire. If you need additional symbols, click the arrow next to the visible library to bring up a drop down menu and select More. You'll be able to search for additional symbols and open any relevant libraries. Click on Set Line Hops in the SmartPanel to show or hide line hops at crossover points. You can also change the size and shape of your line hops.

Select Show Dimensions to show the length of your wires or size of your component.

Standard Wiring Diagram Symbols: Most symbols used on a wiring diagram look like abstract versions of the real objects they represent. For example, a switch will be a break in the line with a line at an angle to the wire, much like a light switch you can flip on and off. A resistor will be represented with a series of squiggles symbolizing the restriction of current flow. An antenna is a straight line with three small lines branching off at its end, much like a real antenna.



Q4. Describe Assembly and disassembly design in electrical and electronic equipment.

Ans. Selecting the attachment technique that is used to assemble and disassemble your electrical and electronic products requires careful consideration.The choice of attachment type is likely to depend on assembly cost and required performance parameters during the product's lifetime. For example, you'll need to decide whether the attachment is permanent during the product's lifetime or if it needs to be reversible for servicing, repair or upgrade. Your choice will affect the purity of recycled materials and hence their value. Reversible attachments need to be accessible, easy to remove and durable, and will give purer materials after disassembly.

Where fasteners are used, you should consider: making fastening points accessible, visible and clearly marked using a simple component orientation using screws in place of rivets for easier disassembly at the end of the product's life standardising screw heads to aid assembly and disassembly avoiding assemblies that require power tools using fasteners of the same material as the parts to be joined to optimise recycling opportunities at the end of the product's life You can design snap-fits to allow rapid and efficient disassembly of the product, eg by ensuring that the tines are easily accessible. However, in some cases they may not provide adequate pressure on connecting parts, for example to ensure adequate conductive continuity in products requiring shielding from electromagnetic interference, and in areas with high levels of vibration. You should avoid joining dissimilar materials using adhesives or welding. Staking techniques for joining thermoplastic parts to other materials can provide a low-cost approach, but reduce opportunities for end-of-life materials and component recycling.

Q5. Explain Equipment Failures and write the its preventation.

Ans. Equipment failure happens. The impact of it can run the gamut from easily fixed with minimal losses to catastrophic, depending on factors like repair costs, total downtime, health and safety implications, and impact on production and delivery of services. There are several common reasons equipment can break down, and understanding why your equipment may be failing is your first line of defence against the serious consequences of unplanned downtime.

5 common causes of equipment failure

Cause 1: Improper operation: There are a whole bunch of people who might be in and around equipment on a daily basis who could have a significant impact on its overall operating condition. Equipment operators are one such group.

Cause 2: Failure to perform preventive maintenance: Most equipment requires regular maintenance for optimal performance, but too often, preventive maintenance is the first task to go when you're short-staffed and overwhelmed.

Cause 3: Too much preventive maintenance: "Surely this is a mistake," you're thinking. "You just told me that NOT doing preventive maintenance will cause things to break." It's true— there's a bit of a Goldilocks situation going on when it comes to preventive maintenance.

Cause 4: Failure to continuously monitor equipment: The cure here is simple in concept but a bit more complex in execution: condition-based maintenance. This is maintenance that's done based on the operating condition of a piece of equipment, instead of just a 'set it and forget it' schedule. It takes a lot of things into account, from manufacturer information equipment history to real-time data like vibration analysis.

Cause 5: Bad (or no) reliability culture: Everyone has been there— major pressure from the top means there's not a second to spare if you have any hope of hitting your production goals. In these circumstances, it can be so tempting (and so easy) for an operator or maintenance worker to notice something's not working at 100%, slap a band-aid solution on it and say,

Three steps to prevent equipment failure:

1) **Establish a maintenance schedule:** When repairs and upkeep take place on machines at regular intervals, these efforts can significantly improve the equipment reliability of these systems. Therefore, organizations should be sure to establish a consistent schedule to follow for preventive maintenance,

2) **Eliminate potential defects:** In addition to creating a plan for preventive maintenance, organizations should also seek to eliminate any potential machinery defects which could lead to failure, stated Lifetime Reliability. Plant managers and operators should do their research about the machines utilized in their facilities, and identify any equipment defects that could create downtime. By looking into past failures of the same machines experienced by other users as well as any notices from the manufacturer, individuals

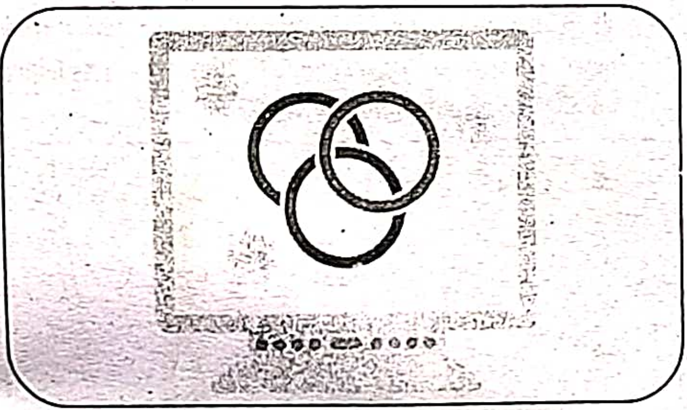
can prevent these defects from affecting their business.

3) **Utilize equipment monitoring:** One of the best ways to prevent equipment failure is to deploy a condition monitoring system to gain insight into the health of key assets. This technology includes sensors to measure key components and provides opportunities to perform preventive maintenance before larger issues arise. This system can boost overall facility uptime as well as equipment reliability, making it a smart investment.

Q6. Describe the Types of Defects of an Electronics equipment.

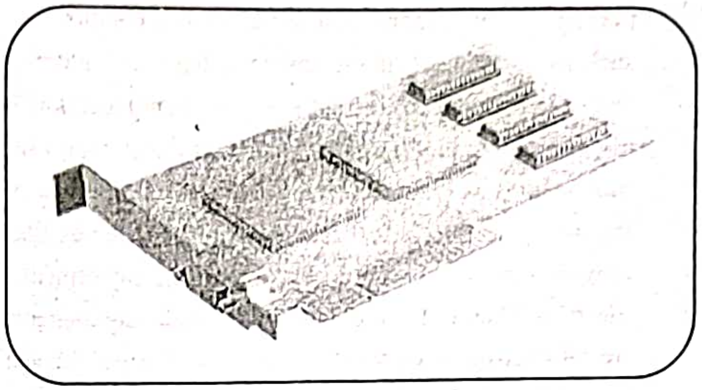
Ans. Recent technology advancements have seen huge improvements in the performance of electronics. The processing power of the phone in your pocket is far beyond the capabilities of the kit that was used for the first trip to the moon. The components are getting smaller and so the technologies required to handle them need to be much more precise.

1. **DISPLAY CONTROL:** With the ever increasing size, resolutions and widespread use of monitors in everyday gadgets, the demand for fast and reliable automated inspection has also increased. Fortunately, the resolutions of sensors has also kept up with it, enabling inspection of even the largest 4K monitors.

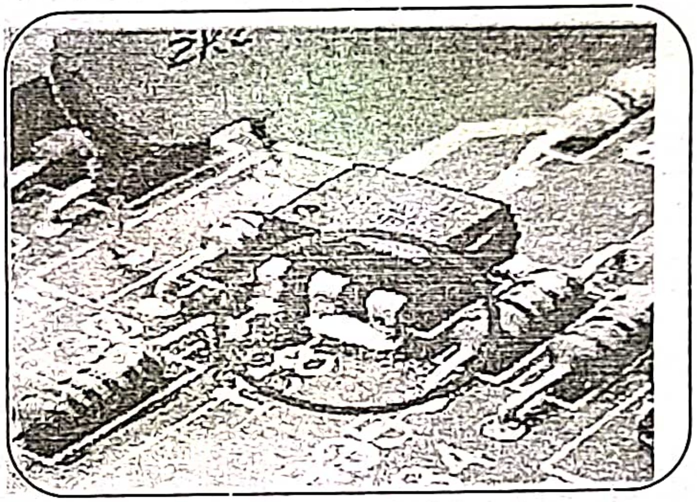


The CVB Foundation Package provides all of the tools necessary for screen inspection, including colour space conversion and look-up-tables (LUTs) to allow cameras' colour response to be calibrated.

2. **HEAT DISSIPATION ANALYSIS:** Electronic components can get quite hot when they are operating at their maximum loads, and they need to be checked to ensure they do not overheat. By using an infrared camera and machine vision software temperature measurements can be fully integrated into automated inspection processes. Thermal machine vision systems are also avaliable in smart camera packages, like Automation Technology's IRSX. The IP67 smart infrared camera is completely self contained and able to communicate directly with industrial equipment.



3. **PRINTED CIRCUIT BOARDS:**



There are many potential sources of PCB failure. From variations in the raw materials and components used at the start, right the way through to the stresses they undergo during operational testing.

Carrying out inspections at as many points as possible during their manufacture helps to minimise losses due to adding processes/parts onto defective PCBs later on in the production process. And, wherever possible, automating these inspections helps to keep costs and missed defects down.

Q7. Describe Transportation and Storage of Electronic Components.

Ans. This document outlines the transportation, packaging, storage and environmental requirements for all electronic components manufactured by Aimtec Inc.

1. **Packaging:** Proper packaging is critical to the successful transportation of any electronic component, be it moved innercity or internationally. Ideally, electronic components would be moved in the original factory packaging material.

such as component tubes, inner boxes, antistatic bags, etc.

2. **Transportation**

Individual Packaging: Components should be bundled in packaging that is appropriate for electronic components, such as component tubes, antistatic bags, inner boxes and/or bubble paper, to ensure that the components will not move during transportation. **Bulk Packaging:** Individual boxes must be wrapped or packed in boxes of the appropriate size and transported in vehicles that provide locked and secure transportation compartments. Electrical charge: Ensure that all electronic components are unloaded of any electrical charge to avoid any additional or accidental electrical charges during transportation. Security: Final packaging should be properly sealed to ensure the safety and security of the contents during transportation.

3. **Storage Environments:** Storage refers to putting components in safe keeping for future use. There may be many reasons to store electrical components for use at a later date. There are also many types and sizes of storage facilities, but all must provide the same environment for the proper storage of electronic components:

Outside Storage: Storage grounds should be free of litter, debris, and sheltered from possible adverse weather conditions. Inside Storage: The building, its floors and the shelves on which components are stored need to be electrically grounded. Smoke detectors are also highly recommended.

Climate Control: To remain in proper operating condition, and to prevent possible damage, all electronic components should be stored in a climate controlled facility. Climate controlled means that the temperature and humidity levels are monitored to ensure that they are stable and within recommended range. Airconditioned storage is recommended, along with humidification and dehumidification capabilities. Simply limiting access to a storage facility can assist in maintaining proper temperature and humidity levels.

Air Quality: Proper ventilation is recommended. Air should circulate freely throughout the storage facility. Ventilation can be achieved with a simple fan or an air conditioning system.

Pest Control: Even when stored in climate controlled environments, electrical components can be at risk of damage or destruction if accessed by pests such as insects, mice, and rats. Prevent pests from invading a storage environment simply by disallowing food, drinks, and fur coats inside the storage facility.

Q8. Explain the inappropriate operating conditions of Electronic Components

Or, Extreme Operating Conditions that Can Wreck our Electronic Components.

Ans. Electronic Components reliability problems associated with extreme conditions include such things as:

Poorly designed Components

Modifications to Components

Excessive Components speeds or loads

Excessive Components vibration

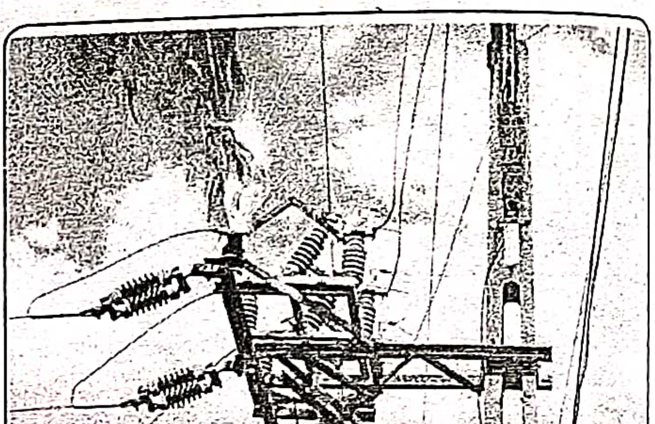
Extreme temperature conditions

Excessive contamination levels

Poor operating practices etc.

Q9. Describe the faults and Types of Faults in Electrical / Electronics Power Systems.

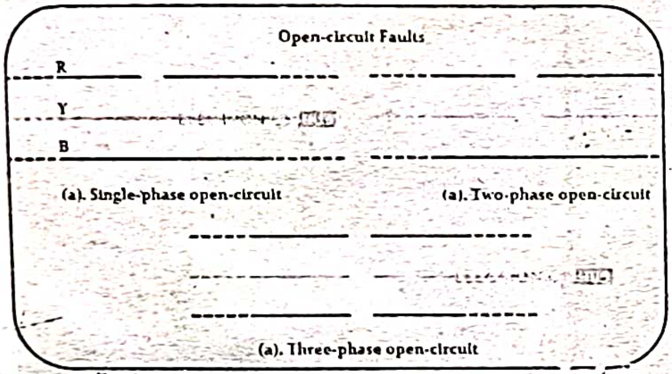
Ans. Electrical networks, machines and equipments are often subjected to various types of faults while they are in operation. When a fault occurs, the characteristic values (such as impedance) of the machines may change from existing values to different values till the fault is cleared. There may be lot of probabilities of faults to appear in the power system network, including lighting, wind, tree falling on lines, apparatus failure, etc.



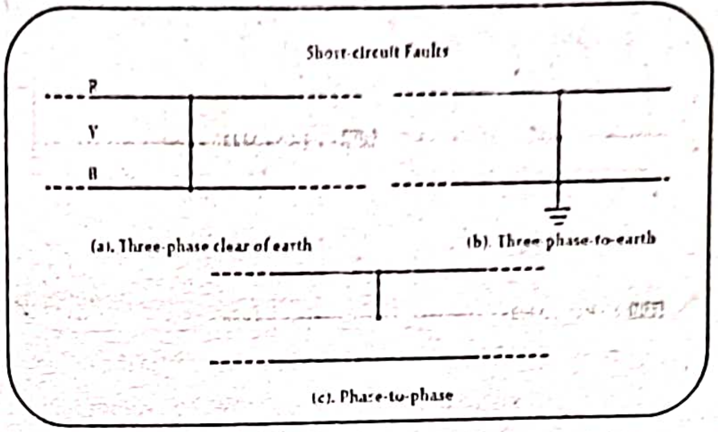
A fault in an electric power system can be defined as, any abnormal condition of the system that involves the electrical failure of the equipment, such as, transformers, generators, busbars, etc. The fault inception also involves in insulation failures and conducting path failures which results short circuit and open circuit of conductors. Under normal or safe operating conditions, the electric equipments in a power system network operate at normal voltage and current ratings. Once the fault takes place in a circuit or device, voltage and current values deviates from their nominal ranges. The faults in power system causes over current, under voltage, unbalance of the phases, reversed power and high voltage surges. This results in the interruption of the normal operation of the network, failure of equipments, electrical fires, etc.

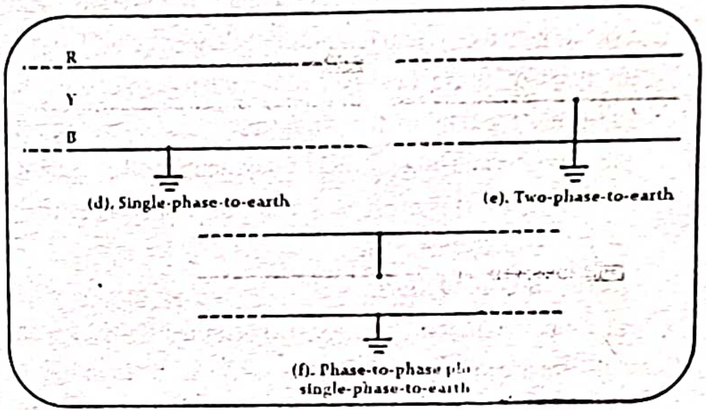
Types of Faults:

1. **Open Circuit Faults:** These faults occur due to the failure of one or more conductors. The figure below illustrates the open circuit faults for single, two and three phases (or conductors) open condition.The most common causes of these faults include joint failures of cables and overhead lines. and failure of one or more phase of circuit breaker and also due to melting of a fuse or conductor in one or more phases.Open circuit faults are also called as series faults. These are unsymmetrical or unbalanced type of faults except three phase open fault.



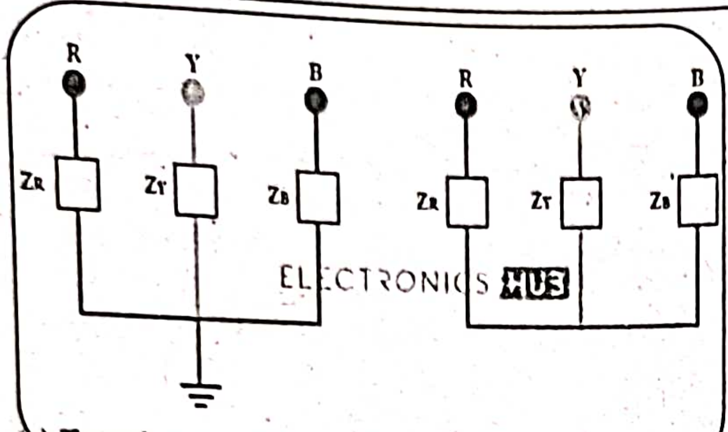
2. **Short Circuit Faults:** A short circuit can be defined as an abnormal connection of very low impedance between two points of different potential, whether made intentionally or accidentally. These are the most common and severe kind of faults, resulting in the flow of abnormal high currents through the equipment or transmission lines. If these faults are allowed to persist even for a short period, it leads to the extensive damage to the equipment.Short circuit faults are also called as shunt faults. These faults are caused due to the insulation failure between phase conductors or between earth and phase conductors or both.The various possible short circuit fault conditions include three phase to earth, three phase clear of earth, phase to phase, single phase to earth, two phase to earth and phase to phase plus single phase to earth as shown in figure.





3. **Symmetrical and Unsymmetrical Faults:** As discussed above that faults are mainly classified into open and short circuit faults and again these can be symmetrical or unsymmetrical faults.

Symmetrical Faults: A symmetrical fault gives rise to symmetrical fault currents that are displaced with 1200 each other. Symmetrical fault is also called as balanced fault. This fault occurs when all the three phases are simultaneously short circuited. These faults rarely occur in practice as compared with unsymmetrical faults. Two kinds of symmetrical faults include line to line to line (L-L-L) and line to line to line to ground (L-L-L-G) as shown in figure below.

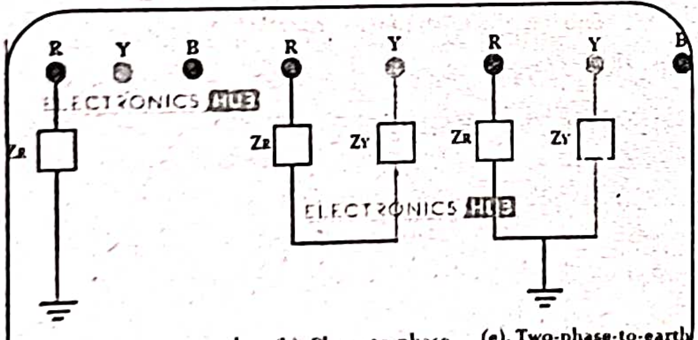


(a). Three-phase-to-earth (L-L-L-G) (b). Three-phase-fault (L-L-L

A rough occurrence of symmetrical faults is in the range of 2 to 5% of the total system faults. However, if these faults occur, they cause a very severe damage to the equipments even though the system remains in balanced condition.The analysis of these faults is required for selecting the rupturing capacity of the circuit breakers, choosing set-phase relays and other protective switchgear. These faults are analyzed on per phase basis using bus impedance matrix or Thevenins's theorem.

Unsymmetrical Faults:

The most common faults that occur in the power system network are unsymmetrical faults. This kind of fault gives rise to unsymmetrical fault currents (having different magnitudes with unequal phase displacement). These faults are also called as unbalanced faults as it causes unbalanced currents in the system.Up to the above discussion, unsymmetrical faults include both open circuit faults (single and two phase open condition) and short circuit faults (excluding L-L-L-G and L-L-L).The figure below shows the three types of symmetrical faults occurred due to the short circuit conditions, namely phase or line to ground (L-G) fault, phase to phase (L-L) fault and double line to ground (L-L-G) fault.

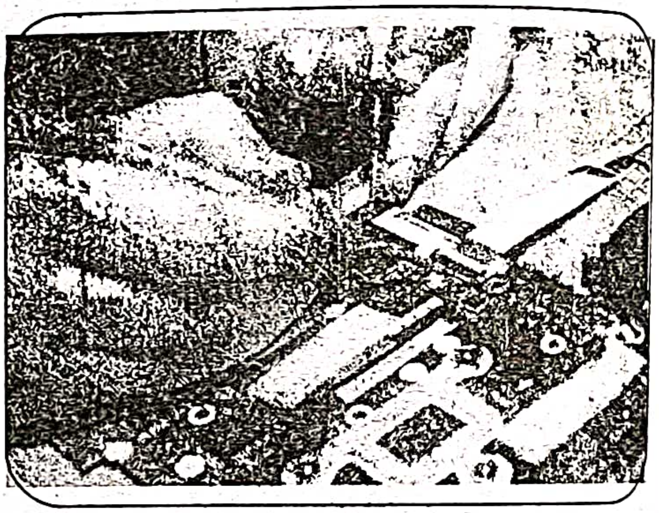


a). Single-phase-to-earth (LG fault) (b). Phase-to-phase (L-L) (c). Two-phase-to-earth (L-L-G)

A single line-to-ground (LG) fault is one of the most common faults and experiences show that 70-80 percent of the faults that occur in power system are of this type. This forms a short circuit path between the line and ground. These are very less severe faults compared to other faults.A line to line fault occur when a live conductor get in contact with other live conductor. Heavy winds are the major cause for this fault during which swinging of overhead conductors may touch together. These are less severe faults and its occurrence range may be between 15-20%.

Q10. Describe the Service and maintenance manuals for Electronics equipments.

Ans. Manual for Electronics Repair and Maintenance:An overview about maintenance and repair of consumer electronics. Entertainment devices like TVs, DVD players, videogames, communication devices like telephones, computers, cell phones and home-office machineries like printers, desktops, paper shredders fall under consumer electronics category.



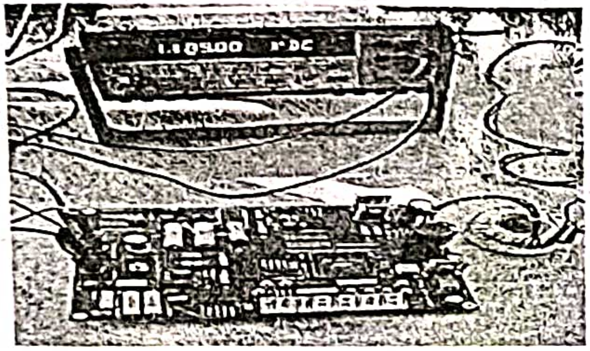
These consumer electronic gadgets contain a cluster of IC chips interconnected with one another to perform their functions such as gaming, communication and multimedia streaming. Nowadays such devices are being manufactured on a large scale by manufacturers based on consumer demands which at times might compromise the quality of the product resulting in malfunction or reduced overall life of the product if not handled properly. Therefore they need to be maintained properly and repaired if any malfunction is encountered.

Q11. Explain Electronic test equipment ans its types.

Ans. Electronic test equipment is used to create signals and capture responses from electronic devices under test (DUTs). In this way, the proper operation of the DUT can be proven or faults in the device can be traced. Use of electronic test equipment is essential to any serious work on electronics systems.Practical electronics engineering and assembly requires the use of many different kinds of electronic test equipment ranging from the very simple and inexpensive (such as a test light consisting of just a light bulb and a test lead) to extremely complex and sophisticated such as automatic test equipment (ATE). ATE often includes many of these instruments in real and simulated forms.Generally, more advanced test gear is necessary when developing circuits and systems than is needed when doing production testing or when troubleshooting existing production units in the field.

Types of test equipment:

Basic equipment



Keysight commercial digital voltmeter checking a prototype

The following items are used for basic measurement of voltages, currents, and components in the circuit under test.

Voltmeter (Measures voltage)

Ohmmeter (Measures resistance)

Ammeter, e.g. Galvanometer or Milliammeter (Measures current)

Multimeter e.g., VOM (Volt-Ohm-Milliammeter) or DMM (Digital Multimeter) (Measures all of the above)

LCR meter - inductance (L), capacitance (C) and resistance (R) meter (measure LCR values).

Advanced or less commonly used equipment

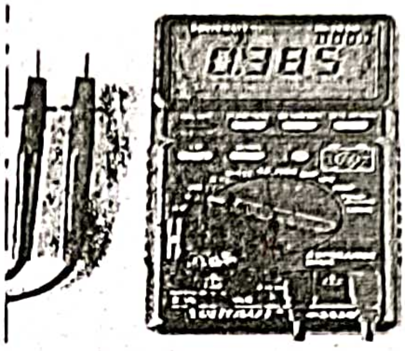
Meters: Solenoid voltmeter (Wiggy)

- Clamp meter (current transducer)

Wheatstone bridge (Precisely measures resistance)

Capacitance meter (Measures capacitance)

LCR meter (Measures inductance, capacitance, resistance and combinations thereof)



EMF Meter (Measures Electric and Magnetic Fields)

Electrometer (Measures voltages, sometimes even tiny ones, via a charge effect).

Q12. Describe the Specific Troubleshooting Techniques.

Ans. 1.Swap Identical Components: In a system with identical or parallel subsystems, swap components between those subsystems and see whether or not the problem moves with the swapped component.If it does, you've just swapped the faulty component; if it doesn't, keep searching.This is a powerful troubleshooting method, because it gives you both a positive and a negative indication of the swapped component's fault: when the bad part is exchanged between identical systems, the rmerly broken subsystem will start working again and the formerly good subsystem will fail.I was once able to troubleshoot an elusive problem with an automotive engine ignition system using this method.

2. **Remove Parallel Components:** If a system is composed of several parallel or redundant components which can be removed without crippling the whole system, start removing these components (one at a time) and see if things start to work again.

3. **Divide System into Sections and Test those Sections:** In a system with multiple sections or stages, carefully measure the variables going in and out of each stage until you find a stage where things don't look right.

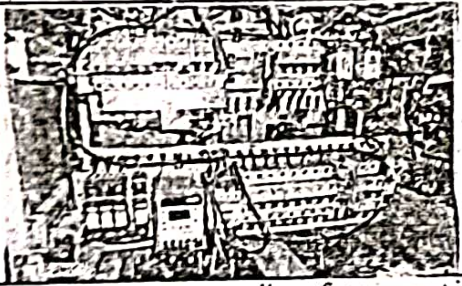
4. **Simplify and Rebuild:** Closely related to the strategy of dividing a system into sections, this is actually a design and fabrication technique useful for new circuits, machines, or systems.It's always easier begin the design and

construction process in little steps, leading to larger and larger steps, rather than to build the whole thing at once and try to troubleshoot it as a whole. Suppose that someone were building a custom automobile. He or she would be foolish to bolt all the parts together without checking and testing components and subsystems as they went along, expecting everything to work perfectly after its all assembled.

5. ***Trap a Signal:*** Set up instrumentation (such as a datalogger, chart recorder, or multimeter set on "record" mode) to monitor a signal over a period of time. This is especially helpful when tracking down intermittent problems, which have a way of showing up the moment you've turned your back and walked away. This may be essential for proving what happens first in a fast-acting system. Many fast systems (especially shutdown "trip" systems) have a "first out" monitoring capability to provide this kind of data.

Q13. Write the Important points about grounding of electronic equipment.

Ans. Grounding electronic equipment for personal safety and clearing of faults is no different than that of any other equipment. Safe grounding requires fast opening of circuit breakers or fuses and minimization of voltage differences between exposed metal surfaces on all of the involved electrical system and equipment, to levels that are safe for people.



1. Typically the safety grounding of equipment is exactly the same for electronic equipment as it is for any other kind of apparatus, whether it is a refrigerator or a printing press. the green wire and conduit/raceway system's grounding which is well documented in the NEC and other codes, defines these requirements completely.

2. Protect the data circuit generally requires additional considerations beyond the intent of the NEC, but not in violation of it. Protection of data circuits from disruption or even damage does not always involve grounding, although good grounding makes this protection a lot easier.

3. The circuits of most electronic systems are almost always sensitive to voltages of a few tens of volts or even to as little as one or two volts. As a result, these systems are designed with great care to keep transients out of the actual circuitry and off of the signal paths between interconnected units of a system.

4. Data signals inside most electronic systems consists of bits of information processed as squar wave at about 5 vitls in amplitude and clock speeds which can exceed 200 MHz. Data transferred between equipment often has a magnitude of 12-18 volts, and the speed of transfer is lower than that of the signal processing speed available inside of the equipment.

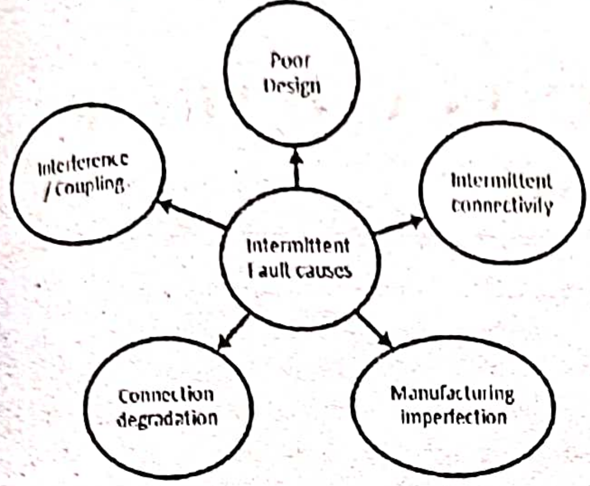
Q14. Explain Temperature sensitive Intermittent problems Corrective actions.

Or, Explain Intermittent Faults and Electrical Continuity.

Ans. Most devices and systems contain embedded electronic modules for monitoring, control, and to enhance the functionality of cars, trains, ships and airplanes. The shrinking size and complexity of electronic circuits, with added redundancies, has led to difficulties in the maintenance of these modules. This becomes a challenge when faults are intermittent in nature. Intermittent faults are a growing problem in electronics equipment (especially for aircraft and other vehicle industry) due to thermal, vibration, moisture and other stresses. A variety of intermittent fault causes include: -

- Loose or corroded wire
- Cracked solder joint
- Corroded connector contact
- Loose crimp connection
- Hairline crack in a printed circuit.
- Broken wire
- Unsoldered joint

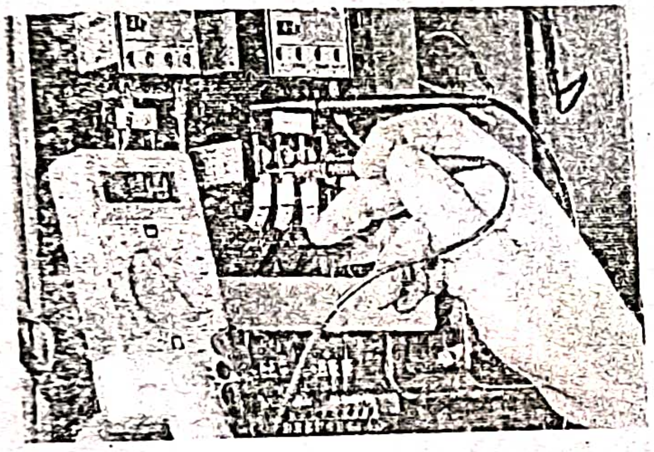
Repairing an intermittent fault may not be difficult but challenging to troubleshoot and it increases the maintenance cost of the product. Further to the literature study, correspondence with industrial partners showed that wire harnesses and connectors are the main issues for intermittence. Often the solution to the problem is to employ maintenance tools which are specially designed to detect them. There is a need to monitor all electrical paths with the capability to capture very short duration discontinuity.



Q15. Describe the situations where repairs should not be attempted by an unskilled person.

Or, Describe the electrical repairs that never attempt to fix by a normal human being.

Ans.



There are a few electrical repairs you will need to learn to do yourself. If one of your circuit breakers trips, you need to know how to locate your electrical panel and reset it. It's a simple enough fix that just about anyone can handle. However, there are some electrical repairs you should not attempt to do on your own under any circumstances. The average electrical repair costs Americans about $300. But paying an electrician to visit your home will be well worth it in the end when it comes to certain kinds of repairs. Take a look at five electrical repairs you should leave to the professionals below.

1. **Service or Replace an Electrical Panel:** likely need to either service your electrical panel or replace it altogether. The electrical panel is the single most important piece of electrical equipment in your home and needs to be working properly at all times. Servicing or replacing an electrical panel is not something the average homeowner should attempt to do, though. These panels have service lugs on them that are always energized, which can make it extremely dangerous for anyone other than a licensed electrician to work on them.
2. ***Fix Your Home's Weatherhead:*** A weatherhead, which is also sometimes called a weathercap or a periscope, is a metal pole that welcomes service lines from the power poles situated outside your house into your home. The weatherhead is designed to keep electrical wires, telephone lines, and more shielded from the elements at the point at which they enter your home. They might not look like very sophisticated pieces of equipment, but they play an important role in your home's electrical system.
3. ***Rewire Your Home's Electrical System:*** If so, you might be planning on moving electrical wires around or updating your home's electrical system as a whole. It's a good idea to consider doing electrical work when you have your walls open and wires are easily accessible.
4. ***Work on Your Home's Electrical System When There Could Be Live Wires:*** Getting shocked is a very real concern for those making electrical repairs. You could be seriously injured or even killed if you attempt to make repairs on live electrical wires. Most homeowners think that avoiding live wires is as simple as shutting off power in the part of the home in which they're working.
5. ***Make Repairs to Large Appliances:*** You might be tempted to open it up and poke around inside of it to see if you can repair it on your own. And as long as you shut off the electricity to it, you might be under the impression it won't pose a threat to you. Never attempt to fix a major appliance on your own unless you're 100% sure of what you're doing.

OBJECTIVE QUESTIONS AND ANSWERS

FOR OBJECTIVE QUESTION KINDLY CONTACT IN THIS NUMBER

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UNIT 02

PASSIVE COMPONENTS AND THEIR TESTING

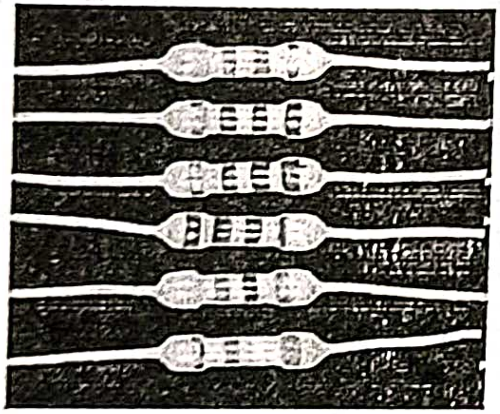
QUESTIONS AND ANSWERS

Q1. Write short notes on Passive Components

1. Resistors

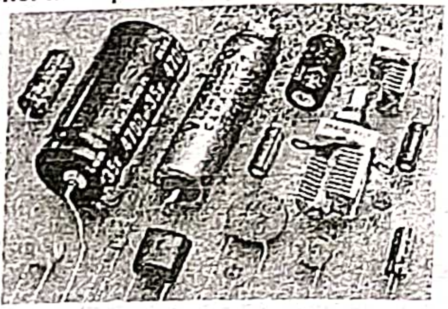
2.Capacitors

1. ***A resistor:*** is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.



Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits.

2. ***A capacitor*** :is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals.The effect of a capacitor is known as capacitance. While some capacitance exists between [illegible] electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser or condensator. This name and its cognates are still widely used in many languages, but rarely in English, one notable exception being condenser microphones, also called capacitor microphones.



The physical form and construction of practical capacitors vary widely and many types of capacitor are in common use Most capacitors contain at least two electrical conductors often in the form of metallic plates or surfaces separated by a dielectric medium. A conductor may be a foil, thin film, sintered bead of metal, or an electrolyte. The nonconducting dielectric acts to increase the capacitor's charge capacity.

Q2. Explain in short inductor failures. ?

Ans. Inductor Failures: Failure analysis of inductors involves a combination of x-ray imaging, dissection, microsectioning, optical microscopy, and SEM/EDS analysis in order to isolate and characterize the root cause of the failure, since inductors are very often potted in an encapsulant. Inductors often fail open due to corrosion or bad internal solder joints or the inductors fail shorted due to electrical overstress, bad magnet wire insulation, or potting issues.

Q3. How to test a resistor with a multimeter. ?

Ans. A resistor is a two-terminal passive electronic component that resists, or limits, the flow of electrical current in a circuit. It's a critical component found in every circuit in various shapes and sizes to control the signal levels, divide voltage, implement biasing, protect other electronic components in the circuit, etc.Thus, if a resistor fails or goes bad, it can lead to circuit failure and render the device unusable. This DIY guide will help you find a bad resistor without completely removing it from the circuit, and measure a resistor value with or without a multimeter.

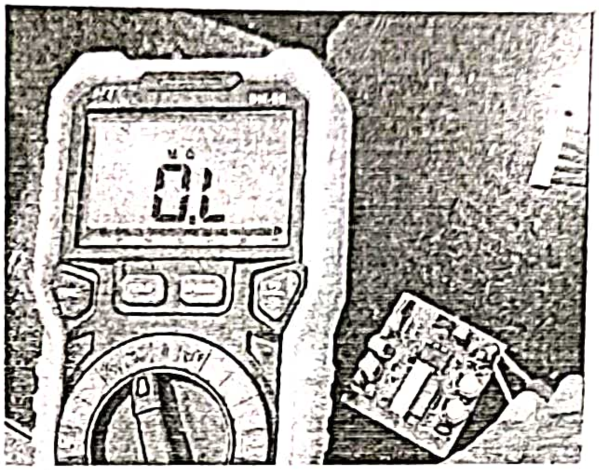
Steps to Test a Resistor With a Multimeter: When a resistor fails, it usually gets charred or burns. As a result, it either stops conducting the electrical current/signal or does not resist the current flow. If you think that a resistor in the circuit has failed or need to test it, follow these steps.

Step 1: Switch Off Power Supply to the Circuit: Before you access or start testing the circuit for a bad resistor, you must unplug the device from the mains power as this can be lethal. If a battery powers the device, remove it as it can lead to false positives or indicate wrong values during the tests.

Step 2: Get a Multimeter: To test or find a bad resistor in a circuit, you need a multimeter with a resistance setting (preferably auto-ranging). If you already have a multimeter, switch the multimeter dial to resistance mode or the setting with the O (ohm) symbol.

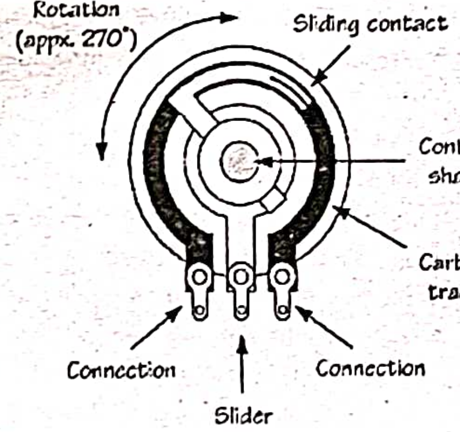
Also, check if there's a large capacitor in the circuit and discharge it by shorting its two terminals before measuring or testing the resistor. Shorting the capacitor terminals will fully discharge it and prevent the multimeter from getting damaged or displaying wrong values. Now you are ready to test the resistor in a circuit.

Step 3: Test or Measure the Resistor Value Using Multimeter : Connect the multimeter probes to the resistor on the circuit that you think is bad or looks charred or burnt. You can touch the probes to the resistor terminals or to the soldered joints on the board to test the resistor.However, it is recommended that you desolder one of the resistor's terminals from the circuit to get the accurate test result and value. After connecting the probes to the resistor terminals, check the value on the multimeter.



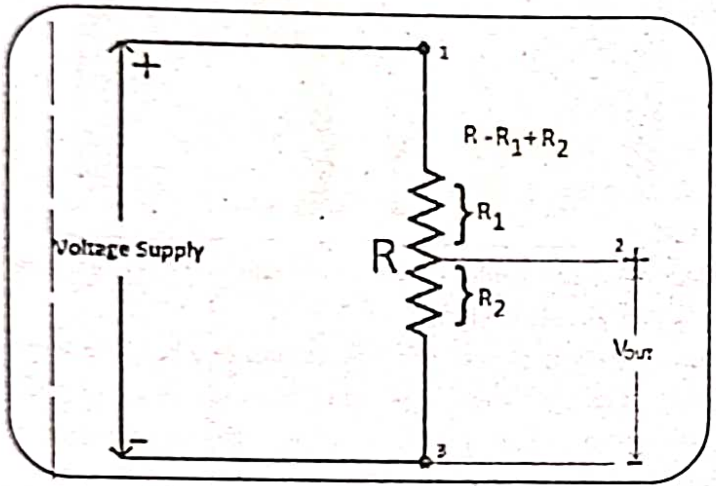
Q4. What is a Variable Resistor ? Explain with suitable figure and circuit diagrams.

Ans. A variable resistor is a type of resistor whose electrical resistance value can be adjusted on demand. Variable resistors are used in an electronic circuit to adjust circuit resistance as a means to control the voltage or current within a circuit (as per Ohm's Law).The electrical resistance is varied by sliding a wiper contact along a resistance track. Sometimes the resistance is adjusted at preset value as required at the time of circuit building by adjusting screw attached to it and sometimes resistance can be adjusted as when required by controlling knob connected to it.



The active resistance value of the variable resistor depends upon the position of the slider contact on the resistance track. It mainly consists of a resistance track and a wiper contact. The wiper contact moves along the resistance track when the adjustable component is adjusted. There are mainly three different types of resistance track used in this resistor they are carbon track, cermet (ceramic and metal mixture) track and wire wound track.Carbon track and cermet track are used for high resistance application whereas wire wound track is used for low resistance variable resistor.The resistance tracks generally are of a circular shape – but a straight track is also used in many cases.

Circuit diagram of Variable Resistor :

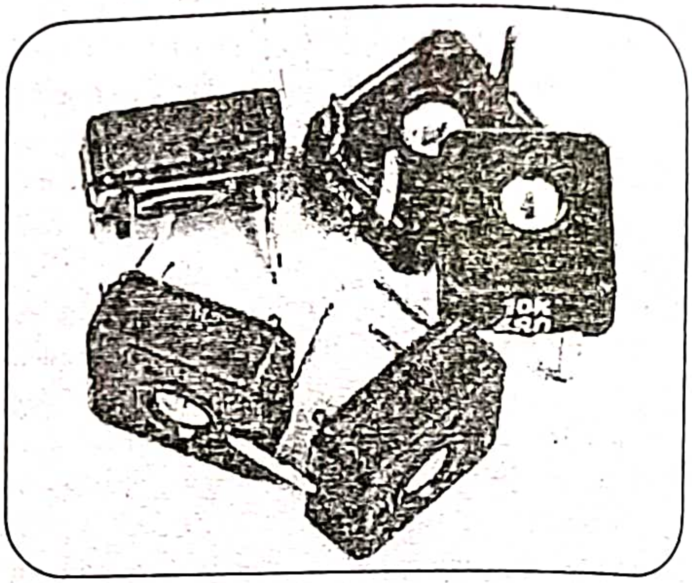


Q5. Explain the variable resistors as a potentiometer and write its any two types.

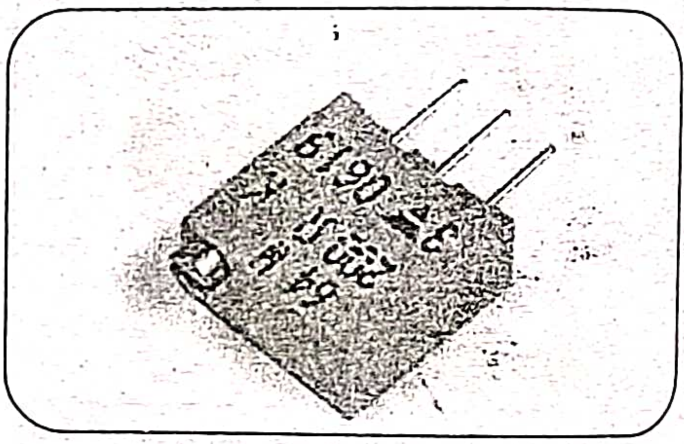
Ans. Variable resistors, or as they are often called potentiometers are used in many areas of electronics. They are used for volume and gain controls as well as a variety of other applications. Preset variable resistors or potentiometers are also used in circuits that need a small adjustment to be made to set the circuit up after manufacture.For convenience variable resistors are made by having a fixed resistor with a variable tapping point. As a result of this arrangement these devices are often called potentiometers or "pots" for short. This name is derived from the configuration used for many in the early days of electricity for measuring voltage. Here the potentiometer consisted of a length of resistance wire with a tapping point that could be moved along the wire - the same configuration as that used in these variable resistors.

Types of variable resistor: There are a variety of types of potentiometer that are available and there are a variety of different ways in which variable resistors or potentiometers can be classified as follow:

1. **Carbon composition:** Carbon composition potentiometers or variable resistors are the most commonly used type. The material used is a mixture of carbon and a filler material, the combination determining the resistivity of the carbon composition film of the potentiometer element.



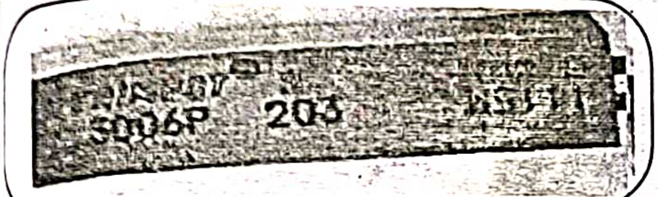
2. **Cermet:** Cermet, as the name implies is a composite material consisting of ceramic and a metal material. It is particularly applicable where any high temperatures may be experienced. They also offer low noise levels than those offered by carbon composition types.



Q6. Elaborate in short Potentiometer Failure.

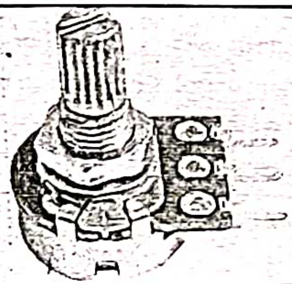
Ans. A potentiometer is a manually adjustable electrical resistor that uses three terminals. In many electrical devices, potentiometers are what establish the levels of output. For example, in a loudspeaker, a potentiometer is used to adjust the volume. In a television set, computer monitor or light dimmer, it can be used to control the brightness of the screen or light bulb.

Trimpot Potentiometer Failures: Gideon Analytical Laboratories received several Bourns Trimpot Trimming Potentiometers for failure analysis. A Potentiometer (known as a pot) is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. They are widely used for volume control in radio and television receivers. The Bourns Trimpot Trimming Potentiometer 3006P 203 has a standard resistance range of 10 to 5 megohms, the power rating of 400 volts maximum, and is ROHS compliant.



Q7. Describe testing methode of a Potentiometer. Write any two testings method and explain them.

Ans.

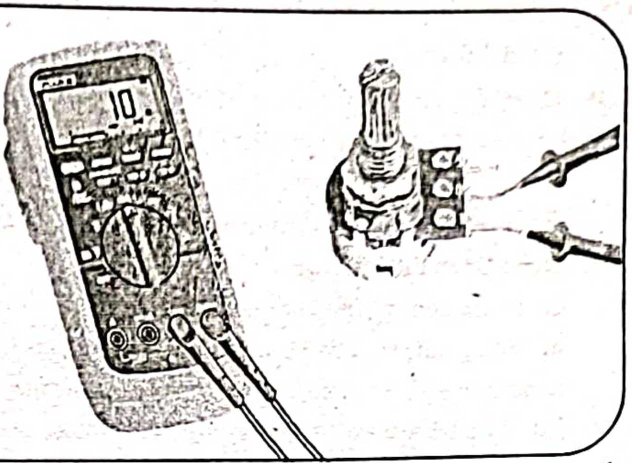


A potentiometer is a manually adjustable variable resistor with 3 terminals. Two terminals are connected to both ends of a resistive element, and the third terminal connects to a sliding contact, called a wiper, moving over the resistive element.The position of the wiper determines the output voltage of the potentiometer. The potentiometer essentially functions as a variable voltage divider. The resistive element can be seen as two resistors in series(potentiometer resistance), where the wiper position determines the resistance ratio of the first resistor to the second resistor.

METHOD 01.

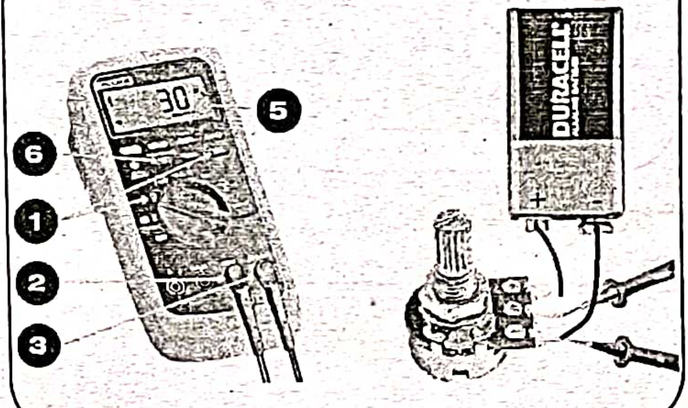
Required Parts: Multimeter, Potentiometer

- First, turn ON the multimeter.
- Find out the rating of your potentiometer. The total resistance in ohms should be written on the side or bottom.
- Set your multimeter to a setting higher than the total resistance of the potentiometer(Low cost multimeter) or select the resistance mode in your multimeter(High cost multimeter). For example, if your potentiometer is rated at 1,000 ohms, set your ohmmeter to 10,000 ohms.



- Connect the probes of your multimeter on the two ends like in the above image.
- Now, rotate the potentiometer knob using your finger it will change the resistance value High to Low or Low to High in the multimeter. if the resistance value is change the potentiometer is good condition or is not change the resistance value potentiometer is bad condition.

METHOD 02.



Required Parts: Multimeter, Potentiometer, 9V Battery or any DC power supply

- First, turn ON the multimeter and select DC voltage mode in your multimeter.
- Put the probes of your multimeter on the two ends like in the above image.
- Now, rotate the potentiometer knob using your finger it will change the Battery DC voltage High to Low or Low to High in the multimeter. if DC voltage is change, the potentiometer is good condition or is not change DC

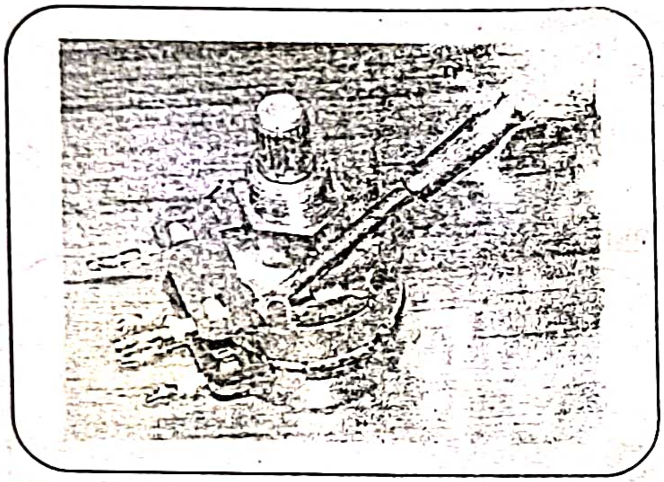
voltage, the potentiometer is bad condition.

Q8. Ilaborate in short about Potentiometer Repair or servicing of Potentiometers.

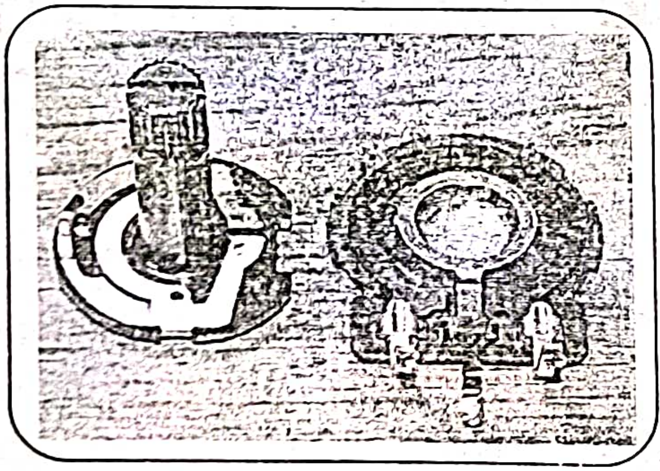
Ans. There are spray "contact cleaners" available for this purpose, but in most cases just mixes the dirt and grime already inside with more dirt and assembly grease and may make the control operate worse than it is already.

Step : Open the Control

Open the control (potentiometer or "pot") by lifting the mounting tabs slightly.Remember that these tabs will not handle being bent more than a few times before they break off. If a tab breaks off, you may be able to solder it back on later.

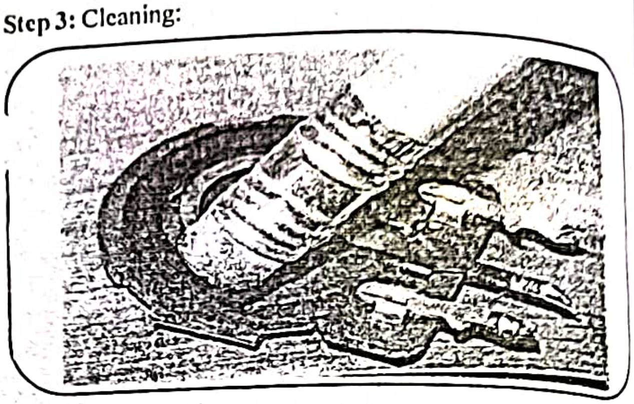


Step 2: Inspect Dirty Contacts:



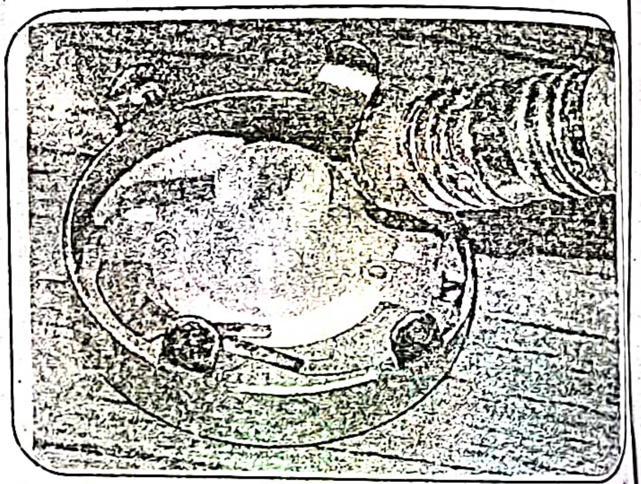
The control is made up of two main parts. The contacts and the carbon resistor.Each side must be cleaned without damaging them further. If the carbon looks burnt or has broken areas, the entire control may need to be replaced. If the contacts are worn too much or broken, the entire control may need to be replaced.

Step 3: Cleaning:



Carefully, clean the contacts and carbon with a pencil eraser. Do not push too hard, and clean the eraser on a piece of paper when it gets too dirty. Do not use any cleaner or solvent except rubbing alcohol or cleaner designated for this type of control. Make sure to blow off any eraser particles left on the control before assembling the part.

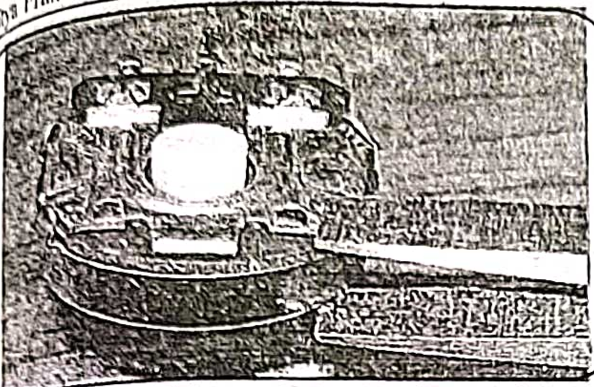
Step 4: Cleaning Continued:



If you are cleaning a dual control, the method will be the same, however it will take twice as long,and you must align both controls so they go back together correctly.

Step 5: After Cleaning - Reassemble the Control

Being careful not to forget any parts, recrimp the case making sure not to bend the case or trap any parts between the case and the parts inside. Turn the control and check for a nice smooth motion from the 0 to 10 locations.

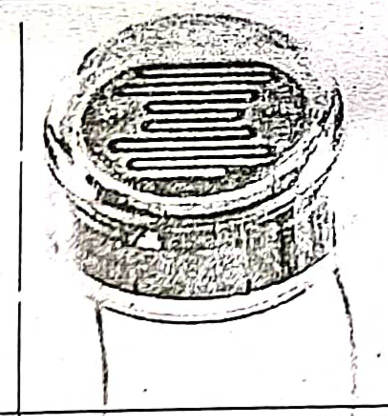


The control should move approx. 120 degrees without any binding or bumps.If you think you assembled one incorrectly, set it aside. and open the next one to look at how it should be assembled to fix the last one. If you need to, take pictures of each phase to help you reassemble the parts later.Try not to get any grease or oil on the contacts while assembling the part. There may be some grease on other areas of the control, but it is not intended to be on the contacts.

There is a special conductive grease that can be used on the contacts, but is not necessary for proper operation.

Q9. Explain Light Dependent Resistor LDR.

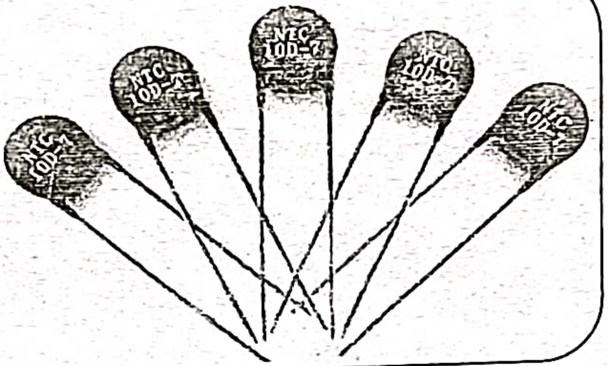
Ans. Light dependent resistors, LDRs, or photoresistors are electronic components that are used to detect light & change the operation of a circuit dependent upon the light levels. Light dependent resistors, LDRs or photoresistors are electronic components that are often used in electronic circuit designs where it is necessary to detect the presence or the level of light.LDRs are very different to other forms of resistor like the carbon film resistor, metal oxide film resistor, metal film resistor and the like that are widely used in other electronic designs. They are specifically designed for their light sensitivity and the change in resistance this causes.



These electronic components can be described by a variety of names from light dependent resistor, LDR, photoresistor. or even photo cell, photocell or photoconductor. Although other electronic components such as photodiodes or photo-transistor can also be used, LDRs or photo-resistors are a particularly convenient to use in many electronic circuit designs. They provide large change in resistance for changes in light level.

Q10. What is thermistors explain it with suitable figure and symbols.

Ans. 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.There are two types of thermistors: Negative Temperature Coefficient (NTC) and Positive Temperature Coefficient (PTC). With an NTC thermistor, when the temperature increases, resistance decreases. Conversely, when temperature decreases, resistance increases.

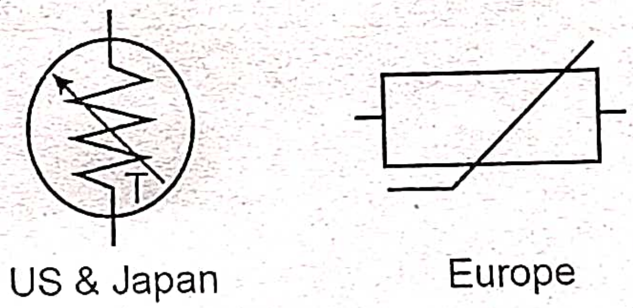


Figure: Thermistor Symbol — US and Japan

This type of thermistor is used the most.A PTC thermistor works a little differently. When temperature increases, the resistance increases, and when temperature decreases, resistance decreases. This type of thermistor is generally used as a fuse. Typically, a thermistor achieves high precision within a limited temperature range of about 50°C around the target temperature. This range is dependent on the base resistance.

Q11. Write the types of capacitors ?

Ans. Types of Capacitors : Let us now know various types of capacitors. Capacitors are categorized into 2 mechanical groups. Fixed Capacitors consisting of fixed capacitance value and variable capacitance with variable capacitance value. Beneath are a brief description of various capacitor types and their properties.

1. Ceramic Capacitors
2. Film Capacitors
3. Power Film Capacitors
4. Electrolytic Capacitors
5. Ceramic capacitors
6. Film capacitors
7. Paper capacitors
8. Electrolytic capacitors

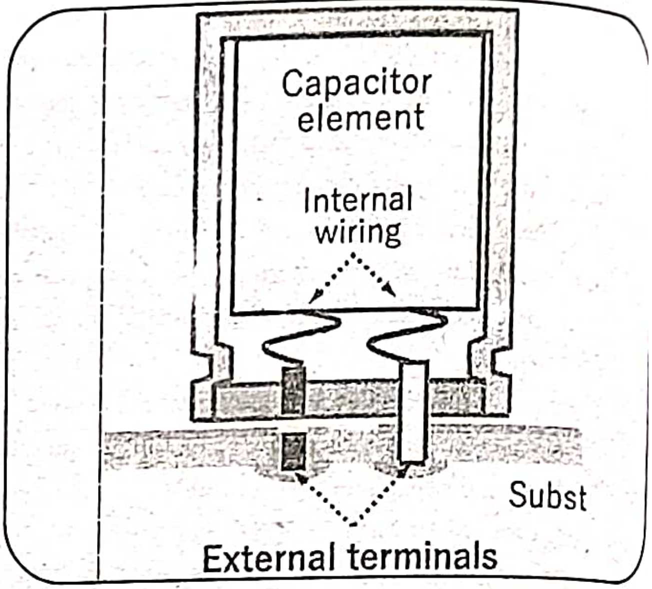
Q12. Explain the Failures in capacitors.

Ans. Capacitors have three main failure modes:

(1) Open failure, in which the resistance (impedance) of the capacitor reaches an extreme value

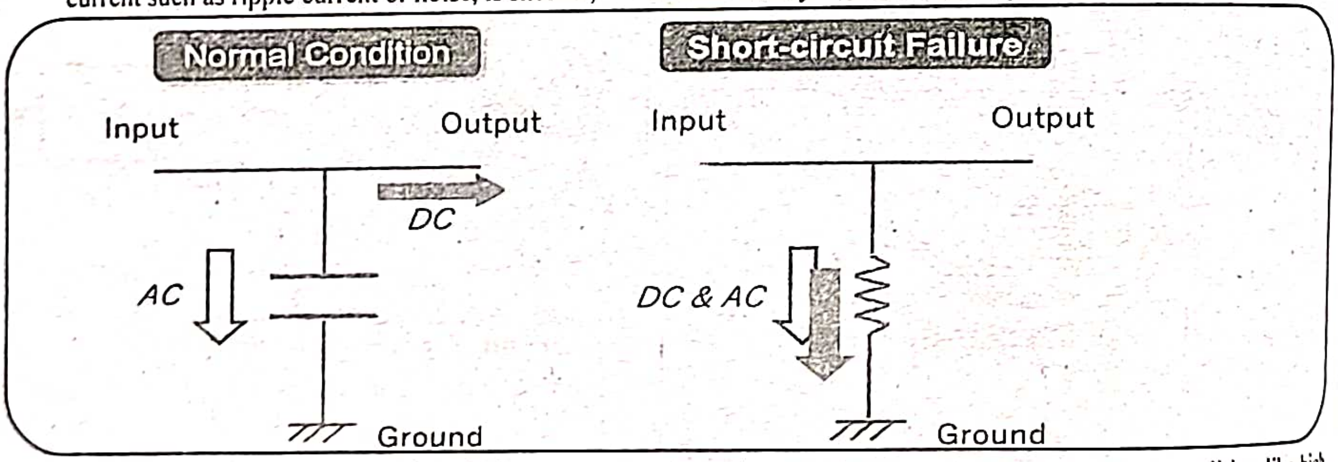
(2) Short-circuit failure, in which the insulation is degraded and a DC current passes through

1. *Open mode failure:* An open failure in a capacitor can have undesirable effects on electronic equipment and components on the circuit. For example, if a large capacit is used in the smoothing circuit of a power supply, a larg wave-like voltage*4 can be converted to a flat DC voltag but if the capacitor is open, a large voltage wave is directl applied to the circuit, which may cause semiconductor and other components to fail. Open failures are mainl caused by disconnection or significant increase i resistance at the capacitor terminals or connections.



For example, when a capacitor was mounted on a board, strong stress on the capacitor damaged the external terminals, resulting in an open (the area shown in red in Figure).

2. *Short-circuit mode failure :* When a capacitor fails a short circuit (Figure 3), DC current flows through the capacitor and the shorted capacitor behaves like a resistor. For example, if a capacitor, placed between the input line and ground to remove AC current such as ripple current or noise, is shorted, DC current directly flows from the input to ground.



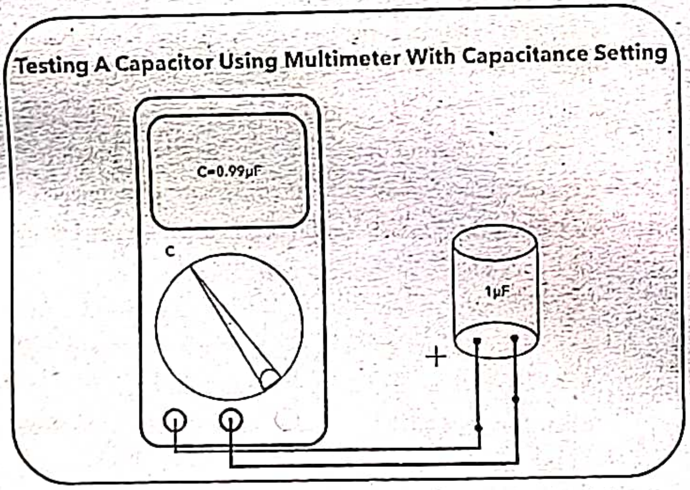
Applying an excess voltage or high ripple current over the rating, or using under harsh environment condition like hig temperatures or high humidity are major causes of short-circuit failure. For polar capacitors, application of pure AC voltag or reverse voltage lead to short-circuit failure. These factors reduce the dielectric's withstand voltage, resulting in dielectric breakdown.Also, since the thickness of dielectric is extremely thin*6, excessive mechanical stress on the capacitor can damage the dielectric and cause a short circuit failure. In addition to taking electrical and environmental factors into consideration, it is also important to devise ways to prevent shock and vibration from being applied to the capacitor.

Q13. Why do we need to Test a Capacitor?.Explain any three types of testing of capacitors.

Ans.When a capacitor is placed in an active circuit (a circuit with active current flowing), charge starts to build up in the capacitor (on one of its plate) and once the plate of the capacitor can no longer accept any more charge, this means the capacitor is fully charged.Now, if the circuit demands this charge (like a bypass capacitor, for example), the capacitor releases the charge back in to the circuit and it continues until the charge is completely released or the circuit stops demanding. These action are called as Charging and Discharging of Capacitor.

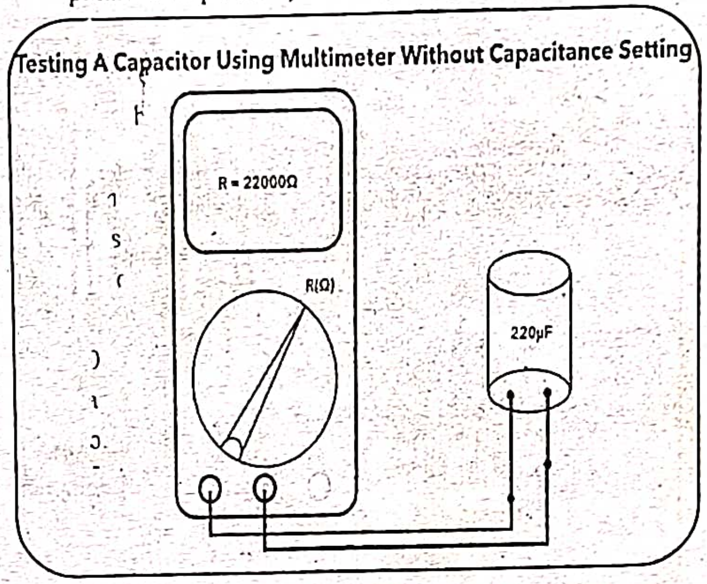
Method 1: Checking a Capacitor using Multimeter with Capacitance Setting

This is one of the easiest, quickest and accurate way to test a capacitor. For this, we need a Digital Multimeter with Capacitance Meter feature. Most of the mid and high end Digital Multimeters include this functionality.The capacitance meter on the digital multimeters often display the capacitance of the Capacitor but few meters display other parameters like ESR, leakage, etc. In order to test a capacitor using Digital Multimeter with Capacitance Meter, the following steps can be followed. isconnect the Capacitor from the circuit board and discharge it completely. f the capacitor ratings are visible on its body, make a note of it. Usually, the capacitance in Farads (often micro Farads) is printed on the body along with the voltage ratings.In the Digital Multimeter, set the knob for capacitance measurement.


Testing A Capacitor Using Multimeter With Capacitance Setting

Method 2: Checking a Capacitor using Multimeter without Capacitance Setting

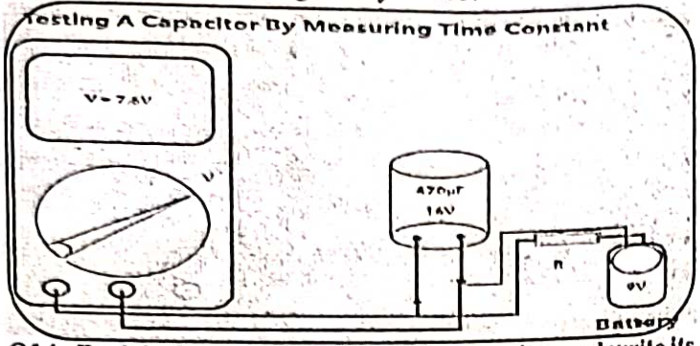
Most of the low end and cheap Digital Multimeters do not include Capacitance Meter or Capacitance Settings. Even with these Multimeters, we can test a Capacitor.Remove the Capacitor from the circuit or board and make sure it is completely discharged.Set the Multimeter to measure resistance i.e., set the knob to Ohm or Resistance Settings. If there are multiple ranges of resistance measurement (on a manual multimeter), select a higher range (often 20 KO to 200 KO).Connect the multimeter probes to the leads of the capacitor (red to positive and black to negative in case of polarized capacitors).


Testing A Capacitor Using Multimeter Without Capacitance Setting

Method 3: Testing a Capacitor by measuring the Time Constant

This method is applicable only if the capacitance value is known and if we want to test whether a capacitor is good or dead. In this method, we measure the Time Constant of the Capacitor and derive the capacitance from the measured time. If the measured capacitance and the actual capacitance are similar, then the capacitor is a good one.Time Constant of a Capacitor is the time taken by a Capacitor to charge to 63.2% of the applied voltage when charged through a known resistor. If C is Capacitance, R is a known Resistor, then Time Constant TC (or Greek

Alphabet Tau – t) is given by t = RC.



Q14. Explain Construction of Variable Capacitor and write its Types.

Ans. Construction of Variable Capacitor : The construction of the variable capacitor is shown below. These capacitors are frequently used in different applications due to their simple construction. Generally, these capacitors are made with 2 sets of hemispherical metal plates which are divided through air gaps. One set of the metal plates is fixed whereas the other one is connected to a shaft so that the user can allow turning the assembly, thus the capacitance can be changed when it is needed. So the construction of each type of capacitor varies based on its type.

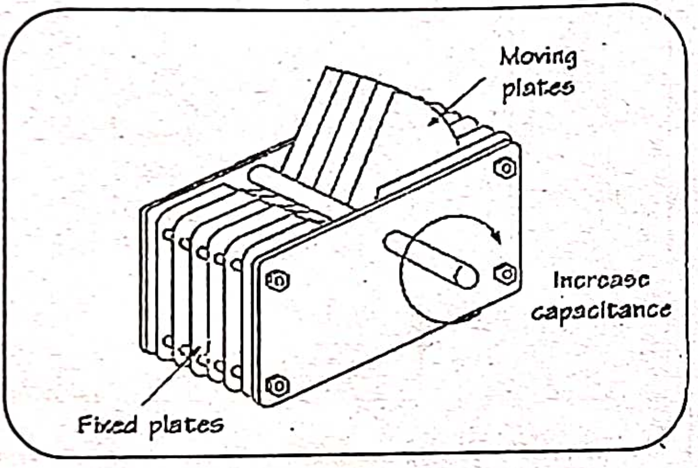


Fig. Construction-of-variable-capacitor

The designing of this capacitor can be done based on the working principle of a normal capacitor. The conductive plates of this capacitor are arranged in parallel and that are divided with dielectric coatings composed with different materials like reinforced paper, mica otherwise certain kinds of ceramics. Not like typically fixed capacitors, these capacitors are designed to change levels of capacitance. In most of the cases, the variable capacitance can be achieved by changing the distance among the parallel plates within a capacitor.

Types of Variable Capacitors :

There are two types of variable capacitors available in the markets which include the following. The capacitance of the following capacitors can be changed manually by using screwdrivers otherwise any devices.

1. Tuning Capacitors
2. Trimmer Capacitors
3. Mechanical Capacitors
4. Electronic Capacitors

1. **Tuning Capacitors :** The designing of tuning capacitors can be done using a frame. This frame includes a stator as well as a rotor. The capacitor's frame can give support to the material mica as well as stator. When the stator is inactive, then the rotors start rotating with the help of a shaft.

2. **Trimmer Capacitors :** Trimmer capacitor is also known as variable capacitors & provides the basic calibration of apparatus while manufacturing otherwise servicing. These capacitors are frequently arranged on the printed circuit board so that the user doesn't have the right of entry to change them. Because of this, these capacitors are not expensive.These capacitors are used to set the values of oscillator frequency, rise, latencies, & fall times within a circuit.

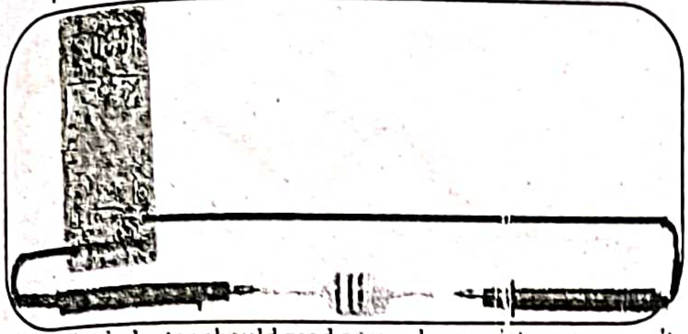
3. **Mechanical Capacitors :** These capacitors have a set of curved plates which are connected to a knob. The main benefit of this is, the capacitance of the capacitor can be altered easily if required. These are reliable when they are mechanical because they are not overly complicated.

4. **Electronic Capacitors :** The capacitance of these capacitors can be changed by applying DC voltage to them. The applications of these capacitors mainly include multi-meters, resistance, and amperage. Here the DC (direct current) is the kind of current supplied from a battery.

Q15. Explain about test an inductor with a multimeter.

Ans. Test an Inductor with a Multimeter in the Ohmmeter Setting for Resistance:

The best test to check whether an inductor is good or not is by testing the inductor's resistance with your multimeter set to the ohmmeter setting. By taking the inductor's resistance, we can determine whether the inductor is good or bad. We do this by taking the probes of the multimeter and placing them across the leads of the inductor. The orientation doesn't matter, because resistance isn't polarized.



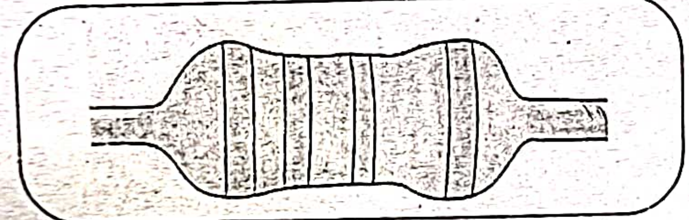
The inductor should read a very low resistance across its terminals, only a few ohms. If an inductor reads a high resistance, it is defective and should be replaced in the circuit.If an inductor is reading very, very small resistance, less than an ohm (very close to 0 Ω), this may be a sign that it's shorted. Functional inductors normally read a few ohms, greater than 1 Ω and normally less than 10 Ω. This is a healthy range for an inductance value. Outside this range and this is normally a sign the inductor is bad.

So a resistance check is a simple but effective method for finding out if an inductor is defective or not.

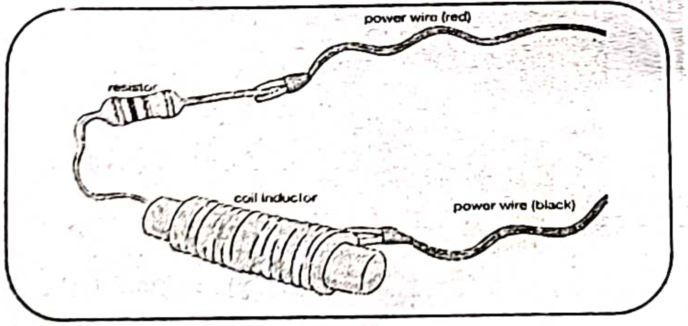
Q16. Describe briefly how to measure inductance with suitable figures.

Ans. Inductance is usually measured in units called millihenrys or microhenrys. It is commonly measured by using a frequency generator and an oscilloscope or an LCM multimeter. It can also be calculated through a voltage-current slope measuring the change in the electrical current passing through the coil.

Method 1: Using a Resistor to Determine Inductance:-

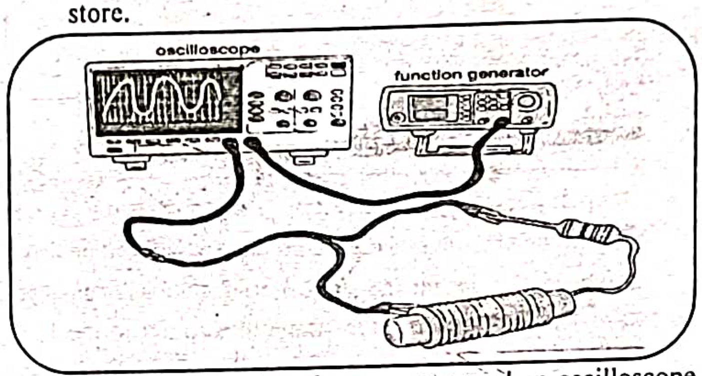


Step1 : Choose a 100-ohm resistor with 1% resistance. Resistors have colored bands that can help you tell them apart. A 100-ohm resistor will have a brown, black, and brown band. The final band at the far end will also be brown to represent 1% resistance.



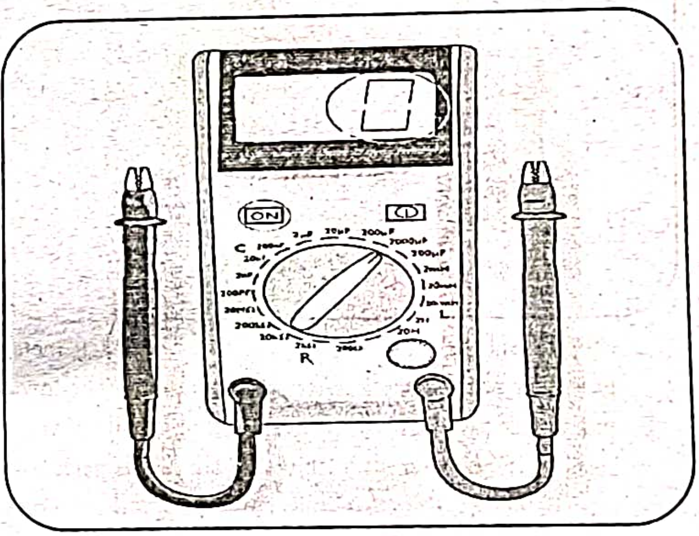
If you have a bunch of resistors to choose from, pick one with a known resistance value. Resistors are labeled when they are new, but they can be easy to mistake once they are out of the packaging. Always test inductance using a resistor you are familiar with to ensure you get an accurate result.

Step 2 : Connect the inductor coil in series with the resistor. In series means the current passes through the coil one after the other. Start setting up a circuit by placing the coil and resistor next to each other. Make sure they have 1 terminal touching. To finish the circuit, you will also need to touch power wires to the exposed ends of the resistor and inductor.Purchase power wires online or at a hardware store.

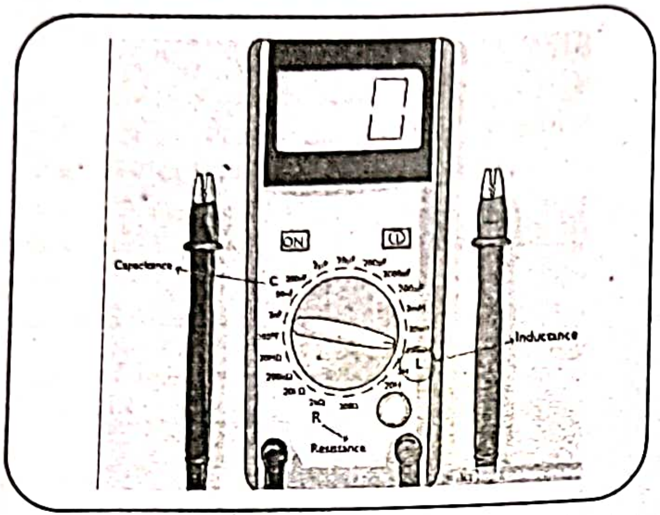


Step 3 : Wire a function generator and an oscilloscope into the circuit. Take the output leads from the function generator and plug them into the oscilloscope. Then, turn on both devices to make sure they are working. Once they are both on, take the function generator's red output lead and connect it to the red power wire in your circuit.

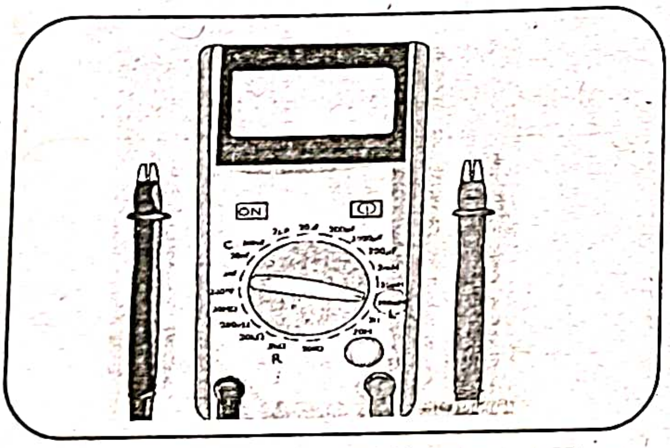
Method 2 : Measuring with an LCR Meter.



Step 1 : Power the LCR meter and wait for it to turn on. A basic LCR meter is very similar to a multimeter normally used to measure things like voltage and current. Most meters are handheld with a readout screen that will display 0 after you press the power button. If it doesn't display 0, press the reset button to set the meter at 0.

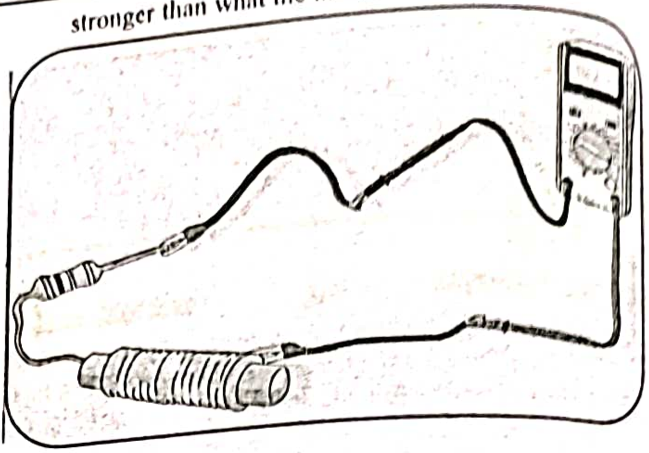


Step 2: Set the LCR to measure L, or inductance. An LCR meter can take several measurements, which will be listed on the dial. L means inductance, so it is the one you need. For handheld meters, turn the dial to point to the L. If you're using an electronic device, press the buttons on the screen to set the machine to L. LCR meters have multiple settings, so make sure you're using the correct one. The C setting is for capacitance and the R is for resistance.



Step :3 Set the meter to 100 kHz at 1 volt. LCR meters generally offer several different test settings. The lowest inductance test is usually something like 200 uH. If you're setting a tabletop meter, 100 kHz at 1 volt is perfect for most devices. Using the wrong setting makes the test more inaccurate. Most LCR meters are meant to test at a low current, but you should still avoid making the current

stronger than what the inductor coil can handle.



UNIT 03

TESTING OF SEMICONDUCTORS

QUESTIONS AND ANSWERS

Q1. Describe Testing Semiconductor Devices and Explain them.

Ans. Testing Semiconductor Devices with a VOM or DMM

VOMs and DMMs: Analog and Digital meters behave quite differently when testing nonlinear devices like diodes and transistors. It is recommended that you read through this document in its entirety.

Caution: An analog VOM on the lowest resistance range may put out too much current for smaller devices possibly damaging them. Ironically, this is more likely with better meters like the Simpson 260 which can test to lower ohms (X1 scale). Use the next higher resistance range in this case or a DMM as these never drive the device under test with significant current. However, this can result in false readings as the current may be too low to adequately bias the junctions of some power devices or devices with built in resistors.

Testing Diode Junctions with a Multimeter :

On an (analog) VOM, use the low ohms scale. A regular signal diode or rectifier should read a low resistance (typically 2/3 scale or a couple hundred ohms) in the forward direction and infinite (nearly) resistance in the reverse direction. It should not read near 0 ohms (shorted) or open in both directions. A germanium diode will result in a higher scale reading (lower resistance) due to its lower voltage drop.

Transistor Testing Methodology :

As with diode junctions, most digital meters show infinite resistance for all 6 combinations of junction measurements since their effective resistance test voltage is less than a junction diode drop (if you accidentally get your skin involved it will show something between 200K and 2M Ohms).

Testing with a (Analog) VOM : For NPN transistors, lead "A" is black and lead "B" is red; for PNP transistors, lead "A" is red and lead "B" is black (NOTE: this is the standard polarity for resistance but many multi-meters have the colors reversed since this makes the internal circuitry easier to design; if the readings don't jive this way, switch the leads and try it again).

Testing with a (Digital) DMM : Set your meter to the diode test. Connect the red meter lead to the base of the transistor. Connect the black meter lead to the emitter. A good NPN transistor will read a JUNCTION DROP voltage of between .45v and .9v.

Testing Power Transistors : Power transistors without internal damper diodes test just about like small signal transistors using the dual diode model, high in one direction B-E or B-C.

Testing Darlington Transistors : A Darlington is a special type of configuration usually consisting of 2 transistors fabricated on the same chip or at least mounted in the same package. Discrete implementations as well as Darlingtons with more than 2 transistors are also possible. The current gains (Hfe) of the individual transistors it is composed of are multiplied together and, the B-E voltage drops of the individual transistors it is composed of are added together. Darlingtons are used where drive is limited and the high gain - typically over 1,000 - is needed. Frequency response is not usually that great, however.

Q2. Write the different types of semiconductor devices.

Ans. The following is a small list of some of the commonly used semiconductor devices. Based on the physical structure of the device, the following list is categorized into Two-terminal Devices and Three-terminal Devices.

Two-terminal Semiconductor Devices :

*Diode

*Schottky Diode

*Light Emitting Diode (LED)

*DIAC

*Zener Diode

- *Photo Diode (Photo Transistor)
- *PIN Diode
- *Laser Diode
- *Tunnel Diode
- *Photo Cell
- *Solar Cell
- *Gunn Diode
- *IMPATT Diode
- *TVS Diode (Transient Voltage Suppression Diode)
- *VCSEL (Vertical Cavity Surface Emitting Laser)

Three-terminal Semiconductor Devices :

- *Bipolar Transistor
- *Field Effect Transistor
- *Insulated Gate Bipolar Transistor (IGBT)
- *Darlington Transistor
- *Silicon Controlled Rectifier (SCR)
- *TRIAC
- *Thyristor
- *Unijunction Transistor

There are also a few four-terminal semiconductors like Optocoupler (Photocoupler) and Hall-effect Sensor.

Q3. Explain the Causes of failure in Semiconductor Devices.

Ans. A device usually fails because it experiences conditions that stress it beyond its maximum ratings. The way a device fails is called a failure mechanism. Typically, electricity, heat, chemicals, radiation, mechanical stresses, and other factors cause the failures.

1. **Encapsulation failure :** These failures occur when the encapsulation used to package a device develops a fault—usually a crack. Mechanical or thermal stress and differences in the coefficient of thermal expansion between the encapsulation material and metal used for leads can cause the cracks to form. These openings let moisture enter the package when humidity is high or when the device gets exposed to flux, cleaning agents, and so on. Chemical action can degrade the device and cause it to fail.
2. **Die-attach failure. :** Improper contact between the die and substrate decreases thermal conductivity between the two. As a result, the die can overheat, which leads to stressing and cracking, and thus device failure.
3. **Wire-bond failure :** Thermal overstress due to high current flow, mechanical stress in the bond wire due to improper bonding, cracks at the interface between bond wire and die, electromigration of silicon, and excessive bonding pressure can each cause wire-bond failures. When a bond fails, so does the device, because one of its conductors no longer exists.
4. **Bulk-silicon defects :** Sometimes, faults caused by crystal defects or the presence of impurities and contaminants in the silicon bulk material will cause a device to fail. Process defects caused by diffusion problems during device fabrication can also cause devices to fail.
5. **Oxide-layer faults :** Electrostatic discharge and high-voltage transients propagating through device leads can cause thin oxide layers—insulators—to break down and cause a device to malfunction. Cracks or scratches in the oxide layer or the presence of impurities in the oxide can also lead to failures.

Q4. Describe methods for testing diodes using digital or analogue multi-meters. ?

Ans. Multimeter Diode Testing : Diodes can be tested using a multi meter. It is normally the resistance of the diode in both forward and reverse directions that is tested. There are however a number of points to remember when testing diodes.

1. **With Digital Meters :** Most digital multi-meters are suitable for diode testing, and in many cases will have a special 'diode test' range usually marked with a diode symbol. This range should always be used when testing diodes or any other semiconductor device. The reason for this is that the meter tests the diode by applying a voltage across the diode junction.

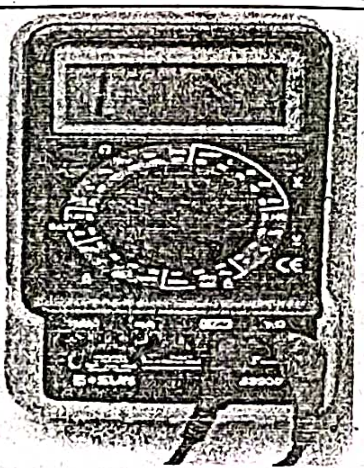


Fig. Digital Meter

The normal voltages used by the meter on other resistance ranges may not be high enough to overcome the diode's forward junction potential and so will not make the diode conduct, even in the forward direction. This would give an indication that the diode was open circuit (very high resistance). If the diode range is used, the test voltage applied by the meter will be high enough in most cases to overcome the forward junction potential and the diode will conduct. Therefore in the forward direction (meter positive lead to the diode anode, and the negative lead to the cathode) the diode's resistance can be measured.

2. **With Analogue Meters :** Metrix analogue meter with a diode range

Fig. Analogue Meter

If an analogue meter is used for testing it must be remembered that because zero on the resistance and voltage scales are reversed, due to the inner workings of the meter, the polarity of the probes when using analogue meters for resistance measurement, is also reversed compared to digital meters. Therefore when measuring resistance of a diode with an analogue meter on any range the BLACK lead is positive and the RED lead is negative. This means that the black lead should be connected to the anode and red to cathode to measure the FORWARD resistance of the diode. Some analogue meters have a specific diode testing range, but most analogue meters will be quite suitable for diode testing. The most suitable analogue range will normally be indicated in the user instructions, but as with digital meters the actual voltage used on the testing range should be checked to to understand its effect on the expected forward and reverse resistances.

3. **Testing Zener Diodes :** All Zener diodes have a defined voltage, and if the voltage measured across them under working conditions, is higher than that printed in the circuit manual (or on the diode if you can see the markings), then the diode is faulty, (probably open circuit) and must be changed. Zener diodes exhibit similar short and open circuit faults to other diodes, but in addition may become 'noisy'. The normally very stable voltage across them suffers from very rapid fluctuations similar constant to the 'background noise' hiss on a poor audio signal. As Zener diodes are often used to stabilise power supply lines, this rapid fluctuation of voltage can give rise to strange faults, depending on what is being supplied by the power supply in question. The moral is - If a circuit is behaving strangely, and noise on the power supply is suspected, check any Zener diode stabilising that line by substituting it with a known good diode.

Q5. Write the different types of Diodes and draw their symbols.

Ans. *Types of Diodes :*

1. Light Emitting Diode
2. Laser diode
3. Avalanche diode
4. Zener diode
5. Schottky diode
6. Photodiode
7. PN junction diode

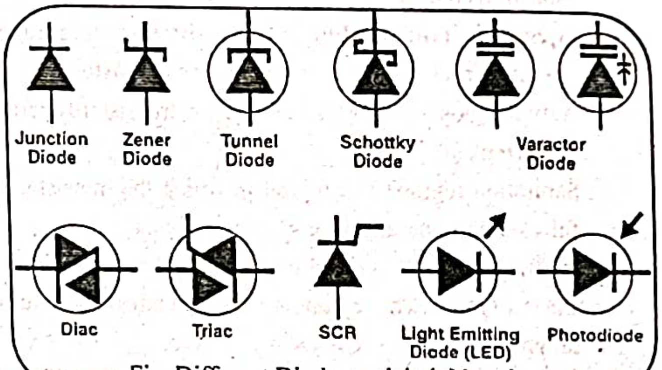


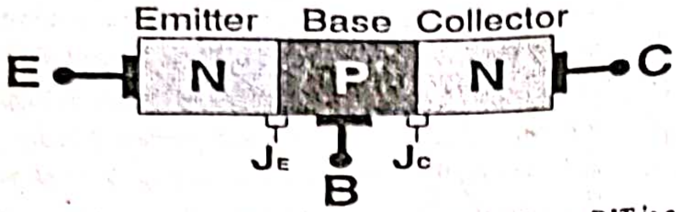
Fig. Different Diodes and their Notation

Q6. Explain Construction and Operation of Bipolar Junction Transistors.

Or. What is a Bipolar Junction Transistor (BJT)? draw the Symbol of (BJT).

Ans. *Bipolar Junction Transistor (BJT) :* A bipolar junction transistor is a three-terminal semiconductor device that consists of two p-n junctions which are able to amplify or magnify a signal. It is a current controlled device. The three terminals of the BJT are the base, the collector, and the emitter. A signal of a small amplitude applied to the base is available in the amplified form at the collector of the transistor. This is the amplification provided by the BJT. Note that it does require an external source of DC power supply to carry out the amplification process.

Bipolar Junction Transistor Symbol :



Construction of Bipolar Junction Transistor : BJT is a semiconductor device that is constructed with 3 doped semiconductor Regions i.e. Base, Collector & Emitter separated by 2 p-n Junctions. Bipolar transistors are manufactured in two types, PNP and NPN, and are available as separate components, usually in large quantities. The prime use or function of this type of transistor is to amplify current. This makes them useful as switches or amplifiers. They have a wide application in electronic devices like mobile phones, televisions, radio transmitters, and industrial control.

Operation of Bipolar Junction Transistor : There are three operating regions of a bipolar junction transistor:

- Active region: The region in which the transistors operate as an amplifier.
- Saturation region: The region in which the transistor is fully on and operates as a switch such that collector current is equal to the saturation current.
- Cut-off region: The region in which the transistor is fully off and collector current is equal to zero.

Q7. Describe What is a Field Effect Transistor (FET)? and its psychical overview. ?

Ans.

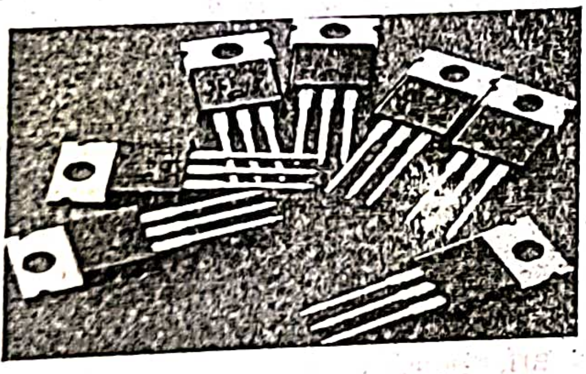
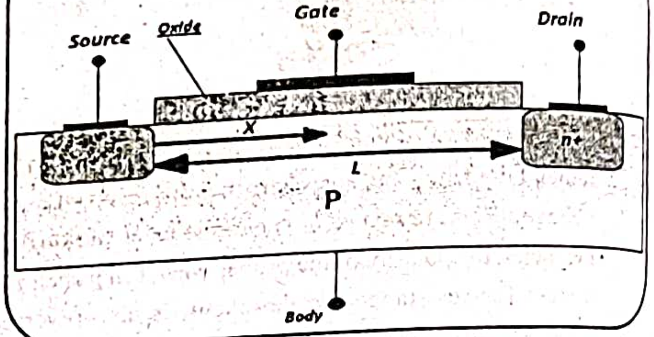


Fig. Field Effect Transistor (FET)

A Field Effect Transistor (FET) is a three-terminal Active semiconductor device, where the output current is controlled by an electric field generated by the input voltage. FETs are also known as unipolar transistors because, unlike bipolar transistors, FETs only have either electrons or holes operating as charge carriers. FET uses the voltage applied to its input terminal (called the Gate), to control the current flowing from the source to drain, making the Field Effect Transistor a "Voltage" operated device. FETs are extensively used in Integrated Circuits (ICs) due to their compact size and significantly lower power consumption. Apart from that, FETs are also used in high power switching applications, as voltage-variable resistors (VVRs) in operational amplifiers (Op-Amps), and tone controls, etc., for mixer operation on FM and TV receivers and in logic circuits.

Psychical Overview of Field Effect Transistor (FET)



A FET has four terminals named Source, Drain, Gate, and Body.

1. **Source:** Source is the terminal through which the majority charge carriers are entered in the FET.
2. **Drain:** Drain is the terminal through which the majority charge carriers exit from the FET.
3. **Gate:** The gate terminal is formed by diffusion of an N-type semiconductor with a P-type semiconductor. This creates a heavily doped PN junction region that controls the flow of the carrier from source to drain.
4. **Body:** This is the substrate on which the FET is built. In discrete applications, it is internally tied to the source pin allowing its effects to be ignored entirely. However, in integrated circuits, this pin will be typically connected to the most negative power supply in an NMOS circuit(most positive in a PMOS circuit) because many transistors will share it. Careful connections and design are critical to maintaining FET performance when the Body connection is involved.

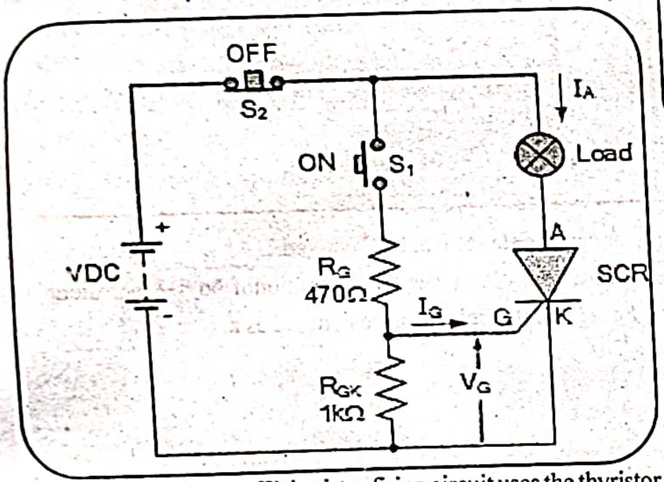
Q3. Explain Thyristors Operational Amplifiers circuit.

Or, Explain DC Thyristor Circuit and AC Thyristor Circuit.

Ans. Thyristors are semiconductor devices that are specifically designed for use in high-power switching applications and do not have the ability of an amplifier. Thyristors can operate only in a switching mode, acting like either an open or closed switch. Once triggered into conduction by its gate terminal, a thyristor will remain conducting (passing current) always. Therefore in DC circuits and some highly inductive AC circuits the current has to be artificially reduced by a separate switch or turn off circuit.

DC Thyristor Circuit : When connected to a direct current DC supply, the thyristor can be used as a DC switch to control larger DC currents and loads. When using the Thyristor as a switch it behaves like an electronic latch because once activated it remains in the "ON" state until manually reset. Consider the DC thyristor circuit below.

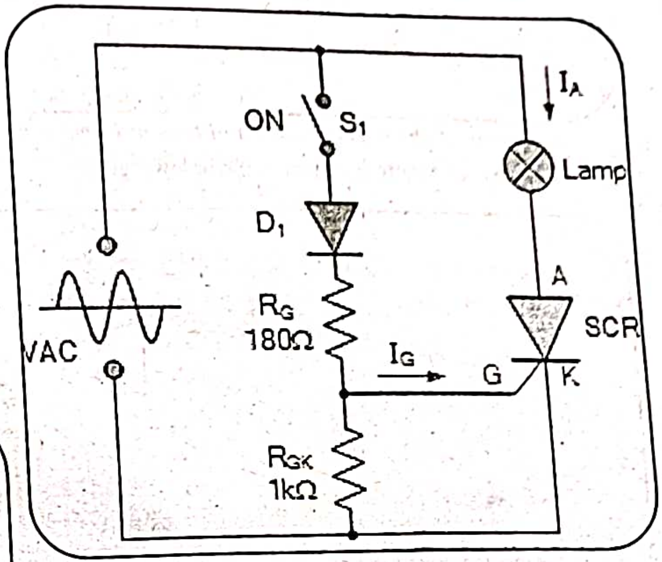
DC Thyristor Switching Circuit :



This simple "on-off" thyristor firing circuit uses the thyristor as a switch to control a lamp, but it could also be used as an on-off control circuit for a motor, heater or some other such DC load. The thyristor is now turned fully "ON" (conducting) allowing full load circuit current to flow through the device in the forward direction and back to the battery supply.

AC Thyristor Circuit : When connected to an alternating current AC supply, the thyristor behaves differently from the previous DC connected circuit. This is because AC power reverses polarity periodically and therefore any thyristor used in an AC circuit will automatically be reverse-biased causing it to turn-"OFF" during one-half of each cycle. Consider the AC thyristor circuit below.

AC Thyristor Circuit : The thyristor firing circuit is similar in design to the DC SCR circuit except for the omission of an additional "OFF" switch and the inclusion of diode D1 which prevents reverse bias being applied to the Gate. During the positive half-cycle of the sinusoidal waveform, the device is forward biased but with switch S1 open, zero gate current is applied to the thyristor and it remains "OFF".



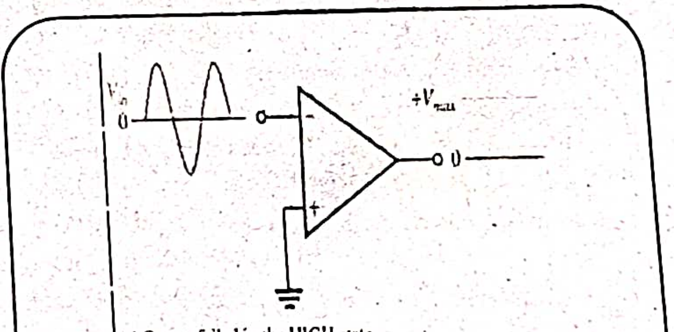
Q9. Desceribe Fault diagnosis in op-amp circuits.

Or, How to Troubleshoot OP-Amp Circuits.

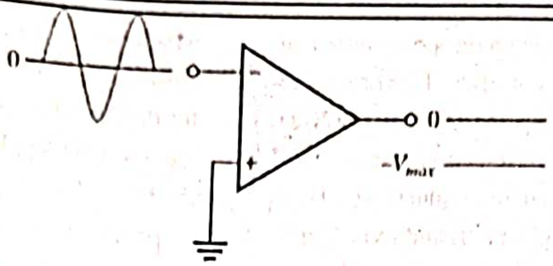
Ans. As ICs created with the operational amplifier can be easily handled, operate well in normal conditions but some faults exist in these modules with In today's post, we will have a detailed look at How to Troubleshoot OP-Amp Circuits. As ICs created with the operational amplifier can be easily handled, operate well in normal conditions but some faults exist in these modules with In today's post,

How to Troubleshoot OP-Amp Circuits:

*The below figure describes the inner fault of comparator circuitry which generates stuck results.

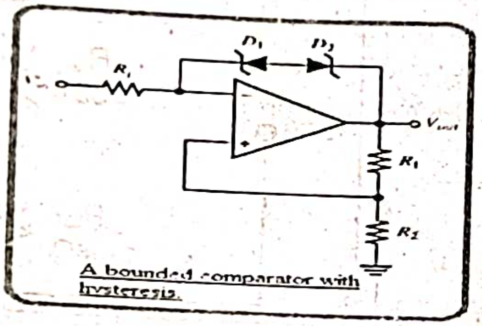


(a) Output failed in the HIGH state



(b) Output failed in the LOW state

Symptoms of Outer Component Failures in Comparator Circuits :The comparator circuit having Zener grounding and hysteresis configure is drawn in the below figure.



A bounded comparator with hysteresis.

*For damaging of the operational amplifier the Zener diode or any resistance can be damaged.

*For instance, assume that there is one diode that has an open circuit. It causes the separationof both Zener diode and circuitry will operate like an unbounded comparator. It can be seen in the below figure denoted as a.

UNIT 04

LOGIC IC FAMILIES, PACKAGES IN DIGITAL ICS

QUESTIONS AND ANSWERS

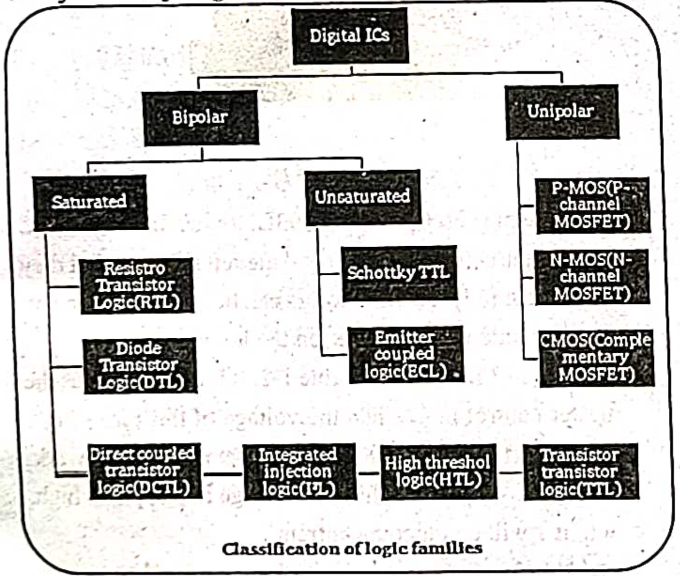
Q1. Explain Logic IC families and write their classification.

Ans. Various digital ICs available in the market belong to various types. These types are known as Logic Families.

Based on the components and devices internally used, digital logic families are named as :

1. RTL(Resistor Transistor Logic)
2. TTL(Transistor Transistor Logic)
3. DTL(Diode Transistor Logic)
4. CMOS etc.

Classification of Logic Families:



Classification of logic families

The two basic techniques for manufacturing ICs are:

1. **Bipolar Technology :**
2. **Metal oxide semiconductor (MOS) technology :**

1. **Bipolar Families:**

* The bipolar families of logic circuits construct, especially from components fabricate bipolar transistor on the chip.

* In the bipolar category there are three basic families called Diode transistor logic(DTL),

* Transistor Transistor Logic(TTL) and Emitter Coupled Logic (ECL).

* DTL uses diodes and transistor, TTL uses transistors almost exclusively, TTL has become the most popular family in SSI (Small scale integration) and MSI(medium scale integration) chips, while ECL is the fastest logic family which is used for high speed applications.

2. **MOS Families:**

* The MOS family fabricates MOS field effect transistor (MOSFETs).

* In the MOS category there are three logic families namely PMOS(p-channel MOSFTEs) family, NMOS(n-channel MOSFET) family and CMOS(Complementary MOSFET) family.

*PMOS is the oldest and slowest type. NMOS used for LSI(large scale integration) field for microprocessors and memories.

* CMOS which uses a push pull arrangement of n-channel and p-channel MOSFETs, is extensively used where low power consumption is needed such as in pocket calculators.

Q2. What is IC packaging? and write its different types.

Ans. Integrated Circuit Packaging refers to the encasing of a semiconductor component. The core of any IC are semiconductor wafers that are layered in a complex formation with copper and other materials. The cut and formed mash-up of these semiconductor wafers is called a die. The die has all its components and interconnections fabricated at a microscopic level. In the final stage of IC production, macroscopic electrical contacts are taken out from the die, so the integrated circuit can connect with other components on a PCB. The IC packaging is all about encasing the semiconductor 'die' and taking out macroscopic electrical contacts for interconnections on a PCB.

Instead of a tree-structured classification generally used by suppliers and manufacturers, we are listing the major IC package types. These are the following –

1. Single in-line

2. Zigzag in-line
3. Dual in-line
4. Quad in-line
5. Ceramic flat pack
6. Surface-mount small-outline
7. Surface-mount leadless
8. Flatpack
9. Chip carrier
10. Chip scale
11. Grid Array/Matrix.

Q3. Explain the term how to identify integrated circuit chips.

Ans. Attempting to identify an integrated circuit (IC) can be confusing as there is no standardized numbering system. Manufacturers use their own data sheets and identification numbers. It may be difficult to find a cross reference for a similar part from another manufacturer. However, there are three approaches to finding this information: data sheets, electronic parts retailers and the equipment manufacturer's schematics and part list.

Identify the manufacturer first. Sometimes the company name is printed on the IC, but others may be obscure symbols. Use a reference document in a electronic retailer catalog or an online source. Always look at the IC identifiers under magnification because the print is often very small and some numbers may be difficult to read. There are usually three printed lines on each IC: the manufacturer's vendor code, the part number and a date code, though they may not be in that order.

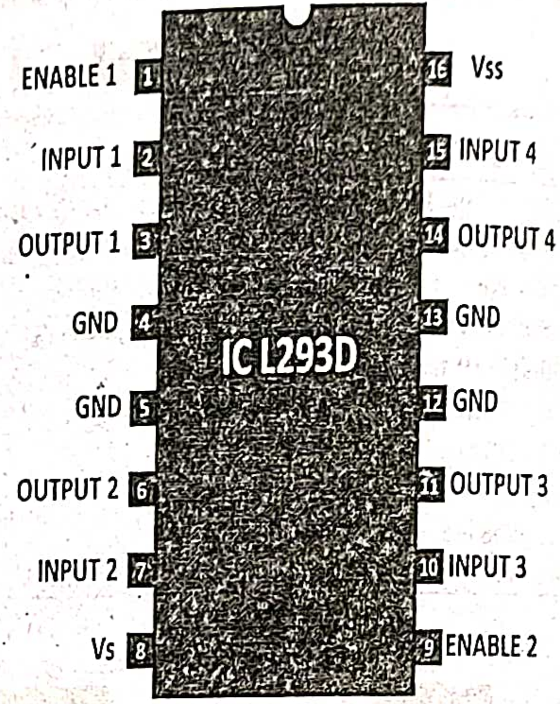
Look up data sheets in the manufacturer's printed catalog. This may be most beneficial when trying to identify an obsolete part. Manufacturers print catalogs detailing their entire product line, often broken down into "families" of related parts. The data sheets contain all the engineering specifications for each part as well as a drawing of its outline and how it should be configured in a circuit board.

Q4. Describe IC L293D pinout diagram and terminal identification.

Ans. IC L293D is a motor driver IC that works in the principle of the H-Bridge Principle. Generally, this IC is used by interfacing with the microcontroller ICs. We know that heavy load motors are required more electrical current to operate but the microcontroller ICs give output up to a few milliamperes. So, if we connect the heavy motors directly to the microcontroller IC, it will damage. That is why, the motor controller ICs such as L293D are used to operate the motor. These ICs takes low signals from the microcontroller ICs and operated heavy motor by the helping of auxiliary power supply.

IC L293D Pinout Diagram :

Here, you can see the pin diagram of IC L293D :



IC L293D PinOut Diagram

Here, the pin description of L293D. Remember that this IC has two parts right side part and the left side part and they work separately. So two motors can be connected, one on the right side while another on the left side.

Pin No. 1 - Enable 1 or Enable 1-2. It is also known as the master control pin. When the voltage of this pin is high, the left part of the IC will work, another part will not work.

Pin No. 2 - Input 1. When the voltage at this pin is high, output 1 will conduct the current.

Pin No. 3 - Output 1. It is to be connected to anyone terminal of the motor.

Pin No. 4 - Ground Pin

Pin No. 5 - Ground Pin

Pin No. 6 - Output 2. It is to be connected to another terminal of the motor with respect to output 1.

Pin No. 7 - Input 2. When the voltage to this pin is high. The output 2 will conduct current.

Pin No. 8 - Vs. This pin is to be connected to the high voltage power supply at which the motor will work such as 12V DC.

Pin No. 9 - ENABLE 2 or Enable 3-4. When the voltage at this pin is high, the right part of the IC will work and another part of the IC will not work. It is also called the master control pin for the right part of the IC.

Pin No. 10 - Input 3. When the voltage to this pin is high the output 3 will conduct current.

Pin No. 11 - Output 3. It is to be connected to anyone terminal of the motor.

Pin No. 12 - Ground Pin

Pin No. 13 - Ground Pin

Pin No. 14- Output 4. It is to be connected to another terminal of the motor with respect to output3.

Pin No. 15 - Input 4. When the voltage to this pin is high, output 4 will conduct current.

Pin No. 16 - Vcc. This pin is to be connected to the low voltage power supply at which the internal integrated circuit of the IC will operate. Generally, it is to be connected to the 5V DC power supply.

Q5. Write short notes on :

1. Logic clips

2. Logic probes

3. Logic pulser

4. Logic current Tracer.

1. **Logic clips :** It is spring-loaded devices that are designed to clip onto a dual-in-line package IC while the IC is mounted in its circuit. It is a simple device that usually has 16 lightemitting diodes (LEDs) mounted at the top of the clips. The LEDs correspond to the individual pins of theIC, and any lit LED represents a high logic state. An unlit LED represents a low logic state. Logic clipsrequire no external power connections, and they are small and lightweight. Their ability to simultaneouslymonitor the input and output of an IC is very helpful when you are troubleshooting a logic circuit.

2. **Logic probes :** The logic probe or digital tester is normally a low cost handheld probe contained within a pen-like tube with indicator lights to show the state of the line being probed.

Fig. Simple logic probe tester

Typically logic probes are used to test digital circuits like those using TTL or CMOS logic. They often have three indicator lights on the body to indicate the state of the line. As such logic probes are very basic forms of digital testers, only able to test the state of a single line, but they can be useful in many applications.The logic probe is normally powered by the circuit under test - there are normally leads with crocodile / alligator clips that can be attached to the ground and supply of the circuit under test.

3. **Logic pulser :** It resembles the logic probe in that it has a body or housing to which a slender conductive point attaches. And like the logic probe, the logic pulser also has red and black leads with alligator clips that are intended to be connected to the positive and negative dc power supply rails.

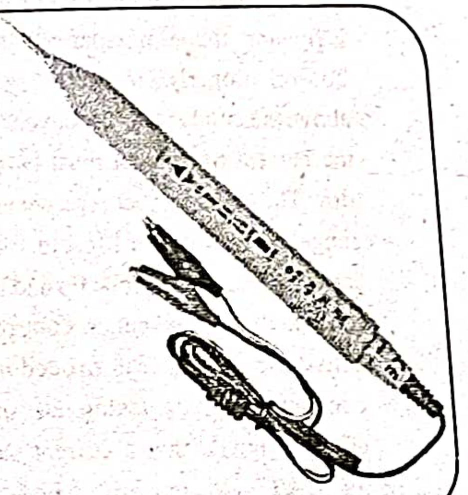


Fig. Logic pulser

A typical logic pulser has, in its internal circuitry, an output transistor that is protected by a 1-kO resistor that limits the current in the probe and in the device under test. Accordingly, the pulser can touch any pin of an IC without fear of damaging the pulser or semiconductor.If the equipment being tested has known good output devices, they will show the results of the injected pulses. In the absence of such indicators, a logic probe is needed. By moving one or both of these diagnostic tools from point to point, a large amount of information can be quickly accumulated, preparing the way for more definitive oscilloscope tests.

4. **Logic current Tracer :** Another instrument that is highly relevant to digital debugging and troubleshooting is the digital current tracer. Here again the tool's appearance resembles that of the logic probe. But its functionality and physical construction are quite different. The digital current

tracer has a probe-body construction but rather than a needle-like electrode, it has a magnetic pick-up head.

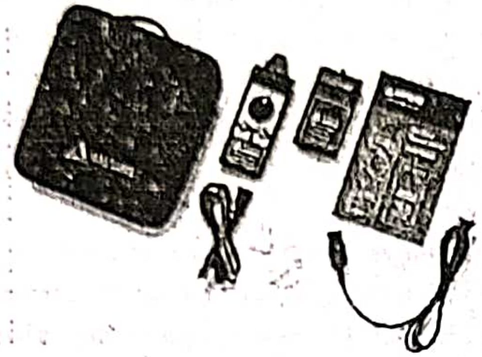


Fig. Logic current tracer

The basic idea is that the tracer detects the magnetic field that surrounds a conductor or trace through which current is flowing. It does not matter if the conductor is insulated. To work properly, the current tracer must be held vertically above the conductor. Moreover, there is a dot on the tip of the current tracer that must be aligned with the current flow.The current tracer is responsive to current over a wide range, typically from 1 mA to 1 A. A prominent indicator lamp resides at the probe tip and its brightness varies with the amount of current. A control can be used to adjust sensitivity. Then, the procedure is to move along a conductor or trace, taking note of the current. An abrupt change signals that a current sink or source has been located.Trouble can arise when there is a fault within an IC, but such difficulties are probably less frequent than nearly-invisible solder bridges that ground out (with varying amounts of resistance) or short adjacent live traces. When this fault has been corrected; operation is frequently restored without wholesale replacement of numerous semiconducting devices.

Q6. Explain Flip-flop and its types.

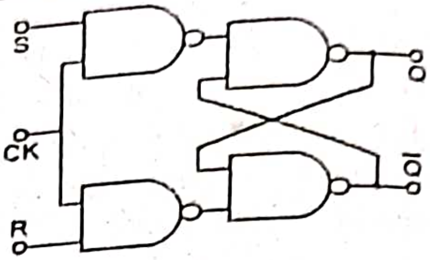
Or, Explain Flip-flop and their Conversion and Applications.

Ans. Flip-flop is a circuit that maintains a state until directed by input to change the state. A basic flip-flop can be constructed using four-NAND or four-NOR gates. Types of flip-flops:

1. RS Flip Flop *2. JK Flip Flop*
3. D Flip Flop *4. T Flip Flop*

Logic diagrams and truth tables of the different types of flip-flops are as follows:

1. **S-R Flip Flop:**



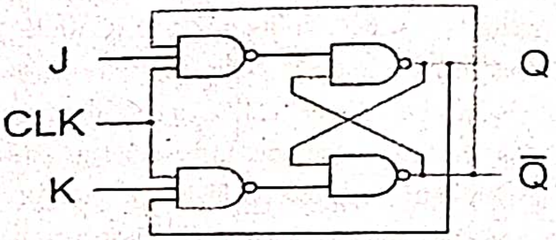
TRUTH TABLE

S	R	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	-
1	1	1	-

Characteristics Equation for SR Flip Flop:

$$QN+1 = QNR'+SR'$$

2. **J-K Flip Flop:**



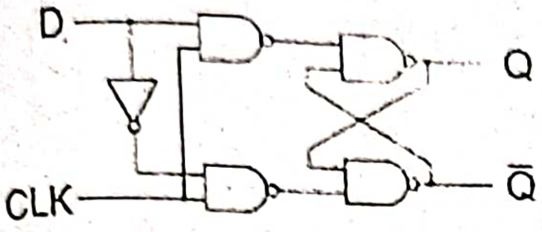
TRUTH TABLE

J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Characteristics Equation for JK Flip Flop:

QN+1 = JQ'N + K'QN

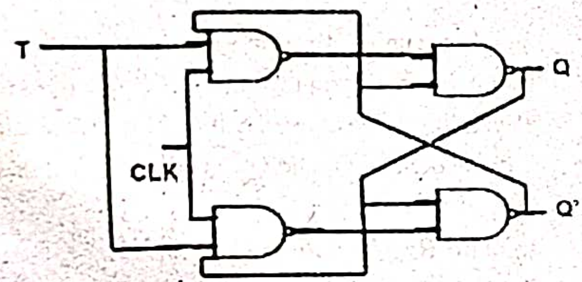
Flip Flop:



Q	D	Q(t+1)
0	0	0
0	1	1
1	0	0
1	1	1

Characteristics Equation for D Flip Flop: QN+1 = D

T Flip Flop:



T	Q_n	Q_{n+1}
0	0	0
0	1	1
1	0	1
1	1	0

Characteristics Equation for T Flip Flop:

QN + 1 = Q'NT + QNT' = QN XOR T

Conversion for Flip Flops:

EXCITATION TABLE:

Q_n	Q_{n+1}	S	R	J	K	D	T
0	0	0	X	0	X	0	0
0		1	0	1	X	1	1
1		0	1	X	1	0	1
1	1	X	0	X	0	1	0

Applications of Flip-Flops: These are the various types of flip-flops being used in digital electronic circuits and the applications of Flip-flops are as specified below.

*Counters

*Frequency Dividers

*Shift Registers

*Storage Registers

*Bounce elimination switch

*Data storage

*Data transfer

*Latch

*Registers

*Memory

Q7. Describe Counters in digital logic and also give their Classification.

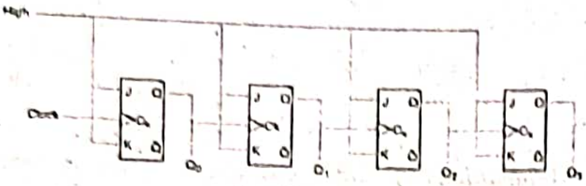
Ans. A Counter is a device which stores (and sometimes displays) the number of times a particular event or process has occurred, often in relationship to a clock signal. Counters are used in digital electronics for counting purpose, they can count specific event happening in the circuit. For example, 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:

1. Up counter 2. Down counter

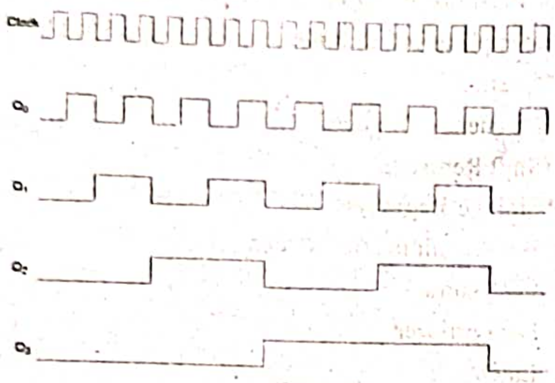
Counter Classification : Counters are broadly divided into two categories :

1. Asynchronous counter 2. Synchronous counter

1. **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-



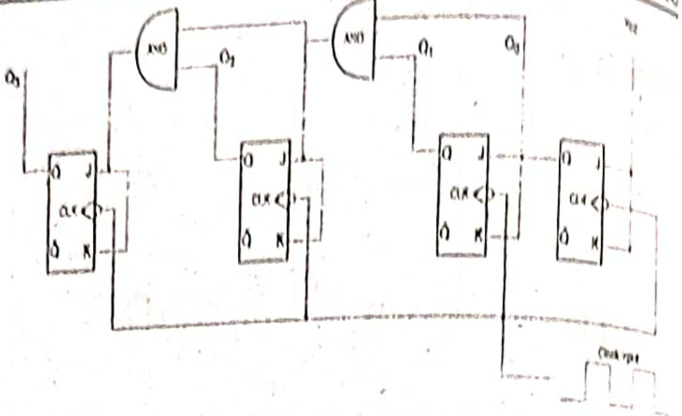
(a) Asynchronous counter



(b) Timing Diagram

It is evident from timing diagram that Q_0 is changing as soon as the rising edge of clock pulse is encountered, Q_1 is changing when rising edge of Q_0 is encountered(because Q_0 is like clock pulse for second flip flop) and so on. In this way ripples are generated through Q_0,Q_1,Q_2,Q_3 hence it is also called RIPPLE 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

2. **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.



Synchronous counter circuit :

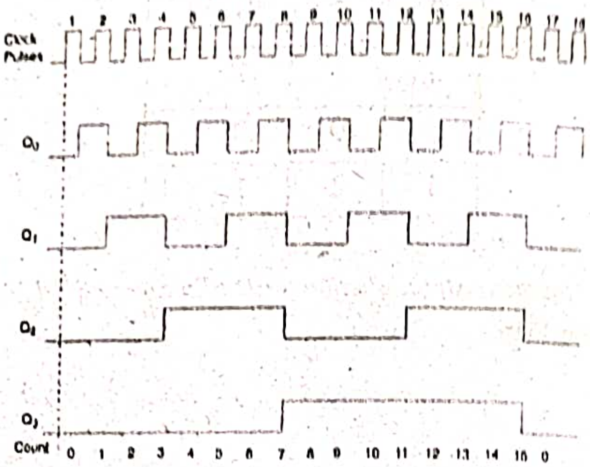


Fig. Timing diagram synchronous counter

From circuit diagram we see that Q_0 bit gives response to each falling edge of clock while Q1 is dependent on Q_0, Q_2 is dependent on Q_1 and Q_0 , Q_3 is dependent on Q_2,Q_1 and Q_0.

Q8. Explain Registers and its Types.

Ans. Register are used to quickly accept, store, and transfer data and instructions that are being used immediately by the CPU, there are various types of registers those are used for various purpose. Among of the some Mostly used registers named as AC or accumulator, Data Register or DR, the AR or Address Register, program counter (PC), Memory Data Register (MDR), index gister, memory buffer Register. These registers are used for performing the various operations. While we are working on the system then these registers are used by the CPU for performing the operations. When we gives some input to the system then the input will be stored into the registers and when the system will gives us the results after processing then the result will also be from the registers. So that they are used by the CPU for Processing the Data which is given by the User. Registers Perform:-

Fetch: The Fetch Operation is used for taking the instructions those are given by the user and the Instructions those are stored into the Main Memory will be fetch by using Registers.

Decode: The Decode Operation is used for interpreting the Instructions means the Instructions are decoded means the CPU will find out which Operation is to be performed on the Instructions.

Execute: The Execute Operation is performed by the CPU. And Results those are produced by the CPU are then Stored into the Memory and after that they are displayed on the user Screen.

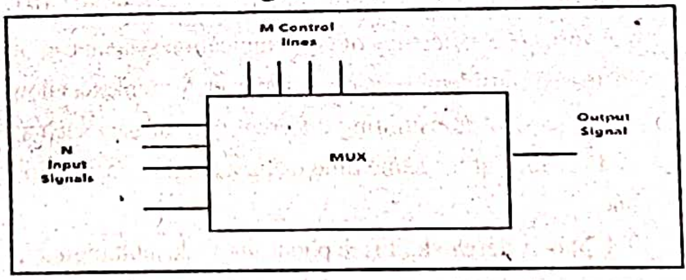
Types of Registers are as Followings :

1. **MAR stand for Memory Address Register :** This register holds the memory addresses of data and instructions. This register is used to access data and instructions from memory during the execution phase of an instruction. Suppose CPU wants to store some data in the memory or to read the data from the memory. It places the address of the-required memory location in the MAR.
2. **Accumulator Register :** This Register is used for storing the Results those are produced by the System. When the CPU will generate Some Results after the Processing then all the Results will be Stored into the AC Register.
3. **Memory Data Register (MDR) :** MDR is the register of a computer's control unit that contains the data to be stored in the computer storage (e.g. RAM), or the data after a fetch from the computer storage. It acts like a buffer and holds anything that is copied from the memory ready for the processor to use it. MDR hold the information before it goes to the decoder.MDR which contains the data to be written into or readout of the addressed location. For example, to retrieve the contents of cell 123, we would load the value 123 (in binary, of course) into the MAR and perform a fetch operation. When the operation is done, a copy of the contents of cell 123 would be in the MDR. To store the value 98 into cell 4, we load a 4 into the MAR and a 98 into the MDR and perform a store.
4. ***Index Register :*** *A hardware element which holds a number that can be added to (or, in some cases, subtracted from) the address portion of a computer instruction to form an effective address. Also known as base register. An index register in a computer's CPU is a processor register used* for modifying operand addresses during the run of a program.
5. **Memory Buffer Register :** MBR stand for Memory Buffer Register. This register holds the contents of data or instruction read from, or written in memory. It means that this register is used to store data/instruction coming from the memory or going to the memory.
6. **Data Register :** A register used in microcomputers to temporarily store data being transmitted to or from a peripheral device.

Q9. Explain Multiplexer also draw the diagram for 4-to-1 Multiplexer and write its Applications.

Ans. Multiplexer means many into one. A multiplexer is a circuit used to select and route any one of the several input signals to a single output. A simple example of an non-electronic circuit of a multiplexer is a single pole multi-position switch. Multi-position switches are widely used in many electronics circuits. However, circuits that operate at high speed require the multiplexer to be automatically selected. A mechanical switch cannot perform this task efficiently. Therefore, multiplexer is used to perform high speed switching are constructed of electronic components.Multiplexers can handle two type of data i.e., analog and digital. For analog application, multiplexer are built using relays and transistor switches. For digital application, they are built from standard logic gates. The multiplexer used for digital applications, also called digital multiplexer, is a circuit with many input but only one output. By applying control signals (also known as Select Signals), we can steer any input to the output. Some of the common types of multiplexer are 2-to-1, 4-to-1, 8-to-1, 16-to-1 multiplexer. Following figure shows the general idea of a multiplexer with n input signal, m control signals and one output signal.

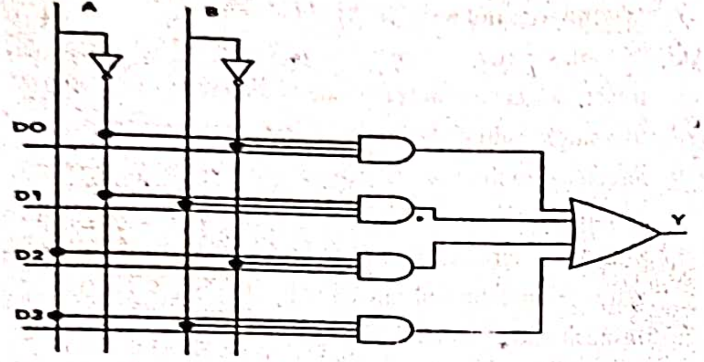
Block Diagram Of A Multiplexer



4-to-1 Multiplexer : The 4-to-1 multiplexer has 4 input bits, 2 control or select bits, and 1 output bit. The four input bits are D0,D1,D2 and D3. Only one of this is transmitted to the output Y. The output depends on the values of A and B, which are the control inputs. The control input determines which of the input data bit is transmitted to the output.

For instance, as shown in figure, when $AB = 00$, the upper AND gate is enabled, while all other AND gates are disabled. Therefore, data bit D0 is transmitted to the output, giving Y = Do.

Logic Circuit Of 4-To-1 Multiplexer



If the control input is changed to $AB = 11$, all gates are disabled except the bottom AND gate. In this case, D3 is transmitted to the output and Y = D3. An example of 4-to-1 multiplexer is IC 74153 in which the output is same as the input. nother example of 4-to-1 multiplexer is 45352 in which the output is the compliment of the input.

Example of 16-to-1 line multiplexer is IC 74150.

Applications of Multiplexer : Multiplexer are used in various fields where multiple data need to be transmitted using a single line. Following are some of the applications of multiplexers –

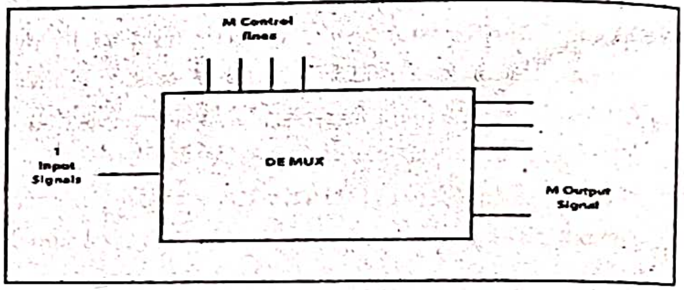
1. **Communication System :** Communication system is a set of system that enable communication like transmission system, relay and tributary station, and communication network. The efficiency of communication system can be increased considerably using multiplexer. Multiplexer allow the process of transmitting different type of data such as audio, video at the same time using a single transmission line.
2. **Telephone Network :** In telephone network, multiple audio signals are integrated on a single line for transmission with the help of multiplexers. In this way, multiple audio signals can be isolated and eventually, the desire audio signals reach the intended recipients.
3. *Computer Memory :* Multiplexers are used to implement huge amount of memory into the computer, at the same time reduces the number of copper lines required to connect the memory to other parts of the computer circuit.
4. *Transmission from the Computer System of a Satellite :* Multiplexer can be used for the transmission of data signals from the computer system of a satellite or spacecraft to the ground system using the GPS (Global Positioning System) satellites.

Q10. Explain Demultiplexer also draw the diagram for 1-to-4 Demultiplexer and write its Applications.

Ans. Demultiplexer means one to many. A demultiplexer is a circuit with one input and many outputs. By applying control signal, we can steer any input to the output. Few types of demultiplexer are 1-to 2, 1-to-4, 1-to-8 and 1-to 16 demultiplexer.

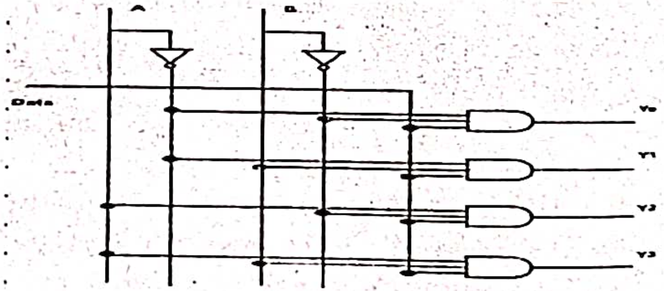
Following figure illustrate the general idea of a demultiplexer with 1 input signal, m control signals, and n output signals.

Block Diagram Of A Demultiplexer



1-to-4 Demultiplexer : The 1-to-4 demultiplexer has 1 input bit, 2 control or select bits, and 4 output bits. An example of 1-to-4 demultiplexer is IC 74155. The 1-to-4 demultiplexer is shown in figure below-

Logic Circuit Of 1-To-4 Demultiplexer



The input bit is labelled as Data D. This data bit is transmitted to the selected output lines, which depends on the values of A and B, the control or Select Inputs. When A B = 0 1 , the second AND gate from the top is enabled while other AND gates are disabled. Therefore, data bit D is transmitted to the output Y1, giving Y1 = Data. If D is LOW, Y1 is LOW. If D is HIGH, Y1 is HIGH. The value of Y1 depends upon the value of D. All other outputs are in low state. If the control input is changed to A B = 1 0 , all the gates are disabled except the third AND gate from the top. Then, D is transmitted only to the Y2 output, and Y2 = Data.

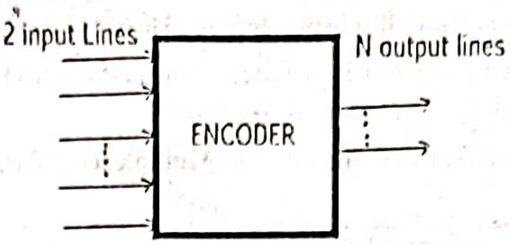
Applications of Demultiplexer :

1. *Demultiplexer is used to connect a single source to multiple destinations* - The main application area of demultiplexer is communication system, where multiplexers are used. Most of the communication system are bidirectional i.e., they function in both ways (transmitting and receiving signals). Hence, for most of the applications, the multiplexer and demultiplexer work in sync. Demultiplexer are also used for reconstruction of parallel data and ALU circuits.
2. *Communication System* – Communication system use multiplexer to carry multiple data like audio, video and other form of data using a single line for transmission. This process make the transmission easier. The demultiplexer receive the output signals of the multiplexer and converts them back to the original form of the data at the receiving end. The multiplexer and demultiplexer work together to carry out the process of transmission and reception of data in communication system.

Q11. Explain Encoders and Decoders in Digital Logic.

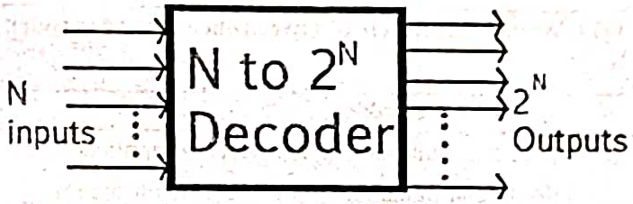
Ans. Binary code of N digits can be used to store 2N distinct elements of coded information. This is what encoders and decoders are used for. Encoders convert 2N lines of input into a code of N bits and Decoders decode the N bits into 2N lines.

1. **Encoders** – An Encoder is a device that converts the active data signal into a coded message format or it is a device that converts analogue signal to digital signals. It is a combinational circuit, that converts binary information in the form of a 2N input lines into N output lines which represent N bit code for the input. When an input signal is applied to an encoder then logic circuitry involved within it converts that particular input into coded binary output.



To decode is to perform the reverse operation :converting a code back into an unambiguous form code and the device which perform this operation is termed as Decoder.

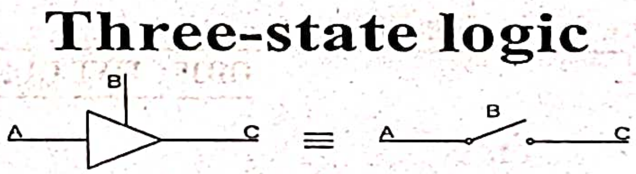
2. **Decoders** – A decoder is also a combinational circuit as encoder but its operation is exactly reverse as that of the encoder. A decoder is a device that generates the original signal as output from the coded input signal and converts n lines of input into 2n lines of output. An AND gate can be used as the basic decoding element because it produces a high output only when all inputs are high.



Q12. Explain Three-State Logic.

Ans. Three-state logic is a logic used in electronic circuits wherein a third state, the high-impedance state, is added to the original 1 and 0 logic states that a port can be in. This high-impedance state effectively removes the port from the circuit, as if it were not part of it. So in the third state of high impedance, the output from the port is neither 1 nor 0, but rather the port does not appear to exist.

Three-state logic is also known as tri-state logic.



Three-state logic is used to allow multiple circuits to share the same output or bus lines which may not be capable of listening to more than one device or circuit at a time. In this way, the high-impedance state acts as a selector which blocks out circuits that are not being used. Three-state logic is implemented in most bus drivers, registers, flip-flops in the 4000 and 7400 series as well as many others. Three-state logic is commonly used internally in many integrated circuits such as microprocessors, RAM or memory as well as many chips used in peripheral devices. Many of these are controlled by what is called as active-low input which indicates whether the output leads or pins should be placed in a high-impedance state or to drive their loads, that is to either output the standard 1 or 0.

Q13. Write the Difference between Multiplexer and Demultiplexer.

Ans.

Multiplexer	Demultiplexer
1. Multiplexer processes the digital information from various sources into a single source.	1. Demultiplexer receives digital information from a single source and converts it into several sources
2. It is known as Data Selector	2. It is known as Data Distributor
3. Multiplexer is a digital switch	3. Demultiplexer is a digital circuit
4. It follows combinational logic type	4. It also follows combinational logic type
5. It has n data input	5. It has single data input
6. It has a single data output	6. It has n data outputs
7. It works on many to one operational principle	7. It works on one to many operational principle
8. In time division Multiplexing, multiplexer is at the transmitter end	8. In time division Multiplexing, demultiplexer is used at the receiver end

Q14. Write the Difference between encoder and decoder.

Ans.

Encoder	Decoder
1. Encoder circuit basically converts the applied information signal into a coded digital bit stream.	1. Decoder performs reverse operation and recovers the original information signal from the coded bits.
2 In case of encoder, the applied signal is the active signal input	2 Decoder accepts coded binary data as its input.
3. The number of inputs accepted by an encoder is 2n.	3. The number of input accepted by decoder is only n inputs.
4 The output lines for an encoder is n.	4. The output lines of an decoder is 2n.
5. The encoder generates coded data bits as its output	5. The decoder generates an active output signal in response to the coded data bits.
6. The operation performed is simple.	6. The operation performed is complex.
7. The encoder circuit is installed at the transmitting end	7. The decoder circuit is installed at the receiving side.
8. OR gate is the basic logic element used in it.	8. AND gate along with NOT gate is the basic logic element used in it.
9. It is used in E-mail, video encoders etc.	9. It is used in Microprocessors, memory chips etc.

OBJECTIVE QUESTIONS AND ANSWERS

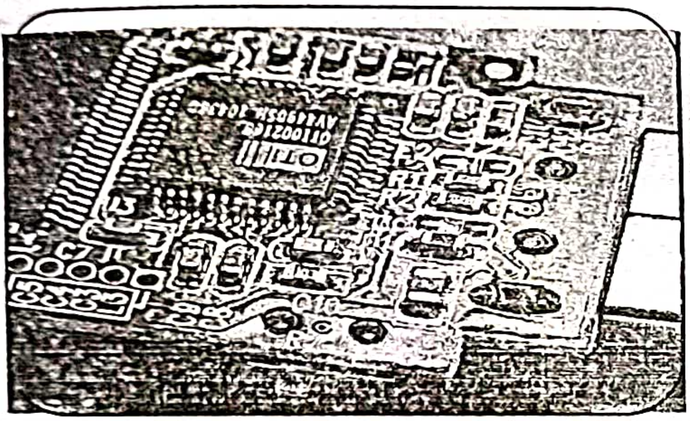
UNIT 05

REWORK AND REPAIR OF SURFACE MOUNT ASSEMBLIES SURFACE

QUESTIONS AND ANSWERS

Introduction to Surface-mount technology.

Surface-mount technology (SMT) is a method in which the electrical components are mounted directly onto the surface of a printed circuit board (PCB).



An electrical component mounted in this manner is referred to as a surface-mount device (SMD). In industry, this approach has largely replaced the through-hole technology construction method of fitting components, in large part because SMT allows for increased manufacturing automation which reduces cost and improves quality. It also allows for more components to fit on a given area of substrate. Both technologies can be used on the same board, with the through-hole technology often used for components not suitable for surface mounting such as large transformers and heat-sinked power semiconductors.

An SMT component is usually smaller than its through-hole counterpart because it has either smaller leads or no leads at all. It may have short pins or leads of various styles, flat contacts, a matrix of solder balls (BGAs), or terminations on the body of the component.

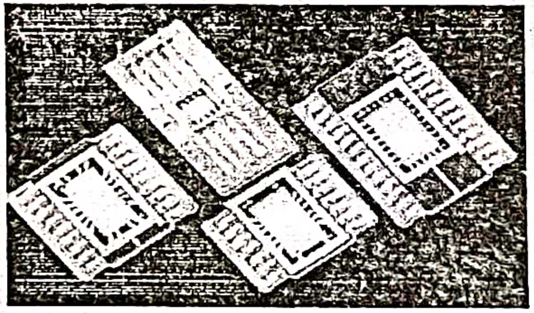
Common abbreviations

Different terms describe the components, technique, and machines used in manufacturing. These terms are listed in the following :

SMp term	Expanded form
SMD	Surface-mount devices (active, passive and electromechanical components)
SMT	Surface-mount technology (assembling and mounting technology)
SMA	Surface-mount assembly (module assembled with SMT)
SMC	Surface-mount components (components for SMT)
SMP	Surface-mount packages (SMD case forms)
SME	Surface-mount equipment (SMT assembling machines)

Q1. Explain SOIC – Small Outline Integrated Circuit and its advantages. ?

Ans. The Small Outline Integrated Circuit, or SOIC, is a small rectangular surface-mount plastic-molded integrated circuit package with gull wing leads. The leads protrude from the longer edge of the package. It is one of the most commonly used surface mount packages. SOIC packages are JEDEC-compliant, and come in a variety of body widths. The most common are either the narrow body of 150 mils or 3.8 mm, or the wide body of 300 mils or 7.5 mm. The standard SOIC lead pitch is nominally 50 mils (1.27 mm). The SOIC is ideal for all applications that require dense placement of chips on boards.



Advantages of SOIC :

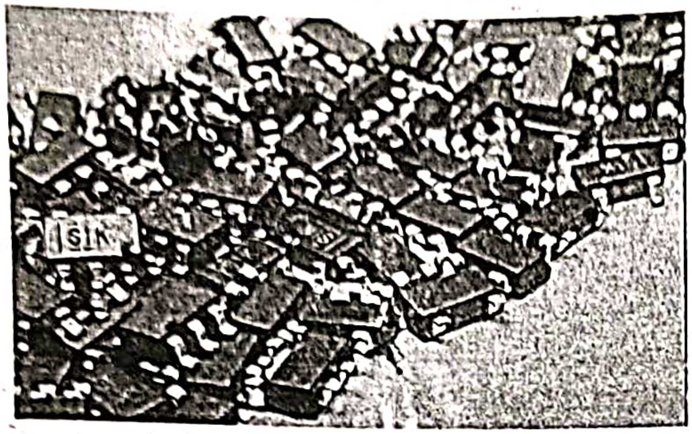
Multilayer Ceramic Package

Surface Mount with .050" lead spacing

Comparable Foot Print as Plastic SOP
Solder, Glass or Epoxy Seal
Gull Wing Lead Configuration
Gold Plated Leads

Q2. Describe the SOT Package Types for Surface Mount Components and its types. ?

Ans.



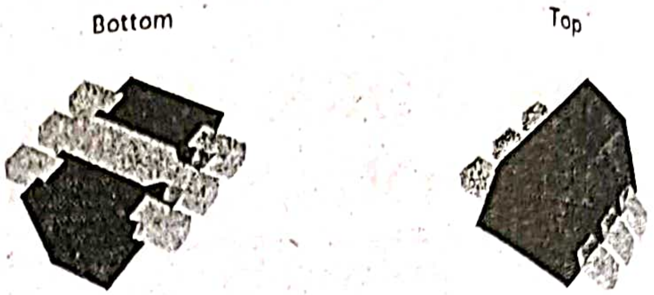
In particular, SOT packages are commonly used for a variety of components, ranging from discrete transistors to linear regulators. These components are simple to understand and layout, and they have less chance of defects during wave soldering, as they have larger land patterns than other surface-mount components.

SOT packages are a common option. It helps to understand the various SOT package types, as not all SOT components are created equal. Once you do select your SOT components, you'll need to make sure you have the right PCB footprints for your components to use in your CAD software.

SOT Package Types :

Different components that come in **SOT** packages can have different pin counts, lead sizes, lead pitches, and required land patterns. In the case of SMD components, the land pattern gives the required pad size for soldering to the board, which needs to be included in a component library for PCB design. If you know a bit about the different package types, you can figure out how to design the land pattern to accommodate the component on your board. You can also quickly compare different land patterns for SOT package types simply by looking at the package name.

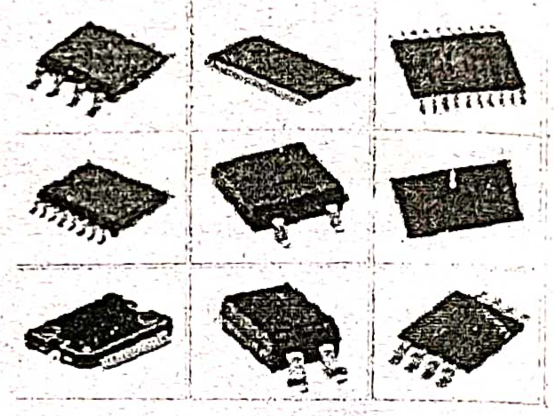
SOT89-5 Package



Q3. Explain Leadless Chip Carrier (LCC)

Or, What Does Leadless Chip Carrier (LCC) Mean?

Ans. A leadless chip carrier (LCC or LLCC) is an integrated circuit package that has no pins/leads for contact. This surface-mount device makes use of metal pads at the outer edges to establish connection with the circuit board. Leadless chip carriers are popular, as they are light in weight, adaptable to a wide range of applications and are considered ideal for surface-mount applications.



A leadless chip carrier is usually square or rectangular in shape. Unlike other integrated circuit packaging, leadless chip carriers do not establish connection to devices by means of pins, but by means studs or metal pads provided around the periphery of the package. Due to reduction in weight, area and volume, leadless chip carriers are more durable and could withstand more vibration and shock compared to dual-in-line packages.One of the salient features of a leadless chip carrier is its easy and convenient direct insertion to its socket mounted on the circuit board. It can also easily mount directly on the board. It is a low-cost solution for surface mounting, as it is lightweight and has no metallic external legs or leads. Unlike dual-inline packages, no holes are required for leadless chip carriers.There are a few drawbacks associated with leadless chip carriers. The system is not considered homogeneous when leadless chip carriers are mounted to printed circuit boards. Failures of these systems have been common after limited stressing or thermal expansion. Most of these issues can be resolved by selecting the proper printed circuit board material.

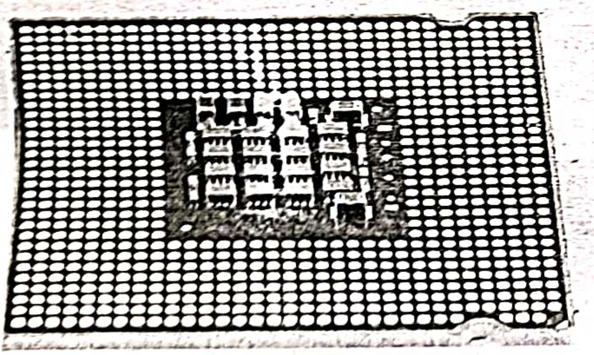
Q4. What is LGA?

Ans. The LGA package makes the second level interconnect (from package to motherboard) with a array of solderable surfaces. This may consist of a layout similar to a BGA with no solder spheres. However, it may also have an arbitrary arrangement of solderable surfaces that typically include large planes for grounding or thermal dissipation, smaller lands for signals or shielding grounds, and, in some cases, mechanical reinforcement features for mechanical durability. Freescale has introduced the LGA package using a high coefficient of thermal expansion (HCTE) ceramic in larger body sizes. Figure 1 shows the top and bottom sides of an LGA device. HCTE LGA and HCTE BGA packages use the identical substrate, high-lead electroplate bumps, die attach procedure, including underfill material, and allow for the same recommended CBGA board assembly process (See Freescale CBGA Customer Presentation). Products from the same line have the same moisture sensitivity level (MSL) and maximum allowable peak reflow temperature regardless of whether it is LGA or BGA.

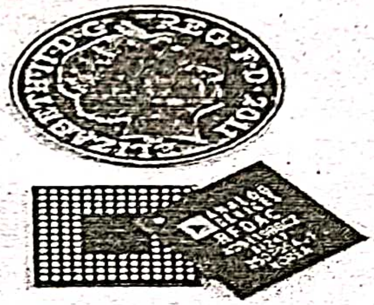
Freescale's product portfolio also includes LGA packages with organic laminate substrates. These may feature High Density Interconnect (HDI) substrates or Bismaleimide Triazine (BT) substrates. In some cases an array of joints similar to the BGA may be presented. More often, the lands are square, rectangular, or irregular, as seen in these illustrations of the 34 I/O RF Power Amplifier Module.

Q5. Explain Ball Grid Array, BGA and its uses.

Ans.



The Ball Grid Array has become increasingly popular for SMD ICs that require high density connections. Using the under-side of the IC package rather than connections around the edge, this enables connection density of be reduced, simplifying PCB layout. The main problem with using SMD BGA IC packages is that using the under-side of the chip means that direct access to the connections is not possible, making soldering, de-soldering and inspection more difficult. However with mainline PCB production equipment, these issues are easy to overcome and the overall reliability and performance can be improved.



BGA usage : There have rationale for the introduction and use of the ball grid arraye, BGA is quite straightforward as there had been issues with other technologies. The conventional quad flat pack style packages had very thin and very closely spaced pins. This configuration gives rise to a number of difficulties.

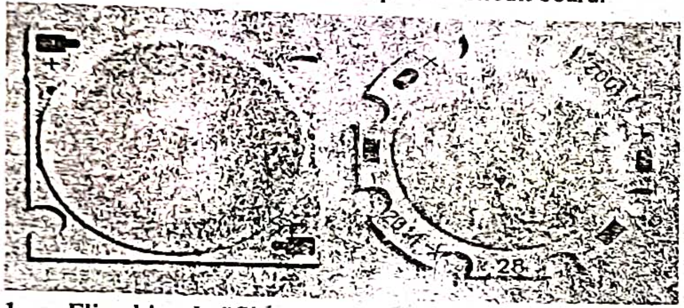
1. ***Damage:*** The pins on QFPs are naturally very thin and their spacing means that their position needs to be controlled very closely. Any mishandling can lead to them being displaced and when this happens they are almost impossible to restore. ICs using high pin counts tend to be very expensive, so this can become a major issue.
2. ***Pin density:*** From a design viewpoint, the pin density was such that, taking the tracks away from the IC also proved to be problematic as there could be congestion in some areas. Soldering process In view of the very close spacing of the QFP pins, very careful control of the soldering process is required otherwise contacts can be easily bridged.

The BGA package was developed to overcome these problems, and improve reliability from the soldered joints. As a result the BGA is widely used and processes and equipment have been developed to overcome the problems with their use.

Q6. Describe the constructional parts of Chip on board (COB) and its uses.

Ans. Chip on board (COB) is a method of circuit board manufacturing in which the integrated circuits (e.g. microprocessors) are attached (wired, bonded directly) to a printed circuit board, and covered by a blob of epoxy. By eliminating the packaging of individual semiconductor devices, the completed product can be more compact, lighter, and less costly. In some cases, COB construction improves the operation of radio frequency systems by reducing the inductance and capacitance of integrated circuit leads.COB effectively merges two levels of electronic packaging: level 1 (components) and level 2 (wiring boards), and may be referred to as "level 1.5".

Construction : A finished semiconductor wafer is cut into dies. Each die is then physically bonded to the PCB. Three different methods are used to connect the terminal pads of the integrated circuit (or other semiconductor device) with the conductive traces of the printed circuit board.



1. **Flip chip :** In "flip chip on board", the device is inverted, with the top layer of metallization facing the circuit board. Small balls of solder are placed on the circuit board traces where connections to the chip are required. The chip and board are passed through a reflow soldering process to make the electrical connections.
2. **Wire bonding :** In "wire bonding", the chip is attached to the board with an adhesive. Each pad on the device is connected with a fine wire lead that is welded to the pad and to the circuit board. This is similar to the way that an integrated circuit is connected to its lead frame, but instead the chip is wire-bonded directly to the circuit board.
3. **Flexible circuit board :** Main articles: Flexible electronics and Flexible circuit .In "tape-automated bonding", thin flat metal tape leads are attached to the semiconductor device pads, then welded to the printed circuit board.

In all cases, the chip and connections are covered with an encapsulant to reduce entry of moisture or corrosive gases to the chip, to protect the wire bonds or tape leads from physical damage, and to help dissipate heat. The printed circuit board substrate may be assembled into the final product, for example, as in a pocket calculator, or, in the case of a multi-chip module, the module may be inserted in a socket or otherwise attached to yet another circuit board. The substrate wiring board may include heat-dissipating layers where the mounted devices handle significant power, such as in LED lighting or power semiconductors. Or, the substrate may have low-loss properties required at microwave radio frequencies.

Uses :

1. LED Flood lamp for exterior use containing a COB LED
2. PCB with glop-top COB Chips on board is widely used in electronics and computing, identifiable by "glop tops" often made of epoxy.

Q7. Write short notes on :

1. Flatpacks

2.Quad Packs

1. **Flatpacks :** Flatpack is a US military standardized printed-circuit-board surface-mount-component package. The military standard MIL-STD-1835C defines: Flat package (FP). A rectangular or square package with leads parallel to base plane attached on two opposing sides of the package periphery. The standard further defines different types with varying parameters which includes package body material, terminal location, package outline, lead form and terminal count.

The main vehicle for testing of high reliability flatpack packages has been MIL-PRF-38534 (General Specification for Hybrid Microcircuits). This document outlines the general requirements of fully assembled devices, whether they are single chip, multichip, or of hybrid technology. The test procedures of these requirements are found in MIL-STD-883 (Test Methods and Procedures for Microelectronics) as a listing of test methods. These methods cover various aspects of the minimum requirements that a microelectronics device must be able to attain before it is considered a compliant device.

2. **Quad Packs :** A quad flat package (QFP) is a surface-mounted integrated circuit package with "gull wing" leads extending from each of the four sides. Socketing such packages is rare and through-hole mounting is not possible.

Versions ranging from 32 to 304 pins with a pitch ranging from 0.4 to 1.0 mm are common. Other special variants include low-profile QFP (LQFP) and thin QFP (TQFP). The QFP component package type became common in Europe and United States during the early nineties, even though it has been used in Japanese consumer electronics since the seventies. It is often mixed with hole mounted, and sometimes socketed, components on the same printed circuit board (PCB). A package related to QFP is plastic leaded chip carrier (PLCC) which is similar but has pins with larger pitch, 1.27 mm (or 1/20 inch), curved up underneath a thicker body to simplify socketing (soldering is also possible). It is commonly used for NOR flash memories and other programmable components.

Q8. Explain Electron beam current in high power cylindrical diode.

Ans. Intense electron beam generation studies were carried out in high power cylindrical diode to investigate the effect of the accelerating gap and diode voltage on the electron beam current. The diode voltage has been varied from 130 to 356 kV, whereas the current density has been varied from 87 to 391 A/cm2 with 100 ns pulse duration. The experimentally obtained electron beam current in the cylindrical diode has been compared with the Langmuir–Blodgett law. It was found that the diode current can be explained by a model of anode and cathode plasma expanding toward each other. However, the diode voltage and current do not follow the bipolar space-charge limited flow model. It was also found that initially only a part of the cathode take part in the emission process. The plasma expands at 4.2 cm/ μs for 1.7 cm anode-cathode gap and the plasma velocity decreases for smaller gaps. The electrode plasma expansion velocity of the cylindrical diode is much smaller as compared with the planar diode for the same accelerating gap and diode voltage. Therefore. much higher voltage can be obtained for the cylindrical diodes as compared with the planar diodes for the same accelerating gap.

Q9. Describe the SMD (Surface Mounted Devices) repairs also write its advantages as well as limitations.

Ans. At earlier eighties began a trend to replace a traditional through - hole technique with the surface mounted technology (SMT) using surface mounted devices (SMD). The SMT, although intended in principle for automatic manufacturing only expand more and more, even into a hobby world. This trend will continue, because many new components are available in SMD versions only. The SMT technique opens advantages and new applications through miniaturising of the components and increasing of reliability. The industry standard unfortunately allows that most of the SMD components does not have a clear description. Since a tiny size of the components they are labelled with a code. Therefore a sure identification of the components is impossible without appropriate technical documentation. Moreover the polarity and pin - outs of different components could be not identified without data sheets. Since all of this factors is SMD for beginners a very hard job. This brochure brings a help and clearance for a newcomer and moreover should help a service technician to start a repair of the instruments made with the SMD components. It presents most of the SMD components available at the 1998 end with pin-outs and encoding comparison tables: SMD / classic and classic / SMD. The SMD does not present a "new technique", it is only a miniaturisation of the components. But this components requires a different processing technology. Surface mounted devices (SMD) are active and passive electronics components without conventional connecting wires.

ADVANTAGES:

1. PCBs area much smaller then 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 bounding and cutting of the wires.
4. Automatic assembling very easy. Low cost of the assembling.
5. For great series low manufacturing cost.

LIMITATIONS :

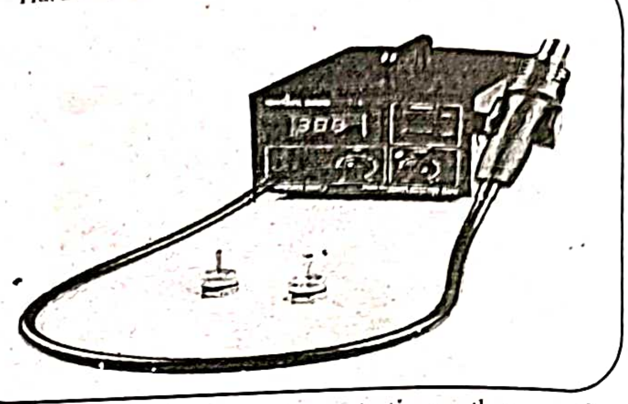
1. Using ICs with a high amount of the pins (raster 0.5 to 1.27 mm, max. 148 pins) makes placing of the paths between IC pins impossible.
2. Design of SMD layout is very complex. Distances between soldering pads are fix. Dimensions and distances between paths depends from soldering technology used by manufacturer.
3. High packing density brings thermal problems. Power dissipation of the power components is transferred directly through a copper layer of the PCB. The high temperature of the layer influence a neighbour components.
4. Lack of the general SMD normalisation.
5. Repair is more complex and difficult than by the conventional components.

Q10. Explain rework and use of a hot air rework station with the help of proper diagrams.

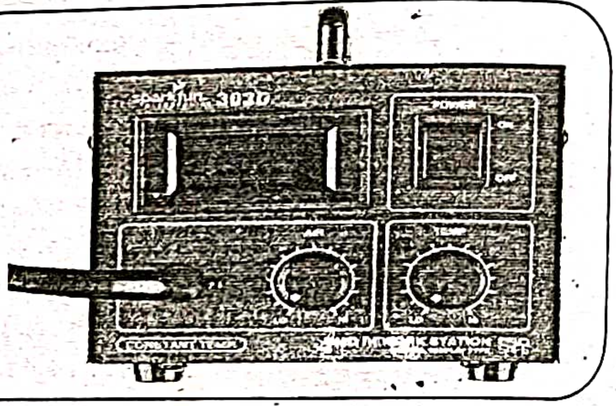
Ans. ***Rework :*** Rework (or re-work) is the term for the refinishing operation or repair of an electronic printed circuit board (PCB) assembly, usually involving desoldering and re-soldering of surface-mounted electronic components (SMD). Mass processing techniques are not applicable to single device repair or replacement, and specialized manual techniques by expert personnel using appropriate equipment are required to replace defective components; area array packages such as ball grid array (BGA) devices particularly require expertise and appropriate tools. A hot air gun or hot air station is used to heat devices and melt solder, and specialised tools are used to pick up and position often tiny components.

Use of a Hot Air Rework Station : Hot-air stations or heat guns are very useful tools and are essential for any electronics workbench. When working with or building printed circuit boards, there is a lot of room for errors to be made. Whether you're relying on machines to do the building for you or building by hand, solder can often have a mind of its own. Sometimes the person doing the building (or the person programming the machine that does the building) can make a mistake. Other times, the solder or components on the PCB can react in ways that are not desirable during reflow. Have no fear though, there are ways to remedy this! The SparkFun hot-air rework station - 303D is one such solution.

Hardware Overview

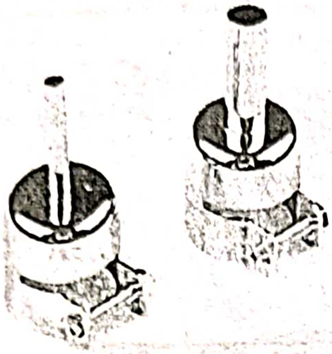


Let's take a look at the features starting on the upper right side of the 303D hot air rework station.

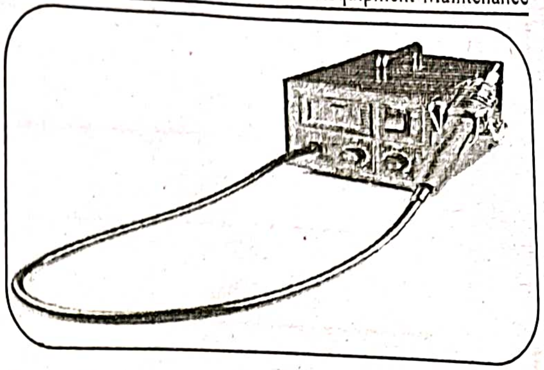


1. **Power Switch** -- The 303D uses a standard North American plug/outlet (~110VAC). Hopefully the power on/off switch is self-explanatory. Move the switch to "ON" to turn the hot-air rework station on, move the switch to "OFF" to turn the hot-air rework station off. Easy peasy.The device will not power off immediately after turning the switch to the "OFF" position. It will continue to blow air until the air temperature is below 100°C.
2. **LED Digital Output** -- The LED digital output lists both your temperature range as well as your air flow. The display will change as you turn either the air or temperature knobs.
3. **Temperature Range** -- Output temperatures range from 100°~480° Celsius. You can adjust the working temperature by turning the temperature setting knob. The LED output will display the setting temperature for 3 seconds and then return to the actual air temperature of the nozzle. The indicator in the temperature box will twinkle when the desired temperature is reached.

4. **Nozzles** -- The 303D comes with 2x changeable hot-air nozzles. The smaller nozzle is good for focusing the hot air on smaller components. The bigger nozzle is great if you are trying to focus hot air around a big area on the board.



Wand Holder -- The unit comes with a wand holder for the hot air gun. It can be attached on either side of the hot air rework station.



Uses :

1. Salvaging electronic components from old PCBs.
2. Reflowing solder paste applied with a stencil between SMD components and a PCB.
3. Shrinking heat-shrink to secure wire connections.
4. Heating up and bending certain plastics (with the correct settings).
5. Heating up hot glue to remove or reposition items that were glued incorrectly.